An investigation of reading abilities and the impact of programmed instruction on reading outcomes in children with autism spectrum disorder

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An Investigation of Reading Abilities and the Impact of Programmed Instruction on Reading Outcomes in Children with Autism Spectrum Disorder

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Dissertation submitted in partial fulfilment of the requirements for the Degree of Doctor in Philosophy in Applied Behaviour Analysis

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Declaration and Statements

DECLARATION
This work has not been previously accepted in substance for any degree, and is not being concurrently submitted in candidature for any degree.

Signed........................................................................... (candidate)

Date..............................................................................

STATEMENT 1
This thesis is the result of my own investigations, except where otherwise stated. Where correction services have been used, the extent and nature of the correction is clearly marked in a footnote(s). Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

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Date..............................................................................

STATEMENT 2
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Date..............................................................................
Abstract

This thesis investigates reading abilities and programmed instruction, i.e., instruction that is scripted and sequenced, with explicit learning goals, based on the principles of Applied Behaviour Analysis, in children with autism spectrum disorder (ASD). The purpose of this work was to examine the levels of reading abilities in children with ASD and to ascertain reading outcomes following programmed instruction (i.e., Edmark®; Headsprout®). Furthermore, the studies aimed to investigate the impact of curriculum delivery, more specifically, programmed instruction with parent as facilitators and computer-assisted delivery versus print-based formats on standardised and direct reading outcomes. Additional investigations were conducted to identify accommodations/supports necessary throughout the delivery of such programmed reading instruction.

An online survey was administered to educators of children with ASD in Chapter 2 to gain information regarding reading instruction in schools and services across Ireland. There were a total of 60 respondents. Results indicated that standardised reading assessments were often not taken within educational settings among children with ASD. Additionally, there was little use of computer-assisted instruction (CAI) and reading curricula were not selected based on empirical evidence of efficacy.

Chapter 3 examined the reading performance of a nationally representative sample of 110 children with ASD. The sample was divided into two groups by age; under six years (Group 1) and over six years (Group 2). Core reading components were assessed, which included; word reading, comprehension, phonological awareness, reading rate, vocabulary, accuracy and non-word reading across both groups. Language abilities and autism symptom severity were also assessed to
examine possible correlations with reading skills. The data demonstrated impaired reading skills across all reading components in both groups, with the exception of word reading pre-requisites for Group 1 and reading rate for Group 2. In an analysis of the full sample, many participants performed within the lowest possible range (standard score ≤55) on standardised tests of reading in particular, reading comprehension (82%) and phonological awareness (62%). The largest relationship with language skills was in vocabulary and non-word reading and there were large negative correlations between ASD severity and word reading and non-word reading.

A between-group design was used to investigate the Edmark® Reading Program (ERP) among children with ASD in Chapter 4. In school settings, ERP was compared on reading outcomes using the presentations of table-top instruction (TTI) and computerised-assisted instruction (CAI). Thirty-one participants were assigned to each condition using cluster random sampling. There were statistically significant differences found in favour of TTI on reading accuracy, reading rate, and phonemic awareness, specifically first sound fluency between conditions at post-testing.

A between-group design was used to evaluate Headsprout® on the reading outcomes and print motivation of a sample of 26 children with ASD in Chapter 5. Headsprout® was implemented at home by parents who received training on the identification of learning difficulties, whereby additional support was provided to participants based on these specific learning problems. Results demonstrated that participants who received Headsprout® showed overall greater gains, more specifically in phonological awareness and in the target sound and words of Headsprout®. The results of print motivation demonstrated that only the print material specific to the program had an increase in preference at post-tests. Findings
indicate that this reading program can be successfully implemented with children with ASD by parents in the home environment, with the addition of adaptations and learning support.
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<td>ABA:</td>
<td>Applied Behaviour Analysis</td>
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<td>ABIQ:</td>
<td>Abbreviated Intelligence Quotient</td>
</tr>
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<td>ASD:</td>
<td>Autism Spectrum Disorder</td>
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<td>BIAP:</td>
<td>Belfield Infant Assessment Profile</td>
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<td>BST:</td>
<td>Behaviour Skills Training</td>
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<tr>
<td>CAI:</td>
<td>Computer Assisted Instruction</td>
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<td>CBM:</td>
<td>Curriculum-Based Measurement</td>
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<td>DES:</td>
<td>Department of Education and Science</td>
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<td>DIBELS:</td>
<td>Dynamic Indicators of Basic Early Literacy Skills</td>
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<td>DSM:</td>
<td>Diagnostic and Statistical Manual of Mental Disorders</td>
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<tr>
<td>D-TEL:</td>
<td>Drumcondra Test of Early Literacy</td>
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<td>DTT:</td>
<td>Discrete Trial Training</td>
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<td>EF:</td>
<td>Executive Functioning</td>
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<td>ERP:</td>
<td>Edmark® Reading Programme</td>
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<tr>
<td>EOWPVT:</td>
<td>Expressive One Word Picture Vocabulary Test</td>
</tr>
<tr>
<td>EPSEN:</td>
<td>Education for Persons with Special Needs</td>
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<td>FR:</td>
<td>Fixed Ratio</td>
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<td>FSF:</td>
<td>First Sound Fluency</td>
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<td>HER:</td>
<td>Headsprout® Early Reading</td>
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<td>HFA:</td>
<td>High Functioning Autism</td>
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<td>HRC:</td>
<td>Headsprout® Reading Comprehension</td>
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<tr>
<td>IAI:</td>
<td>IPad® Assisted Instruction</td>
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<tr>
<td>IDEA:</td>
<td>Individual with Disabilities Education Act</td>
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<tr>
<td>IQ:</td>
<td>Intelligence Quotient</td>
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<tr>
<td>MANCOVA:</td>
<td>Multivariate Analysis of Covariance</td>
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<td>MICRA-T:</td>
<td>Mary Immaculate Reading Attainment Test</td>
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<td>NARA:</td>
<td>Neale Analysis of Reading Ability</td>
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<td>NCSE:</td>
<td>National Council for Special Education</td>
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<td>National Reading Panel</td>
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<td>PA:</td>
<td>Phonemic Awareness</td>
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<td>PI:</td>
<td>Principal Investigator</td>
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<td>PSF:</td>
<td>Phoneme Segmentation Fluency</td>
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<td>SB5:</td>
<td>Stanford Binet Intelligence Scales-Fifth Edition</td>
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SCQ: Social Communication Questionnaire
TDI: Teacher-Delivered Instruction
ToM: Theory of Mind
TTI: Table-Top Instruction
WIAT: Wechsler Individual Achievement Test
WCC: Weak Central Coherence
Conference Presentations and Manuscripts in Preparation

Published Manuscripts

Manuscripts in Preparation
Nally, A., Holloway, J., Lydon, H., Healy, O. The Edmark® Reading Programme: A Comparison of Computerized and Table Top Presentation in Reading Outcomes in Children with Autism Spectrum Disorder.


Conference Presentations


Chapter 1:

Literature Review
1.1 Long term Impact of Reading Ability in Children

Reading is a multifaceted skill, resulting in the ability to translate printed symbols into a construct of meaning (comprehension). It is a complex behaviour which involves the ability to match vocal sounds to words, see and say printed symbols, and listen to what one speaks/reads, (i.e., stimulus equivalence; Sidman, 1986). In the alphabetic system (visual representation of text), individual letters are abstract and meaningless, and must be linked to sounds called phonemes, blended together and pronounced as words, at which point meaning is applied (Lyon, 1997). This translation from printed words into meaningful constructs, results in reading comprehension in typically developing individuals.

The ability to read is a necessity for social and economic development (Snow, Burns & Griffin, 1998) and can be arguably the most important outcome of a child’s education. It is a pivotal skill as it exposes the individual to new experiences and opportunities, and is the starting point for the individual to transition to independent learning. Everyday environments are filled with print; therefore, it is a fundamental self-sufficiency skill, for example; reading directions on how to do things, shopping lists, ingredients needed to make meals, or warning labels on foods and medications.

Fluent reading abilities have been described as ‘behaviour cusps’, by Baer & Rosales-Ruiz (1997). These cusps are behaviours that have significant and far reaching implications for further learning and development. They mark changes in the person-environment interactions that enable new interactions (Greer & Ross, 2008). Reading is a behavioural cusp as, once mastered, and provides the learner with access to curricula in primary, secondary and third level education, which in turn paves the way for independent and economic opportunities (Greer & Ross,
Reading fluency has been described as the rate at which readers accurately recognise individual words within a connected text (Burns et al., 2010) and consists of speed, accuracy and proper expression or prosody (Schwanenflugel, Westmoreland & Benjamin, 2013; Silber & Martens, 2010). Fluent readers can also follow directions to use the internet, which in turn, facilitates purchasing of various resources and engaging in different activities e.g., online shopping, travel, concert tickets etc., as well as access to limitless e-learning opportunities (learning conducted via the internet).

It is evident that without the ability to read or with reading deficits, opportunities for independent living and job opportunities will be reduced. In addition, poor reading skills have been linked to the development or exacerbation of associated behaviour and/or emotional problems, including aggressive behaviour, hyperactive behaviour, patterns of poor effort, poor self-concept, and school dropout (Rock, Fessler & Church, 1997). Throughout education, as children progress through higher classes or grades, curricular expectations are continuously evolving (Kennedy & Deshler, 2010). However, lessons and content delivered via print remains a constant, with the only change being in the demands and complexities of the content and vocabulary. Therefore, accessing learning materials independently, through reading, is the definitive educational goal, spanning academic disciplines and translating into meaningful personal, social, and economic outcomes for individuals (Good, Simmons & Smith, 1998).

1.2 Reading Development

The most crucial period for reading development is in early childhood (Neuman, Copple & Bredekamp, 2000). Neurotypical children, as young as two years of age, demonstrate emergent or pre-reading behaviours. These emergent
reading behaviours include print awareness (i.e., the identification that letters and words have meaning), oral language skills (e.g., recite rhymes and letters) and print conventions (knowledge of book orientation, turning pages of a book; Davidson & Weismer, 2013).

1.2.1 Learning to Read Words

Skilled readers read familiar words with ease due to previous exposure and histories with the words. However, ahead of becoming skilled in reading, it is important to explore the development of reading abilities. There are four different way to read words: sight reading, decoding (the application of phonics to individual letters of a word), by analogy to known words and via prediction from context. The latter three methods are primarily used for unfamiliar words (Cain, 2010). Conversely, sight-reading is used for familiar words and the reading of whole-words where, based on their individual letter pattern (orthography), they are read automatically from memory. The automatic and relatively effortless process of sight reading is how skilled adults read the majority of words (Ehri, 1992) and occurs when a direct connection between the visual form of the word and its meaning have been established.

When learning to read via phonics-based instruction, children must learn the connections between the 44 sounds (phonemes) in spoken English and the 26 letters of the alphabet. Children identify the phoneme related to each individual letter, or letter cluster (grapheme), which is known as decoding and then blend the sounds together to form words. To read by analogy, children learn to use information from similarly spelled words in their repertoire in order to pronounce unfamiliar words, for example, using the knowledge of the word ‘green’ to pronounce ‘screen’. Finally, to read unfamiliar words via prediction from context, children use contextual
support, i.e., the application of other information within the text to supplement a connection to the word. This includes memory about the topic of the reading stimuli and memory about the text previously read. Make a comment on how these are traditionally taught.

1.2.2 Stages of Reading Development

According to Ehri’s (1995) model for the development of word reading, there are four phases of reading development: the pre-alphabetic, the partial alphabetic, the full alphabetic and the consolidation alphabetic phase. Each phase is associated with different types of connections between the written and spoken words that they represent. The first phase, the pre-alphabetic phase, is where children have little or no reading skill, but may still appear to ‘read’ words because they have learned to associate selected visual cues with particular words, for example, logos and signs found in the everyday environment. They may also appear to ‘read’ a complete story that they have memorised from repeated readings with a parent or caregiver, from the build-up of associations between the written and spoken language (Cain, 2010).

The partial alphabetic phase of reading is said to have developed when children have learned some letter names, or letter sounds, and can use this knowledge to read words. However, errors are still common in this phase, meaning children can easily mistake the word ‘hat’ and ‘hut’ as the two words share common letters and sounds. The next stage of word reading development is referred to as the full alphabetic knowledge phase, whereby the connections between letters and their spoken sounds are established (Cain, 2010). Children in this stage start to acquire a sight word repertoire (words that they have encountered on several occasions), which are stored in memory and can be accessed without letter-sound applications. The final phase is the consolidation alphabetic phase. In this phase, children can read words by
prediction from context, by decoding, by analogy and most importantly by sight. Sight reading is a sign of skilled reading and enables fast and efficient access to the pronunciation and meaning of printed words (Cain, 2010).

1.3 Component Reading Skills

In order to programme for effective reading instruction and to understand reading difficulties, which may arise, it is important to recognise and identify component reading skills necessary to become a proficient and independent reader. In 2000, The National Reading Panel (NRP) was set up to determine the most effective approaches for teaching children to read. It concluded that a combination of reading components including: phonemic awareness, phonics, fluency, vocabulary and reading comprehension are necessary in order to teach children to read.

1.3.1 Phonemic Awareness

Phonemes are the smallest unit of spoken language which combine to form syllables and words. Phonemic awareness (PA) refers to the ability to focus on and manipulate phonemes in spoken words. Correlational studies have identified both PA and letter knowledge as the best school-entry predictors of how well children will learn to read during their first two years in school (NRP, 2000), highlighting the importance of PA instruction for children. The NRP (2000) provided a clear distinction between PA and phonics instruction, as the latter entails teaching children how to use grapheme (written letter clusters) and phoneme correspondence to decode or to spell a word. Therefore, phonics instruction focuses on teaching sound-spelling relationships associated with print whereas PA involves sounds in spoken words and tasks are mostly oral in nature.
1.3.2 Phonics

An essential part of the process for beginning readers involves learning about the alphabetic principal, that is, letter-sound correspondences and spelling patterns (NRP, 2000). Systematic phonics is the most common instructional method used to teach these skills and is the primary method embedded into many phonics-based reading curricula, for example, Jolly Phonics® (Lloyd & Wernham, 2000), Reading Mastery® (Engelmann, 1983; 1995; 2008) and Headsprout® (Layng, Twyman, & Strikeleather, 2003). Systematic phonics instruction is a way of teaching reading that places emphasis of the acquisition of letter-sound correspondences and their applications to read and spell words (Harris & Hodges, 1995). The goal in all phonics programmes is to enable children to acquire sufficient knowledge of the alphabetic code so that they can progress in reading as well as for comprehension of text. Instructing children in phonics is important, because it allows children to decode and spell approximately 98% of the words in the English language (Eide, 2011). As children learn to sound out words they have never encountered, they become independent textual responders (Geer & Ross, 2008).

1.3.3 Reading Fluency

Fluency is an important component of skilled reading, without which, would result in laboured decoding which would ultimately lead to a loss in reading comprehension. Fluency depends upon well-developed word recognition abilities, and can be defined as reading a text with speed, accuracy and expression (NRP, 2000). Snow, Burns and Griffin (1998) noted that to obtain meaning from print, the development of word recognition accuracy and reading fluency are important skills and so, both should be regularly assessed. Reading fluency is often neglected in teaching environments, however more and more research is highlighting it as a
priori ty component in effective reading protocols and interventions (e.g., Kuhn & Stahl, 2000; Rasinski & Hoffman, 2003).

1.3.4 Vocabulary

Although children continuously learn new words from many sources, knowledge of vocabulary continues to be an important component for the successful reading. Receptive vocabulary is the vocabulary one can understand when it is presented in text or as one listens to others speak, while expressive vocabulary is the vocabulary used in communication (writing or when speaking) with others. It is generally believed that receptive vocabulary is much larger than expressive vocabulary (NRP, 2000). Vocabulary (i.e., receptive and expressive vocabulary) is another critical skill for successful reading.

Beginning readers must use the words they hear receptively to make sense of the words they see in print. Skinner’s account of verbal behaviour (1957) highlights the importance of vocabulary to reading development, as the reader is responding as if the print were a speaker providing directions. Consequently, the child must have the listener abilities for the particular words they read otherwise the sounds are simply nonsense (Greer, Chavez-Brown, Nirgudkar, Stolfi & Rivera-Valdes, 2005). Research suggests that vocabulary knowledge is strongly associated with the development of reading skills, in particular comprehension (see, for example, Beck, Perfetti, & McKeown, 1982; Tannenbaum, Torgesen, & Wagner, 2006).

1.3.5 Reading Comprehension

Reading comprehension is the pivotal goal of reading instruction and is the cornerstone of life-long learning. However, it is one of the most complex reading components and is highly interlinked with the previously outlined reading skills. Teaching children to comprehend text, whether they are typical or atypical learners,
is a difficult task. Children must be able to access prior knowledge, organise and summarise information appropriately, and understand social and emotional situations within stories (El Zein, Solis & Vaughn, 2014; Williamsons, Carnahan & Jacobs, 2009). The empirical evidence from strategies to teach reading comprehension (Rosenshine, Meister & Chapman, 1996) indicates that teaching a variety of reading comprehension strategies leads to increased understanding of text. Subsequent to the reading of a target text, some of these strategies are as follows; questioning answering, summary of main idea, question generation and making inferences based on in-text information. The NRP (2000) found that although there has been considerable success in teaching a variety of effective reading comprehension strategies, the most promising lines of research with reading comprehension strategies focused on teacher’s preparation to teach comprehension. Therefore a great focus of applied research should focus on teachers and teaching skills in selection and implementation of evidence based curricula targeting reading comprehension strategies.

1.4 Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a complex neurodevelopmental disorder, which presents with multifaceted challenges to learning. In 2013, the DSM-IV-TR (American Psychiatric Association, 2000) was revised and replaced with the DSM-5 (American Psychiatric Association, 2013). Under the DSM-5, a dimensional approach to the diagnostic criteria was employed. This meant that autism spectrum disorder (ASD) was now an umbrella term, and individuals with a previous diagnosis of autism, Asperger’s syndrome, and PDD-NOS now fall under this broader diagnostic category. To facilitate this change, the DSM-5 refined ASD as a neurodevelopmental disorder characterised by a dyad of impairments that
include persistent deficits in social communication and interaction, and the presence of highly repetitive and stereotyped patterns of behaviour or interest. The DSM-5 recommends the use of “specifiers” to note the severity of additional symptoms, language and intellectual ability, onset age, and genetic/medical or environmental/acquired conditions (Lai et al., 2013). Within the present thesis, participants’ ASD diagnosis predated the introduction of the DSM-5; therefore, the DSM-IV-TR criteria were used in reference to diagnoses.

Even with the changes in diagnostic criteria between the two versions of the DSM, it still stands that the needs and abilities of children with ASD are complex. ASD has been a focus of considerable research over the last number of years, as well as a growing awareness of the condition among professionals, the public, and an overall increase in prevalence (Parsons et al., 2009). The Centres for Disease Control and Prevention (2014) estimated that in the U.S, 1 in 68 children has been identified with ASD, with diagnoses more common among boys (1 in 42) than girls (1 in 189). Similar prevalence rates have recently been reported in Ireland, with approximately 1% of Irish children thought to have ASD (Boilson, Staines, Ramirez, Posada & Sweeney, 2016).

Further to the increasing frequency in children with ASD diagnoses, is a high comorbidity of an ASD diagnosis with other disorders. Co-morbidity (the occurrence of two or more disorders in the same person; Matson, Nebel-Schwalm, 2007). Simonoff et al. (2008) found that 70% of children had at least one comorbid disorder and 41% had two or more. It is important that there is an understanding of the types of comorbid disorders that affect those with ASD among both practitioners and researchers and their relative impact on reading abilities. In order to implement
the most effective intervention plans for those with ASD, comorbid conditions should be considered.

Although ASD diagnoses have increased significantly in recent years, it still remains unclear if this is due to an actual increase in the prevalence of ASD, to increased awareness amongst teachers, parents, psychologists, and medical professionals, or due to the broadened diagnostic criteria in the DSM-5 (Shattuck, 2006). Nevertheless, this increase places demands on educational settings, as children with sufficient language and cognitive skills are often placed in general education or mainstream classrooms with teachers who have minimal knowledge of ASD, supported by paraprofessionals with little training (Kittle, 2013; Lanter & Watson, 2008).

The clinical presentation of ASD may change between individuals and changes markedly over the course of development, with a tendency towards improved adaptation (Frith, Morton & Leslie, 1991). Nevertheless, the underlying cognitive disorder (and by implication, brain abnormality) appears to remain throughout life. In relation to biological development of performances in ASD, it may be linked to dysfunctional integration of the frontal lobes with the rest of the brain, abnormal developments in neuronal sophistication. Findings of transient delayed postnatal maturation of the frontal lobes in autism (Zilbovicius, Garreau, Samson & Remy, 1995) and reduced functional connectivity of frontal cortex with other cortical and subcortical regions (Luna et al., 2002) support this view. The failure of the frontal lobes to follow a normal maturational pattern is likely to have long-term consequences for all development which inevitably impacts the development of reading abilities. As a result, there is a need for increased knowledge on the disorder with regards its manifestation, learning profiles and
abilities, as well as a necessity for research into effective instruction in teaching basic academic skills.

1.5 Theoretical Frameworks for Comprehension Difficulties in ASD

The relatively consistent pattern of weak reading comprehension in children with ASD has been purported by four theoretical frameworks. The first of which is the Simple View of Reading (Hoover & Gough, 1990), which details a structure of reading comprehension. The other three frameworks are related to dysfunction in the following cognitive areas; Weak Central Coherence (WCC), Theory of Mind (ToM) and Executive Functioning (EF). The Simple View of Reading (Hoover & Gough, 1990) postulates that reading comprehension is the product of decoding and language comprehension (the ability to understand spoken language). Many researchers have used this framework in order to understand reading abilities in children with ASD (e.g., Nation et al., 2006; Norbury & Nation, 2011; Ricketts, et al., 2013), and to highlight that reading comprehension challenges may be due to poor language comprehension, poor word decoding or difficulties with both (Solari et al., 2017).

With regards to children with ASD, cognitive processing may also be of importance to the development of reading comprehension. According to the WCC theory, children with ASD have difficulty summarising salient points and understanding main ideas (Happè, 2005; Williamson et al., 2009). Thus, in the context of reading, many individuals with ASD may hyper-focus on small, and insignificant details, rather than on the “bigger picture”, challenging their ability to comprehend and store important information. As a result, those with WCC challenges may be able to decode words or understand specific vocabulary, but understanding concepts at the paragraph and text level may pose problems.
The ToM hypothesis states that weaknesses in ToM underlie the social and communication impairments that characterises ASD (Baron-Cohen, 1989). More specifically, ToM contributes to understanding the challenges of reading comprehension for children with ASD as they may lack the ability to “perspective-take” (i.e., perceive a concept from another’s point of view), or the understanding of the emotional state of characters in stories, as well as make predictions about characters actions (Carnahan & Williamson, 2010; Williamson et al., 2009). Finally, the dysfunction in EF theory (Pennington et al., 2010) suggests that individuals with ASD have differences in the frontal lobe activity of the brain, which results in difficulties in planning, self-monitoring, and flexibility (Hill, 2004). Specifically in the context of reading, EF dysfunction may influence the ability to monitor understanding of the text, and integrate or make connections between information across paragraphs, texts, or experiences (Carnahan & Williamson, 2010; Carnahan et al., 2011). Collectively, these three theories may posit difficulties with regard text in terms of organising, connecting and monitoring the context of text which are important factors for successful reading comprehension (El Zein, et al., 2014).

Williamson, Carnahan and Jacobs (2012) argued elsewhere that these three cognitive theories are useful inasmuch as they provide a starting point for conceptualising the link between cognition and reading comprehension in ASD (Carnahan & Williamson, 2010; Carnahan et al., 2011).
1.6 Reading Abilities and Autism Spectrum Disorder

Research has identified a pattern of variability across core impairments of ASD (impairments in social communication, and repetitive, stereotyped behaviours), which can often lead to an uneven developmental profile. This pattern of variability also appears to extend to reading abilities in children with ASD, as researchers have reported varied results in terms of reading abilities (Griswold, Barnhill, Smith-Myles & Simpson, 2002; Jones, et al., 2009; Mayes & Calhoun, 2006). Nation, Clarke, Wright and Williams, (2006) examined reading skills in 41 children, aged between 6-15 years with a diagnosis of ASD. Sixteen participants fulfilled the criteria for autism, 13 for atypical autism and 12 for Asperger’s syndrome. Results of this study suggest that considerable individuality exists with regard to reading ability. Levels of word reading, non-word reading and text accuracy fell within the average range; however, reading comprehension was shown to be significantly impaired. Sixty-five per cent of the sample obtained reading comprehension scores at least 1 standard deviation below neurotypical norms. Such findings suggest that a significant number of children with ASD encounter difficulties in reading comprehension, but also that reading skills present differently between and within individuals with ASD.

Similarly, recent research by McIntyre et al. (2017a) found that individuals with high-functioning autism (HFA) performed poorly on reading and language assessments as compared to their same-aged neurotypical and ADHD peers. Solari et al., (2017) investigated the role of text reading fluency in the prediction of reading comprehension in a sample of HFA (n = 68) and aged matched neurotypical children (n = 38). Significant differences were detected between the HFA and neurotypical samples on every reading measure, namely oral reading fluency, rapid automatic naming, phonemic decoding, reading comprehension, sight words and auditory
processing, favouring the neurotypical sample. It was found that text reading fluency significantly predicted reading comprehension. McIntyre et al. (2017b) noted the heterogeneous nature of reading abilities in children with HFA and significant differences between the reading abilities and ASD symptom severity.

Although the literature appears to be growing in the area of reading and school-aged children with ASD, much of the research is restricted to the participants primarily with HFA within average IQ ranges (Asberg et al., 2008; Jacobs & Richdale, 2013; McIntyre et al., 2017a; McIntyre et al., 2017b; Minshew et al., 1994; Nation et al., 2006; Solari et al., 2017) and relatively small sample sizes (minimum = 41; maximum = 81). This creates difficulties in generalising findings across the broader spectrum of ASD. Research has been relatively sparse in providing information on reading abilities of children with ASD with regards language and cognitive skills below the average range. In addition to restrictions in inclusion based on IQ, other studies require pre-requisite reading abilities in advance of analyses. For example, Frith and Snowling (1983) excluded participants who did not demonstrate reading skills at an age appropriate level. These exclusions may result in an over-estimation of reading ability within this population (Nation et al., 2006).

Minshew et al. (1994) investigated academic achievement in 54 children with high-functioning autism (HFA; IQ > 70) in comparison to neurotypical controls ($n = 41$). Decoding was consistent with a comparison group while there was a considerable discrepancy in reading comprehension. Such findings suggest that a significant number of children with ASD encounter difficulties in reading comprehension, but also further emphasises that reading skills present differently between and within children with ASD. Emerging research has investigated the factors that lead to difficulties in reading comprehension in children with ASD.
Jacobs and Richdale (2013) conducted an analysis of variables, which predicted reading in children with HFA and a comparative neurotypical group aged between 6–8 years with average IQ scores. They found that IQ, phonological skills and syntax (grammatical structure) predicted decoding and comprehension for children with HFA and their neurotypical peers. These may be critical elements that if underdeveloped may lead to comprehension difficulties in this population.

One of the most common reading profiles reported for children with ASD is that of advanced word reading or decoding abilities but poor reading comprehension (Frith & Snowling, 1983; O’Connor & Klein, 2004), with a number of studies demonstrating such associations (Huemer & Mann, 2000; Newman et al., 2007; O’Connor & Klein, 2004; Williams, Goldstein, & Minshew, 2006). This has been referred to as hyperlexia, which has been defined as the ability to recognise written words in advance of age and cognitive functioning (Richman & Kitchell, 1981; Silberberg & Silberberg, 1967). Previous research has demonstrated higher frequencies of hyperlexia among children with ASD relative to those with other disorders (e.g., Grigorenko et al., 2002). However, it is still unclear whether hyperlexia exemplifies the reading profile of children with ASD, especially given that a hyperlexic-like reading pattern may also occur in non-ASD children (Nation, Clarke, & Snowling, 2002; Snowling & Frith, 1986).

It is evident that children with ASD can demonstrate difficulties in reading ability. According to Nation et al. (2006), it is difficult to generalise studies reporting adequate levels of reading accuracy in children with ASD as samples were selected on the basis of cognitive ability or reading ability, therefore more research is warranted in relation to this reading profile. Furthermore, there is currently very little information on the heterogeneity of ASD that informs and advances
contemporary educational practices for school-aged children with ASD (Dingfelder & Mandell, 2011; Karasi & Smith, 2013; Machalicek et al., 2008; McIntyre et al. 2017).

1.6.1 Emergent Reading Abilities in ASD

Typically, reading research and formal reading instruction are limited to the school-age years, especially in relation to individuals with developmental delays such as ASD. However, more recently, research has begun to investigate emergent reading abilities in young children with ASD. Westerveld (2016) conducted a systematic review to investigate emergent reading abilities of preschool children with ASD on meaning and decoding skills. They found only three studies from 1998 to 2015 (Davidson & Weismer, 2014; Dynia, Lawton, Logan & Justice, 2014; Lanter et al., 2012). Results indicated that preschool-aged children with ASD tend to have comparable alphabet knowledge to their neurotypical peers; however, they lag behind in print-concept knowledge, vocabulary, and phonological awareness (Dynia et al., 2014). Secondly, although there seems to be a common profile of emergent reading ability for preschool children with ASD, subsets of children with ASD show patterns of heterogeneity of skills across emergent-reading abilities (Davidson & Weismer, 2014). Finally, the authors found that performances of preschool-aged children with ASD on measures of emergent reading abilities appeared to be related to deficits associated with ASD, such as language (Dynia et al., 2014; Lanter et al., 2012), cognition and social skills (Davidson & Weismer, 2014). Subsequent research has also indicated that preschool-aged children with ASD have similar rates of gains in alphabet knowledge and print-concept knowledge as their neurotypical peers (Dynia, Brock, Logan, Justice & Kaderavek, 2016). Furthermore, Dynia, Brock, Justice and Kaderavek (2017) analysed three emergent reading skills (i.e.,
alphabet knowledge, print-concept knowledge and phonological awareness) of 35 preschool-aged children with ASD in comparison to a group of 73 neurotypical peers. They found that phonological awareness was a statistically significant predictor of later decoding for children with ASD, and found no evidence that symptoms of ASD moderated the association between print-concept knowledge and decoding. Based on these findings, the development of emergent reading skills is of central importance to all children for future reading achievement. Therefore teachers should consider emergent-reading skills to be important learning targets for young children with ASD, just as they are for children without disabilities (Dynia et al., 2017).

1.6.2 Challenges with Reading and Children with ASD

Children with ASD face a number of challenges when learning to read, such as difficulties with attention, lack of motivation and problems with textually responding/decoding (Vacca, 2007). In addition, researchers have suggested that reading abilities are highly correlated with language skills (Bishop & Snowling, 2004; Catts & Kamhi, 2005). Since one of the core deficits associated with a diagnosis of ASD is a delay in language development, it is not surprising that associations between poor language skills and poor reading skills have been demonstrated (e.g., Bishop & Adams, 1990; Kjelgaard & Tager-Flusberg, 2001; Lucas & Norbury, 2014; Miniscalco & Sandberg, 2010). Therefore, this population may be at considerable risk of reading delays or difficulties. Other challenges in acquiring reading skills for children with ASD may be associated with difficulties integrating information in context (Hill & Frith, 2003) and deficits in phonological skills (Gabig, 2010), all of which are necessary for reading. Within neurotypical populations, decoding and comprehension skills develop simultaneously; however,
this may not be the case for children with developmental disorders (Nation & Norbury, 2005). According to Greer & Ross (2007), neurotypical children generally learn verbal functions through the efforts of their parents and textual responding (decoding) is a verbal function as outlined in Skinners Verbal Behaviour (1957). However, the presence of a disability, such as ASD, is likely to impact typical language development. Therefore, supplementary support using procedures, such as those made possible from the science of behaviour analysis, are often necessary.

At present, the status of academic achievement (levels of reading, writing, mathematics) for children with ASD in Ireland is unknown and unfortunately, research has shown that children with disabilities may be exempt from standardised measures to track achievement without appropriate alternative assessments (Cumming et al., 2013; Keen, Webster & Ridley, 2016). Furthermore, Dynia et al. (2014) noted that of particular concern, is the little understanding in how best prepare children with ASD in advancing reading skills. It is important to further increase our understanding of reading abilities within this population and expand on the current literature base in order to increase generalisability of findings and to support the development of reading skills for children with ASD.

1.7 Reading Perspectives in Applied Behaviour Analysis

Utilising the science of behaviour analysis provides a potential framework within which to select target behaviours for instruction and the evidence-based procedures necessary to teach these behaviours. Skinner’s (1957) seminal work on verbal behaviour provides a behaviour analytic framework from which to consider reading. In Verbal Behaviour, Skinner (1957) presented a theoretical account of the functions of language and identified six verbal functions, referred to as elementary verbal operants. From a behaviour analytic perspective, verbal repertoires that
children present with are referred to as instructional stages, rather than developmental stages (Greer, 2002). By this means, it is thereby clearer as to how to determine teaching operations, see Table 1.1 for a basic overview.

<table>
<thead>
<tr>
<th>Verbal repertoire</th>
<th>Effects on the environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-listener</td>
<td>Children without listener repertoires are entirely dependent on others to meet their needs. They do not have the skills to follow spoken instruction.</td>
</tr>
<tr>
<td>Listener</td>
<td>Children can respond to speaker instruction (e.g., sit down, point to car).</td>
</tr>
<tr>
<td>Speaker</td>
<td>When in the presence of a listener, can govern consequence with vocals, assistive communication, gestures, or equivalent.</td>
</tr>
<tr>
<td>Speaker as own listener</td>
<td>Children can function as listeners to their own verbal behaviour (e.g., first I do this, and then I do this). It functions as a self-editing repertoire, e.g., playing with toys.</td>
</tr>
<tr>
<td>Reader</td>
<td>Children can respond to environmental contingencies (under the control of textual stimuli) by seeking out and following written text</td>
</tr>
</tbody>
</table>

Reading was described as an extension of the elementary verbal operants (verbal function of behaviour) that are controlled by print. In the early stages of reading, children’s responses to print must be observed, that is, the child’s “see and say” correspondences to print. Thus, textual responding consists of “a visual or tactile verbal stimulus (print) that controls auditory patterns of verbal behaviour, such that, a vocal response is under the control of a non-auditory verbal stimulus” (Skinner, 1957, pp. 65-66). By this means, stimuli come to be symbolic for, or refer to, one another, i.e., an elementary version of Sidman’s (1994) account of stimulus equivalence (for example, the symbol representing the letter “A”, comes to refer to the sound //ah//). Linguists might refer to textual responding as “decoding;” and for
the purposes of the current thesis, decoding will be used to refer to textual responding.

In the development of reading, print and related stimuli acquire joint control over speaker and listener responses; at more advanced levels of early reading, readers begin to “say and hear” within their own skin, so to speak (Lee Park, 2005; Greer & Ross, 2008). Research has shown that those who receive behaviour analytic instruction incorporating verbal behaviour (such as word discrimination training) will have more educationally significant outcomes (e.g., Tsai & Greer, 2006).

1.7.1 Applied Behaviour Analysis and Reading Instruction

The applications and interventions based on the principles of applied behaviour analysis (ABA) have been used in teaching and strengthening learning in children with ASD for over 50 years, with the overall aim to improve adaptive functioning. These interventions have spanned across a plethora of repertoires such as communication (e.g., Olgetree & Oren, 2001), social skills (e.g., Reichow & Volkmar, 2010), independent living skills (e.g., Matson, Hattier & Belva, 2012) and academic skills (e.g., Kamps, Barbetta, Leonard & Delquadri, 1994). Historically, interventions provided for children with ASD have focused on the reduction of the core symptoms of the disorder, rather than on interventions designed to enhance academic skills (El Zein, et al., 2014). However, tactics and principles derived from ABA have great scope and potential to assist struggling readers.

Of the limited literature on teaching reading with the use of ABA instructional tactics, some have included the following: applications of reinforcement (Sutton & Barto, 1998), errorless learning (e.g., Browder et al., 2006), use of stimulus equivalence (i.e., the emergence of accurate responding to untrained stimulus-stimulus relations following reinforcement of responses to other stimulus-
stimulus relations; e.g., Rose, Souza & Hannah, 1996), peer tutoring (e.g., Kamps et al., 1994) modelling (e.g., Dowrick & Kim-Rupnow, 2006), corrective feedback (e.g., Pany & McCoy, 1988), building on prior knowledge (i.e., scaffolding; e.g., Lutz, Guthrie & Davis, 2006), fluency instruction (e.g., Therrien, 2004) and performance criteria (i.e., a fixed number of readings or a performance criterion to determine when to move from one passage to the next). Discrete Trial Training (DTT; Lovaas, 1987) is also a common instructional approach used within ABA settings to teach new skills. DTT is a method for individualising and teaching skills with the task or target skill broken down into small steps and taught using discrete trials to teach one step at a time (Smith, 2001). DTT has been demonstrated to be effective in teaching a wide range of skills to children with ASD (Smith, 2001), and forms the basis of curriculum delivery within programmed instruction. Each discrete trial consists of an antecedent instruction, which occasions the student response, following which, a consequence is provided, either corrective feedback for incorrect responses or reinforcement for correct responses. The unit can be further used to measure effects of the intervention on target outcomes.

According to Greer (2002), the design of curricula can benefit from the perspective of science. A large research effort undertaken by the U.S Federal Government showed that when behaviour analysis was applied to the curricula used by teachers, children did better than in non-behavioural approaches (Greer, 2002). It was found that when carefully analysed and empirically-based curricula were connected to the use of ABA for pedagogy, children’s performance improved further (Engelmann & Carnine, 1982; Greer 1989). Therefore, the design of reading curricula should include all of the necessary contingencies and components associated with the reading repertoire that the child requires, such as the research-
based strategies embedded into programmed instruction. Another important benefit of ABA and reading curricula is that the instruction is based on the child’s current repertoire, rather than on age, race, IQ or ethnicity, disability descriptor or physiological or genetic factors (Greer, 2002). Finally, there are clear expectations of targets of learning along with the provision of effective instruction, whereby explicit objectives and clear curricular sequences for teaching reading are outlined.

ABA interventions are typically based in educational settings and services where specialised staff are trained in the systematic application of ABA methodologies working with the individual in one-to-one or small group formats. There is empirical support for the inclusion of parents as “co-therapists” (Schafer & Breismeister, 1989; Ozonoff & Cathcart, 1998) in intervention, where they can support classroom instruction within the home and community settings. Such collaboration between parents and teaching staff promotes best outcomes and generalisation of targets for the child. Therefore, there may be a need to look beyond the classroom and into the home environments to investigate whether further, supplementary reading instruction could be beneficial to reading skills in children.

1.8 Education Provision for Children with ASD in Ireland

In the early 1990s in Ireland, there was a growth of schools based on ABA for children with ASD. This, in part, was due to a demand in ABA services driven from the results of Lovaas’s (1987) report that intensive, long-term educational intervention using methods of ABA could produce significant improvements in children with ASD (Leslie & Tierney, 2013). This demand led the Department of Education to designate 12 pilot ABA schools (Leslie & Tierney, 2013). However, in more recent years (2010), and without an evaluation of the outcomes of these schools, the Department of Education re-designated the pilot ABA schools as special
education schools, with primary school teachers as lead educators and management responsibilities allocated to school principals. Currently, these special schools adopt an “eclectic” approach to teaching, incorporating a variety of different educational methodologies. Furthermore, according to Kerr, Mulhern & McDowell (2000), despite the research findings demonstrating the effectiveness of ABA over the last 50 years, ignorance exists in Ireland concerning the research and various applications of ABA. The aforementioned educational revisions for children with ASD were applied during the implementation of the current thesis.

1.9 Reading Instruction and Children with ASD: The Challenges

Historically, formal reading instruction was reserved for children displaying a “readiness to learn”. With regards to reading readiness, this is identified in behaviour-analytic research as conditioned reinforcement of textual stimuli for the observation of print (Dinsmoor, 1983; Tsai & Greer, 2006). In terms of a more general educational perspective, this is based upon the premise that prior to instruction, certain prerequisite skills need to be observed, such as, print awareness and letter-sound correspondences. However, these are skills that are commonly delayed or not observed at all in the ASD population.

Additionally, children with ASD are becoming more visible in general education /mainstream schools, receiving education in more inclusive environments. As a result, there may be limited access to specific or individualised instruction that facilitates reading skills (Reisner et al., 2014). As children face increasingly challenging curriculum demands as they progress through the school years, teachers need to prepare them for these challenges (Deshler et al., 2001) and/ or seek training or support to deal with these challenges. Despite these challenges inherent in educating children with ASD, legislation in the USA mandates that all children make
academic progress (Individuals with Disabilities Education ACT, IDEA; 2004; No Child Left Behind Act, NCLB; 2001). Furthermore, both NCLB, (2001) and IDEA (2004) require that all children receive evidence-based reading instruction based on the components of reading (i.e., phonemic awareness, phonics, oral reading fluency, vocabulary and comprehension strategies) consistent with findings from the NRP (2000). Emerging evidence (e.g., Whalon, Al Otaiba & Delano, 2009) supports the view that children with ASD benefit from reading instruction consistent with NRP guidelines, however, such studies are limited.

In Ireland, the provision of the Education for Persons with Special Educational Needs Act (EPSEN; 2004) states that children with special needs have the same rights to avail of, and benefit from, appropriate education as their neurotypical peers. However, there is limited knowledge in terms of how to teach the necessary reading components to children with ASD. Furthermore, within the current educational system, as outlined previously, children are receiving less of an individualised service, and in many cases, have to learn side by side with neurotypical children who are accessing the mainstream (non-individualised) reading curriculum.

According to Cooper (1982), teachers are subject to passing fads in instruction as a result of basing many changes in education on historical accidents, untested theories and the opinions of influential individuals. Notwithstanding this, utilising assessment of children’s reading performances may place teachers in a better position to defend themselves against educational fads and other unproven educational programmes or curricula. However, in an Irish report commissioned by the National Council for Special Education (NCSE), Parsons et al. (2009) found that teachers appeared to be overwhelmed by the assessment process and, more
specifically, the selection of assessment. It was also noted that while teachers almost always demonstrated a very good awareness of the importance of differentiating assessment, challenges were often identified in developing an assessment process appropriate for children with ASD (NSCE, 2009). Finally, within this NCSE report, all teachers consistently referred to the role of observation as “the most important assessment of all” and understood the role of assessment as identifying whether the child had “grasped the concept that I am trying to teach”. This method of assessment is not objective, comprehensive or sufficient to identify the key component reading skills, especially as splintered skills are often observed in children with ASD. In educational settings for children with ASD, it is currently unclear what reading assessments are being administered to identify children with reading difficulties or to monitor reading progress. Curriculum-based measurement (CBM) are an emerging alternative to commercial standardised tests and to informal observations to establish academic growth standards (Deno, Fuchs, Marston & Shin, 2001), such as reading. However, there is little known about the extent to which teachers are implementing these measures with children with ASD.

The availability of reading curricula and reading interventions for children with special needs is growing, thus, the selection of curricula is no easy task. Despite this, recently, researchers and teachers have identified a lack of evaluative research specific to ASD reading practices in the peer-reviewed literature (Costley, Clark & Bruck, 2014). Therefore, despite the risks of reading difficulties or even reading failure in this population, there are very few empirically validated interventions for teaching reading to children with ASD (Browder et al., 2008; Whalon et al., 2009). A growing interest in the gap between research and practices with children with ASD has become a key topic, as this gap has been attributed to
the lack of readily available evidence-based research about effective classroom interventions (Kratochwill, Volpiansky & Clements & Ball, 2007) and school curricula.

1.9.1 Reading Approaches: Phonics or Whole-Word for Children with ASD

In many classrooms, children with ASD are often dismissed from phonics-based instruction (Kliweer, 1998). Instead, instruction typically focuses on memorising sight words, high-frequency words or the development of functional reading skills, such as, reading their name, making lists and following recipes (Erickon, & Koppenhaver, 1995; Porco, 1989). This is referred to as the whole-word approach whereby children learn to recognise words as whole units, without breaking them down to sounds or letter groupings (“Helping Every Child to Read”, 2017). Notwithstanding this practice in educational settings, in a review of research of sight words instruction (Browder & Lalli, 1991), it was found that only a few studies included participants with ASD. Therefore there is still paucity in the research on this approach to teaching reading with this population.

Equally important, phonics-based instruction is highly centred on oral language, for example, the ability to link sounds to letters and the capability to identify and manipulate sounds in spoken words (i.e., phonemic awareness). Language difficulties, both expressive and receptive, are highly prevalent for children with ASD. Therefore, learning to read via this methodology may place further demands, as the task of emitting vocal-verbal behaviour may result in a lag in reading attainment and possible reading failure. However, according to Joseph and Seery (2004), children with ASD can learn to use phonetic-analysis strategies and can benefit from many different types of phonics instruction (Bishop & Adams, 1990). Although delays in functional language are associated with ASD (e.g.,
Vacca, 2007), it does not automatically follow that communication delays goes hand in hand with an inability to read. For example, Diehl et al. (2006) posited that children with ASD may display delayed phonological development, but that cognitive development may otherwise be intact (Arnold & Reed, 2016). Instructional curricula that teach the whole-word reading approach, as well as the phonics-based approach need further investigation with children with ASD.

1.9.2 Motivation and Reading

In selecting methods to teach reading, teachers need to take into account motivational aspects of the curricula, both for themselves as well as the children. The NRP (2000) noted that very few studies have investigated whether teachers or children actually like the tactics and procedures to develop reading abilities, in particular, phonics instruction. Motivation is relevant to learning as the instruction should be engaging in order to capture the child’s attention and interest and to promote optimal learning. One important factor relevant to effective reading intervention, yet not specifically addressed in the literature, is children’s motivation to access reading materials. In other words, the extent to which print-based stimuli serve as conditioned reinforcers. In a survey conducted by O’Flahavan, Gambrell, Gutrie, Stahl and Alvrmann (1992), it was revealed that “creating interest in reading” was rated as the most important areas for future research.

There is evidence of strong links between the motivation to read (often referred to as print motivation and from herein the current thesis) and academic achievement outcomes (e.g., Elley, 1992; Gambrell & Morrow, 1996). Dynia et al. (2014) examined the differences in emergent reading skills, print motivation and the home-reading environments of children with ASD \(n = 35\) in comparison with children with typically developing language \(n = 35\). The authors assessed print
motivation with the use of a survey that aimed to gauge children’s interests in words. Results indicated that children with ASD had significantly higher alphabet knowledge, but significantly lower print-concept knowledge as well as significantly lower print motivation (while controlling for language), in comparison to their neurotypical peers. The evidence for conditioning books as reinforcers is found in both behaviour-analytic and non-behaviour analytic research (e.g., Neuman, 1999; Tsai & Greer, 2006). Respondent conditioning for books as reinforcers/preferred items focuses on children learning to enjoy books at an early stage, such that reading will become a preferred activity Greer and Ross (2008).

According to Greer and Ross (2008), the process of conditioning print stimuli occurs incidentally for most neurotypical children when parents read stories and point to pictures in books. Therefore, this pairing of adult attention (an additional acquired conditioned reinforcer for most children) with books, acts to condition print stimuli as a reinforcer. Conditioning print-based stimuli facilitates the acquisition of learning rates of textual responding/decoding (Tsai & Greer, 2006). Given the significant links with print motivation and reading outcomes, as well as the considerable risk of reading difficulties with children with ASD, there is currently a dearth of research in the area.

1.9.3 Reading Instructors

From the work of continually evolving research over the past decades, the importance of including parents as partners in the educational process has become more and more evident (Harris, 1983). In Ireland, the provision of the Education for Persons with Special Educational Needs Act (EPSEN; 2004) included a statutory right to avail of, and benefit from, an inclusive education. Furthermore, the act highlighted the centrality of parental involvement, and the development and
dissemination of good practice. Teachers should draw on families’ expertise from outside the school walls (Chanler-Olcott & Kluth, 2008) and parents need to be informed about the extent to which they can make differences that can positively influence the academic outcomes for their child. In Ireland and the UK, a gap is apparent between parents and teachers in school whereby many teachers have no training in the methods of ABA and offer little resources for parents who want to uptake such educational provisions (Kerr, Mulhern & McDowell, 2000). Supplementary parental involvement may help bridge the school-home gap, and overcome some of the existing barriers in meeting children’s needs. Emerging research has documented the key role that parents play regarding their children with disabilities to facilitate learning (Keilty & Galvin, 2006), such as, communication with teachers (Epstein, Munk, Bursuck, Polloway, & Jayanthi, 1999) and monitoring homework (Harry, Allen & McLaughlin, 1995). Parents’ influence on their children’s learning opportunities continues throughout adolescence and into adulthood. According to Paratore (2002), nearly all families embed some form of literary events in their daily routines, for example, night time stories and nursery rhymes to increase phonological awareness. However, studies examining parental support of school participation for their children with disabilities have tended to focus on academic achievement in general, with little specific attention to reading (Chanler-Olcott & Kluth, 2008). Consequently, we know little about the reading support that could potentially be provided by parents, especially in the use of evidence-based approaches for their children with ASD.

There has been paucity in research conducted in settings outside of the typical educational settings with children with ASD. Typically, research with this population has been performed in segregated classrooms operating a “pull out”
situation with research projects (Chanler-Olcot & Kluth, 2008), whereby children are removed from the classroom and given the instruction in isolation. Consequently, little is known about how to promote reading for children with ASD and how others, namely parents, may support this important skill. Both school and home-based interventions have their advantages and limitations. One of the strengths of home-based intervention is that parents have full control over the intervention, and as much of a child’s waking hours being spent at home, it closely matches the normative model (Harris, 2002), thus allowing for better generalisation outcomes. Some limitations of intervention conducted in the home setting may include insufficient skills in the contingent application of the intervention and conflicting schedules of home duties (e.g., attending to other children, housework and daily chores).

Conversely, in school-based settings, there are likely to be highly trained and skilled staff in the application of interventions and structure, routine as well as timetabled intervention are more common-place. Although it must be noted that many teachers may not be adequately prepared to implement evidence-based instructional practices as recommended by the NRP (Lyon & Chhabra, 2004). In adopting scientifically validated approaches, such as the behavioural approach, both parents and teachers may learn skills that enable them to identify and promote occurrences of positive behaviour as well as deal with inappropriate behaviour in a way that will not compound the problem (Kerr, Mulhern & McDowell, 2000).

It is clear that there may be many advantages and disadvantages to either setting. However, there is scant research to inform or guide teachers and parents in the selection of reading instruction for children with ASD, especially in relation to ABA-based interventions in the acquisition of reading skills. Pindiprolu and Forbush (2009) conducted, one of the few, studies investigating the effects of parent-
implemented computer based reading programmes. This study included 25 neurotypical children at-risk for reading difficulties. Participants were then allocated (non-randomly) to one of two computer-assisted interventions (CAI) interventions based on the principles of ABA; Funnix® and Headsprout® Early Reading. Parents were trained on the administration of each intervention, and implemented the respective interventions five days per week, for eight weeks in duration. The results indicated that each CAI facilitated gains in phonemic awareness; however there were no statistically significant differences between the two groups on the Dynamic Indicator of Basic Early Literacy Skills (DIBELS; Good, Kaminski & Dill, 2002) measure. The Headsprout® group showed gains on two of the measures and the Funnix® group showed gains across a range of measures. More specifically, the Funnix® group had medium gains on the word-use fluency measure and the Headsprout® group should small gains on the word-use fluency measures. The authors called for future studies to be conducted that examine the outcomes of these or similar CAI and to assess perception of parents with limited or no experience with teaching reading.

According to the evidence-based reading components advocated by the NRP (Silver-Pacuilla & Ruedel, 2004; Pindiprolu & Forbush, 2009), there is potential for parents to become an integral part of the educational process in delivering systematic, comprehensive and explicit programmed reading instruction. Additionally, CAI based on the principles of ABA, may hold great promise as a mode of teaching for educators that do not possess these specialised skills. These types of curricula consists of automated, systematic, explicit instruction, with the ability to present multiple sources of information, such as text, sounds and images and most importantly, embedded evidence-based instructional tactics in CAI.
Therefore this limits instructional errors that may be made with respect to its implementation. According to Cuban (2001), the use of technology has been lacking in schools and homes where the focus should be learning from technology rather than with technology. It is no longer a question about having the availability of personal computers (PC) in today’s classrooms, but about the effective use of these resources.

1.10 Computer Assisted Instruction

In today's society, children and adolescents are spending much of their free time immersed in technology. Advances in technology means than reading now comes in more forms other than traditional print-based stimuli, for example, books, magazines and newspapers. Reading abilities now transcend print and include enabling access to emails, text messages, and social media, which are currently primary means of social-communication for individuals. Furthermore, as mentioned, success in reading is a behaviour cusp, allowing access to explore the world wide web of the internet, thus allowing instant access of information, potential employment (Cain, 2012) and continued life-long learning. In less than 20 years, the social domain in which people grow up in has almost completely changed in terms of how we communicate and access information. Thus, it follows that schools, and indeed home dynamics, must adapt accordingly, and provide opportunities for children to learn to operate and optimise these technological developments in order to maximise learning.

Skinner (1968) gave a comprehensive account of ABA specific CAI, referring to each trial presented by CAI as a “frame” because the machine or device presents the stimuli in a framed window. This frame includes the onscreen target antecedent, prompts and the opportunity or necessity for a response by the child.
Once the child responds correctly to the stimulus, the next frame (i.e., trial) is exposed, which, along with prosthetic reinforcers, serves to reinforce a response. If a response is incorrect, the next frame does not unlock until the child corrects the response (Greer, 2002). It is important to distinguish between technology used for instruction in general education classrooms, and technology used specifically to accommodate the learning and needs of children with disabilities (Constantinescu, 2015). For years, the use of technology (when used with individuals with disabilities) implied augmented communication. For example, devices designed to assist those with physical impairments (Edyburn, 2004) or with communication deficits, for example, the use of augmentative communication devices (Mirenda, 2003). However, the use of technology, namely CAI, is becoming more widely applied to the treatment of individuals with ASD in order to target a host of skill deficits. CAI has been implemented to increase social skills (Moore, McGrath & Thorpe, 2000; Ploog, Sharf, Nelson & Brooks, 2013), vocabulary (Bosseler & Massaro, 2003), communication (Colby, 1973; Ramdoss et al., 2011), and spelling (Stomer, MacKay, Howell, & McVay, 1996). Some researchers have even suggested that computers are a suitable mode of instruction for common characteristics of an ASD diagnosis (Bernard-Opitz, 1990; Chen & Bernard-Opitz, 1993; Heimann, et al., 1995; Panyan, 1984). Ramdoss (2011) outlined some very prominent strengths and weakness associated with CAI and instruction of children with ASD. First, children with ASD often response well to tactics that involve information presented visually (Bondy & Frost, 1994; Whalon et al., 2010). Secondly, CAI could potentially minimise social skills deficits inherent to the ASD profile, by reducing the need to try to understand the complexity of student-teacher interactions, thus allowing more attention to the CAI task at hand. Finally, research
Literature Review

has suggested that children with ASD tend to be more motivated to use computers; the delivery of the task via CIA may reduce the task demand (Ramdoss, 2011). Conversely, CAI could also lead to some negative effects, as it limits vocal-verbal communication (which could be the instructional target), as well as impeding social skills. Such skills include joint attention and eye contact (Ramdoss, 2011).

More recently, research on the use of CAI has become increasingly visible in classrooms to teach academic skills to children with disabilities, such as ASD. Pennington (2010) conducted a literature review of studies supporting the effectiveness of CAI interventions for teaching general education content (i.e., math, science, and reading) to children with ASD. The author reported the significance of CAI in teaching a limited set of educational skills, primarily early reading skills, and found that CAI was more efficient than teacher-only instruction for teaching component reading skills, such as vocabulary (Bosseler & Massaro, 2003; Moore & Calvert, 2000). However, the author noted that much of the research was conducted with very few participants and failed to report effect sizes. Although these were valuable insights to the subject area, the generalisability of CAI to other approaches of reading instruction is limited. A subsequent systematic review by Knight, McKlissick and Saunders (2013), reported that between 1993 and 2012, only four studies, (none of which were group-based), met “acceptable” quality standards for using CAI to teach academic skills to children with ASD. Given the rise in popularity of technological devices, the authors called for caution in the use of CAI to teach academic skills, along with the necessity of continued research and careful consideration of the cost and effectiveness of CAI.

Despite the many advantages, it is still unclear whether CAI is more beneficial than traditional print-based, teacher-directed instruction (TDI). Williams,
Wright, Callaghan and Coughlan (2002) evaluated reading skills in eight children (2-5 years) with ASD in a comparative pilot study; a book-based condition and a CAI condition. The book-based condition consisted of a teacher-led group using books and word cards. For the CAI condition, print-based stimuli used within the book-based condition were scanned onto the computer resulting in participants receiving identical texts (delivered via a book or a computer). Participants were randomly allocated to each condition, and then re-allocated to the alternative condition after ten weeks. Findings indicated that children spent longer durations on-task during the CAI condition \((M = 9.9\) minutes) than in the book condition \((M = 2.8\) minutes), and were also able to identify more words in the CAI condition. Conversely, El Zein et al. (2016) conducted an alternating treatment design to examine the effects of utilising TDI in comparison to iPad® assisted instruction (IAI) intervention on reading comprehension and task refusal of three children with ASD. The TDI sessions consisted of teaching a text preview strategy (i.e., looking at text and picture, making predictions), identifying the main idea of each paragraph using a graphic organiser, and the use of a token economy system. Whereas IAI treatment sessions consisted of the use of an iPad® application that focused on identifying the main idea paired with implementing a token economy system for task completion. Results indicated an improved performance on probes during TDI and IAI treatments, with an indication that the TDI treatment was more effective in increasing accuracy of responding in comparison to the IAI condition. However, both Williams et al. (2002), and El Zein et al. (2016) employed small sample sizes, thus limiting the generality of the outcomes.

A concern expressed by the National Centre for Technology Innovation (2004) focused on technologies being adopted by teachers, before demonstration of
empirical support for these technologies. Ramdoss (2011) conducted a systematic review of reading instruction with individuals with ASD, aged between 3-21 years, on the use of CAI, of which yielded 12 studies that met inclusion criteria. They found that the research base was limited based on the few numbers of studies ($n = 4$) that provided conclusive levels of certainty in relation to their findings. Authors noted that due to the wide variety of reading skills targeted for instruction across the studies and the heterogeneity of participants, from existing literature, it was not possible to provide a summative conclusion regarding the effectiveness of CAI for teaching reading skills to students with ASD. Findings from recent research into reading interventions and curricula useful for children with ASD have not been adequately explored and there is a need for evidence-based knowledge to help enhance reading performances. Ramdoss (2011) highlighted that although the ability to use a computer is a valuable skill, it may not be deemed a priority over making immediate progress in reading for some children. In order for children with ASD to benefit from CAI, teachers must demonstrate the ability to implement the CAI, in addition to the selection of a CAI that is best suited to the student. The authors called for future research evaluating the effectiveness of CAI, versus TDI reading instruction.

1.10.1 Programmed Instruction and Children with ASD

As such, the success of CAI depends on the extent to which the software programme is designed to embed effective teaching procedures, such as those procedure based on the principles of ABA. Even so, if children are presenting with difficulties, ABA teaching strategies may still be implemented to teach missing repertoires (i.e., additional instruction/ accommodations), or be included supplementary to the CAI. This is evident in recent research, which has explored
supplementary instruction as a result of learning barriers faced with children with ASD (e.g., Grindle, Hughes, Saville, Huxley & Hastings, 2013; Plavnick, Mariage, Sue Englert & Constantine, 2014; Plavnick, Thompson, Englert, Mariage & Johnson, 2016). The social and communicative deficits that children with ASD may encounter could have an impact on the child’s languages skills, which in turn impact on the ability to effectively develop adequate reading skills (O’Connor, & Hermilin, 1994; O Connor & Klein, 2004; Reutebuch, Zein, Kim, Weinberg & Vaughn, 2015).

Therefore, all instruction needs to be monitored with the administration of regular assessment to ensure that children are progressing, and if not, suitable accommodations need to be identified that addresses the specific learning problem. More research evaluating curricula and uncovering common learning difficulties will facilitate effective and efficient reading instruction for future teachers of children with ASD. Plavnick et al. (2014) highlighted that research targeting academic skills for children with ASD has identified some key instructional components, including high rates of accurate responding (e.g., Plavnick et al., 2016), immediate feedback (e.g., Ranick, Persicke, Tarbox & Kornack, 2013), carefully sequenced instructional targets and interspersed yet predictable instructional formats. From a behaviour analytic perspective, curricula that are scripted with clear goals and sequences are referred to as programmed instruction. For the purpose of the current thesis, the terms programmed instruction and curricula will be used interchangeably throughout. Programmed instruction allows for the control of instructional and content delivery, thus increasing fidelity of implementation (Cooke et al., 2011; Plavnick et al., 2014).

According to Watkins and Slocum (2004), scripted curricula (i.e., programmed instruction) ensure that content is systematically outlined and procedures for the implementation of the curriculum are delineated. Programmed instruction is one of
the few educational innovations shown to be reliably effective in research in education (Stephens, 1967). The arrangement of curricula into task analysed instructional hierarchies is a key contribution of behaviour analysis to education (Daly, & Martens, 1994).

Plavnick, Marchand-Martella, Martella, Thompson and Wood, (2015) reviewed the literature on the effectiveness of teaching academic skills (i.e., reading & math) to children with ASD using explicit and systemic scripted programmes (programmed instruction). A total of nine studies met inclusion criteria and results showed that only one study met all quality indicators for single-case research. Four points were outlined by the authors; firstly, these programmes are not currently considered evidence-based practices for student with ASD. Only three of the nine studies included broad reading outcomes, such as outcomes from standardised or curriculum-based measurements. Secondly, the authors called for the use of standardised assessments that have been psychometrically validated, as well as within programme assessments (e.g., mastery tests), which could be added to the often used “researcher-developed” measures to strengthen inferences made about the efficacy of programmed instruction. The third point detailed limitations of the size and quality of the research-base, and the call for future research to guide teachers in need of academic curricula for children with ASD. Finally, Plavnick at al. (2014) noted that a more detailed description was necessary for “treatment as usual” conditions and more clarification on whether the programmes are best used in isolation or in combination with other instruction. These similar instructional components are included in two published programmed instruction based upon the principles of ABA; Edmark® Reading Programme (Tague, Kiddler & Bijou, 1967; Pro-Ed, 2011) and Headsprout® (Layng et al., 2003). Both of which are scripted,
with procedures applied in a systematic manner allowing consistent implementation across instructors of varying skill level (e.g. parents as well as teachers that may not have much experience with delivering instruction to children with ASD).

1.10.1.1 Edmark® Reading Programme

Edmark® Reading Programme (ERP; Tague, Kiddler & Bijou, 1967; Pro-Ed, 2011) is a whole-word reading programme that aims to expand word-discrimination repertoires by teaching the recognition of words as single written symbols that represent an entire word or phrase, without indicating its pronunciation. It was originally designed for children with intellectual disabilities and language delays, but has since been used with other populations, for example, neurotypical children presenting with reading challenges (e.g., Mayfield, 2000). Publishers of ERP suggest that by the end of the curriculum, children can progress from non-readers to a 1.0 (first grade/class) reading level. ERP provides 153 lessons towards teaching 150 words, in addition to the suffixes of –ing, –ed and -s. Vocabulary, comprehension and fluency skills are also developed. This programmed instruction uses systematic advances in task demands and teaching methodologies such as errorless learning, scaffolding, direct instruction, consistent repetition, positive reinforcement, and individual pacing, to help children experience immediate reinforcement for their responses. The behavioural prerequisites to access ERP are minimal, requiring only the abilities to point and provide answers; say or sign words as well as receptive language in order to follow the teacher’s directions. There are two formats of the curriculum available; a printed/table-top, or a computerised version. In identical sequences, both formats aim to teach matching target words and phrases along with beginning comprehension skills, via table-top or computer. A second edition was released in 2011 (print version only), but the core activities
remain the same, with words taught in the same way and in the same order (see Chapter 4 for further details of this curriculum).

To date, no research has been conducted with any population on the second edition of ERP. Six peer-reviewed studies have examined the efficacy of the first edition of ERP. Two of which have examined its effects with neurotypical children (Anderson, Lict, Ullman, Buck and Reid, 1979; Mayfield, 2000) and four with children with intellectual disabilities (Meeks, Martinez & Pienta, 2014; Vandever, Maggart & Nesser, 1976; Vandever & Stubbs, 1977; Walshe & Lamberts, 1979). Results of these studies have indicated that participants in the ERP group showed significantly more improvements on oral reading of target ERP words (Anderson et al., 1979), sight word vocabulary, and comprehension (Mayfield, 2000), than the control group in post-tests. The remaining studies investigating the efficacy of ERP were conducted with children with intellectual disabilities (Vandever et al., 1976; Vandever & Stubbs, 1977; Walshe & Lamberts, 1979; Meeks, et al., 2014). The outcomes have revealed ERP as being effective in teaching target words of the curriculum.

On review of the literature, although the initial findings were promising, limitations were evident which suggests the use of caution when interpreting the findings. Such issues relate to unreported dosages of curriculum (Vandever et al., 1976), short intervention periods, for example, 10 minutes per day for five successive days in each treatment (Walshe & Lamberts, 1979), non-equivalent word lists (Vandever et al., 1976), small sample size (e.g., Meeks et al., 2014), lack of fidelity checks or observations of reinforcement contingences of ERP versus the comparison group (Anderson et al., 1979), comparisons of one-to-one instruction with group based instruction (Mayfield, 2000; Meeks et al., 2014), awareness of
group assignment and lack of validity and reliability on the dependent variable (Mayfield, 2000). Notwithstanding the growing prevalence of CAI being used to teach reading skills in many educational settings (Mirenda, 2003), it is therefore imperative for continued research on the specific outcomes of ERP and to date; research has not examined its effects in relation to children with a diagnosis of ASD. Further to this, there is currently no research on the CAI version of ERP with neurotypical children, or those with ASD.

1.10.1.2 Headsprout® Reading Programme

Headsprout® (Layng et al., 2003; Learning A-Z Inc.) is an umbrella title for two levels of the internet-based computerised reading curriculum; Headsprout® Early Reading (HER) and Headsprout® Reading Comprehension (HRC). HER is an example of programmed instruction based upon the principles of ABA, featuring embedded contingent reinforcement, scaffolding (which is building upon children’s previous knowledge), direct instruction, stimulus equivalence for words not explicitly taught, as well as systematic and sequenced instruction. The curriculum also incorporates the five essential areas of the reading instruction identified by the NRP, (2000). It automatically records responses given in each episode, time spent on episodes, percentage of correct responses, and a “reading activity” record outlining the specific skills accessed by the student (see Chapter 5 for a full description of the programme). The term episode is used for the purpose of this chapter to refer to lessons of Headsprout®. There are currently 11 peer-reviewed studies examining the effects of the CAI: Headsprout® with varying populations. Four of these are with neurotypical children, deemed “at-risk” for reading difficulties (Hufstetter et al., 2010; Pindiprolu & Forbush, 2010; Storey, McDowell & Leslie, 2017; Tyler et al., 2015), one with children with intellectual disabilities (Tyler et al., 2015).
2015), two with children with ADHD (Clarfield & Stoner, 2005; Cullen, Alber-Morgan, Schnell & Wheaton, 2014) and four with children with ASD (Grindle et al., 2013; Plavnick et al., 2016; Plavnick et al., 2014; Whitcomb, Bass & Luiselli, 2011). Participant numbers for the four ASD studies combined is 12. While these studies are valuable, there is a need to conduct studies with more participants in order to promote generality and to examine the programme on a larger scale.

Whitcomb et al. (2011) investigated the effects of HER with a 9-year-old boy assessing the percentage of words read from HER word-sets (target words explicitly taught by the programme) and four short stories (Sprout stories accessible through HER). Researchers used a multiple baseline design across four set to assess outcomes. HER episodes were conducted 20 minutes per day. The length of intervention was unspecified. Following the completion of 23 episodes, results indicated improved gains on word-sets, during which the teacher administered prompts for the participant to attend and respond to HER instructions. Breaks, tangibles reinforcers and error correction procedures were also applied throughout the course of the intervention. The participant demonstrated increases from baseline to intervention for words and word-sets contained in stories (Sprout stories). Some limitations of this study included the use of only one participant, as well as increasing trends in word reading during baselines for three out of four word sets, which limits the extent to which inferences can be drawn from the results.

Grindle et al. (2013) conducted a preliminary evaluation of HER with four children with ASD, aged between 4-6 years. It was a single subject pre-post-test design assessed by DIBELS (Good & Kaminski, 2002) and Word Recognition and Phonics Skills Test (WRAPS; Carver & Moseley, 1994) at three points across the intervention. HER was completed 3 times per week for a total of 14 weeks. Results
demonstrated improvement in word recognition reading-ages for all participants, and a follow-up test showed these gains were maintained eight weeks post-intervention. The study also investigated whether adaptations to the standard Headsprout® protocol were necessary and found that additional supports were warranted to successfully complete all 80 episodes. These adaptations included the necessity for the teacher to sit with the child for the provision of additional prompts (verbal) to attend and to speak out loud along with the computerised output. Other additional supports included manipulating motivating operations for challenging behaviour due to participants’ demonstrating escape and avoidance behaviours throughout the episodes. Extrinsic reinforcement was delivered throughout for following directions, attending, and for episode completion. Finally, specific strategies were also necessary to increase on-task behaviours; episodes were divided into two/three sittings across the day, avoiding times when distractibility could potentially be higher (e.g. before breaks, before home time). Learning problems that arose during the programmes instruction were remediated using DTT that targeted the specific learning problem from the episode. A final problem noted by the authors were difficulties with fluency; participants were reading too slowly or reading with errors. This was remediated with the use of additional practice opportunities to increase speed using the target words on flashcards with the appropriate pace modelled for participants. It concluded that all four participants were able to complete the 80 HER lessons, demonstrating similar trials correct to that reported of neurotypical children (with the provision of additional and individualised teaching strategies). Despite some limitations, namely, the absence of a control group, small group size and narrow reading subtests assessed, this study provided a valuable initial probe in to the accessibility of HER for children with ASD.
More recently, Plavnick et al. (2016) conducted an examination of HER in addition to an additional supports (consisting of match-to-sample training, and contingent reinforcement) on the independent progression of three 6-year-old children with ASD. Participants completed episodes daily over 68 sessions. The length of intervention was unspecified. Results of episodes completed ranged from 10-59 and all participants demonstrated an increase in correct interactions per minute. Two participants learned to independently complete one HER episode each day, and could orally read the companion Sprout Stories which suggested that some children with ASD can be supported in the use of HER. The results revealed that due to the supplementary supports, two out of the three participants could independently complete HER episodes in less than 40 sessions. Some limitations included practical challenges in training and administering reinforcement procedures, as well as variable and increasing baseline trends for one participant, and the lack of use of standardised reading measures in assessing the outcomes. Authors called for future research to evaluate moderating variables of HER with this population. Despite much research outlining reading comprehension as an area of particular difficulty for children with ASD, none of the above studies have assessed the reading outcomes of HRC with children with ASD.

1.11 Summary and Research Aims and Chapter Overview

Although emerging research suggests that there are some relative reading strengths in children with ASD, it is evident that there remains some ambiguity regarding reading skills in children with ASD. There is a large degree of uncertainty on how to approach reading instruction in schools for students with ASD. More specifically, there is uncertainty regarding which reading curricula are used in schools in Ireland, as well as which reading assessments are being conducted in
order to identify students presenting with challenges in learning acquisition. Chapter 2 of this thesis will evaluate assessments being employed by educators to ascertain levels of reading abilities, as well as reading instruction for children with ASD. Chapter 3 extends on Chapter 2, with the objective of investigating the reading abilities of a large sample of children diagnosed with ASD. The chapter aims to explore the specific factors impacting on reading abilities by employing a range of reading assessments.

With growing numbers of children with ASD being educated within mainstream educational settings, as well the challenges within these settings in teaching reading skills to this population, it is critical to examine effective curricula based instructional methodologies. There has been increasing recognition regarding the benefits of using CAI in education, with more and more research emerging showing positive outcomes for children with disabilities, including ASD. Chapters 4 and 5 will examine the effects of programmed instruction on reading outcomes for children with ASD. Chapter 4 will investigate the outcomes of ERP with 31 children with ASD. This study compares a print-based programmed instruction, relative to a CAI presentation. Chapter 5 will examine the effects of parent-facilitated delivery of Headsprout® in 26 children with ASD. A consultative model will be employed to ascertain what, if any, accommodations would be necessary for participants’ successful progress through episodes, as well as to assess the reading related outcomes of print motivation in children with ASD.
Chapter 2

Reading Assessments and Curricula for Children with Autism Spectrum Disorder in Ireland: An Exploratory Study
2.1 Introduction

As discussed in Chapter 1, the Education for Persons with Special Needs Act (EPSEN; 2014) states that children with special needs have the same rights to avail of, and benefit from, appropriate education as their neurotypical peers. It is expected that this should include access to appropriate reading curricula and assessment. However, this isn’t always the case for children with disabilities; in fact, to the best of the author’s knowledge, the level of assessment of reading skills in educational settings is currently unknown for children with ASD. Chapter 1 outlined the challenges faced by children with ASD in terms of reading abilities (e.g., language deficits or cognitive processing difficulties). As a result, this may impact on the ability to assess children with ASD on standardised reading assessments. According to Arnold and Reed (2016), mainstream schools have an obligation to assess the literacy skills of neurotypical children, in addition to the provision of reading instruction that includes measurement of progress. The outlined difficulties associated with children with ASD (e.g., language) may prevent them accessing general education curricula (Mirenda, 2003b). Despite this, reading instruction for children with ASD may be loosely taught without reference to a specific syllabus or curriculum (e.g., Fossett & Mirenda, 2006; Kamps et al., 1990). Even with a curriculum in place, anecdotally, it appears to be common practice that one component may be selected from the curriculum and delivered, without pre-and post-testing of its outcomes.

It can be argued that some children with ASD are educated under ABA instructional methodologies with data collection systems as a central feature, thus ensuring the on-going assessment and evaluation of abilities, such as reading. However, such settings may only evaluate the learning of very specific reading
components (e.g., word recognition) which would not yield composite reading scores. Although this allows for assessment of individual component progress, these scores would then not be comparable to a standardised/norm-referenced sample, which could provide information of reading abilities relative to their neurotypical peers. Nevertheless, there is little current knowledge on the extent of use of these kinds of standardised assessments in schools for children with ASD. Furthermore, Arnold and Reed (2016) noted that literature searches for reading assessments tailored towards those with special needs (i.e., ASD) revealed that no reading assessments specific to this population appeared to be in common use. It is therefore important to investigate the means by which reading abilities are monitored in educational settings for children with ASD. The term educator will be used for this chapter to make references to teachers and therapists in charge of reading instruction in school settings for children with ASD.

The current study investigated a researcher-developed, exploratory survey for educators of school-aged children with ASD across Ireland. The primary aim of the research was to identify the reading curricula and assessment procedures being used to evaluate and teach reading skills for children with ASD in Ireland. As described in Chapter 1, CAI is a promising stream of intervention for this population, however there is little data on the nature of its use in schools for children with ASD. Therefore, the secondary aim of the research was to examine the use of reading CAI in educational settings for children with ASD. The final aim of the research was to assess the satisfaction of educators in relation the reading curricula employed, as well as perceptions on the curricula suitability, and selection procedures of reading curricula for children with ASD.
2.2 Method

2.2.1 Recruitment and Participants

Social media and online educational forums were used as the platforms for recruitment, where invitations were posted on education posts or special interest groups for educators of children with ASD in Ireland. The survey was posted on the following websites and social media groups: ABA Ireland, Facebook page; www.educationposts.ie, which is a forum for primary school teachers in Ireland; and www.autismireland.ie, which is a website providing information on education and intervention support to those interested in ASD. This post invited staff members of mainstream and special schools for children with ASD to participate by clicking on the hyperlink, which re-directed participants to the online survey.

All participants were self-reported practising professionals, working in schools that accommodated education for children with ASD in Ireland. Participants included primary school teachers (Bachelor of Education) and instructors with a Master’s Degree in Psychology or Education. For the purposes of this research, these professionals will be described as educators. The email address of the principal investigator (PI) was included in the post, to provide opportunities for participants to make contact if they required further information or technical support during the course of their participation. However, no participant indicated that this support was necessary.

2.2.2 Survey Design

The questions were devised by the PI and the PI’s primary supervisor. The target questions were formulated based on information that was considered absent in relation to reading data for children with ASD in Irish schools, and also for the purposes of reading curricula selection in subsequent chapters of this thesis.
Assessments and reading curricula commonly used in educational settings were complied, and others were derived from an internet search of current reading curricula, such as the NCSE webpage. The results of these searches were then included as curricula options in the survey. Data were collected via an online survey, using the software package, Survey Monkey®. Survey Monkey® is a cloud-based software company that provides customisable surveys and also data representation tools, for example, pie charts and bar charts.

The survey included 17 items (see Appendix A for a printed version of the online survey). Responses were based upon participant’s knowledge of their classroom and reading abilities of their students. Survey items included open-ended questions (e.g., “What are the age ranges of your ASD children?”) and closed-ended formats (e.g., “Why did you select this particular reading curriculum?”). To illustrate, for the latter, response choices included the following: (i) research-based selection, (ii) word of mouth from other instructors, (iii) previous experience with the curriculum, and (iv) the curriculum has always been used in the school. All 10 of the closed-ended questions included an additional text box beneath for participants’ supplementary comments. Comment boxes allowed participants to explain their selection or add any further details, thus allowing researchers to gather as much information as possible without limiting participant responses. A multiple-choice method was selected for 13 of the questions in order to ensure that comparable quantitative data could be obtained. Questions 1 to 3 related to basic information about the educational setting and the ASD levels of the children (e.g., severity of ASD; mild, moderate or severe). These levels were based on DSM-IV-TR criteria (APA, 2000) as the survey was launched prior to the release of the DSM-5 (APA, 2013). Questions 4 to 6 related to levels of reading abilities in classrooms,
specifically the numbers of children with no reading skills, those who read via sign and those who can match pictures to words. Questions 7 to 14 sought to identify the curricula and assessment tools employed in respective educational setting, including the use of CAI to teach or supplement reading skills. The final section of the survey (Questions 15 to 17) focused on participants’ professional opinions with regard to the suitability of the curricula employed for children with ASD. Within these questions, a five point Likert-scale was used to report educators’ perceptions of suitability, motivation of children and effectiveness of the reading curriculum employed. Response options ranged from “strongly agree” to “strongly disagree” with an option to select “not sure”. Space was provided at the end of the survey for any further comments participants wished to make.

2.2.3 General Procedure

A brief description of the survey topic, along with the specific requirement that participants currently work with children with ASD and an annotation outlining that participation was voluntary with no obligation to complete the survey. Participants were informed that all information would be collected anonymously, with no opportunities for participants to include identifying information, such as their name, addresses, or name of the educational setting. Informed consent was obtained by participants ticking a box to indicate that they had read this information and willing to participate. This survey was available online for a period of three months, and was refreshed on the webpages (i.e., re-pinned to the top of the posting-page) a second time approximately 1.5 months following the initial post. Upon the PI’s trialling of the survey completion prior to its upload, it was found that the survey took no longer than 10 minutes to complete in one sitting. Following the
lapse of the three month data collection period, the survey was closed by removing the hyperlink from all websites.

2.2.4 Data Analysis

Descriptive statistics were used to examine participant’s responses on all questions. Chi-Square Tests ($\chi^2$) were also conducted to examine relationships between a number of variables. Although, Chi-Square Tests were reported, an assumption was violated for this type of analysis (i.e., expected cell count was not less than five). However, some authors suggest that the analyses can be still be reported (Kim, 2017).

2.3 Results

A total of 60 educators responded to the online survey. Data were analysed by coding each response with a number and generating descriptive statistics in the software, Statistics Package for Social Science (SPSS; Nie, Bent & Hull, 1970).

2.3.1 Characteristics of Children with ASD

The levels of ASD severity reported were mild (22%), moderate (50%), and severe ASD (27%). Participants were asked to report the age ranges of their children with ASD, with ages categorised based on school age-ranges. This did not necessarily mean that children were attending these types of schools. See Figure 1 for a visual representation of these data.
2.3.2 Instructional Approaches within Settings

The instructional approaches employed by schools were examined and shown in Figure 2. Inspection of these data revealed that ABA was the most commonly employed method of instruction; followed by the Eclectic model, Mainstream and TEACCH (Treatment and Education of Autistic and Communication related handicapped Children). TEACCH (Mesibov, Shea & Schopler, 2005) facilitates learning through a visual and structured method. An eclectic approach involves a combination of teaching methodologies in instruction. Other approaches listed were Precision Teaching (although this is also under the umbrella of ABA), design of schools own curriculum and the ASDAN (Award Scheme Development and Accreditation Network) curriculum.
2.3.3 Use and Selection of Reading Curricula

Participants were asked to report on the main reading curriculum employed to teach reading abilities to children with ASD. Frequency counts of the reading curricula most commonly used by participants were conducted and have been reported in percentages (see Figure 3). The most commonly reported curriculum was the Edmark® Reading Programme (Tague, Kiddler & Bijou, 1967; 2011). This was followed by the primary school curricula, Jolly Phonics® (Lloyd & Wernham, 2000) and Graded Reader Series (also known as readers). The third most popular reported curriculum was Reading Mastery® (Engelmann et al., 1983; 1995; 2003). “Other” curricula reported included the following: Fuzz Buzz® (Harris & Lippiatt, 1978), Success for All® (Slavin & Madden, 2001), Oxford Reading Tree® (Hunt, 2011), or a combination of all of the options listed, while some (n = 4) commented that they do not use any reading curriculum (as indicated in the comment box).
Figure 3. Reading curricula employed by schools for children with ASD.

Participants noted that the selection of the reading curriculum was mainly based on the resources having “always been used” in the school, followed by “previous experience” or “word of mouth” from other educators in the field and from “reading research” (See Figure 4). Comments made regarding selection indicated that the curriculum was selected based on the availability of resources in the school, while others indicated that this was not applicable as they did not employ any reading curriculum.

Figure 4. Reading curricula selection procedures.
2.3.4 Reading Abilities and Assessments

Just under half of the participants ($n = 29$) reported that 50% or more of their children with ASD had no reading abilities. A further 19 participants reported that between 10-40% of their children having no reading abilities and 10 participants reported that all of their children with ASD had reading abilities. When asked if any of the student in the participants class(es) read via the use of signs, a total of 11 participants (18%) indicated “yes” and a total of 37 participants (61%) indicated a “no” response, while 20% of participants skipped this question.

In relation to Question 11, on reading assessments, it was found that more than half (60%) of the participants did not use any standardised reading assessment (see Figure 5). Of those that did employ standardised assessment, the most commonly employed assessment was the Belfield Infant Assessment (BIAP; Spellman & McHugh, 1995); followed by the Drumcondra Test of Early Literacy (DTEL; Educational Research Centre, 2010) and the Mary Immaculate Reading Attainment Test (MICRA-T; Wall & Burke, 2004). Other assessments reported, as identified in the comments section, were not standardised tests (e.g., Verbal Behaviour Milestone Assessment and Placement Program® (VB-MAPP; Sundberg, 2008), Dolch List (Dolch, 1936), and the Assessment of Basic Language and Learning Skills- Revised® (ABLLS-R; Partington, 2002).
2.3.5 Computerised Assisted Instruction

Over half (53%) of participants reported that they did not use CAI to teach reading skills. Of those who did report its use 5% used it as the core reading curriculum, 23% reported to using it as a supplement to their core reading curriculum (the curriculum outlined in the previous question), and 17% reported that they use CAI for games and rewards with only a minor learning element. Comments in relation to “Other” detailed that use of CAI involved a mixture of the above categories, dependent on motivational needs (i.e., children who found computers to be a highly reinforcing used it as a core curriculum, and those that did not used it as a supplement).

2.3.6 Opinions of Educators in relation to Curricula Employed

Participants were asked if there were any reading components that they considered their reading curriculum did and did not address. Results are displayed in Table 2.1 of participant’s ratings of specific reading components the curriculum employed predominantly targeted.
The final section of the survey focused on the professional views of participants with regard to the suitability, motivation and ease of use of the curricula employed within their school. These data are displayed in Table 2.2.

Table 2.2 Participant Views on Curriculum Employed.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Not sure</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children enjoy and are motivated to use the Curriculum</td>
<td>15%</td>
<td>52%</td>
<td>17%</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>The Curriculum is easy to implement and will be used in the future</td>
<td>17%</td>
<td>58%</td>
<td>10%</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>The curriculum is not suitable/ appropriate for student with ASD</td>
<td>2%</td>
<td>7%</td>
<td>15%</td>
<td>57%</td>
<td>8%</td>
</tr>
</tbody>
</table>

2.3.7 Further Statistical Analysis

In addition, a number of Chi-Square Tests ($\chi^2$) were conducted to evaluate the relationship between (i) educators ratings of suitability of the curriculum and the reading curriculum employed; (ii) instructional approaches (i.e., ABA, TEACCH, Primary School, Eclectic and Others) and the reading curriculum employed; and (iii)
instructional approaches and selection of reading curriculum procedures (i.e.,
research, word of mouth, previous experience of a history of its use). Contingency
tables and results are presented in the following sections.

2.3.7.1 Educators Ratings of Suitability of Curriculum Employed and ASD

Severity

A chi-square test was carried out to see if there was an association between
ASD Severity and participant ratings of the Suitability of Curriculum Employed. All
expected cell frequencies were not greater than five (i.e., this assumption was
violated). It was found that there was no significant association between severity
and participant ratings of the suitability of curriculum employed within this study, $\chi^2$
$(8, N = 52) = 8.75, p = .36.$

Table 2.3 ASD Severity & Suitability of Curriculum Employed

<table>
<thead>
<tr>
<th>Suitability</th>
<th>Mild ASD</th>
<th>Moderate ASD</th>
<th>Severe ASD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Agree</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Not Sure</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Disagree</td>
<td>9</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>0</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

2.3.7.2 Instructional Approaches and Curriculum Employed

A chi-square test was carried out to see if there was an association between
Instructional Approaches (Setting Type) and Curriculum Employed. All expected
cell frequencies were not greater than five (i.e., the assumption was violated). It was
found that there was a significant association between instructional approach and curriculum employed in this study, $\chi^2 (16, N = 59) = 35, p = .004$. Of the participants who attended an ABA School, 75% employed the ERP.

Table 2.4. Instructional Approaches & Curriculum Employed

<table>
<thead>
<tr>
<th>Curriculum</th>
<th>ABA</th>
<th>TEACCH</th>
<th>Eclectic</th>
<th>Primary</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERP</td>
<td>21</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Jolly Phonics</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Reading Mastery</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Reader Series</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

2.3.7.3 Instructional Approaches and Curriculum Selection Procedures

A chi-square test was carried out to see if there was an association between Instructional Approaches and curriculum selection procedures. All expected cell frequencies were not greater than five (i.e., the assumption was violated). It was found that there was a significant association between instructional approach and curriculum selection procedure in this study, $\chi^2 (16, N = 57) = 26.43, p = .048$. Of the participants who reported employing an ABA approach, 7.4% relied on research, 33.3% relied on previous experience, 11% word of mouth and 44% selected a curriculum based on “it always has been used”. Of the participants who employ TEACCH, 20% relied on research, 0% relied on previous experience, 0% word of mouth and 80% selected a curriculum based on “it always has been used”.

61
Table 2.5 Instructional Approaches & Curriculum Selection Procedures.

<table>
<thead>
<tr>
<th>Curriculum Selection</th>
<th>ABA</th>
<th>TEACCH</th>
<th>Eclectic</th>
<th>Primary</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Previous Experience</td>
<td>9</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Word of Mouth</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Always Used</td>
<td>12</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

2.4 Discussion

The purpose of this exploratory research was to uncover information in relation to the most commonly used assessment procedures and reading curricula for children with ASD within Irish schools. Furthermore, it was aimed to assess the perceived effectiveness, suitability and utility (i.e., ease of implementation) of the reported curricula by educators. The outcomes of the survey found that there were a range of curricula utilised in schools, with ERP as the most commonly reported curriculum, as well as minimal use of CAI to teach or supplement reading abilities. A large portion of children with ASD were reported to have no reading abilities. Additionally, many educators relied on observation alone to identify reading difficulties reported to use no standardised reading assessment.

There was also a degree of uncertainty from educators in their ability to report on motivation of children to engage with the curricula, and also if the reading curricula was suitable for this population. This indicated that educators may be implementing reading curricula for children with ASD without confidence with
regard to how appropriate it is to meet their reading needs. Furthermore, in Chapter 1, the importance of motivation and reading outcomes were highlighted, however, the findings of the current study indicated that educators did not appear to know whether or not their students were motivated to participate in the reading curriculum.

The most commonly reported curriculum to teach reading skills was ERP. As ERP is based upon the principles of behaviour analysis, this finding may have been due to the high number of participants using ABA methodologies. However, educators reported there were core reading components not targeted by their curriculum employed, given that ERP was a commonly reported curriculum, it may not teach the necessary reading components. More specifically, they reported that the curriculum does not address reading fluency, phonics (decoding skills) or reading comprehension skills. Therefore, it may be necessary to supplement curricula employed with additional reading instruction or accommodations that target these skills or alternatively select comprehensive curricula that have the ability to target all core reading components. Just over half of participants (58%) were responsible for the delivery of reading instruction to school-age children with moderate levels of ASD. Despite this, the second most common curricula employed was Jolly Phonics®, a primary school curriculum for neurotypical children. Research has found that phonological awareness skills are below average in children with ASD (Smith-Gabig, 2010), therefore, this raises the question as to its suitability for children with developmental disabilities. This premise may be further supported with 15% of educators reporting that they were not sure if the curriculum they were employing was suitable for their children and a further 9% agreeing that it was not suitable. One way to determine the suitability of a curriculum would be to collect
data, or specifically utilise reading assessments regularly to determine if learning is occurring.

With regard to the selection of the curricula employed within settings, it was found that educators are not referring to research to inform their selection of the reading curricula for this population. Instead, findings from the current study indicate that educators are relying on experience, available resources and word of mouth from other educators for guidance on the selection. This is problematic as there could be potentially ineffective and unsuitable curricula being employed for these children, especially given their high academic needs. As a result, other, more effective and efficient means of instruction could be overlooked which denies these children access to the most effective resources. These results highlight the need for further research on effective curricula for children with ASD, and more effective dissemination of the findings to educators working in the field to ensure they can make informed choices with respect to the selection of reading curricula for their educational settings. The results indicate that CAI is under-utilised as a mode of reading instruction, despite the growing research-base (e.g., Knight, McKissick & Saunders, 2013). This means that educators are potentially overlooking a valuable means of instruction or supplementary instruction for their ASD learners. Chapters 4 and 5 of the current thesis will investigate table-top instruction and CAI that teach reading through the most common curriculum approach reported in the current study; the whole-word approach and the phonics approach.

Furthermore, participants indicated that 41% of children with ASD in their class(es) have no reading abilities. This is a worrying figure given the finding that the majority of educators employed their current reading curricula based on availability of resources in the school. This is not a valid rationale for the provision
of instruction to an at-risk population for reading deficits. Chapter 3 will investigate in more detail the levels of reading abilities in this population. Despite this, for the most part, participants agreed (67%) that children enjoyed and were motivated to use the curriculum employed. A further 75% (combination of agreement statements) reported its ease of use, along with the intention to continue its use into the future.

A large number (62%) of participants were not using any standardised reading assessments for children with ASD. This means that children were not being compared to the normative levels of reading standards of neurotypical children at their own chronological age. Instead, it was reported that participants used criterion-based assessments which provide a broader profile of reading. A further 30% of educators reported no use of any other types of assessment (e.g. assessment at the beginning, during or post reading intervention). This meant that only 8% if participants reported the use of reading assessment of any type. However, information yielded from reading assessments is important as it allows educators to monitor reading progress of their children and plan for future interventions, if necessary. On the other hand, due to the nature of ASD (e.g., communication difficulties), this may have impacted on the ability of educators to assess reading abilities. Typically, the design of reading assessments includes the requirements to not only to read words, but also to verbalise them. According to UK reports, it is estimated that approximately 25% of ASD children are nonverbal (National Autistic Society, 2013; Deweerdt, 2013). This presents a challenge for educators working with children with ASD who can be nonverbal in many cases (Arnold & Reed, 2016). Chapter 3 will implement a battery of standardised assessments to children with ASD to examine in more detail performances of reading abilities.
2.4.1 Limitations and Future Research

A limitation of this study was the low response rate with 60 responses to invitations to participate in the survey. A longer data collection period or direct emails to schools providing education to children with ASD may have rendered more participants. Despite this, there were still enough responses in order to conduct descriptive analyses and direct the course of subsequent studies. Another issue pertained to the responses, all responses reflect participant’s self-reports, and do not include direct observations of reading-related practices. For the purposes of generalisation, it is necessary to interpret the results with caution as social desirability may impact on responding specifically, the tendency for participants to respond to survey items in ways that make them appear in a positive light. However, this is the nature of surveys and is an issue in all survey research (Schutt, 2011), but this was less likely in the current survey as responses were confidentially reported. Additionally, since the Department of Education and Science (DES) has made changes to the provision of education for students with ASD, (outlined in a report in commission by the NCSE, 2016), specific ASD teaching approaches such as ABA were mentioned by only three settings within the report, and are more associated with special classes than in mainstream provisions. The numbers in ABA specific settings since the time of this survey’s administration may be significantly reduced. However, given that this was intended as a brief, exploratory survey to inform later studies, it was necessary to balance information required, against the time taken to ensure satisfactory response rates. Finally, given that the Chi-square Test violated the assumption of cell counts greater than five, results may not be valid and must be interpreted with caution.
2.4.2 Conclusion

In conclusion, the findings of the current survey indicated that many children with ASD were reported by educators to have no reading skills. Furthermore, educators mainly utilised a whole-word reading approach (ERP) as the main reading curriculum, using CAI as a supplement with only minor learning elements (or not at all).

It would be useful to explore in more detail the exact levels of reading abilities in children with ASD along with characteristics (i.e., autism severity and language levels) that may be associated with reading performances. Chapter 3 aims to fill this gap by using direct, standardised reading assessments of children from pre- to post primary school age. Chapter 4 will examine how effective the ERP curriculum is in teaching reading abilities in children with ASD and therefore may provide some research for educators with regard to their future selection of this curriculum. As results from the current study indicated that there was minimal use of CAI, Chapter 4 will also investigate the efficacy of print based curricula versus computerised presentations in order to provide more information on the respective utility of each. Chapter 5 will further provide insights into the use of CAI in terms of the instructional accommodations necessary, different facilitators and print motivation.
Chapter 3:

An Analysis of Reading Abilities in Children with Autism Spectrum Disorder
3.1 Introduction

Proficient reading ability is considered one of the single most important outcomes in a child’s education (Anderson, Hiebert, Scott & Wilkinson, 1985). The Education for Persons with Special Educational Needs Act in 2004 specified that children with special educational needs should be educated, wherever possible, in an inclusive environment and as a result, an increasing number of children with Autism Spectrum Disorder (ASD) are educated within regular classrooms. Research investigating effective interventions with school-aged children with ASD tends to focus on improving central deficit areas associated with the disorder; namely, communication and social skills (Ramdoss et al., 2011; Scheips, Reid, Behrmann & Sutton, 1998). Independence into adulthood requires abilities beyond social and communication skills, specifically reading skills. Reading is a pivotal skill which can expand learning opportunities, adaptive living skills, future employment, and improve general quality of life (Lyon, 2001; Grigorenko, 2011).

3.1.1 Reading Development

A number of skills are required to read a sentence ranging from recognizing each individual letter, letter group, whole-word recognition, through to understanding the intended meaning of the text (Nation, Clark, Wright & Williams, 2006). In early school years, children typically learn to decode unknown words, recognize sight words, read connected text with some fluency and comprehend simple sentences (Kittle, 2013). In later years, reading becomes more complex, focusing on expanding vocabulary and grammatical concepts. In order to comprehend text, the reader requires certain pre-requisite skills. These are multi-faceted skills, which include the following; proficient oral language skills, adequate
vocabulary, make inferences from text, relate text to prior knowledge, and the ability to integrate all of these skills together.

3.1.2 Emergent Literacy

An important period for reading development is in early childhood (Neuman, Copple & Bredekamp, 2000). Neurotypical children as young as 2 years-of-age demonstrate emergent or pre-reading behaviors. These emergent reading behaviors include print awareness (letters and words have meaning), oral language skills (recite rhymes and letters) and print conventions (knowledge of book orientation, turning pages of a book; Davidson & Weismer, 2014). Historically, reading instruction was not provided for individuals with ASD based upon the premise that pre-requisite skills were deficient within this population. However, more recently, research has begun to investigate emergent reading skills in this population (Davidson & Weismer, 2014; Dynia, Brock, Logan, Justice & Kaderavek, 2016; Dynia, Brock, Justice & Kaderavek, 2017; Lanter, Williamson, Erickson, & Freeman, 2012; Lanter et al., 2013). Westerveld (2016) conducted a systematic review to investigate emergent literacy skills of preschool children with ASD. Results found three studies (Davidson & Weismer, 2014; Dynia et al., 2014; Lanter et al., 2012) which indicated that children with ASD tend to have comparable alphabet knowledge to their neurotypical peers, however, they lag behind in print-concept knowledge, vocabulary, and phonological awareness (Dynia et al., 2014). The authors also noted that there seems to be a common subset profile of heterogeneity across emergent-literacy skills (Davidson & Weismer, 2014). Finally, they found that performances of emergent literacy seem to be associated to deficits related to ASD, such as language (Dynia et al., 2014; Lanter et al., 2012, McIntyre et al., 2017a), cognition and social skills (Davidson & Weismer, 2014). Subsequent research has also
emerged indicating that children with ASD are unlikely to acquire print concept knowledge at the rate of their neurotypical peers (Dynia et al., 2016). Existing research show that prior to starting school, children with ASD already face difficulties in pre-reading skills (Ricketts, 2011; Westerveld, 2016), this highlights the importance of investigation in this area, however, relative to research in school-aged children, research is scant.

3.1.3 Variability and Challenges in Reading Skills in ASD

Previous research in reading abilities in children with ASD have reported varied results (Griswold, Barnhill, Smith-Myles & Simpson, 2002; Jones, et al., 2009; Mayes & Calhoun, 2006; Nation et al., 2006). Researchers have suggested that reading abilities are highly correlated with language skills (Bishop & Snowling, 2004; Catts & Kamhi, 2005, McIntyre et al., 2017a), as well as with ASD symptom severity (Aberg et al., 2010; Estes et al., 2011; Jones et al., 2009; Norbury & Nation, 2011, McIntyre et al., 2017; Ricketts et al., 2013; Westerveld, 2017). Since one of the core deficits associated with a diagnosis of ASD is a delay in language development, it is therefore not surprising that associations between poor language skills and poor reading skills have been demonstrated (e.g., Gabig, 2010, Kjelgaard & Tager-Flusberg, 2001; Lucas & Norbury, 2014; Miniscalco & Sandberg, 2010). Therefore, this population may be at considerable risk of reading delays or difficulties. Other challenges in acquiring reading skills may be associated with difficulties integrating information in context (Hill & Frith, 2003) and deficits in phonological skills (Gabig, 2010), all of which are necessary for reading. Conversely, other researchers have identified individuals with ASD as showing typical word reading skills (Gabig, 2010; Nation et al., 2006; Newman et al., 2007).
3.1.4 Comprehension Difficulties in ASD

In general, decoding and comprehension skills develop simultaneously; however, this may not be the case for children with developmental disorders (Nation & Norbury, 2005). One of the most common reading profiles reported for children with ASD is that of advanced word reading or decoding abilities but poor reading comprehension (Frith & Snowling, 1983; O Connor & Klein, 2004). This has been referred to as a hyperlexic profile (Silverberg & Silverberg, 1967; 1968). Hyperlexia is the ability to recognize written words in advance of age and cognitive functioning (Richman & Kitchell, 1981; Silberberg & Silberberg, 1967). A number of studies indicate that this hyperlexic reading profile exemplifies children with ASD (Huemer & Mann, 2010; Newman et al., 2007; O’ Connor & Klein, 2004; Williams, Goldstein, & Minshew, 2006) with approximately 5-10% of individuals with ASD being characterized as hyperlexic (Burd & Kerbeshian, 1985).

3.1.5 Factors that Influence Reading Skills

Previous research has contributed to the understanding of reading patterns within this population (e.g., Leytham et al., 2014; May et al., 2015; Nation et al., 2006; Reutebuch et al., 2015). However, these studies consist of specific diagnostic inclusion criteria and relatively small samples sizes; thus, narrowing the selection of participants and creating difficulties in generalizing findings across the broader spectrum of ASD. Research has been relatively sparse in providing information on reading abilities of children with ASD with language and cognitive skills below the average range. Previous literature on reading skills have only included children with an IQ of ≥75 consistent with the profile of Higher-Functioning Autism (HFA; Aberg et al., 2008; Jacobs & Richdale, 2013; McIntyre et al., 2017a; McIntyre et al., 2017b; Minshew et al, 1994; Nation et al., 2006; Solari et al., 2017). Furthermore, other
studies require pre-requisite reading skills in advance of analyses. For example, Frith and Snowling (1983) excluded participants who did not demonstrate reading skills at an age appropriate level. Additionally, McIntyre et al., (2017a) excluded all participants that had a co-occurring diagnosis or medical disorders other than ASD (e.g. epilepsy, sensory or motor impairments). These exclusions may result in an over-estimation of reading ability within this population (Nation, 2006).

3.1.5 Aims of the Present Study

The current study aims to extend the currently knowledge on reading abilities in students with ASD in three ways. Firstly, it includes a larger sample than all other known literature on this area. Secondly, there are no exclusions based on cognitive levels of functioning, which makes for a more representative sample, as comorbidity estimates are over 70% in the ASD population, with an additional 41% having two or more comorbid diagnoses (Simonoff et al., 2008). Finally, there is a wider range of reading components considered that includes, decoding skills, accuracy of reading connected text, vocabulary and reading rate. Group performances on all measures were examined to determine patterns of reading strengths and weakness. This included a sample of children from early childhood through to school age to identify variables that are associated with reading components, specifically, age, language and severity ASD symptoms.

To date, the research published on the analysis of reading abilities in children with ASD, who present with language and cognitive skills below the average range in addition to co-morbid diagnoses, is limited. This study therefore, represented an exploratory approach to clarifying the core reading components impacting reading performance in this cohort and establishing the relationship between reading performance, language ability and autism symptomatology.
3.2. Method

3.2.1 Participants

One hundred and twenty-six individuals with ASD were recruited through schools and preschool services for children with ASD. Large portions of the sample (80%) were not accessing reading curricula appropriate to their chronological age (as reported by respective teachers). Diagnoses of ASD were completed by licensed psychologists independent of the study, using the DSM-IV (APA, 1994) or DSM-IV-TR (APA, 2000) criteria. Participants were included in the study if they could vocally echo a minimum of two words (this was to ensure reading skills were detectable) and presented with a diagnosis of ASD. Of the 126 participants, 14 were excluded from the study, as they did not meet the minimum echoic language level. A further two participants had no measurable levels of reading component skills (i.e., they did not score on the letter knowledge, word reading or phonological awareness despite meeting initial vocal inclusion criteria). These participants were also excluded from further analyses. The final sample included 110 participants, twenty-five of which presented with a diagnosis of ASD alone. The remaining 85 participants presented with a co-occurring disability (see Table 3.1 for a summary) and participants’ co-occurring diagnoses were unobtainable. The available information on participant diagnosis was attained from review of their most up to date psychological reports from their respective services and schools. Participants attended settings that provided education through Applied Behaviour Analysis (\( n = 79 \)) and mainstream school services with ASD units that provided education through an eclectic teaching model (\( n = 31 \)). There were 97 males and 13 females, with a mean age of eight years (range: 3:10–17:3 years) and all participants were of Caucasian ethnicity. The sample was divided into two groups by age: with 45
participants in Group 1 (age range: 3:10-5:10 years) and 65 participants in Group 2 (age range: 6:00-17:3 years).

Table 3.1 Co-occurring Disabilities with Autism Spectrum Disorder ($N = 85$)

<table>
<thead>
<tr>
<th>Co-occurring disability</th>
<th>$N$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intellectual Disability</td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>19$^a$</td>
</tr>
<tr>
<td>Moderate</td>
<td>30$^b$</td>
</tr>
<tr>
<td>Intellectual Disability &amp; Epilepsy</td>
<td>4$^a$</td>
</tr>
<tr>
<td></td>
<td>3$^b$</td>
</tr>
<tr>
<td>Dyslexia</td>
<td>2</td>
</tr>
<tr>
<td>Dyspraxia</td>
<td>4</td>
</tr>
<tr>
<td>Intellectual Disability &amp; Obsessive Compulsive Disorder</td>
<td>1$^a$</td>
</tr>
<tr>
<td>Obsessive Compulsive Disorder</td>
<td>1</td>
</tr>
<tr>
<td>Intellectual Disability &amp; Down Syndrome</td>
<td>1$^b$</td>
</tr>
<tr>
<td>Down Syndrome</td>
<td>1</td>
</tr>
<tr>
<td>Intellectual Disability &amp; Oppositional Defiance Disorder</td>
<td>1$^b$</td>
</tr>
<tr>
<td>Oppositional Defiance Disorder</td>
<td>1</td>
</tr>
<tr>
<td>Sensory Processing Disorder</td>
<td>1</td>
</tr>
<tr>
<td>Sight impairment</td>
<td>1</td>
</tr>
<tr>
<td>Anxiety Disorder</td>
<td>1</td>
</tr>
<tr>
<td>Unknown*</td>
<td>14</td>
</tr>
</tbody>
</table>

*Data for co-occurring disabilities were unobtainable

$^a$Mild Intellectual Disability, $^b$Moderate Intellectual Disability
3.2.2 Measures

Four reading measures were utilized to assess six reading components/skills: word reading, phonological awareness, reading rate, comprehension, non-word decoding and vocabulary. Measures of language and ASD symptom severity were also administered to both groups. The specific assessments administered to the children were dependent upon the group to which they were assigned according to their age.

Pre-reading skills of children in Group 1 were assessed using the Wechsler Individual Achievement Test, Second UK Edition (WIAT-II; Wechsler, 2005), which assessed word reading and the Dynamic Indicators of Basic Early Literacy Skills, 6th Edition, (DIBELS; Good & Kaminski, 2002; 2007) to assess phonological awareness and letter knowledge. Reading skills of children in Group 2 were assessed using WIAT-II, the Neale Analysis of Reading Ability, Second Edition (NARA-II; Neale, 1997; Neale, 1999), the Expressive One-Word Picture Vocabulary Test, Fourth Edition (EOWPVT-4; Martin & Brownell, 2011), and DIBELS.

3.2.2.1 Preschool Language Scale- 4th Edition

Language skills were evaluated using the Preschool Language Scale, Fourth Edition (PLS-4; Zimmerman, Steiner & Pond, 2002). The PLS-4 is an individually administered test designed to identify auditory comprehension and expressive communication in children from birth to 6:11 years of age. It consists of two subscales to assess receptive and expressive language. The test-retest stability coefficients ranged between .82 and .95 for the subscale scores and .90 to .97 for the Total Language Score (Zimmerman, Steiner & Pond., 2002).
3.2.2.2 Social Communication Questionnaire

The Social Communication Questionnaire (SCQ; Rutter, Bailey & Lord, 2003) is a brief 40-item questionnaire used to screen children for ASD. A score of 1 is given for the presence of a particular abnormal behavior and 0 for its absence. The total score ranges from 0-39. Internal consistency reliability of the SCQ was .90 (Berument et al., 1999) suggesting excellent internal consistency. It provides information about the child’s movements, use of language, gestures and interaction styles. The SCQ total score yields an optimal cut-off score of 15 for predicting a diagnosis of ASD, however, scores can also be used to compare overall levels of ASD symptomatology. The lifetime form, which addresses a child’s entire developmental history, was administered in this study.

3.2.2.3 Wechsler Individual Achievement Test

Word reading and non-word decoding were assessed using the Wechsler Individual Achievement Test, Second UK Edition (WIAT-II; Wechsler, 2005). The Word Reading subtest requires participants to name letters, identify and generate rhyming words, identify initial sounds in words, match sounds with letters and letter blends, and read aloud from a graded word list. Non-word decoding assesses the ability to apply phonetic decoding skills to pseudo-words. The individual is asked to read aloud a list of nonsense words designed to mimic the phonetic structure in the English language. This item has strong inter-item consistency within subtests, with average reliability co-efficient ranging from .80 to .98 and strong inter-scorer reliability between pairs of scores ranging from .94 to .98 across ages, with an overall reliability of .94 (Wechsler, 2005). This assessment tests individuals between the ages of 4:00-85 years.
3.2.2.4 Neale Analysis of Reading Ability II

Reading accuracy, reading comprehension and reading rate were assessed using the Neale Analysis of Reading Ability, Second Edition (NARA-II; Neale, 1997; Neale, 1999). The NARA-II is a widely used attainment and diagnostic test requiring individuals to read aloud a series of short passages and then answer a set of open-ended questions after each passage. The NARA-II provides reading ages and standardized scores for two parallel sets of passages based on a fully representative UK sample (Neale, 1997). The assessment tests individuals aged between 6:00-12:11 years of age.

3.2.2.5 Expressive One-Word Picture Vocabulary Test

Vocabulary was tested using the Expressive One-Word Picture Vocabulary Test, Fourth Edition (EOWPVT-4; Martin & Brownell, 2011). The test consists of 190 developmentally sequenced items based on a normative sample. It has a high degree of reliability for internal consistency, ranging from 0.93 to 0.97 for the various age groups, with a median of 0.95 across all ages (Martin & Browell, 2011). The test-retest correlation for raw scores is 0.98 and 0.97 for standard scores (Martin & Browell, 2011) and tests individuals between the ages 2:00-80 years.

3.2.2.6 Dynamic Indicators of Basic Early Literacy Skills

Phonological awareness was assessed using the Dynamic Indicators of Basic Early Literacy Skills, 6th Edition, (DIBELS; Good & Kaminski, 2002; 2007). This measure encompasses phonemic awareness which is slightly different to phonological awareness, as it is specific to small differences in word sounds, whereas phonological is a broader terms that includes the different ways in which words function (e.g., segmenting words). Participants were required to identify and segment sounds in spoken words, and name letters of the alphabet. All tests in the
DIBELS were conducted in 60-second timings to calculate fluency levels. This included First Sound Fluency (FSF), Phonemic Segmentation Fluency (PSF) and Letter Naming Fluency (LNF). The median concurrent validity of single DIBELS probes with the Woodcock-Johnson Broad Reading cluster were .36 for FSF, .56 for PSF, and .75 for LNF.

3.2.3 Assessment and Scoring Protocols

Many standardized tests are interpreted with reference to the scores of a normative sample (standardized based on the performance of typically developing children; Adamovich, Chapey & Larkins, 1987). More specifically, in standardized assessments, participant’s scores are determined based on a child’s raw score on a test and the child’s chronological age at the time of testing. For children with autism, chronological age and scores on a test often do not correlate. This was particularly the case in this study; as participants were unable to access age-appropriate curricula. As a result, it was considered acceptable to: (i) use standardized measures that were developed for children with a lower chronological age, namely the PLS-4 and NARA-II, and (ii) to use raw scores, rather than age normative scores, for our statistical analyses (Demouy et al. 2011; Moran, Stewart, McElwee & Ming, 2014; Rosenberg, 2008).

3.2.4 Procedure

Assessments were individually administered to participants by the first author, and took place in the participant’s school or home setting (depending on parental preference). The SCQ was given to a parent/caregiver to complete. The assessments took approximately 50 minutes per participant to complete and were presented in a single session. Breaks were allowed as necessary, for example, if a participant appeared restless (i.e., moving in seat or shifting of attention to
something unrelated to the assessment task) or if participants used their preferred mode of communication to request a break.

3.3 Results

Data were analyzed to evaluate reading skills of the whole sample \((n = 110)\). A second phase of data analysis was conducted to determine reading skills according to groups (Group 1; \(n = 45\) and Group 2; \(n = 65\)). Table 3.2 summarizes the dependent variables for the whole sample (i.e., Groups 1 and 2 together) displaying mean reading abilities, language scores and autism severity scores across the sample. The mean total language score for the whole sample was 66.46 \((SD = 29.59)\) and the mean autism severity score as measured by the SCQ was 20.58 \((SD = 9.84)\). As a whole sample, reading scores were within the lowest ranges of achievable score on sub-components of standardized assessments (frequently referred to as floor effects). Over 82% of the sample met the floor effects for reading comprehension. Over half of the sample (52%) showed scores of reading accuracy of connected text that were 2 \(SDs\) below age normative. Similarly, non-word decoding fell 2 \(SDs\) below age normative scores, and vocabulary was scored 1 \(SD\) below population averages.

Phonological awareness skills were shown to be severely deficient in the sample; FSF and PSF had floor levels of 62% and 67% respectively for the whole sample. Some 21% of the group showed reading rate skills of 1 \(SD\) below age normative scores with a further 31% scoring 2 \(SDs\) below the norm. Almost half of the sample (41%) showed reading rate skills within the average range with standard scores ranging between 85 and 115. A further three participants (5%) showed reading rate scores that were at least 1 \(SD\) above the average population. Under 15% \((n = 8)\) of the sample scored within average ranges of reading accuracy and 31% were in
average ranges for vocabulary scores, (13% were 1 SD and 48% were 2 SDs or more below the norm).

Analyses for each participant grouping were subsequently conducted. Participants in Group 1 were assessed on basic pre-reading skills using the WIAT-II reading sub-component Word Reading, EOWPVT-4 subcomponent of expressive vocabulary and DIBELS subcomponents FSF, LNF, and PSF. PSF scores were below average ranges for word reading ($M = 83, SD = 31$). Scores for vocabulary were just below average ranges ($M = 82, SD = 18$). Performances on the phonological awareness tasks were impaired with a mean score of 2.84 ($SD = 5.7$) for FSF and a mean score of 1.25 ($SD = 3.5$) for PSF. Letter naming (LNF) was higher with a mean score of 9.54 ($SD = 13.6$).

Reading comprehension was assessed only in Group 2 (age 6 years and above), as instruction in comprehension begins in typical educational settings at this chronological age. Severe deficits in reading comprehension were demonstrated across this group, with only three out of the 51 participants (5%) scoring within the typical ability range. Ninety-eight percent of the sample showed deficits in reading comprehension, with standard scores falling at least 1 SD below population norms. The largest deficits in reading skills were demonstrated in reading comprehension with 42 of the 51 participants (82%) obtaining the lowest possible standardized score for this item meeting floor levels of this assessment (score of 69; see the score range 69-130 with a mean score of 70). A further 9% ($n = 5$) showed standard scores that were at least 1 SDs below population norms. Word reading was slightly stronger with 16 participants (17%) demonstrating word reading in typical ranges. Five participants (5%) demonstrated word reading scores 1 SD above population norms with a further one participant showing word reading scores 2 SDs above the average
population. Furthermore, 12 participants (23%) scored within average ranges of reading accuracy (i.e., reading words in a connected text).
Table 3.2 Performance of reading skills, language and autism severity for different age groups

<table>
<thead>
<tr>
<th>Assessments (test range)</th>
<th>Component</th>
<th>ASD all ages</th>
<th>Group 2</th>
<th>Group 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>Range</td>
<td>M (SD)</td>
<td>Range</td>
</tr>
<tr>
<td></td>
<td>N = 110</td>
<td>3.10-17.30</td>
<td>N = 65</td>
<td>6.00-17.3</td>
</tr>
<tr>
<td></td>
<td>Age 8.10</td>
<td></td>
<td>10.5</td>
<td></td>
</tr>
<tr>
<td>SCQ*</td>
<td>Test range (0-39)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ASD severity</td>
<td>20.58 (9.84)</td>
<td>3-37</td>
<td>24.37 (7.66)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WIAT-II</td>
<td>Word Reading (40-160)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Word reading</td>
<td>65.56 (28.35)</td>
<td>40 – 146</td>
<td>50.48 (12.86)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pseudoword decoding</td>
<td>64.53 (19.41)</td>
<td>50 – 97</td>
<td>64.53 (19.41)</td>
</tr>
<tr>
<td>NARA-II Test**</td>
<td>Test range (69-130)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accuracy (text)</td>
<td>76.41 (10.45)</td>
<td>69-109</td>
<td>76.41 (10.45)</td>
</tr>
<tr>
<td></td>
<td>Accuracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reading Comprehension</td>
<td>71.05 (5.95)</td>
<td>69-98</td>
<td>71.05 (5.95)</td>
</tr>
<tr>
<td></td>
<td>Comprehension</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reading Rate</td>
<td>86.49 (16.55)</td>
<td>69-130</td>
<td>86.49 (16.55)</td>
</tr>
<tr>
<td>DIBELS</td>
<td>FSF (0-60)</td>
<td>3.30 (6.33)</td>
<td>0-27</td>
<td>3.6 (6.7)</td>
</tr>
<tr>
<td></td>
<td>Phonemic awareness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LNF (0-110)</td>
<td>22.46 (26.45)</td>
<td>0-109</td>
<td>31.04 (29.4)</td>
</tr>
<tr>
<td></td>
<td>LNF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PSF (0-80)</td>
<td>4.89 (10.80)</td>
<td>0-55</td>
<td>7.4 (13.1)</td>
</tr>
<tr>
<td></td>
<td>Phonological awareness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test</td>
<td>Subtest</td>
<td>Score (SD)</td>
<td>55-128</td>
<td>55-112</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------</td>
<td>------------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td><strong>EOWPVT-4</strong></td>
<td>Vocabulary</td>
<td>73.31 (18.91)</td>
<td>19-128</td>
<td>66.68 (19.0)</td>
</tr>
<tr>
<td></td>
<td>Auditory</td>
<td>60.89 (12.68)</td>
<td>53-100</td>
<td>55.44 (2.57)</td>
</tr>
<tr>
<td></td>
<td>Expressive</td>
<td>60.00 (13.05)</td>
<td>55-118</td>
<td>55.00 (.00)</td>
</tr>
<tr>
<td><strong>Total Language score (55-185)</strong></td>
<td>Total language</td>
<td>66.46 (29.59)</td>
<td>55-182</td>
<td>56.45 (7.95)</td>
</tr>
</tbody>
</table>

*SCQ- cut off score for ASD is a score of 15 **Tests for children aged 6 years and over.
Table 3.3 and 3.4 displays a matrix of correlations of reading components, language and autism severity for each respective group. Pearson product-moment correlation coefficients were calculated to assess relationships between comprehension, language scores, autism severity, reading rate, reading accuracy, word reading, non-word reading and vocabulary. Scores on measures differed widely from those expected at chronological age with extremely high standard deviations and floor effects (Demouy et al. 2011). As this is an atypical population, and given that a high number of participants scored in the lowest possible range of standard scores, raw scores were used in place of standard scores to examine individual variation.
Table 3.3 Group 1 Correlation Co-efficients for Reading Components Language and Autism Severity.

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. FSF</td>
<td>-</td>
<td>.532**</td>
<td>.643**</td>
<td>.272</td>
<td>.461**</td>
<td>-.140</td>
<td>.353</td>
</tr>
<tr>
<td>2. LNF</td>
<td>-</td>
<td>.440**</td>
<td>.293</td>
<td>.554**</td>
<td>-.081</td>
<td>.376*</td>
<td></td>
</tr>
<tr>
<td>3. PSF</td>
<td>-</td>
<td>.268</td>
<td>.401**</td>
<td>-.269</td>
<td>.409*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Vocabulary</td>
<td>-</td>
<td>.287</td>
<td>-.636*</td>
<td>.569**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Word Reading</td>
<td>-</td>
<td>-.212</td>
<td>.232</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Autism Severity</td>
<td>-</td>
<td>.636*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Total Language</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3.4 Group 2: Correlation coefficients for reading components, language and autism severity

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>8</th>
<th>9</th>
<th>10</th>
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</tr>
</thead>
<tbody>
<tr>
<td>1. FSF</td>
<td>-</td>
<td>.327*</td>
<td>.449**</td>
<td>.408</td>
<td>.505**</td>
<td>.431**</td>
<td>.454**</td>
<td>.365**</td>
<td>.229</td>
<td>-279</td>
<td>.465**</td>
</tr>
<tr>
<td>2. LNF</td>
<td>-</td>
<td>.323**</td>
<td>.604**</td>
<td>.407**</td>
<td>.085</td>
<td>.276</td>
<td>.309*</td>
<td>.122</td>
<td>.476**</td>
<td>.519**</td>
<td></td>
</tr>
<tr>
<td>3. PSF</td>
<td>-</td>
<td>.418*</td>
<td>.563*</td>
<td>.160</td>
<td>.123</td>
<td>.226</td>
<td>.225</td>
<td>.546**</td>
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<td></td>
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<td>4. Vocabulary</td>
<td>-</td>
<td>.638**</td>
<td>.315</td>
<td>.547**</td>
<td>.585**</td>
<td>.394*</td>
<td>.847**</td>
<td>.832**</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>5. Word Reading</td>
<td>-</td>
<td>.541**</td>
<td>.651**</td>
<td>.536**</td>
<td>.418**</td>
<td>-664**</td>
<td>.535**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Comprehension</td>
<td>-</td>
<td>.478**</td>
<td>.345*</td>
<td>.402*</td>
<td>-.157</td>
<td>.362</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Accuracy</td>
<td>-</td>
<td>.500**</td>
<td>.675**</td>
<td>-.246</td>
<td>.596**</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>8. Rate</td>
<td>-</td>
<td>.262</td>
<td>-.383</td>
<td>.762**</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>9. Non-word reading</td>
<td>-</td>
<td>-.198</td>
<td>.503**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Autism Severity</td>
<td>-</td>
<td>.568**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Language</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. **Correlation is significant at the 0.01 level *Correlation is significant at the 0.05 level
Reading Abilities in Children with ASD

Inspection of these data for Group 1 revealed that there was a strong and medium, statistically significant correlation between language and (i) vocabulary \( (r = .56, p < 0.01); (ii) \) PSF \( (r = 0.40, p < 0.5); (iii) \) LNF \( (r = .38, p < 0.05) \), and as anticipated there was a strong negative correlation between language and autism severity (measured using the SCQ). There was also a strong and significant correlation between word reading and; (i) LNF \( (r = .54, p < 0.01); (ii) \) phonemic awareness \( (r = .46, p < 0.01) \) and (iii) vocabulary \( (r = .40, p < 0.01) \). There were also strong correlations between phonemic awareness and (i) PSF \( (r = .64, p < 0.01); (ii) \) LNF \( (r = .53, p < 0.01) \) and (iii) word reading \( (r = .46, p < 0.01) \). Finally, there was a strong negative and statistically significant correlation with SCQ and vocabulary \( (r = .57, p < 0.01) \).

The additional reading components (reading accuracy, comprehension and rate and non-word reading) were added to Group 2 due to the ages of participants. Due to the high statistically significant correlations, these additional components were reported; see Table 3.4 for additional correlations. There were strong/medium and statistically significant relationships between reading accuracy and (i) word reading \( (r = .65, p < 0.01); (ii) \) non-word reading \( (r = .67, p < 0.01); (iii) \) language \( (r = .59, p < 0.01); (iv) \) rate \( (r = -.50, p < .01); (v) \) comprehension \( (r = .48, p< 0.01); (vi) \) phonemic awareness \( (r = .45, p < 0.01 \) and (vii) vocabulary \( (r = .55, p < 0.01) \). There were strong/medium and statistically significant correlations between reading comprehension and: (i) word reading \( (r = .54, p < 0.01); (ii) \) accuracy \( (r = .48; p < 0.01) \); (iii) phonemic awareness \( (r = .43, p < 0.01); (iv) \) non-word reading \( (r = .40, p < 0.01) \) and (v) rate \( (r = .34, p < .01). \) There were statistically significant correlations between reading rate and (i) language \( (r = .72, p < 0.01); (ii) \) vocabulary \( (r = .58, p < 0.01); (iii) \) word reading \( (r = .54, p < 0.01); (iv) \) phonemic awareness \( (r = 36, p < \)
0.01); and (v) LNF ($r = .31$, $p < 0.01$). There were also strong/medium statistically significant correlations between non-word reading and (i) accuracy ($r = .67$, $p < 0.01$); and (ii) language ($r = .50$, $p < 0.01$); word reading ($r = .42$, $p < 0.01$); and (iv) vocabulary ($r = .39$, $p < 0.01$).

Word reading and reading rate were the highest scoring reading outcomes whereas reading comprehension and FSF (phonemic awareness) were the lowest scoring outcomes of the current research, therefore, four Standard Multiple Regressions were conducted to examine if particular profiles of children (age, language and autism severity scores) predicted these reading outcomes.

### 3.3.1 Predictors of Word Reading

The first multiple regression was conducted to examine the influence of language, age, reading rate, autism severity and vocabulary on word reading. The multiple regression model statistically significantly predicted word reading, $F (3, 32) = 7.93$, $p < .01$, adj. $R^2 = .427$. Regression coefficients and standard errors can be found in Table 3.5. Age and autism severity were significant predictors for the outcome variable word reading had a $β = -.351$, $t = -2.42$, $p = .021$ and $β = -.543$. $t = -3.62$, $p = .001$.

**Table 3.5 Summary of Standard Multiple Regression of Word Reading**

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>Error B</th>
<th>$β$</th>
<th>$ΔR^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-2.55</td>
<td>1.050</td>
<td>-.351*</td>
<td>.427*</td>
</tr>
<tr>
<td>Language</td>
<td>-.264</td>
<td>.144</td>
<td>-.275</td>
<td></td>
</tr>
<tr>
<td>ASD Severity</td>
<td>-1.55</td>
<td>.430</td>
<td>-.541***</td>
<td></td>
</tr>
</tbody>
</table>

**Note.** *$p < .05$. **$p < .01$. ***$p < .001$.**
3.3.1.2 Predictors of Phonemic Awareness

The second multiple regression was conducted to examine the influence of language, age, and autism severity on phonemic awareness. The multiple regression model did not statistically significantly predict word reading, $F(3, 32) = 1.40, p > .05$, adj. $R^2 = .033$. However, autism severity was a significant predictor for the outcome variable FSF had a $\beta = -.378$, $t = -2.03$, $p = .050$. Regression coefficients and standard errors can be found in Table 3.6.

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>Error B</th>
<th>$\beta$</th>
<th>$\Delta R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>.185</td>
<td>.291</td>
<td>.114</td>
<td>.033</td>
</tr>
<tr>
<td>Language</td>
<td>-.024</td>
<td>.040</td>
<td>-.114</td>
<td></td>
</tr>
<tr>
<td>ASD Severity</td>
<td>-.243</td>
<td>.119</td>
<td>-.378*</td>
<td></td>
</tr>
</tbody>
</table>

Note. *$p < .05$. **$p < .01$. ***$p < .001$.

3.3.1.3 Predictors of Reading Rate

The third multiple regression was conducted to examine the influence of language, age, and autism severity on reading rate. The multiple regression model statistically significantly predicted word reading, $F(3, 12) = 4.07, p < .05$, adj. $R^2 = .505$. Age and Autism severity were significant predictors for the outcome variable with a $\beta = .506$, $t = 2.03$, $p = .040$ and $\beta = -.650$, $t = -2.86$, $p = .014$. Regression coefficients and standard errors can be found in Table 3.7.
Table 3.7 Summary of Standard Multiple Regression of Reading Rate

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>Standard Error B</th>
<th>β</th>
<th>ΔR²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>.185</td>
<td>.291</td>
<td>.114*</td>
<td>.033*</td>
</tr>
<tr>
<td>Language</td>
<td>-.024</td>
<td>.040</td>
<td>-.114</td>
<td></td>
</tr>
<tr>
<td>ASD Severity</td>
<td>-.243</td>
<td>.119</td>
<td>-.378*</td>
<td></td>
</tr>
</tbody>
</table>

Note. * p < .05. **p < .01. ***p < .001.

3.3.1.4 Predictors of Reading Comprehension

The final, multiple regression was conducted to examine the influence of language, age, autism severity on reading comprehension. The multiple regression model statistically significantly predicted reading comprehension, $F(5, 10) = 3.402, p < .01$, adj. $R^2 = .445$. Age was the only significant predictor for the outcome variable reading comprehension with a $\beta = -.796, t = -3.65, p = .003$. Regression coefficients and standard errors can be found in Table 3.8.

Table 3.8 Summary of Standard Multiple Regression of Reading Comprehension

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>Standard Error B</th>
<th>β</th>
<th>ΔR²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>.168</td>
<td>.211</td>
<td>.168</td>
<td>.428*</td>
</tr>
<tr>
<td>Language</td>
<td>-.059</td>
<td>.029</td>
<td>-.449</td>
<td></td>
</tr>
<tr>
<td>ASD Severity</td>
<td>-.315</td>
<td>.086</td>
<td>-.796**</td>
<td></td>
</tr>
</tbody>
</table>

Note. * p < .05. **p < .01. ***p < .001.
3.4 Discussion

The findings of the current study demonstrated that all of participants within the sample had at least one severely impaired reading component skill. Reading comprehension was the most severely impaired with 82% of participants in Group 2 meeting the lowest possible score on the assessment. Phonological awareness was also severely impaired with 62% of the entire sample scoring within the lowest possible range. There were relative proficiency in other reading components, namely vocabulary and early word reading for Group 1 and reading rate for Group 2. Concurrent analyses revealed the high inter-relationships with many components as well as language and autism severity. Further analyses revealed that autism severity predicted reading outcomes.

3.4.1 Reading Abilities.

3.4.1.1 Word Reading

Early word reading skills, were just below the average range for Group 1. It must be noted that this measure assesses pre-requisites to word reading only (i.e., letter knowledge). Decoding of whole words was not measured, as this would not be expected at the given chronological age. This relatively high score in word reading supports previous research (Davidson & Weismer, 2014; Dynia et al., 2014; 2016) demonstrating strengths in alphabetic knowledge (i.e., pre-requisites to word reading). However, word reading for Group 2 was significantly below the average, which contrasts with other literature (Gabig, 2010; May et al., 2014, Nation et al., 2006). This suggests that although the pre-requisite skills for word reading may be emerging, this does not necessarily predict later ability word reading abilities. This indicates that word reading is an area that needs continued support and intervention.
in educational settings. Further research is needed to examine longitudinal reading development in children of ASD, which would assess maintenance of reading skills.

3.4.1.2 Reading Comprehension

Group 2 presented with significant deficits in reading comprehension as measured by the NARA-II, which supports the findings of previous research (Nation et al., 2006; Newman et al., 2007). Unlike previous research (e.g., Nation et al., 2006), the sample in the current study did not reflect the hyperlexic profile (Grigorenko, Klin & Volkmar, 2003; Richman & Kitchell, 1981; Saldaña, Carreiras & Frith, 2009;) as only a small percentage of participants demonstrated average/above average scores in word reading abilities and reading accuracy (4% and 21% respectively) alongside reading comprehension difficulties. Although there are no definite criteria for hyperlexia, word reading abilities in the present sample were not strong enough to be considered “precocious” or above average. This suggests reading interventions should target both on word reading abilities and reading comprehension.

3.4.1.3 Phonological Awareness

Phonological awareness skills (inclusive of phonemic awareness) were impaired for entire sample. This finding supports previous research (e.g., Dynia et al., 2017; Gabig, 2010; Heimann, Nelson,). As phonological awareness is important for reading development (Mann, 1984; Stanovich, 1985), this indicates early difficulties in pre-requisite reading skills as well as deficits that continued into later years. Language scores were also below average for both groups, suggesting a relationship between phonological awareness and language ability (as indicated by correlation analyses). This relationship highlights the importance of early language skills interventions and incorporating explicit phonological awareness instruction
from early years with children with ASD (e.g., Hudson et al., 2017). Considerations for educators include the administration of assessments consisting of simple tasks in phonological awareness to quickly identify those at risk of reading difficulties in this area. Educators should also be selecting curricula that includes phonological awareness, as according to Dynia et al. (2017), it may be even more important for young children with ASD than for children without disabilities.

3.4.1.4 Reading Rate

An interesting result was the high scores in reading rate, as measured by the NARA-II. Just under half of the participants (41%) scored within average ranges, with three participants performing above average range (i.e., standard score of 115 and above; despite begin within the chronological age-range of the test). Many studies have shown strong correlations between oral reading fluency and reading comprehension (e.g., Fuchs et al, 2001; Kim et al., 2012). It would appear that participants in this sample were relatively fluent in decoding words; however, by definition, fluency requires both accuracy and speed (Binder, 1996). The calculation of reading rate in the current study did not account for word reading inaccuracies; therefore, this does not exemplify fluent reading behavior. Given the concurrent difficulties in reading comprehension, the finding of high reading rate in addition to poor reading accuracy may indicate that children with ASD may read with speed but simultaneously experience word reading errors, which may ultimately lead to a loss of meaning of the text. This suggests that intervention in accuracy of reading connected texts as well as reading words out of context is necessary.

3.4.1.6. Vocabulary

Vocabulary (i.e., expressive vocabulary) scores were relatively high in the current sample. As vocabulary skills are essential to reading comprehension, this is
a promising finding. One possible explanation for this may be that the assessment itself is expressive, rather than receptive vocabulary, as tested by the EOWPVT-4. This assessment process involved the presentation of coloured pictures and participants were required to name the item shown. There was no functional use of the target picture required (i.e., the task only requires the phonological reproduction of the word outside of the context of reading). Developmentally, the ability to tact (verbal behavior under the control of nonverbal stimuli; Skinner, 1957) is one of the early targets in language and verbal development (Sunberg & Partington, 1998). Interventions for children with autism frequently teach language in the context of a single skill arrangements (e.g., Lovaas & Smith, 2003) and as many participants in the current study were in receipt of ABA intervention, this may underlie this relatively high score. Although many studies have shown the strong correlation between vocabulary and reading comprehension (Nagy, 1988; Nelson-Herber, 1986), the results of the current research suggests that expressive vocabulary (i.e., vocabulary out of context) is insufficient to derive meaning from text. Future studies should also assess receptive vocabulary, as this could provide more information about links to poor reading comprehension and vocabulary.

3.4.2 Relationships and Predictions across Reading Components.

Correlation analyses demonstrated the complexity and inter-relations of variables in reading as well as other covariates (i.e., language and severity of ASD symptoms). The strong association between language and reading components supports previous research (Davidson & Weismer et al., 2014; Dickinson et al., 2010; Jacobs & Richdale, 2013; McIntyre et al., 2017; Storch & Whitehurst, 2002; Tager-Flusberg & Joseph, 2003), which demonstrated that poor language skills predicted poor reading abilities. Furthermore, the strongest negative correlation with
reading components for both groups included vocabulary and autism severity. This suggests the potential benefit of administering language assessments that include measures of vocabulary prior to beginning reading instruction. This would allow the identification of students at risk of developing reading difficulties and offers opportunities to remediate such deficits prior to beginning reading instruction, especially for children with more symptoms of ASD.

Multiple regression analyses demonstrated the influences between autism severity and reading components of word reading, reading comprehension, reading rate and phonemic awareness. The current research support previous research indicating that reading is negatively associated with ASD and symptom severity (Åsberg et al., 2010; Estes et al., 2011; McIntyre, Solari, Gonzales et al., 2017; McIntyre, Solari, Grimm et al., 2017; Norbury & Nation, 2011; Ricketts et al., 2013). This study benefited from a larger sample as well as a broad range of ASD profiles (co-morbid diagnoses), suggesting that educators must take into account the profile of their learners in terms of ASD symptom severity. The negative influence of age and reading also indicated that as children get older, their rate of reading decreases, supporting previous research (Solari et al., 2017; Whalon, Otaiba & Delano, 2009) that highlights the importance of fluency instruction on reading development.

3.4.3 Limitations

Although this is one of the first studies to examine reading skills in a large population of children with ASD with minimal exclusionary criteria, limitations in the research include the absence of an IQ measure. These scores may have allowed further analyses of the associations of reading deficits in terms of cognitive functioning. With regards to the regression analyses, variance predictors (i.e., age,
autism severity and language) only accounted for a small percentage of the variance in reading scores. Perhaps the remainder of the variance could be accounted for by participant’s levels of IQ. There was also no age-matched neurotypical group for comparisons. This group may have provided a useful sample from which to compare specific reading and language abilities. However, since standardized reading and language tests were used, this allowed comparisons to a normative sample to a certain degree. A large portion of the sample (77%) had at least one co-occurring diagnosis; these concurrent diagnoses may contribute to the deficits observed in reading components (Vivanti, Barbaro, Hudry, Dissanayake & Prior, 2013). Consequently, as ASD is highly linked with co-occurring disabilities (Wing & Gould, 1979), this study, and indeed other studies may not demonstrate an accurate representation of reading abilities in the ASD population as a whole. Future research in reading abilities should include data on participants that have no reading skills, and analyze exceptional profiles (e.g., hyperlexia), as well as synthesise how concurrent diagnoses may affect reading abilities.

3.4.4 Conclusion

This study included a large sample size, which examined reading skills of children with ASD and highlighted the necessity of early assessment for reading difficulties. It can be concluded that children with ASD presented with severely impaired reading skills, as well as some relative proficiency in a small number of reading sub-components, however this proficiency appeared to reduce with age and/or as reading complexity advances, children are at risk of falling behind in many areas, (most notably, reading comprehension). It is therefore important to design intensive reading interventions that match the specific learners’ reading profile. The severe deficits in phonological awareness and language skills are consistent with
other research (e.g., Dynia et al., 2017; Gabig, 2010; Whalon & Hart, 2011) indicating that these reading pre-requisites are not present in this population, both in early and later reading stages. This indicates there may be a lack of focus on strategic instruction targeting phonological awareness and language comprehension in the early years of education (Whalon & Hart, 2011).

Overall, the findings from the present study expand the understanding of the severe reading deficits that are prevalent across children with ASD by its large sample size and inclusion of those with co-morbid diagnoses. Results also emphasize the possibility of identification of these deficits based on ASD profiles and emergent reading skills prior to formal reading instruction. In summary, educators are challenged with developing sufficient reader abilities in their ASD students in addition to focusing on language development. It is clear that more intensive reading instruction is necessary for those with more severe symptoms of ASD in order to overcome risks of reading deficits in this population.
Chapter 4:

The Edmark® Reading Programme: A Comparison of Computerised and Table-Top Presentation in Reading Outcomes in Children with Autism Spectrum Disorder
4.1 Introduction

Children with ASD are considered an “at-risk” group regarding reading difficulties (Frith & Snowling, 1983), which was supported by the results of Chapter 3, demonstrating that reading skills are greatly defected in this population. It is therefore critical to find effective and evidence-based curricula to teach this core academic skill. However, identifying appropriate instructional techniques that match specific curricular goals can be difficult for teachers of children with ASD (American Psychiatric Association, 2013) and it may prove a challenge to select effective curriculum to teach reading skills. This was highlighted in Chapter 2, with the findings identifying that many different types of reading curricula are used for children with ASD.

The use of technology, namely CAI, has become more widely applied to the treatment of individuals with ASD within classroom settings. CAI may increase levels of engagement, as computers by nature are predictive which may appeal to children with ASD and be beneficial by providing highly systematic instruction for children with disabilities (Ellis & Sabornie, 1986). With regard to reading, research has shown that CAI is an effective instructional approach for children with ASD to increase reading skills such as; word reading, (Yaw et al., 2011) phonics, (Whalen et al., 2010) and reading comprehension (Khowaja & Salim, 2013). However, the findings from Chapter 2, found that CAI was minimally used for academic instruction, with over 53% of the sample (teachers for children with ASD) reporting an absence of its use. Given the rise in popularity of technological devices, in addition to highlighting the potential of CAI, the authors (Yaw et al., 2011; Whalen et al., 2010; Khowaha & Salim, 2013), have called for caution in the use of CAI to teach academic
skills as more research is needed to carefully consider its effects, as well as the cost and effectiveness of CAI.

As more and more children with ASD are receiving reading instruction in general education classrooms, they are likely to receive phonics-based instruction; a method of teaching that focuses on the acquisition of letter-sound correspondences. However, Mirenda (2003b) noted that the decontextualized nature of traditional phonics instruction makes it extremely difficult for mastery of this sub-component skill in children with ASD. Conversely, the whole-word recognition approach has frequently been used to teach children with ASD basic reading skills (Forbes et al., 2013; Mulè, Volpè, Fefer, Leslie & Luiselli, 2015). Teaching via this method provides children with a see-say approach, whereby the child reads the whole word based upon the topography of the written word. As found in Chapter 2, the Edmark® reading programme (ERP; Tague, Kidder, & Bijou, 1967; Pro-Ed, 2011) was shown to be the most prevalent reading curriculum in Irish schools for children with ASD with over 65% of teachers reporting its use. Despite this, since the initial validation studies of ERP in the late 1960’s, (Bijou, Birnbauer, Kidder & Tague, 1966; Birnbauer, Kiddler & Tague, 1964; Birnbauer, Bijou, Wolf & Kiddler 1965), research on the effectiveness of ERP has been scant. Therefore, there is a necessity for additional research on the specific outcomes of ERP and to date, research has not examined its effects in relation to children with a diagnosis of ASD, nor has it examined the 2nd edition of ERP which now comes in full colour (as per the CAI presentation). ERP is currently available in two formats: a hardcopy delivered through table-top instruction (TTI) and software (CAI).

Notwithstanding the growing prevalence of CAI being used to teach literacy skills in many educational settings (Mirenda, 2003b), there is currently no research
Comparison of TTI and CAI Presentations

on the CAI version of ERP with neurotypically developing children, or those with
disabilities, including ASD. Nevertheless, some researchers have begun
comparisons of many forms of CAI versus teacher-led instruction across various
academic targets (El Zein et al., 2016; Williams, Wright, Coughlan & Callaghan,
2002).

The current research aims to add to the existing body of research by
examining the effects of ERP in teaching core reading components (word reading,
non-word reading accuracy, reading rate, reading comprehension, phonemic
awareness, and vocabulary) in children with ASD. Secondly, the research intends to
compare whether CAI is more effective than a print-based format in teaching these
same core reading skills to children with ASD by comparing the two formats of
ERP. Finally, this research aims to assess teacher’s and children’s perceptions on
TTI and CAI instruction through the completion of social validity measures. For the
purposes of this research, the printed presentation of the ERP curriculum (second
edition; the book-based presentation) is referred to as table top instruction (TTI) and
the computerised form of the same curriculum is referred to as CAI.

4.2 Method

4.2.1 Ethical Considerations

Full ethical approval for this study was granted by the Research
Ethics Committee at the National University of Ireland, Galway on September 25th,
2015. Consent forms were emailed to teachers and were returned to the PI, ahead of
screening for inclusion.

4.2.2 Sample and Participants

Eighty-five children were recruited and screened for inclusion of the study.
Participants were included for intervention if they presented with, i) reading levels
Comparison of TTI and CAI Presentations

below age normative scores on the Neale Analysis of Reading Ability-II; ii) a
diagnosis of autism spectrum disorder, which met the criteria outlined in the
Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American
Psychiatric Association, 1994), by a clinical psychologist; iii) language skills
sufficient to participate i.e., vocal-verbal skills consisting of two word imitation, as
tested on the by the oral expression subtest of the Wechsler Individual Achievement
Test (WIAT-II; Welscher, 2006); iv) the ability to respond accurately to 10 one-step
directions (e.g., “touch your nose”) based on a specific list developed by the
principal investigator which were verbally administered to each participant. This skill
ensured that participants had the receptive ability to follow the verbal instructions in
the programme; and v) equal to or below 70% correct responding on the target words
of the ERP programme, as tested on the Edmark® Mastery Test (EMT; Edmark,
2011).

Of the 85 children screened, 49 did not meet the inclusion criteria. Of the 33
participants that met inclusion criteria 2 participants failed to complete the target
intensity of the study due to behavioural issues unrelated to the current study. The
final sample included 31 participants (26 males and five females) ranging in age
from 4:10-18:00 years (mean = 8:09 years, SD = 3.1) took part in the study. The
mean language score was 46 (SD = 10.3) and mean ABIQ was 94 (SD = 14.1).
Clusters of participants (schools) were randomly assigned to either, the TTI
condition or the CAI condition. The TTI condition included 16 participants and the
CAI included 15 participants. All children in the CAI condition could independently
navigate the mouse (i.e., move the mouse in all directions and accurately clicking on
target icons) therefore additional teaching was not necessary for computer skill
development. Participants in the TTI condition had a mean age of 8:00 years, a
mean language score of 45, and a mean ABIQ (abbreviated IQ) score of 55. Participants in the CAI condition had a mean age of 9:07 years, a mean language score of 47, and a mean ABIQ score of 55. Further information on individual participant’s age, ABIQ, language scores, and educational setting are provided in Table 4.1 for each group.
### Table 4.1 Ages, Language, ABIQ Scores and Educational Settings of TTI and CAI Group.

<table>
<thead>
<tr>
<th>Table Top Instruction Group</th>
<th>Computerised Assisted Instruction Group</th>
</tr>
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<tbody>
<tr>
<td>Age</td>
<td>CELF-4 Language</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>9.5</td>
<td>40</td>
</tr>
<tr>
<td>11.2</td>
<td>40</td>
</tr>
<tr>
<td>7.1</td>
<td>56</td>
</tr>
<tr>
<td>6.7</td>
<td>44</td>
</tr>
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<td>7.11</td>
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<tr>
<td>7.2</td>
<td>70</td>
</tr>
<tr>
<td>6.11</td>
<td>46</td>
</tr>
</tbody>
</table>
4.2.3 Setting

Participants were recruited from eleven co-educational schools across Ireland. The school settings included; i) ASD units within mainstream schools ($n = 12$); ii) special schools for children with ASD ($n = 15$); or iii) attended a mainstream school and received additional support (one hour per day) from a resource teacher ($n = 4$), see Table 4.1. Participants within units in mainstream schools and special schools completed ERP in their regular classroom. Each classroom consisted of a maximum of six other children and contained cabinets, children’s desks, a teacher’s desk and a group instruction table. For the TTI group, 1:1 instruction was delivered to the participant at the rear of the classroom while the class worked on other tasks whereby paraprofessionals attended to other children in the classroom at this time. Participants in the CAI condition completed lessons either on the PC within the classroom, ($n = 12$) or in a PC lab with their teacher ($n = 3$). CAI participants wore headphones to prevent distraction of other children. Teachers ($n = 19$) were qualified primary school teacher with a Bachelor of Education degree.

4.2.4 Experimental Design and Assignment to Groups.

A between-group design was used to evaluate ERP-TTI ($n = 16$) or ERP-CAI Groups ($n = 15$). Schools (clusters of participants) were randomly allocated to each respective group. Both groups received treatment-as-usual (TAU) in terms of academic literacy instruction as well as the ERP, which included typical classroom instruction and additional learning support classes. In the various settings, learning support classes were typically conducted three times per week in small groups of four to five children for 30 minutes. These classes consisted of additional supplemental instruction in reading which was designed by the learning support teacher and based on individual child’s needs, in line with recommendations from
the Department of Education and Science (DES, 2000).

4.2.5 Materials

4.2.5.1 Edmark® Reading Programme (ERP), Level 1.

ERP (either presented via CAI or TTI) was employed for the purposes of this study. ERP is a whole word reading programme that aims to expand word-discrimination repertoires by teaching the recognition of words as single written symbols that represents an entire word or phrase without indicating its pronunciation. ERP uses systematically progressive teaching opportunities, presented as trials, to rotate instruction across listener (pointing) and speaker (textual) responses. The curriculum specifies contingent reinforcement to be presented on a continuous reinforcement schedule, with each correct response resulting in social reinforcement (i.e., praise) or tangibles (on a more intermittent schedule). Both versions of this programmed instruction aim to teach identical target words and phrases, along with beginning comprehension skills in an identical sequence, with only the medium of instruction varying by table-top or computer.

4.2.5.1.1 Table Top Instruction (TTI)

The second edition of ERP became commercially available in 2011. The complete programme includes eight components; i) word recognition books (consisting of 153 lessons in total); ii) picture-match cards and corresponding boards, iii) phrase match cards and corresponding boards; iv) three story books, v) lesson record books, vi) mastery tests, vii) display masks, and viii) word-sign DVDs. The general protocols of the TTI presentation were as follows: each participant receives a lesson record book, which is a supplemental outline of lessons, for recording participants’ progress of the programme across the various instructional activities. Typically, teachers administer the lessons in sequence to each participant in 1:1
Comparisons of TTI and CAI Presentation

ratios (teacher: child), although it may be conducted in small groups. For the purposes of the current study, all lessons were delivered within a 1:1 participant-teacher ratio.

Word recognition lessons consisted of the presentation of single words, which the participants were required to read, or a multiple choice of words and non-words which required a selection response upon the teacher’s antecedent instruction. The teacher placed the display-mask, which contained a transparent window displaying only the target word, words or a sentence, over the lesson page. See Figure 6 for a display sample of a word recognition lesson. Teachers selected the correct antecedent (verbal instruction) to deliver during instruction by the code (symbol) in left-hand column of each line. Based on the teachers’ instruction, participants were required to make either multiple choices or read-back responses. For multiple-choice selections, participants pointed to the correct word. For read-back lines, the participant read aloud the word, phrase or sentence. In each lesson, the new target word appeared on a line that was indicated with dashed lines, (e.g. --- spoon ---). Participants were repeatedly exposed to similar instructions in each lesson, such as; “see”, “point to” and “read”. As outlined, teachers provided contingent reinforcement in the form of verbal praise, for all correct responses on an FR1 schedule. Conversely, if participants selected an incorrect word on a multiple-choice line, the teacher covered the incorrect response and allowed them to make to point to the correct word. If again, the participant made a second incorrect response, both incorrect responses were covered and, again, participants were allowed to select the one remaining response. If the participant did not a selection (point response), they were physically assisted by guiding his/her index finger to point to the correct word. On a sentence read-back line, the participant received the opportunity to read
the word or words independently. If the participant had difficulty, the words were blocked out (with the use of the teachers’ index and middle fingers) and the remaining words were read in isolation.

Figure 6. Sample lesson of ERP-TTI, Word Recognition lesson.

Across Level 1 of the curriculum, there are 39 picture-match boards numbered by lesson and 263 picture match cards which are numbered sequentially. Cards and boards to be used together are matched based on the colour on the reverse of the board and also indicated the card numbers to be issued with each lesson. For these picture-match lessons, participants were presented with picture cards. Teachers help the participant turn all the cards face up and lay on a table sorted into similar objects (e.g., different coloured cars together). Participants were then required to tact the picture, and match the picture card to a series of text (approximately 10 text options) on an A3 board. More picture cards were presented in lessons than text options, in order to prevent participants from completing the
activity via a process of elimination. Participants were given the opportunity to scan and select pictures independently and to self-correct or exchange a picture throughout the activity. See Figure 7 for a display sample of a picture match lesson. When the participant had made all of his or her responses (i.e. matched the pictures to all possible words on the board), the teacher corrected the responses. Participants received social praise for each correct match, on an FR1 schedule of reinforcement. If the participant emitted an incorrect response, the teacher gestured towards the target picture and removed it into a separate stack of “incorrect responses”. When all of the picture cards have been removed, and placed in the correct or incorrect stacks, the teacher re-presents all of the incorrect stack and prompting the participant to re-read and allowed a second chance to make the correct response, if again the incorrect text was chosen for the target picture, the teacher gestured to the correct location on the board. This correction procedure was repeated for all of the incorrect responses.

Figure 7. Sample of ERP-TTI, Picture Match lesson.
The reverse of materials of picture match lesson is the case for phrase match. Whereby participants were presented with an A3 sized board, representing coloured pictures and corresponding phrase match cards which were laid face up on the table. Participants were instructed to read each phrase card individually; they were required to scan the illustrations on the board and match the phrase to the illustration. See Figure 8 for a display sample of a phrase match lesson. Following the opportunity for the participant to independently place the phrase match cards onto the corresponding picture, the teacher reinforced (verbal praise, on an FR1 schedule of reinforcement) each correct match removing to “correct responses stack”. The correction procedure was identical to that of the procedure for the picture match activity.

ERP stories presented an opportunity for participants to practice the words they have learned through previous lessons in a “book” format. The publishers of ERP report that the aim of this task is to give a “sense of achievement” in reading and allow participants to “view themselves as readers” (Edmark, 2011). Presumably, this is achieved since participants contact contingencies of reinforcement by using words they have previously contacted into a different context. Stories are placed intermittently after lessons providing a total of 86 short stories that allowed for practice opportunities of mastered words from preceding lessons. Following the participants oral reading of the target story, teachers asked participants a series of brief questions in relation to the story. These questions are scripted and located at the end of each story.
Following a participant’s response, the teachers then provided corrective feedback of incorrect responses, and/or social praise for correct responses on an FR 1 schedule of reinforcement. Picture and phrase match lessons consisted of participants matching pictures and phrases to the corresponding word(s) or pictures, and teachers provide corrective feedback following each response. The usage measures reported in this study were reports from classroom teachers which were noted daily on individual record books that are supplied with the curriculum. Mastery criterion was set at 90% once, as recommended by the ERP programme (Edmark, 2011). Teachers calculated this manually and recoded the score within the individual record books by taking data on responses, then dividing the correct response by the number of learning opportunities per lesson. Duration data were collected by the use of stop watch or timer on the onset of the lesson and stopping the timer when the participant had completed the lesson for that session.
4.2.5.1.2 Computerised Assisted Instruction (CAI)

Edmark® Reading Programme software was the mode of instructing used for the CAI condition. This was installed onto classroom PCs ($n = 13$) or classroom laptops ($n = 2$) with the use of the ERP CD-ROM. Feedback was provided through an automated voice as part of the software, and additional sounds and animations for correct and incorrect responses were delivered on an FR1 schedule of reinforcement. See Figure 8 and 9 for a screenshot lesson samples. It included many salient learning features, enriched with colour and sound, e.g., an animation of a train engine introduces each lesson on comprehension. To control for reinforcement schedules across groups, similar to the teacher training on the curricular guidelines of ERP-TTI, ERP-CAI trials delivered reinforcement (signals and animations to indicate correct responses), on an FR-1 schedule of reinforcement. In a like manner, ERP-CAI corrections (re-presenting of trials and auditory signal to indicate incorrect response) were all delivered automatically.
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Figure 9. Sample screenshot of an ERP-CAI, Word Recognition lesson.

Figure 10. Screenshot sample of an ERP-CAI, Picture/Phrase match lesson.
During lessons, by default, a “Call Your Teacher” screen signalled for assistance after certain time points. More specifically, the alert signalled under the following conditions; i) at the end of each lesson; ii) after more than two minutes of inactivity; or iii) if there were more than four consecutive errors. When this signal appeared on screen, instruction was stopped necessitating teacher’s assistance to proceed with the current or subsequent lessons. Differential responding was necessary for this alert, dependent on the function of the alert for example; if the alert was signalled due to inactivity, it was necessary for teachers to prompt the participant back to the lesson with verbal instruction. If the alert was signalled due to errors, teachers were instructed to verbally repeat the onscreen instruction and provide the participant with an opportunity to respond. If no response was given, the teacher provided a gestural prompt towards the correct response.

Data from the programme’s automatic, computerised records provided information about usage of the product, including mastery criterion of no more than four errors within each lesson (90% per lesson). This included a printable record of dates, lessons complete, and data of correct and incorrect responding. However, this did not track the time the participants were logged on. Data on duration data was recorded manually by teachers. As per TTI condition, this was collected by the teacher starting a stop watch or timer on the onset of the lesson and stopping the timer when the participant had completed the lesson for that session, and were then noted daily on researcher developed, individual record books. See intervention section for more details of each curriculum’s delivery.
4.2.7 Measures

In addition to measures of reading, assessments of language (CELF-4) and abbreviated IQ (ABIQ) were conducted at baseline to allow for a more detailed description of participants.


The CELF-4 is an individually administered test designed to assess receptive and expressive language scores for individuals aged from 5 through 21 years of age. An evaluation of language ability can be determined from the test, as well as detection of language delays. The core language subtests yield an average standard score of language, as well as subtest scores for: Concepts and Following Directions (in which the participant point to pictured objects in response to oral directions); Word Structure (participants complete sentences using the targeted structures); Recalling Sentences (the participant imitates sentences presented orally by the examiner); Formulating Sentences (participants formulate sentences about visual stimuli using a targeted word or phrase); and Word Classes (in this two-part test, participants choose two related words and describes their relationship). The test-retest reliability scores range from .71 to .86 for subtests and .88 to .92 from composite scores based on the standardisation population. Internal consistency ranges from .69 to .91 for subtests and from .87 to .95 for composite scores (Pearson Assessment: technical report, 2008).
4.2.7.2 Stanford-Binet Intelligence Scales Fifth Edition Abbreviated Battery

(ABIQ: Roid, 2003)

The Abbreviated Battery IQ (ABIQ) scale of the Stanford-Binet Intelligence Scales Fifth Edition was used in this study and is suitable for individuals between the ages of 2 to 85 years of age. The ABIQ consists of two subtests; one nonverbal (object series/matrices) and one verbal (vocabulary). The non-verbal (object series/matrices) assesses what are referred to as “fluid reasoning skills”, including sequential reasoning and classic matrix items, where the individual selects the best alternative to complete a series or a matrix. The verbal subtests measure verbal knowledge, in particular, vocabulary. The reliability coefficient for the ABIQ is .91 (Johnson & D’Amato, 2004).

4.2.8 Dependent Measures

4.2.8.1 Wechsler Individual Achievement Test, (WIAT-II: Wechsler, 2005)

Word reading and non-word (pseudoword) decoding were assessed using the Wechsler Individual Achievement Test, Second UK Edition (WIAT-II; Wechsler, 2005). See Chapter 3 for a full description of this measure.

4.2.8.2 Neale Analysis of Reading Ability, Second Edition. (NARA-II; Neale, 1999)

Reading comprehension and reading rate was assessed using the Neale Analysis of Reading Ability, Second Edition (NARA-II; Neale, 1997; Neale, 1999). See Chapter 3 for a full description of this measure.
4.2.8.3 Expressive One-Word Picture Vocabulary Test, Fourth Edition

(EOWPVT-4; Martin & Brownell, 2011)

Vocabulary was assessed using the Expressive One-Word Picture Vocabulary Test, Fourth edition (EOWPVT-4; Martin & Brownell, 2011). See Chapter 3 for a full description of this measure.

4.2.8.4 Dynamic Indicators of Basic Early Literacy Skills- Next, (DIBELS; Good & Kaminski, 2002, 2011)

Phonemic awareness was assessed using the DIBELS- Next. All DIBELS tasks were timed for 1 minute; this included First Sound Fluency (FSF), Phonemic Segmentation Fluency (PSF) and Letter Naming Fluency (LNF). Phonemic awareness skills (the ability to hear and manipulate sounds in words) were assessed with the use of FSF and PSF tasks. The FSF assessment involved the examiner orally presenting a target word, the participants were then required to orally identify the first/ beginning sound of that word, e.g., moon = /m/. In the PSF task, the examiner orally presented words of three to four phonemes (individual sounds) and the participants were required to verbally produce the individual phonemes for each word. The assessment of LNF required participants to name upper and lower-case letters arranged in a random order. The median concurrent validity of single DIBELS probes with the Woodcock-Johnson Broad Reading cluster were .36 for FSF, .56 for PSF, and .75 for LNF (Good et al., 2004). These subtests are suitable for children aged 4 years and above as an indicator of basic early literacy skills.

4.2.8.5 Edmark® Mastery Test (EMT; Edmark, 2011)

The EMT is a criterion-referenced, nationally field-tested measure, designed to specifically assess the performance of participant using ERP (Edmark, Pro-Ed Inc., 2011). This test consists of four subtests; Discrimination, Picture/Phrase
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Match, Word Recognition, and Oral Reading, all of which closely mirror the instructional format of ERP. For the discrimination task, participants were asked to select, from four choices, the target word verbally presented by the examiner. In the picture/phrase match tasks, participants were required to select the sentence that best describes the accompanying picture. In word recognition lessons, participants read aloud a series of individual words. Finally, the task of oral reading requires participants to read aloud three short passages in a book-based format. When calculated together, the above tasks yield a mastery score of entire curriculum, while also indicating an optimal starting point, if used as a placement test. This instrument was used for formative and summative assessment.

4.2.9 Procedure

4.2.9.1 Pre-tests

The full battery of tests (including the EMT) were administered to participants within both groups, with testing sessions lasting approximately 60-90 minutes per participant. Assessments were generally delivered in parts, with two testing points (on the same day) to avoid fatigue. There was no additional feedback, for correct or incorrect responses during testing sessions. Participants were tested individually either in their classroom or in a room adjacent to their classroom. Classrooms consisted of a maximum of ten others including peers, paraprofessionals, and teachers. Within the room next to the classrooms, there were no other persons present except for the participant, the paraprofessional, and the PI. The individual test settings were noted for each participant and the PI ensured the post-testing sessions were conducted in the same setting. Participants were pre-tested in the winter 2015/ spring 2016.
4.2.9.1.1 Additional Participant Information

Language (CELF- 4; Semel, Wiig & Secord, 2003) and abbreviated IQ score (ABIQ; Roid, 2003) were conducted to gather information in relation to participant profiles, no post-tests were conducted with these measures.

4.2.9.1.2 Standardised Assessments

Four standardised reading measures were used to assess six reading components: word reading (WIAT-II), non-word decoding (WIAT-II), reading accuracy (NARA-II), reading rate (NARA-II), comprehension (NARA-II), phonemic awareness (DIBELS) and vocabulary (EOWPVT). All standardized measures and EMT were taken at pre- and post-exposure to ERP.

4.2.9.1.3 Placement on ERP lessons

The start-point in the lesson sequence in each condition was determined by conducting the EMT, which determined mastery of each word sets of ERP. There were a total of 15 word-sets, with approximately 10 words per set. Although this test is specifically designed for the TTI version of ERP, placement was also deduced for the CAI group based on the first unknown word set. This was possible as the sequencing of instruction for both TTI and CAI were the same (i.e. target words were taught in the same order). Based upon the EMT, some participants scored 70% or above of the word-sets ($n = 6$, TTI; $n = 3$, CAI; $n = 3$), however these participants demonstrated low scores (30% or below) on the comprehension components of the programme (picture and phrase match tasks). These six participants were given the opportunity to participate in the study by only completing the lessons that targeted these comprehension strategies. These comprehension lessons were clearly outlined in the ERP lesson plan, allowing teachers to easily identify the subsequent comprehension lesson for delivery.
4.2.10 Teacher Training

Teachers received specific training on CAI or TTI, depending on the experimental group participants were assigned to. The teachers were blind to the nature of the assessments as well as the research questions of the study, and each school participated in only one form of the intervention. Training protocols were similar for both groups of teachers, with the specific change only for the curriculum employed (see Appendix B). Teacher training comprised of a behavioural skills training model following a model-lead-test instructional format. The PI modelled each part of the ERP lesson procedures for the teachers, leading them through the procedures as a group, and finally assessing the teachers’ independent use of the procedure in dyads. This involved the PI demonstrating the instructional activities to the teachers and then the teachers engaged in role-playing the activities in pairs, with one acting as teacher and the other as the learner. There was no mastery criterion set for these tests; any errors following the training session were corrected within the fidelity checks throughout the intervention.

In addition to the training provided, a teacher protocol manual was developed by the PI and consisted of an 11-page booklet based on the ERP programme manual, which summarised all the key details and protocol (see Appendix B). It included an overview of the programme, key features of each lesson, sample scripts for the implementation, and correction procedures, as well as how to record participant data. Training was administered by the PI for two sessions per setting. The same content was repeated in both sessions to enable any absent staff to access the content and to refresh staff. Contact details of the PI were given to all teachers and continued support was available, if required. Two teachers from the CAI group required this support throughout the intervention, for the purposes of technical issues.
4.2.10.1 TTI Condition

Teachers \( n = 10 \) received onsite training in the administration of the curriculum. Paraprofessionals \( n = 4 \) were also invited to attend, with their roles to include observation only as they were not involved in the curriculum delivery in this study. Training comprised of a verbal presentation of the procedures and modelled the implementation of ERP (i.e., how to deliver word recognition lessons, picture match lessons, phrase match lessons and stories). In each participant’s lesson record book, teachers recorded correct and incorrect responses, as well as the date and time spent in the daily lesson.

4.2.10.2 CAI Condition.

Training methods for the CAI condition were identical to that in the TTI condition with the exception of materials (i.e., the computer software was used instead of the table-top materials). Training was conducted with teachers \( n = 9 \) and two paraprofessionals in the classroom or PC suite on the specific computer or laptop that the participant would be using. The PI modelled how to launch the programme and sign-in participants. Teachers were instructed to provide participants with the opportunity to progress through lessons independently, and to only attend to participants when the “Call Your Teacher” alert was indicated. The modelling and role play tests were conducted with the computer technologies within each classroom. Teachers were provided with notebooks for each participant and were instructed to record the time that participants logged on and off the CAI programme.
4.2.11 Intervention

4.2.11.1 Table Top Instruction; TTI.

ERP lessons were scheduled in participants’ daily timetable and were individually administered to each participant by classroom teachers within the respective settings. Each participant received a lesson record book which entailed an outline of each lesson and activity be administered per lesson, e.g., lesson 9 includes a picture match activity, in addition to a word recognition activity. Teachers recorded the date and time spent in the implementation of ERP alongside each sequential lesson, as well as correct and incorrect responses for calculations of lesson mastery criterion (i.e., 90% or above per lesson) in the lesson record book. If participants received a score of 90% or more, they progressed to the next lesson. If participants did not meet the criterion of 90%, they repeated the same lesson until criterion was reached. Participants received an average of one lesson per day (five days per week), for a period of 10 weeks (approximately one full school term), lessons lasted an average of 10 minutes in duration. A 10-week block was chosen as previous studies on reading behaviour have used similar intervention timeframes (e.g., Andersen et al., 1979; Clarified & Stoner, 2005; Conner et al., 2006; Flores et al., 2008; Meek, Martinez & Pienta, 2014; Williams et al., 2002). If participants were midway through a lesson after 10-minutes, the duration was extended to complete the lesson. Social praise from the teacher was provided for correct responses, no additional reinforcement contingencies were in place. Correction procedures were followed as outlined in the materials section.
4.2.11.2 Edmark® Reading Programme-Computerised Assisted Instruction; ERP-CAI.

The PI registered participant names along with the identified starting point, based on the EMT pre-tests. Participants were scheduled to complete one lesson per day at the same designated time in the class timetable. At that time, the teacher guided the participant to the computer and launched the programme, and recorded the time of login within the participant’s record book. An animated professor “host” character, introduced the programme. Following the brief introduction, participants were required to select their name from an onscreen dropdown box. Participants were then automatically directed to their correct lesson and presented with automated vocal instructions by which point, teachers started the timer. Participants independently competed lessons navigating the mouse and following these instructions. Teachers only intervened if the “Call Your Teacher” signal was alerted, in which participants’ were prompted back to the lessons, or given the assistance with the lesson (as described in materials section). During any of these times where teachers attended to the participant, paraprofessionals attended to the other children in the class. Each participant in the CAI condition received the same intervention dose as within the TTI condition (i.e., five days per week), for a period of 10 weeks (approximately) one full school term. As per the TTI condition, if participants were midway through a lesson after 10-minutes, the duration was extended just enough to complete the lesson. There were no additional reinforcement contingencies in place other than the automated feedback from the CAI itself. At the end of each lesson, teachers recorded the log-off time in the participants’ individual record book.
4.2.12 Procedural Fidelity

Fidelity checks were conducted by the PI in both conditions for a total of three visits to the 10 schools, each teacher was observed for a minimum of two lessons during each visit. The procedural checklist incorporated the teaching elements delivered during the teacher training sessions (see Appendix C). These same elements were also included in the teacher manual given to each school and available to teachers to refer to during the intervention sessions. As there were steps and procedures that differed from the TTI condition (i.e. 10 steps for TTI checklist and 8 for the CAI checklist); an alternate checklist was devised for the CAI condition. Teachers were directly observed on the occurrence and non-occurrence of each step on the checklist, e.g., teacher correctly gave the correct verbal antecedent cue; teacher correctly delivered the error correction procedure (TTI condition only). If fidelity fell below 100% for a teacher, correct implementation of the step was modelled by the PI, and teachers were provided with opportunities for questions.

4.2.13 Post-Tests

Four standardised reading measures (i.e., NARA-II, WIAT-II, EOWPVT-4 and DIBELS-Next) were used to assess seven reading components: word reading, non-word decoding, reading accuracy, reading rate, comprehension, phonemic awareness, and vocabulary following 10-week intervention for each participant. The EMT was also re-administered and the alternate form of the NARA-II was administered in post-testing. All other test administration was identical to pre-tests. Post-tests were undertaken in spring/ summer 2016, approximately three months later. All participants were given a researcher developed certificate of achievement (see Appendix D) for taking part in the study.
4.2.13.1 Social Validity

Following completion of the intervention phase, a questionnaire was used to assess user acceptability of the respective forms of ERP, and was administered to teachers (see Appendix E). The questionnaire entailed a 15-item rating-scales ranging from strongly disagree to strongly agree. This questionnaire was based on the Behaviour Intervention Rating Scale, developed (Elliott & Treuting, 1999). Questions focused on teacher’s perceptions of the programme, its utility, how it fitted into the classroom, how effective they thought it was, and their likelihood of re-using the programme. There was an open space provided for any additional comments from teachers. The same questionnaire was used for both the TTI and CAI condition.

A 10-item questionnaire (see Appendix E) was also devised for participants, which included seven statements, whereby participants were required to give a “Yes” or “No” response (with an option for “No Response”). The PI read the social validity questions to the participants and responses were recorded. Questions focused on; participants’ enjoyment of programme, whether they would like to continue its use, and if they find reading easier than before. There were three open-ended questions, which required participants to indicate their favourite and least favourite part of the programme. The questionnaire also presented an open-ended option (i.e., any further comments) to gather any other remarks the participants had on the curriculum. The same questionnaire was used for both the TTI and CAI condition.
4.3 Results

Differences between both ERP groups were analysed for the following: difference in age, language and ABIQ. Difference in lesson gains, early reading skills and overall efficacy of ERP in both formats (TTI and CAI) was assessed. Finally, reading sub-components were individually analysed in both conditions to assess differences from pre- to post-tests in both groups. Although other reading intervention have used similar sample sizes (e.g., Allor, Mathes, Roberts, Jones & Champlin, 2010; Asberg & Sandberg, 2010; Heimann, Nelson, Tjus & Gillberg, 1995; McTiernan, Holloway, Healy & Hogan, 2016), non-parametric analysis (Mann Whitney U-Tests and Wilcoxon Signed Rank) tests were conducted in addition to parametric analysis (i.e., a multivariate analysis of covariance, MANCOVA).

4.3.1 Differences in Age, Language and ABIQ

Three Mann Whitney U-tests were conducted to compare age, language, and ABIQ for both the TTI and the CAI groups. This test revealed no statistically significant differences in age between the TTI ($Mdn = 8.30$, range 7.0) and CAI ($Mdn = 8.70$, range 13.9), $U = .520$, $z = -.653$, $p = 5.14$. There was also no statistical significant differences in language between the TTI ($Mdn = 41$, range 30) and CAI ($Mdn = 40.0$, range 32), $U = .830$, $z = -.264$, $p = 791$. Finally, there were no statistical significant differences in ABIQ between the TTI ($Mdn =47.0$, range 54) and CAI ($Mdn = 47$, range 44), $U = .744$, $z = .702$, $p = .702$. This indicated that equal variance in age, language and ABIQ between groups can be assumed.
4.3.2 Efficacy of the ERP

For both groups, in relation to ERP combined, both TTI and CAI, there were no changes in mean word reading standard scores from pre-tests ($M = 65$, $SD = 19.3$) to post-tests ($M = 65$, $SD = 20.1$). In non-word reading there was a drop in one standard score from pre-test ($M = 68$, $SD = 12.1$) to post-test ($M = 67$, $SD = 11.5$). There was an increase in reading accuracy from pre-test ($M = 71$, $SD = 6.3$) to post test ($M = 75$, $SD = 10.9$) and there was also a slight increase in reading comprehension from pre-test ($M = 69$, $SD = 2.04$) to post test ($M = 70$, $SD = 6.02$). The highest increase in standardised tests was evident in reading rate with scores from pre-test ($M = 75$, $SD = 11.7$) increasing to ($M = 84$, $SD = 16.5$) at post-test. There were also increases in vocabulary from pre-tests ($M = 71$, $SD = 17.0$) to post-test ($M = 73$, $SD = 18.1$). There were very slight increases in First Sound Fluency (FSF) scores from pre-test ($M = 2.3$, $SD = 6.52$) to post-test ($M = 3.2$, $SD = 7.9$). Again, there were slight increases for PSF from pre-test ($M = 3.3$, $SD = 7.94$) to post test ($M = 5.0$, $SD = 9.8$). There were no differences in LNF from pre-tests ($M = 21$, $SD = 17.2$) to post-tests ($M = 21$, $SD = 18.0$). There were increases in the EMT assessment from pre-tests ($M = 31$, $SD = 30.2$) to post-tests ($M = 51$, $SD = 34.7$).

Wilcoxon Signed Rank Tests were conducted on each dependent variable of the whole sample from pre- to post- test. There were statistically significant increases from pre- to post- tests on the standardised measures of reading (non-word reading, reading accuracy, reading comprehension, reading rate, vocabulary and ERP words). See Table 4.2 for all of the Wilcoxon Signed Rank Test scores.
Comparisons of TTI and CAI Presentation

Table 4.2 Wilcoxon signed ranks of reading outcomes, ERP combined

<table>
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<th>DV</th>
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Note. \(*p < .05.**p < .01.***p < .001.

4.3.3 Lesson Gains

Both groups progressed through the reading programmes achieving mean gains of 50 lessons each, in the 10-week intervention period. Table 4.3 provides information on the mean number of lessons and minutes of exposure for each group. For both groups, the mean number totalled 512 minutes. When considered separately, the TTI group had mean lesson gains of 53 lessons and mean number of minutes was 505. The CAI group had a mean gain of 48 lessons with a mean of 518 minutes. A Mann Whitney U-test was conducted to compare lesson gains for both
groups. There were no significant differences in lesson gains between TTI ($Mdn = 50$, range 97) and CAI ($Mdn = 43$, range 83), $U = .475, z = -.786, p = .451$.

Table 4.3 Mean Number of Sessions, Lessons and Minutes Achieved by each Group.

<table>
<thead>
<tr>
<th></th>
<th>Minutes Mean (SD)</th>
<th>Range</th>
<th>Lesson gains Mean (SD)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>512 (16.8)</td>
<td>489-555</td>
<td>50 (29.2)</td>
<td>14-117</td>
</tr>
<tr>
<td>TTI</td>
<td>505 (11.9)</td>
<td>489-538</td>
<td>53 (31.5)</td>
<td>20-117</td>
</tr>
<tr>
<td>CAI</td>
<td>518 (18.5)</td>
<td>497-555</td>
<td>48 (26.9)</td>
<td>14-97</td>
</tr>
</tbody>
</table>

4.3.4 Comparison of Groups

To evaluate the effects of the programmes (TTI and CAI) on the early reading skills of participants, two types of analyses were conducted. A multivariate analysis of co-variance (MANCOVA) was conducted to compare the differences between the TTI and CAI groups on all reading dependent variables. Participants’ pre-test scores were used as the covariates in order to control for pre-existing differences for each group. Post-hoc analyses were also conducted for each variable using Wilcoxon Signed Rank tests to investigate statistical difference in scores from pre-and post-testing, for both the TTI and CAI groups.

The results of the MANCOVA for the combined effects of each group on reading sub-components (words reading, non-word reading and accuracy, comprehension, rate, vocabulary, phonemic awareness and EMT) were not statistically significant, $F (2.1, 10), \lambda = .179, \eta^2 = .783$. Table 4.4 summarises the adjusted mean performance for both groups on each dependent measure at both pre- and post-tests.
Comparisons of TTI and CAI Presentation

Table 4.4 Adjusted Mean Post-Test Scores for Reading Dependent Measures.

<table>
<thead>
<tr>
<th>DV</th>
<th>TTI Group</th>
<th></th>
<th></th>
<th>CAI Group</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>Std. Error</td>
<td>N</td>
<td>M</td>
<td>Std. Error</td>
</tr>
<tr>
<td>Word Reading</td>
<td>16</td>
<td>64.7</td>
<td>1.43</td>
<td>15</td>
<td>62.5</td>
<td>1.66</td>
</tr>
<tr>
<td>Non-Word Reading</td>
<td>15</td>
<td>68.2</td>
<td>.763</td>
<td>14</td>
<td>67.24</td>
<td>2.66</td>
</tr>
<tr>
<td>Accuracy</td>
<td>15</td>
<td>77.07</td>
<td>1.17</td>
<td>14</td>
<td>74.58</td>
<td>1.37</td>
</tr>
<tr>
<td>Comprehension</td>
<td>15</td>
<td>70.11</td>
<td>.942</td>
<td>14</td>
<td>72.35</td>
<td>2.92</td>
</tr>
<tr>
<td>Rate</td>
<td>15</td>
<td>89.9</td>
<td>2.55</td>
<td>14</td>
<td>76.3</td>
<td>2.97</td>
</tr>
<tr>
<td>FSF</td>
<td>16</td>
<td>5.75</td>
<td>1.08</td>
<td>15</td>
<td>1.22</td>
<td>1.26</td>
</tr>
<tr>
<td>LNF</td>
<td>16</td>
<td>25.14</td>
<td>1.01</td>
<td>15</td>
<td>22.90</td>
<td>1.18</td>
</tr>
<tr>
<td>PSF</td>
<td>16</td>
<td>7.192</td>
<td>1.73</td>
<td>15</td>
<td>3.927</td>
<td>2.01</td>
</tr>
<tr>
<td>Edmark Words</td>
<td>16</td>
<td>54.20</td>
<td>3.79</td>
<td>15</td>
<td>57.16</td>
<td>4.41</td>
</tr>
</tbody>
</table>

4.3.5 MANCOVA Significant Results for Individual Components

When considered separately, statistically significant differences between groups on post-test scores were found on the components of reading rate, reading accuracy (NARA-II; Neale, 1999), and the phonemic subcomponent- first sound fluency (FSF; DIBELS; Good & Kaminski, 2002). No significant differences were observed for the subtests of the word reading and non-word reading (WIAT-II; Wechsler, 2005), the subtest of comprehension (NARA-II; Neale, 1999), PSF and LNF (DIBELS; Good & Kaminski, 2002; 2007), vocabulary (EOWPVT; Martin & Brownell, 2011).
4.3.5.1 NARA-II

A significant difference was found between TTI and CAI groups on the Reading Rate subtest, $F(1, 58), \lambda = 8.90, p = .009, \eta^2 = .372$. The TTI Group scored higher than the CAI Group at post-test. A significant difference was found between the TTI and the CAI group on Reading Accuracy, $F(1, 74), \lambda = 5.38, p = 0.35, \eta^2 = .264$. The TTI group scored higher than the CAI group at post-test.

4.3.5.2 DIBELS

A significant difference was found between the TTI and the CAI group on First Sound Fluency subtest, $F(1, 63), \lambda = 5.40, p = 0.35, \eta^2 = .265$. The TTI Group scored higher than the CAI Group at post-test. There was a statistically significant increase in scores on the FSF subtest for the TTI Group from pre-test ($M = 1.68, SD = 4.64$) to post-test ($M = 3.68, SD = 8.59$), $t(15) = 1.40, p < .05$. The partial eta squared statistic (.15) indicated a small effect size.

A correction to control for multiple testing was not included in statistical analyses since it is recommended that corrections be used when investigators are searching for significant relationships but without pre-established hypothesis (Armstrong, 2014; Perneger, 1998). The current research investigated specific hypotheses outlined prior to data collection and statistical analyses.

4.3.6 Within-subjects analyses

Wilcoxon Signed Rank tests were conducted to evaluate the impact of dependent measures (word reading, non-word reading, reading comprehension, reading rate, phonemic awareness, vocabulary, and EMT) of participants’ from pre-testing to post-testing in each group. Statistically significant increases in reading performances were found in the TTI group on the following variables; Reading accuracy, reading rate, LNF, PSF and ERP words. Statistically significant increases
in reading performances were also found in the CAI group on the following variables, vocabulary and Edmark words. Table 4.5 summarises the results.
Comparisons of TTI and CAI Presentation

Table 4.5. Wilcoxon signed rank tests for TTI and CAI groups.

<table>
<thead>
<tr>
<th>DV</th>
<th>TTI Group</th>
<th>CAI Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$Z$</td>
<td>$Mdn$/Range 1</td>
</tr>
<tr>
<td>Word Reading</td>
<td>-0.700</td>
<td>59/82</td>
</tr>
<tr>
<td>Non-word</td>
<td>-6.42</td>
<td>68/57</td>
</tr>
<tr>
<td>Accuracy</td>
<td>-2.52</td>
<td>69/29</td>
</tr>
<tr>
<td>Comprehension</td>
<td>-1.826</td>
<td>69/11</td>
</tr>
<tr>
<td>Rate</td>
<td>-2.66</td>
<td>69/104</td>
</tr>
<tr>
<td>FSF</td>
<td>-1.09</td>
<td>0/15</td>
</tr>
<tr>
<td>LNF</td>
<td>-2.20</td>
<td>23/60</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>-1.18</td>
<td>70/49</td>
</tr>
<tr>
<td>PSF</td>
<td>-2.20</td>
<td>0/34</td>
</tr>
<tr>
<td>Edmark Words</td>
<td>-3.23</td>
<td>20/70</td>
</tr>
</tbody>
</table>

*Note. *$p < .05$. **$p < .01$. ***$p < .001$
4.3.7 Fidelity checks

A total of three visits (excluding pre- and post-testing visits) were made to each setting across the 10-week intervention period to conduct fidelity to intervention. During these visits, a minimum of two lessons were observed of teacher’s administration of the intervention. These checks accounted for 6% of participants’ sessions with fidelity accuracy scores for CAI of 97% and for TTI 88%. Fidelity was calculated by adding the number of correctly implemented step by the teacher, and dividing by the number of steps in total and multiplying by 100.

4.3.8 Social Validity

Thirteen teachers and 10 participants completed the questionnaire. Results from the social validity measures revealed that 80% of participants demonstrated positive attitudes/responses towards ERP, with 70% indicating that they would like to continue its use. Ninety present of teachers strongly agreed that ERP was an acceptable and effective intervention for children with ASD and would recommend its use to others. Two teachers noted that the programme established beginning reading abilities in participants; a skill that they once taught would never occur, and has also instilled confidence in participants. Conversely, another teacher indicated that attention rates were low with the use of the curriculum and some features were not clear enough for participants with ASD in the TTI condition. Some teachers in the TTI condition (n = 2) indicated that there were some refusals from participants to engage with the programme. It is important to note that these participants were ultimately excluded from analyses as they did not meet the criterion number of minutes of exposure. Moreover, two teachers from the TTI condition expressed an interest in switching from the TTI to the CAI condition.
4.4 Discussion

The current study demonstrated that ERP, both in its print and computerised format, successfully increased specific reading targets (i.e., target ERP whole words) as tested by the EMT of children with ASD. The study also demonstrated that when ERP was compared in its table-top (TTI) and computerised (CAI) format, that TTI was more effective in specific standardised reading components. More specifically, participants showed greater gains in; reading accuracy, reading rate, and first sound fluency within the TTI condition.

In relation to ERP combined (i.e., TTI and CAI), similarly to previous research (e.g., Andersen et al. 1979), there were no statistically significant findings for standardised reading components, although it must be noted that results were approaching significance in reading accuracy. Despite failing to reach statistical significance, gains were found in mean scores from pre- to post-tests for non-word reading, reading accuracy, reading comprehension, vocabulary, and phonemic awareness subtests, similar to results found by El Zein et al., (2016). Therefore, ERP demonstrated positive results in teaching many of the core reading components necessary in order to become an independent reader. Contrary to the findings of Williams, Wright Callaghan and Coughlan (2002), word reading (as measured by the WIAT-II) was the only standardised reading sub-component that made no gains from pre- to post-test. This result was surprising, as ERP is a whole-word reading curriculum focusing on teaching words out of context. Moreover, the format of the word reading protocol was in a similar presentation, i.e., assessing whole words out of context. However, apart from one word (i.e. the), words in this assessment do not overlap with the words taught in ERP. Similar to the study by Andersen et al. (1979), this would suggest that the ERP curriculum is effective only in teaching the
Comparisons of TTI and CAI Presentation

target words, and transfer or generalisation to other “non-criterion” words does not occur.

The second exploratory aim was to examine if CAI was more effective than its print counterpart (TTI), in teaching early reading skills (i.e., word reading, non-word reading, reading accuracy, reading rate reading comprehension, vocabulary and phonemic awareness). Despite much research suggesting that CAI is more suitable to children with ASD (e.g., Heimann, Nelson, Tjus & Gillbeg, 1995; Moore & Calvert, 2000; Pennington et al., 2010), the current research found that TTI was more effective in teaching some of the core reading skills to children with ASD, which is in line with the research from El Zein at al., (2016). These findings indicate that print-based presentation and the direct teacher delivery that may permit a superior format and for reading (both words out of context and connected text) rather than a computerised interface. Moreover, as FSF scores increased for the TTI group and not CAI, TTI may also facilitate phonemic awareness with personalised teacher-feedback, thus allowing for immediate correction of participant responses, e.g., mispronunciation of words. CAI does not allow for this corrective feedback, as the interactive functions do not extend to correction of oral responding in real time. As the impact of facilitators, it could have been an impact on the results; Chapter 5 will expand on this by examining the possibility of other such facilitators, i.e., parents, in the implementation of reading curricula.

Although not statistically significant, mean progression through lessons were slightly higher (mean lesson gain = 53) compared to CAI (mean lesson gain = 48). Although very small, this result is contrary to research suggesting that CAI is more effective in teaching reading skills than a book-based presentation (Williams, Wright & Coughlan, 2002) and supports the findings of El Zein et al., (2016). However, it
Comparisons of TTI and CAI Presentation

must be noted that it was found from teacher interviews post-intervention, that more refusals were evident from participants in the TTI condition. These participants were ultimately allowed to withdraw from the study and were not included in the analyses. Furthermore, as there were no instances of attrition or refusals in the CAI condition, this suggests that participants were more motivated when reading material was presented in a computerised format. Finally, teachers and participant’s perceptions of each instructional condition were also examined. Overall most teachers \((n = 12)\) found ERP to be very acceptable and effective in teacher reading skills to children with ASD and wished to continue its use in the future. Although overall reading results suggested that TTI was the most effective instructional presentation, it was interesting to note that some teachers in this condition expressed a desire to switch from the TTI to the CAI presentation.

4.4.1 Limitations and Future Research

By virtue of their presence in classrooms, participants were exposed to a range of educational interventions during the course of this study, some of which may have included instruction on literacy skill (e.g., phonics). Results should be interpreted with caution as they reflect ERP outcomes in addition to TAU, however as both TTI and CAI were exposed to TAU it is possible to draw conclusions from the results. The sample sizes was somewhat small for a group design and the absence of a control group (a third group of participants with ASD that had no exposure to either ERP-TTI or CAI) makes conclusions of the results more tenuous. Future studies would be more robust with more participants and the addition of a control group. Fidelity checks on teachers’ implementation of lessons were low (6% of lessons). This was largely due to the widespread geographical location of each of the settings.
4.4.2 Conclusion

While previous research has proven the efficacy of ERP with children with ID and typically developing children, none have examined ERP with children with ASD nor evaluated it in comparison to the software version and none have they evaluated CAI in group-based research. The current study lends support to its effectiveness with children with ASD of varying levels of age, language skills and intellectual functioning. Overall, it was demonstrated that ERP is a successful means of teaching target sight words to children with ASD. As a result of this study, schools wishing to implement ERP will have an informed choice with regard to which format to purchase and what the advantages and disadvantages of each are.

To conclude, this study contributes to the current knowledge base related to whole-word reading instruction, as well as the selection of presentation for children with ASD by demonstrating the efficacy of two modalities of ERP. Despite the programmed instruction’s commercially availability for more than 40 years; the current study provides data suggesting that ERP has still notable potential in improving core reading components for children with ASD. To provide further choice and knowledge on “what works” in relation to reading curricula for children with ASD, Chapter 5, will instigate the alternative approach to reading instruction, phonics-based instruction, by examining its implementation to children with ASD with alternative facilitators and settings to assess reading outcomes.
Chapter 5:
Evaluating Reading Outcomes in Children with Autism Spectrum Disorder
Following Parent Facilitated Headsprout®
5.1 Introduction

Chapter 3 evaluated reading skills in children with ASD and results demonstrated significant deficits in reading skills on most reading sub-components, (most notably phonological awareness and reading comprehension). This highlighted that children with ASD are at-risk of developing reading difficulties and given that Chapter 4 examined a whole-word reading curriculum, it was therefore necessary to identify phonics based programmed instruction.

Academic education typically occurs in the classroom, however, in order to overcome risk of developing reading difficulties and to increase reading opportunities, one possibility is to supplement classroom instruction with intervention in the home environment. The inclusion of parents as “educational partners” in supplementary intervention has proven to be a critical component towards successful reading outcomes (Hoover-Demsey & Sandler, 1997). To date however, there is little information regarding the features of parent-led interventions, namely, reading interventions, for children with ASD. Pindiprolo and Forbush (2009) proposed that parents may not have sufficient skills to teach reading in the explicit and systematic manner that is necessary to facilitate learning in children with ASD. Nonetheless, given the availability of computers currently in most homes, there is great potential for the provision of systematic, comprehensive and explicit instruction through CAI.

As discussed in Chapter 1, CAI may provide many benefits for this population as it is; a) relatively easy to implement; b) has inbuilt explicit instruction, thus reducing instructional errors; c) has automated feedback so that following a child’s response, correction can be provided or reinforcement delivered immediately; and d) the potential to provide instruction that can adapt to each child’s needs. In
Chapter 4, it was highlighted that facilitators may have impacted on the results of TTI’s superiority. Therefore, it is necessary to explore the potential for other facilitators in different environments, as well as an alternative approach to teaching reading. The extent of external, supplementary and high quality instruction is currently under researched. Furthermore, there are potential benefits of home reading instruction, as it provides more opportunities for practice outside of school, thus leading to better reading outcomes. Parents are typically motivated to establish reader skills in their children and also it is a cost effective means of instruction (i.e., it is not necessary for professionals to provide instruction, as it is already packaged, sequenced with explicit, individualised instruction). Findings from Chapter 2 indicated that many schools were not utilising CAI, or else they used it only as a supplementary form of instruction/source of reinforcement for children with ASD. Additionally, it is costly for schools to provide sufficient technological resources to ensure all children are accessing equal opportunities to access the curriculum. Consequently, it is necessary to investigate the greater utility of CAI with children with ASD, and to assess its use outside of classrooms, as well as within. Finally, research conducted in the home environment allowed for more random assignment than school clusters.

In recent years, there has been an upsurge of research investigating the use of the CAI, Headsprout® Early Reading (HER) in relation to reading achievement in children with ASD (e.g., Grindle et al., 2013; Plavnick et al., 2014; 2016; Whitcomb, Bass & Luiselli, 2011). Such research has demonstrated promising outcomes; however, all have used single-subject research designs to evaluate Headsprout® with children with ASD. Therefore, many of these authors have called for future research of
Parent Facilitated CAI

Headsprout®, on a larger scale (e.g., Grindle et al., 2013; Pindiprolu & Forbush, 2009)

With regards to reading development, CAI should be presented in an engaging format, enriched with positive reinforcement and feedback (all central features of Headsprout®). When learners have positive experiences in relation to reading instruction, this may subsequently establish sounds, words, print and book-based materials as reinforcers, i.e., establish print motivation. Print motivation is the child’s interest in and enjoyment of books and reading (Lance, Rodney & Schwarz, 2009). Research has provided strong support for associations between print motivation and reading achievement (Baker & Wigfield, 1999; Guthrie & Wigfield, 2005; Pintrich, 2003, Taboada, Tonks, Wigfield & Guthrie, 2009). However, to date, no research has investigated print motivation following exposure to reading interventions, in relation to children with ASD.

The current study employed a between-groups design to evaluate the effects of Headsprout® in comparison to a control group, both of which received treatment as usual. The current research aimed to investigate the outcomes of a reading CAI, Headsprout®, implemented by parents in their home. Parents received training on the identification of learning difficulties and the remediation of learning problems under the close supervision of the PI, in order for their children to progress through the reading CAI. Therefore, a consultative model was employed, consisting of a collaborative process involving family consultation, whereby the focus of the additional supports was set by the family’s expressed concerns.

The aims of the present study were as follows (i) to utilise previously established procedures described by Grindle et al. (2013), contingent on individual needs, with the intervention delivered by parents; (ii) with the use of a larger sample
of children with ASD, to assess if there were further learning difficulties experienced other than those described in Grindle et al. (2013); (iii) to assess what, if any, learning difficulties arose within the second level of the programme, Headsprout® Reading Comprehension (HRC); (iv) to assess whether exposure to Headsprout® would increase participants’ interests in reading material (print motivation) as compared to the Control Group and; (v) to examine parents’ perceptions of the effectiveness of the programme, as well as participants’ perceptions of the desirability of the programme.

5.2. Method

5.2.1 Ethical Considerations

Full ethical approval for this study was granted by the Research Ethics Committee at the National University of Ireland, Galway on September 25th, 2015. Consent forms were emailed to parents and were returned to the PI, ahead of screening for inclusion.

5.2.2 Sample and Participants

Forty-one participants were recruited and screened for inclusion for the study. Participants were included for intervention if they presented with: i) a diagnosis of autism spectrum disorder, which met the criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 1994); ii) reading scores below age-normative scores (chronological age) on the Neale Analysis of Reading Ability-II (NARA-II; Neale, 1999); iii) language skills sufficient to participate (i.e., vocal-verbal skills consisting of two word imitation), as tested on the by the oral expression subtest of the Wechsler Individual Achievement Test (WIAT-II; Welscher, 2005); and iv) the ability to respond to 10 two-step directions (e.g., “stand up and touch your nose”),
based on a specific list developed by the PI which were verbally administered to
each participant. This assessment was included to ensure participants had sufficient
listener skills to follow the automated instructions of Headsprout® (as per Grindle et
al., 2013).

Out of the 41 participants initially screened for inclusion, nine did not meet
the inclusion criteria. Of the remaining 32 participants that met inclusion criteria,
four participants failed to complete the target intensity of the study due to scheduling
difficulties in the household, and two participants (Control Group) were lost to
attrition. The final sample included 26 participants, 22 male and 4 females, (1
female in experimental condition and three females in Control Group) ranging in age
from 4:07-12:08 (mean = 8:02, $SD = 2.06$). The mean language score, as measured
by the Clinical Evaluation of Language Fundamentals, Fourth Edition (CELF-4;
Semel, Wiig & Sencord, 2003), was 59.9, $SD = 24.0$ and mean IQ score, as
measured by the Stanford-Binet Intelligence Scales, Fifth Edition (SB-5; Roid,
2003) was 64.0, $SD = 24.0$. Two children participated from the same family. All
children in the CAI condition could independently navigate the mouse (i.e., move the
mouse in all directions and accurately clicking on target icons) therefore additional
teaching was not necessary for skill development. Participants in the experimental
group had a mean age of 7:05 years, a mean language score of 54.1 ($SD = 20.3$), and
a mean IQ score of 64.3 ($SD = 24.2$). Participants in the Control Group had a mean
age of 8:08 years, a mean language score of 66.2 ($SD = 26.9$), and a mean IQ score
of 63.7 ($SD = 16.9$). Further information on individual participant’s age, IQ,
language scores, and scores of autism symptomatology severity are provided in
Table 5.1 for each group.
Table 5.1 Mean Age, Language scores, Autism Severity and IQ of groups

<table>
<thead>
<tr>
<th></th>
<th>Both Groups</th>
<th>Experimental</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 26)</td>
<td>(n = 13)</td>
<td>(n = 13)</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Age</td>
<td>8.02 (2.06)</td>
<td>7.05 (1.9)</td>
<td>8.08 (2.0)</td>
</tr>
<tr>
<td>Range</td>
<td>4.7-12.8</td>
<td>4.70-10.02</td>
<td>5.70-12.8</td>
</tr>
<tr>
<td>Language</td>
<td>59.9 (24.0)</td>
<td>54.1 (20.3)</td>
<td>66.2 (26.9)</td>
</tr>
<tr>
<td>(40-145)</td>
<td>40-103</td>
<td>40-98</td>
<td>40-103</td>
</tr>
<tr>
<td>ASD Severity</td>
<td>21.2 (5.75)</td>
<td>21.3 (5.8)</td>
<td>21.0 (5.8)</td>
</tr>
<tr>
<td>(0-39)</td>
<td>13-34</td>
<td>15-33</td>
<td>13-34</td>
</tr>
<tr>
<td>ABIQ</td>
<td>64.0 (20.8)</td>
<td>64.3 (24.2)</td>
<td>63.7 (16.9)</td>
</tr>
<tr>
<td>(40-160)</td>
<td>47-124</td>
<td>47-124</td>
<td>47-97</td>
</tr>
</tbody>
</table>

5.2.3 Setting

Participants resided in urban and rural communities from seven different counties across Ireland. Sessions were conducted within participant’s homes. Participants were seated at a computer, laptop or tablet at a desk, in a quiet area of their home (usually the sitting room or dining room). No additional reading instruction was implemented within the home in either group, in addition to the typical parent-child interactions with print material. In school settings, both groups were exposed to their typical reading instruction, which included typical classroom instruction and additional learning support classes. In the various settings, learning support classes were typically conducted three times per week in small groups of four to five children for 30 minutes. These classes consisted of additional supplemental instruction in reading, designed by the learning support teacher and
based on individual child needs, in line with recommendations from the Department of Education and Science (DES, 2000).

5.2.4 Design and Participant Assignment to Condition

A between-groups design was used to evaluate the Headsprout® on the reading outcomes and print motivation of children with ASD. Participants were matched on level of entry to Headsprout® (i.e., HER, or; HRC), therefore stratified random sampling was used, as it was aimed to have an even distribution of participants beginning the programme at these two different levels. Parent-child dyads across groups were matched according to level of entry of the reading intervention and were subsequently randomly assigned to either an experimental (n = 13) or Control (n = 13) condition as recruited. Table 5.2 shows details of experimental participants and matched controls, numbers of participants assigned to condition and further information on individual scores on age, language, IQ, and autism severity score.
Table 5.2 Age, Level on CAI, Language, IQ and ASD Severity Scores

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>Level</td>
</tr>
<tr>
<td>4.4</td>
<td>1</td>
</tr>
<tr>
<td>9.3</td>
<td>1</td>
</tr>
<tr>
<td>5.2</td>
<td>1</td>
</tr>
<tr>
<td>7.4</td>
<td>1</td>
</tr>
<tr>
<td>5.2</td>
<td>1</td>
</tr>
<tr>
<td>9.4</td>
<td>1</td>
</tr>
<tr>
<td>8.0</td>
<td>1</td>
</tr>
<tr>
<td>6.10</td>
<td>1</td>
</tr>
<tr>
<td>9.2</td>
<td>1</td>
</tr>
<tr>
<td>6.9</td>
<td>1</td>
</tr>
<tr>
<td>10.7</td>
<td>2</td>
</tr>
<tr>
<td>6.8</td>
<td>2</td>
</tr>
<tr>
<td>8.9</td>
<td>2</td>
</tr>
</tbody>
</table>
5.2.5 Materials

Computer desktops, laptops or tablets, with internet access, were used to access Headsprout®. Additional Headsprout® resources, progress maps (available to download from the programme) enabled participants to track progress of completed episodes.

5.2.5.1 Curriculum

Headsprout incorporates principles from the scientific investigation of early reading and applied analysis of behaviour (Layng, Twyman & Stikeleather, 2004). Headsprout® is an umbrella title for two levels of the internet-based computerised reading programme; Headsprout® Early Reading and Headsprout® Reading Comprehension. It is an example of programmed instruction and automatically records children’s correct responses in each episode, time spent on episodes, and a “reading activity” record outlined the specific skills accessed by the child. The programme utilises specific behaviour analytic instructional practices, for example, contingent reinforcement, mastery criteria, data collection, multiple exemplars and stimulus equivalence.

5.2.5.1.1 Headsprout® Early Reading (Level 1; HER).

The HER level presents instruction on beginner and/or supplemental reading skills, developed for neurotypical learners aged 4-7 years of age (Junior Infants to First Class). Each lesson presents the child with highly interactive reading instruction along with self-directed opportunities to progress through the instructional levels at their own pace. In other words, the child progressed onto subsequent lessons once he/she had demonstrated mastery of the material on the current episode. Multiple learning trials automatically adapt to the specific needs of each child.
In addition to the online material (i.e., 80 lessons), there are 80 printable stories which total an average of 30 hours of individual instruction. The aim is for each child to work independently on the episodes, lasting on average 20 minutes per presentation. See Figure 11 for a screenshot HER episode sample. The episodes begin with instruction on simple mouse skills, then gradually introduce letters and sounds which increase in difficulty by building upon each other (scaffolding) through guided practice, repetition and cumulative review.

*Figure 11.* Screenshot sample of HER, Episode 5.

### 5.2.5.1.2 Headsprout® Reading Comprehension (Level 2; HRC)

This second level is aimed towards reading skills typically taught to neurotypical children aged 7–10 years approximately. The episodes target comprehension strategies in narrative, expository, and poetic text. The strategies and targets are as follows; identifying factual information, making inferences, providing
the main idea, and answering vocabulary questions about what is read. According to Leon et al. (2011), building repertoires of strategies to use in situations in which the child has to answer a question about what is read can vastly increase the likelihood that the child will answer the question correctly. HRC incorporates an average 25 hours of engaging, individualised instruction, see Figure 12 for a screenshot sample of HRC.

![Figure 12. Screenshot sample of HRC, Episode 3.](image)

5.2.6 Measures

5.2.6.1 Descriptive Measures

Additional measures were completed prior to intervention to compile participant profiles, providing information on participants’ language, autism symptomatology severity and IQ. The CELF-4; Semel, Wiig & Sencord, 2003) was taken as a measure of language ability. The Abbreviated Battery IQ (ABIQ; Roid,
2003) scale of the Stanford-Binet Intelligence Scales 5th edition was used as a measure of cognitive ability and intelligence. Finally, the Social Communication Questionnaire (SCQ; Rutter, Bailey & Lord, 2003) was utilised to quantify participants’ overall levels of autism symptomatology. See Chapters 3 and 4 for full descriptions of these measures.

5.2.6.2 Dependent Measures

Two standardised reading measures were used to assess four reading components: word reading (WIAT-II), non-word decoding (WIAT-II), reading rate (NARA-II), and reading comprehension (NARA-II). Direct fluency measures were taken of the Headsprout® target words and sounds, as well as a paired-stimulus preference assessment to identify a ranking of print based materials as potential reinforcers. Placement assessments were conducted for both experimental and control participants to allocate which items in the HER direct measures would be administer to participants. All measures were taken at pre- and post-exposure to Headsprout®. The PI administered all of the assessments and a second investigator scored the results of the measures. This second investigator was a Master’s level Psychology child, blind to the study aims and hypotheses.

5.2.6.2.1 Wechsler Individual Achievement Test.

Word reading and non-word (pseudoword) decoding were assessed using the Wechsler Individual Achievement Test, Second UK Edition (WIAT-II; Wechsler, 2005). See Chapter 3 for a full description of this measure.
5.2.6.2.2 Neale Analysis of Reading Ability.

Reading comprehension and reading rate was assessed using the Neale Analysis of Reading Ability, Second Edition (NARA-II; Neale, 1997; Neale, 1999). See Chapter 3 for a full description of this measure.

5.2.6.2.3 Headsprout® words.

Headsprout words® (referred to as Sprout cards on the programmes website) were the phonetically regular words used to assess acquisition of the programmes’ target words. These flashcards were available to download from the resources section on the Headsprout® website. Each flashcards maps onto target words explicitly taught in episodes. Only the Sprout cards that corresponded to episodes that the participants would be exposed to during treatment were administered as baseline assessment of Sprout words and sounds. For example, if a participant was assigned to begin Headsprout® at Episode 1, they were administered a random selection of words from episodes 1-30, alternatively if a child began at Episode 41 or later they received Sprout cards from Episodes 41-76 and if child began at Episode 67 they received the Sprout cards from Episode 67-80. Word lists printed and laminated and then presented to participants on paper copies, one word at a time, along with the instruction: “I am going to set the timer for 1 minute, I want you to tell me as many words you can, ready, go!” The stopwatch timer was started for one minute. The PI pointed to each individual target cuing the participant to say the word. No corrective feedback was given. When the 60 seconds was up, the total number of correct responses was noted and social praise was given for taking part. This gave an estimate of fluency of decoding Sprout words.
5.2.6.2.4 Headsprout® Sounds (phonemes)

Fluency building packs available from the Headsprout® website were used to assess the phonemic elements used; sounds and word parts. These packs consisted of A4 documents which outlined seven rows of six phonemes or word parts. Similar to the Headsprout® words, these phonemes correspond to specific episodes, therefore selection of assessment were individualised to each participants starting point. The testing procedure was identical to that used for Headsprout® words, apart from the material used. This assessment provided a fluency estimate for Headsprout® sounds.

5.2.6.2.5 Print Motivation

A paired-stimulus preference assessment (Fisher et al., 1992) was individually administered to participants. Six items were included in the assessment, four preferred items (typically toys and games) selected by the participant, a book of their choice, and a Headsprout® Stories (Sprout Stories) printed in full colour and presented in a book format. It was the Sprout Stories, and the book of participants’ choice, which were the target stimuli to assess print motivation. The procedure was as follows; i) the PI placed two items in front of the participant and waited for up to 5 seconds ;ii) if the participant selected or touched an item, the non-chosen item was immediately removed and the participant was permitted to interact with the chosen item for 5 seconds ;iii) if the participant attempted to select both items, he/she was blocked by holding the two items down on the table ;iv) if the participant made no selection after 5 seconds, they were prompted (gestured) to sample each item for 5 seconds. These paired trials were repeated until every item had been paired with each other, allowing for the creation of a ranked-hierarchy of each participant’s preferred items.
5.2.7 General Procedure

5.2.7.1 Allocation to Headsprout® Episodes

The starting-point on the CAI, Headsprout® was determined individually for each participant by conducting the Headsprout® placement test. The placement test comprised of four short passages from which participants were instructed to read aloud. A blank page was used to cover the subsequent sections to avoid distraction. Errors were then counted during participants’ oral reading (self-corrects were not counted as errors). Specific placement instructions were detailed in each section of the test, allowing for participant placement on an exact episode or alternatively continue reading on to subsequent test passages. Allocation to HER was determined by the number of errors made in each passage. To be placed on the HRC level, there was an additional timing element included on the test. Participants were required to read a short passage within 2 minutes with no more than 13 errors, for placement on episode 1 of HRC. Corrective feedback was not provided to participants during testing sessions. Based on the outcome of this placement tests, participants could start on level one (HER), or at six other points in the episode sequence, or begin on episode one of HRC. See Table 5.2 for placement information of each participant.

5.2.7.2 Pre-Tests

The full battery of tests were administered to participants in both groups and lasted approximately 60 minutes, per participant. Assessments were delivered by the PI in the participant’s home, in a quiet room with a table and chair, and at least one parent present. Breaks were given as needed to avoid fatigue. There was no additional corrective feedback provided, for correct or incorrect responses during testing sessions.
5.2.7.3 Parent Training

At the onset of intervention for the Experimental group, training was individually administered to parents on the implementation of Headsprout®. Training occurred in each respective setting, (i.e., the setting in which intervention would take place in the participant’s home). Training comprised of a behavioural skills training (BST), following a model-lead-test instructional format. This consisted of a verbal introduction to the background of Headsprout® and its research, followed by an overview of the behaviour-change procedures (e.g., reinforcement, scaffolding, multiple exemplars) of the programme. Following this introduction, participants were briefed on the training session whereby they were given an overview of the reading programme. The PI modelled how to launch the programme and allowed the participant to choose a pictorial password of their choice (later relayed to parents) to accesses the episodes. The PI modelled each part of the Headsprout® episode procedures for the parents, leading them through the procedures, and finally assessing the parents’ independent use of the procedure in dyads (parent and child). Although the vast majority of the instruction was aimed to be completed by the participant as independently as possible (as it is possible to navigate through the programme by correctly responding to instruction and stimuli onscreen), parents were instructed to attend to key tasks, such the provision of prompts for participants to read out loud and remain on-task. The test part of the BST, involved the PI remaining present for the completion of the first episode, whereby corrective feedback was given and questions and answer time was provided. Parents had to receive 100% in the all steps once, in the fidelity check protocol, in order to progress to independently implement the programme with their child.
In addition to the training provided, a protocol manual was developed by the PI (see Appendix F) and consisted of a three-page booklet based on the recommendations and key areas of learning difficulties outlined in Grindle et al. (2013). Parents could refer to this manual throughout the intervention, as it provided an overview of tactics to ameliorate difficulties identified by Grindle et al., (2013). Additionally, explicit training was provided in overcoming these specific difficulties, namely negation, recall and vocabulary comprehension. Despite this training, if these difficulties or any other difficulties occurred with participants, parents were instructed to contact the PI for support. The training lasted approximately 45 minutes and parents were informed that the PI would be in regular contact to arrange fidelity checks and were advised that if questions or problems occurred in the meantime, to contact the PI as soon as possible.

5.2.7.4 Intervention

Participants were exposed to the Headsprout® for on average of 15-25 minutes, three times per week for a duration of 10 weeks. A 10-week block was chosen as previous studies on reading behaviour have used similar intervention timeframes (e.g., Anderson et al., 1979; Clarified & Stoner, 2005; Conner et al., 2006; Flores et al., 2008; Meek, Martinez & Pienta, 2014; Williams et al., 2002). The duration of intervention for some participants took 11 or 12 weeks due to illnesses ($n = 2$), or family holidays ($n = 2$), or other events ($n = 1$). However, all participants had similar exposure to the intervention despite these short breaks. Instructional time took place after school hours and/ or at the weekend depending on what suited the individual family. Parents prompted participants to log onto Headsprout® with the unique password (selected by the participant during the training session). Participants responded to the stimuli presented onscreen as
Parent Facilitated CAI

independently as possible, with parents present nearby to provide assistance as necessary. In other words, dependent on participant responding, parents provided verbal prompts to stay on task and provided social praise for completion of each episode. Parents were not required to take data on any part of the delivery, only to note learning issues or progression failures, if any, on episodes. At the end of the episode, participants were required to read a story containing the target words for the current episode. This software does not allow children to progress to the next episode until they reach approximately 80% mastery criterion. Alternatively, if they did not reach criterion, they practiced the same episode up to three times until they reached criterion. If they still did not meet criterion, parents alerted the PI and additional support was then provided by the PI. Upon meeting criterion, participants marked off the episode using the progress map, which was usually posted on the wall adjacent to the PC/laptop area. Participants could complete up to three different online episodes in one week, provided they consistently reached criteria.

5.2.7.5 Additional Supports Required

In addition to the direct contact with the PI for technical and learning support, an online parent support group was launched. This group provided an online platform for parents to discuss the progress, difficulties, and general issues in relation to the Headsprout®. Descriptive data were taken on all problems presented on the forum. The support platform was launched on a popular social media site with customised privacy settings (i.e., non-members were unable to join, comment, or view the page without authorisation from the PI). Parents were provided with a URL link via email to join the group, and membership of the group was optional. A total of 10 parents joined the group. The PI managed and facilitated questions and
answers to the group. There were on average of 10 posts (either publically posted or privately messaged) per member throughout the course of the 10 weeks.

Seven participants required additional supports during the intervention to support their progression through the episodes. The episodes which required additional support varied across participants. The decision to implement additional teaching strategies was made from the online data collection, as well as parental reports which revealed if participants had not mastered an online episode in one week, after a minimum of three attempts. The PI was present in each home and gave feedback throughout these additional procedures. Five participants from HER and two participants in the HRC group required four main adaptations. Table 5.3 provides an overview of these learning difficulties and additional supports required.

5.2.7.6 Fidelity Checks

A procedural fidelity checklist was developed by the PI using instructions from the Headsprout® teacher manual (available from previous publishers; Mimio®) which included essential or critical elements, e.g., re-direction to the task, appropriate reinforcement for speaking out-loud, and completing episodes independently (see Appendix G). Fidelity checks were conducted remotely via video calls. Video calls were conducted at least once every second week by the PI with parents of participants in the experimental group. During these video calls, parents positioned the camera (generally phone camera) so that it was possible to observe participants engaging with the reading programme. During these sessions, parents were provided with direct feedback regarding their supervision skills and further advice provided where necessary. During these calls, parents also discussed any learning difficulties they observed as their child engaged with the treatment. Tactics
to resolve these issues were discussed by the PI and visits were arranged if needed in order to remediate the learning difficulties.

5.2.8 HER Additional Supports

Five participants required support at various points in the reading programme. Two participants required support on negation tasks (Episode 4). The supports were deigned based on tactics employed by Grindle et al. (2013). One participant required support to sustain attention throughout the programme and a further two participants required a conditioning procedure with certain elements of the programme. The list of tactics included: discrete trial training, token economy systems and conditioning programme stimuli (see Table 5.3).

5.2.8.1 Discrete Trial Teaching (DTT)

The PI visited the participants’ home and, alongside parents, implemented DTT. Firstly, participants were taught to follow receptive instructions with negation using familiar objects/mastered concepts. Examples included the following; “Show me the one that is NOT the horse” versus “Show me the one that IS the horse”, “Find the one that is NOT blue” versus “Find the one that IS blue.” Initially, these instructions were kept short and succinct (e.g., “NOT blue” and the participant had to touch the red colour card). When the participant could receptively discriminate these instructions (90% correct responding once), they were tested again, on the relevant episode. If they still could not follow the computer directions, they received additional DTT, which more closely resembled the computerised instruction (e.g., “click on the fish. If it is not the fish click on the arrow”). During all trials, an arrow figure was placed on the table in front of the child (pointing in the same direction as the arrow on the computer screen) with a picture of an animal to the left of the arrow. The participant was taught first to touch the picture of the animal that always
corresponded to the animal named in the instruction (e.g., a picture of a horse would be placed next to the arrow and they were required to touch it).

5.2.8.2 Token Economy

One participant required extra support to maintain attention throughout episodes. This adaptation included the addition of a token economy system throughout episodes. This participant was familiar with token economy systems as he had history of its use within his school and home setting, therefore little additional training on its implementation was required. Tokens were delivered as reinforcement contingent on sitting appropriately, looking at the screen and making responses on a Variable Interval of 10-seconds. Tokens were administered irrespective of correct target reading responses to the programme instructions, as the goal was to increase and maintain attention only. The participant exchanged the tokens after receiving 10 tokens on the token mat and was allowed “free choice”, which included a 2 minute break away from the screen to play with toys or activities of his choice. After the 2 minutes had elapsed, the participant was instructed to return to the screen again and the procedure was re-started at the point in the episode where he left off. The participant’s parent continued this support for the remainder of the study.

5.2.8.3 Desensitisation Procedure

An additional support necessary for two participants (siblings) was a desensitisation procedure for the characters of the programme. There were “alien” characters in the programme that presented with a-typical features (i.e., three eyes, goldfish with teeth). Contingent upon the appearance of these particular characters, a fear-response was elicited (i.e., crying, covering eyes and running away from the computer area). Within the preference assessment conducted at pre-tests, colouring
activities were ranked as top reinforcers for these participants. Headsprout® readers were downloaded from the website in black and white (stories that included the target characters). Social praise and edibles were delivered each time the participant coloured the characters or part of the characters. Parents were also instructed to make reference to the a-typical features of the alien and to deliver phrases such as “that’s very funny” and “what colour will we colour his third eye”. Thus exposing the participant to the target features and allowing them to be accessed “safely”. Access to other colouring materials were temporarily withheld during this conditioning procedure which lasted two days.

5.2.9 HRC Additional Supports

It was found that the variety of features inbuilt into the programme (i.e., animations, automated feedback such as “Great!”) were insufficient to motivate participants on this level. Upon parental feedback; two participants were found to engage in avoidance escape behaviours (running away when it was time for Headsprout®, clicking out of the programme, and vocalisations of opposition “No” and “I don’t like it”). Upon further, feedback from parents, this behaviour was typical for these participants in relation to similar tasks that they found challenging. Subsequently, backup reinforcers were identified for these participants, which mainly included access to video games or internet sites of their choice, identified based on the parents knowledge and verbally specified preferences of the participants. Access to these reinforcers were administered following episode completion without avoidant or escape behaviours, irrespective of reading performance, which then reduced the value of reinforcement through engaging in these target behaviours, see Table 5.3 for further information.
5.2.10 Post-Tests

On the completion of 10-weeks of intervention, participants were tested again at their home using the same dependent variables as in the pre-tests (i.e., NARA-II, WIAT-II, HER words and sounds and preference assessments). The alternate form of the NARA-II was administered in post-tests and different toys were allowed to be included in the post-test of paired-stimulus preference assessment, to allow for change of preferences over the course of 10 weeks. The only specification, as per pre-test, was that the preference assessment must include one book of choice and a *Sprout Story.*
Table 5.3 Examples of Difficulties on HER and HRC Remediated through Additional Teaching.

<table>
<thead>
<tr>
<th>Level of Headsprout®</th>
<th>Target skill</th>
<th>Difficulty area</th>
<th>Tactic applied to remediate difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>HER</td>
<td>Negation</td>
<td>Participants were required to click on a word or sound if it matched a spoken</td>
<td>As per Grindle’s (2013) protocol: Participants were taught this skill independent of the programme via</td>
</tr>
<tr>
<td></td>
<td></td>
<td>sound or click on the arrow if it did not. i.e., “Click on the “ch”, if it is not</td>
<td>the use of mastered tacts. Next, instructions and material were modelled more closely to those used in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“ch”, click on the arrow’</td>
<td>HER. A token economy system was put in place to reinforce on task behaviours and also allowed for</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>breaks with each exchange. A VI 10 seconds schedule was necessary to maintain attention throughout the</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>study (i.e., the schedule was not thinned).</td>
</tr>
<tr>
<td>HER</td>
<td>Attention to instruction</td>
<td>HER episodes increase in duration with</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>progression. Participants are required to remain on task (look at screen, listen</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>to instruction and make responses accordingly). One participant had difficulty</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>maintaining attention even with verbal prompts to look at screen, or listen.</td>
<td></td>
</tr>
<tr>
<td>HER</td>
<td>Desensitisation of characters</td>
<td>Particular characters on the programme were fear eliciting stimuli for two</td>
<td>Colouring was identified as a preferred activity for participants. Participants were instructed to</td>
</tr>
<tr>
<td></td>
<td></td>
<td>participants (siblings), a-typical, characters included aliens from outer</td>
<td>colour the pictures and were paired with edibles, social praise and tacting the character’s name. Next,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>spaces, some presenting with three eyes or one eye.</td>
<td>the screen was presented with the same character and his name tacted and along with gestures to the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>colouring. Premack principal was introduced for these participants; following completion of an episode,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>they were allowed access to a preferred activity.</td>
</tr>
<tr>
<td>HRC</td>
<td>Motivation</td>
<td>HRC passages can be quite lengthy and require much attention. Participants began</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>to display escape behaviours (refusals, avoidance) contingent on instruction to</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>begin HRC.</td>
<td></td>
</tr>
</tbody>
</table>
5.2.11 Social Validity

Following completion of the intervention phase, a questionnaire was devised based upon the Behaviour Rating Scale (Elliott & Von Brock Trouting, 1991) and administered to parents to assess acceptability of the reading intervention (see Appendix H). The questionnaire entailed a 15-item rating-scale, ranging from strongly disagree to strongly agree. Questions focused on parents’ perceptions of the programme, its utility, how it fitted into the home environment, how effective they thought it was, and their likelihood of re-using the programme. There was an open space provided for any additional comments.

A 10-item researcher-developed questionnaire was also devised for participants which included seven statements, whereby participants were required to give a “Yes” or “No” response to indicate agreement or disagreement with the target statements. It also included an option for No Response (see Appendix H). The questions were read aloud to participants by the PI and recorded on the questionnaire. Questions focused on participants’ enjoyment of Headsprout®, whether they would like to continue its use, and if they find reading easier than before. There were also three open-ended questions which asked participants about their favourite and least favourite part of Headsprout®, and finally an option to say anything further about Headsprout®.

5.3 Results

Over the course of the 10 weeks, participants in the Experimental Group completed a mean of 30 episodes, \((M = 30.1, \ SD = 10.4)\) and an average of 12 hours and 6 minutes, \((M = 12.6, \ SD = 0.80)\) of exposure to Headsprout®. Differences between the Experimental and Control Group were analysed for the following; differences in age, language and ABIQ (to assure equal variances between groups ahead of intervention). Differences in reading outcomes between the groups were assessed for overall efficacy of the intervention;
individual analyses of reading sub-components, and finally differences in preferences of print-material, from pre- to post-tests.

5.3.1 Differences in Age, Language, SCQ and ABIQ

Mann Whitney U tests were conducted to determine if there were differences in age, language, ABIQ and autism symptomatology between the Experimental and Control Groups. A Mann-Whitley U test was conducted and revealed no statistically significant differences in Age between the Experimental ($Mdn = 72$, range 6.0) and Control ($Mdn = 8.5$, range 7.1), $U = 53, z = -1.616, p = .106$. A Mann-Whitley U test was conducted and also revealed no statically significant differences in autism severity scores between Experimental ($Mdn = 20$, range 18) and Control ($Mdn = 22$, range 15), $U = 65, z = -.349, p = .727$.

A Mann-Whitley U test revealed no statically significant differences in language scores between Experimental ($Mdn = 42$, range 58) and Control ($Mdn = 59$, range 63), $U = 62, z = -.911, p = .363$. Finally, Mann-Whitley U test revealed no statically significant differences in ABIQ scores between Experimental ($Mdn = 55$, range 77) and Control ($Mdn = 57$, range 106), $U = 75, z = -.166, p = .868$. Combined, these results indicated that equal variances in Age, IQ, language and SCQ between Experimental and Control Groups can be assumed.

5.3.2 Comparisons of Groups

Similar to Chapter 4, in order to evaluate the effects of Headsprout®, two types of analyses were undertaken. A multivariate analysis of co-variance (MANCOVA) was conducted to compare the differences between the Experimental and Control Groups on all dependent variables. Participants’ pre-tests scores were used as the covariates in order to control for pre-existing differences for each Group. Post- hoc analyses were also conducted for each variable using Wilcoxon Signed Ranks to investigate statistical difference in scores from pre- and post-tests for both the Experimental and Control Groups.
Preliminary analyses were conducted to make sure no assumption of the MANCOVA was violated. The results indicated that the variables of reading rate, reading comprehension, non-word reading, were not significant, indicating equal variances between groups at pre-test. However, the homogeneity of variances results were violated for dependent variables; HER words and sounds (i.e., were statistically significant according to the Levene’s test). This indicated that equal variances at pre-test cannot be assumed between the two groups for target HER sounds and words, therefore these variables were not individually investigated further within the MANCOVA.

The results of the MANCOVA for the combined effects of each group on the remaining reading sub-components (words reading, non-word reading, comprehension, rate, and preference for print –based materials) were statistically significant, $F(8.7, 7), \lambda = .005, \eta^2 = .897$. Table 5.4 summarises the adjusted mean performance for both groups on each dependent measure at both pre- and post-tests.

Table 5.4 Adjusted Mean Post-Test Scores for Reading Dependent Measures.

<table>
<thead>
<tr>
<th>DV</th>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$N$</td>
<td>M</td>
</tr>
<tr>
<td>Word Reading</td>
<td>13</td>
<td>85.1</td>
</tr>
<tr>
<td>Non-word Reading</td>
<td>13</td>
<td>82.5</td>
</tr>
<tr>
<td>Comprehension</td>
<td>11</td>
<td>80.5</td>
</tr>
<tr>
<td>Reading Rate</td>
<td>11</td>
<td>93.6</td>
</tr>
<tr>
<td>FSF</td>
<td>11</td>
<td>14.0</td>
</tr>
<tr>
<td>Pref Books</td>
<td>13</td>
<td>49.9</td>
</tr>
<tr>
<td>Pref HER Books</td>
<td>13</td>
<td>30.1</td>
</tr>
</tbody>
</table>
5.3.3 MANCOVA Significant Results for Individual Components

To consider dependent variables separately, univariate one-way ANCOVA were performed. There were statistically significant differences in adjusted means for Headsprout books $F(8.0, 1) = .014, p < .05, \text{partial } \eta^2 = .38$. There were no statistically significant differences between groups for the other dependent variables. No significant differences were observed for the subtests of the word reading (WIAT-II; Wechsler, 2005), FSF (DIBELS, 2006) reading comprehension, reading rate (NARA-II; Neale, 1999) or preference for general books. However it must be noted that the results of FSF $F(4.5, 1), p = .053$ and word reading $F(4.0, 1), p = .067$ were approaching significance.

A correction to control for multiple testing was not included in statistical analyses since it is recommended that corrections be used when investigators are searching for significant relationships but without pre-established hypothesis (Armstrong, 2014; Perneger, 1998). The current research investigated specific hypotheses outlined prior to data collection and statistical analyses.

5.3.4 Within-Subject Analysis

Wilcoxon Signed Ranks were conducted to evaluate the impact of dependent measures (word reading, non-word reading, reading comprehension, reading rate, HER words and sounds and print motivation) of participants from pre-testing to post-testing in each group.

5.3.4.1 Control Group Performance Decreases

A Wilcoxon signed-rank test determined that there was a statistically significant decreases in word reading in participants in the Control Group compared with the Experimental group, $z = -1.99, p < .05$. The Median scores of non-word reading decreased from pre-test ($Mdn = 86$) to post-test ($Mdn = 81$). A Wilcoxon signed-rank test determined that there was a statistically significant decreases in PSF participants in the Control Group.
compared with the Experimental group, $z = -2.25, p < .05$. The Median scores of non-word reading decreased from pre-test ($Mdn = 8$) to post-test ($Mdn = 5$).

**5.3.4.2 Experimental Group**

Statistically significant increases were found for tests of FSF, PSF, HER sounds and words and preferences for Headsprout® stories. Table 5.5 summarises results for both Experimental and Control groups.

<table>
<thead>
<tr>
<th>DV</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$z$</td>
<td>$Mdn$/Range 1</td>
<td>$Mdn$/Range 2</td>
</tr>
<tr>
<td>Word Reading</td>
<td>-1.88</td>
<td>87/102</td>
<td>89/100</td>
</tr>
<tr>
<td>Non-word</td>
<td>-1.96</td>
<td>76/41</td>
<td>77/47</td>
</tr>
<tr>
<td>Comprehension</td>
<td>-1.36</td>
<td>69/25</td>
<td>81/61</td>
</tr>
<tr>
<td>Rate</td>
<td>-1.59</td>
<td>91/111</td>
<td>93/61</td>
</tr>
<tr>
<td>FSF</td>
<td>-2.38</td>
<td>0/40</td>
<td>8/41</td>
</tr>
<tr>
<td>PSF</td>
<td>-2.55</td>
<td>0/17</td>
<td>8/40</td>
</tr>
<tr>
<td>HER Sounds</td>
<td>-2.20</td>
<td>23/60</td>
<td>24/59</td>
</tr>
<tr>
<td>HER Words</td>
<td>-2.80</td>
<td>0/5</td>
<td>10/34</td>
</tr>
<tr>
<td>Pref Sprout</td>
<td>-2.28</td>
<td>0/60</td>
<td>20/60</td>
</tr>
<tr>
<td>Pref Books</td>
<td>-1.43</td>
<td>10/100</td>
<td>40/60</td>
</tr>
</tbody>
</table>

*Note. *$p < .05$. **$p < .01$. ***$p < .001*
5.3.6 Fidelity Checks

A total of 60 video calls were made to the Experimental Groups across the 10 week intervention period to conduct fidelity to intervention. Each parent had a minimum of five fidelity checks. These excluded the home visits, in which additional training was conducted. During these calls, one episode was observed of the parent-child dyad of intervention. These checks accounted for 17% of participants’ sessions with fidelity accuracy scores of 89%. Fidelity was calculated by adding the number of correctly implemented steps by the teacher and dividing by the number of steps in total and multiplying by 100.

5.3.7 Social Validity

Ten parents and five participants completed the questionnaire. Results indicated that 100% of parents agreed that it was an effective reading intervention for their child and would recommend its use to other parents and continue to use it following the cessation of the study. All parents agreed that they liked the procedures used in Headsprout® and following its exposure, reported it had provided lasting improvements in reading for their child. Ninety per cent of parents agreed that their child was motivated to use the programme. Ten per cent of parents agreed that there were negative side-effects from using the programme, these respondents were part of Level 2: HRC. Ten per cent also disagreed that Headsprout® would be an appropriate intervention for a variety for children with diagnoses other than ASD. Thirty-three per cent disagreed that the intervention produced enough improvement that their child no longer had difficulty with reading. All but one parent disclosed that they would like to continue to use the programme following the cessation of the study, this parent was part of the HRC level of the intervention.

Of the five participants who completed the social validity measure, the majority (80%) indicated that they enjoyed using the programme, 80% of participants indicated that they would like to continue to use the programme following the cessation of the study.
Finally, 80% of participants reported finding it easier to read following the intervention.

Eighty per cent of the participants also felt happier from learning new words and phrases.

See Table 5.6 for examples of parental and participant comments.

Table 5.6. Examples of parental perceptions of Headsprout

| Comment |
|-----------------|---------------------------------|
| Parent          | “I could not praise this programme enough, my son has struggled with his reading (in particular phonics) since junior infants (now 1st class) and having only completed 20+ episodes myself, his teacher, SNA & resource teachers have seen a massive improvement. My son still has a long way to go but if the improvements so far are anything to go by (after just 20 episodes) I am really looking forward to seeing where he is at when he fully completes the programme. My son has become much more confident in attempting to read aloud in class and is trying his best to sound out anything he gets stuck on, thanks to the skills learned with the programme. The only slight criticism I would have of the programme is the American accents, as he is copying them but it’s a very minor thing and would not stop me using Headsprout”.
| Parent          | “I have seen a definite interest in books; J is now reading everything in her environment and paying more close attentions to print in books, besides only looking at the pictures. I will keep it going as long as we have the licence. She loves it, loved all the animations and would squeeze my hand during the cartoons. We intend to do more instruction through the computer. J did need prompts to speak out loud”.
| Parent          | “I never thought he would be able to read, but now he can read independently, it’s been a life saver, I would use it again”.
| Participant (aged 8) | “Sometimes it’s hard to know what question they are talking about.” |
| Participant (aged 7) | “You get to play games before you start, I like it!” |
| Participant (aged 9) | “I liked when the episodes were finished.” |
5.4 Discussion

The present study demonstrated that exposure to Headsprout® was effective in overall reading performances in the Experimental Group, when compared to a Control Group. More specifically, participants who received Headsprout® showed greater gains in non-word reading, PSF, FSF, HER sounds and HER words. This study also demonstrated that this reading programme can be successfully implemented with children with ASD by parents in the home environment and with the addition of adaptations and learning support. Moreover, with regards the Control Group, the outcomes of decreases on certain outcomes, word reading and PSF indicates that with the absence of targeted intervention, performances in reading may actually decline over time. However, with respect the Experimental Group, the results of this study are very encouraging for future instruction for this population.

As per the findings of Whitcombe, Bass, Luiselli (2011) that found increases in HER words with children with ASD, the findings of the current study indicated that HER targets (words and sounds), showed improvement following exposure to the programme. A full list of target words and phonemes are available from the programme under Teacher Resources. Parents and educators can anticipate that, at the very least, this programme will results in these specific outcomes. The findings of significance in word reading and non-word reading are promising as it suggests that this intervention is effective in the generalisation of decoding strategies employed. From a phonetical perspective, participants are taught to decode a word based on each individual letter-sound correspondence, meaning that once these associations are taught, participants should potentially have the ability to decode any novel word (words not explicitly taught). The standardised assessment, WIAT-II, aimed to assess this ability as it measures word reading (reading words out of context) and non-word reading, (applying phonetic strategies to pronounce nonsense words). The outcomes revealed significant
findings which are very promising in terms of the future provision of explicit and systematic applications of the phonetic approach to teaching reading, such as the systems used in Headsprout® with the ASD population.

Although there were no significant gains in reading comprehension, there were only three participants of the Experimental Group on this level that specifically targeted comprehension skills, therefore, this was result was not surprising. This study only measured HER direct reading targets (Sprout words and Headsprout® sounds). There were no similar measures available from the publishers of Headsprout® that directly measure the comprehension targets of this level. Perhaps the standardised measure utilised in this study was not sensitive enough to detect smaller changes in this skill. Therefore, there are still gaps in knowledge remaining on the HRC level and to the specific comprehension outcomes that this level can teach to children with ASD.

The current study also aimed to ascertain if exposure to Headsprout® would result in an increased print motivation, i.e. preference towards print material, as assessed in the paired stimulus preference assessment. The results demonstrated that only the print material specific to the programme, i.e., Sprout Stories, had an increase in preference at post-tests. This may be as a result of learning histories with the characters as participants regularly come into contact with these characters through episodes and there are SproutStories to read following the completion of episodes. Furthermore, the new abilities to successfully read the material in these booklets may have contributed to this result, whereas in the general books selected by participants may have included many words and pictures unfamiliar to the participants.

This study sought to extend the work of Grindle et al. (2013) by addressing some of the limitations outlined by the authors, namely, the absence of a Control Group, Group size, and narrow reading subtests assessed. Many of the difficulties identified in Grindle’s study
were found to be similar in the current study, (i.e., difficulties in negation skills, motivational issues and the necessity of a prompter nearby). Just over half of the participants in the Experimental Group required additional strategies, of which, were derived from teaching procedures common in ABA methodologies to allow progression throughout the episodes. These strategies were individualised to each participant, considering each participants’ specific learning difficulties and transitory interests (Grindle et al., 2013). However, it is important to consider the practical challenges with administering the intervention used in the present investigation. Training parents to implement additional tactics (e.g., DTT) in order for their children to progress past a learning problem or certain episode was time-intensive and was dependent upon the motivation of each parent, which may vary. In order to progress as swiftly as possible, it was necessary to have the PI present in all additional teaching protocols. As the spread of participants were vast, it proved to be relatively labour and time-intensive.

Despite this cost, it was still very useful for educators and parents to become aware of the areas of learning difficulties of their learner. As per the research conducted by Pindiprolu & Forbush (2009), the current study has shown that parents can become actively involved in their child’s learning and see how difficulties can be overcome without dependence upon their respective educational setting to solely teach academic skills or to resolve learning issues. Guidelines or information are rarely passed on from school to home, in order for parents to teach or supplement reading skills to their children. Irrespective of diagnoses, phonics, is an extremely difficult and complex skill to acquire, therefore, it is not surprising, especially given possible language difficulties that it is an even more difficult skill to acquire for individuals with ASD. The presence of technology is becoming more and more of a stable entity in all children’s life, but subsequent work is needed to transform this entity into something that had more advantages than as a leisure activity and object to passively
view media. It needs to be utilised to the utmost of its potential and contribute to the early learning of children at risk of reading difficulties.

5.4.1 Limitations and Future Directions

Although fidelity checks increased from Chapter 4 to the current study, fidelity checks were still relatively low (17% of all episodes). This resulted in fidelity checks being “grouped” with one group contacted one week and the other the following week. In addition, it sometimes proved difficult for parents to allocate the time to sit with their children each week and for 10 weeks due to busy schedules. Events such as holidays, illnesses, and family events occasionally resulted in a session being missed and this required the session to be carried out to compensate, with the addition of another week. In these instances, it meant a loss of participants due to the imbalance in exposure to the intervention which lessened the final sample size for analysis. However, on average, parents were motivated and co-operative in the necessities of this research. This compliance may have been due to the recruitment process employed, whereby the research post was advertised on social media and only the interested parents were obliged to make contact with the researcher. This allowed for motivated parents, specifically interested in the topic of reading, to come forward and participate.

As demonstrated in Chapter 3, children with ASD need individualised support for reading skills, most notably comprehension skills. Although the current study offered the individualised support, there were no significant gains on this component. As previously outlined, this may have been due to the small sample size and the specific comprehension measures used in this study. Further investigation on level 2, HRC is warranted along with a reading comprehension measure that is more sensitive to changes.
5.4.2 Conclusion

This study is the first study to evaluate Headsprout® using a group design with individuals with ASD as well as the inclusion of an assessment of print motivation. The contribution of CAI in the acquisition of early reading skills and also the remediation of reading difficulties of children with ASD, as observed in this study are very encouraging. This study indicated that it is necessary to explore and invest more time and effort into expanding and using more of these kinds of learning environments and materials for this specific population. The present investigation provides a promising insight to the immense work that can be carried out by parents and to encourage more involvement, and to bridge the gap between school and home-based instruction. The potential for parents to facilitate effective, research-based instruction in addition to instruction in schools and/or during summer breaks may have the capacity to ameliorate much of the reading difficulty risks of the ASD population.
Chapter 6:
General Discussion
6.1 Overview of Research Area and Aims

Reading ability is one of the most important outcomes in a child’s education, regardless of other “specifiers”, such as diagnosis or having English as a second language. It is a behaviour cusp as it exposes the child to multiple new learning opportunities, as well as leisurely activities, which would not be possible without this skill. However, even for neurotypical children, the development of this skill is not seamless. As described in Chapter 1, developing proficient repertoires in reading involves a multitude of complex, intricate and inter-dependent skills. If even one reading sub-component is missing from the “reading puzzle”, this can jeopardise the development of this critical repertoire. It is therefore imperative that educators utilise evidence-based reading curricula that incorporate research-based strategies to ensure success, or at the very least, make improvements in a child’s reading abilities.

Over the last few decades, ABA has been demonstrated to be effective in the education of children with ASD (e.g., Kamps et al., 1994; Lovaas, 1987; Reichow & Volkmar, 2010). However, it is unclear if schools in Ireland for children with ASD are utilising such evidence-based practices. There is currently a dearth of information regarding the types of reading curricula being employed and methods that can monitor reading progress and identify struggling readers. Chapter 2 of the current thesis aimed to gather information relating to reading education practices in settings for children with ASD.

Empirical studies investigating reading abilities pertaining to the ASD population are growing (e.g., Dynia et al., 2016; Dynia et al., 2017; McIntyre et al., 2017; Nation et al., 2006). Previous research has detected splintered reading abilities highlighting that some children with ASD may present with typical or even above average abilities in one domain, but may be severely lacking in another (e.g.
General Discussion

Jones et al., 2009; Myles et al., 2002; Norbury & Nation, 2010). The research presented in Chapter 3 aimed to provide a comprehensive investigation of the level of reading abilities in an Irish sample of children with ASD. Eligibility for participation in this study was not based upon/restricted based upon high language or IQ scores, as such profiles are not typically representative of the ASD diagnosis. Instead, this research aimed to assess reading abilities based on diagnosis alone, thereby including children who presented with a broad range of deficits. Additional information, namely, age, language and autism severity, were measured to inform an evaluation of the degree of relationships between these factors and concomitant reading capacities.

According to the Individuals with Disabilities Education Act (IDEA Act, 1997), special education teachers are expected to integrate CAI for children with disabilities. However, this legal mandate does not provide clear guidelines regarding the type, frequency, or the purpose for which CAI can be used (McLaughlin, 2015), and most notably, for what population it is effective. The responsibility for making these decisions rests with teachers and members of the Individualised Education Plan team. Children today are surrounded by technology and grow up with access to the internet and with computers, mobile phones and tablets present in almost every aspect of their educational and social communities. Additionally, schools have access to a variety of technology devices (e.g., interactive white boards, touch screen computers). Therefore, it could be considered essential for schools to provide opportunities for children to learn to navigate newer, more innovative technologies to support their education across curricular areas.

Research on CAI has shown some promise in teaching a variety of skills, as well as being suitable to the variations in skill proficiency presented by children with
ASD (Panyan, 1984). Consequently, it was necessary to investigate the potential efficacy of CAI, relative to the traditional teacher delivered curriculum. Chapter 4 investigated the utility of a whole word approach CAI curriculum in comparison to a TTI curriculum. A knowledge gap exists with regard to which reading approach (whole-word or phonics based) to use with children with ASD. The whole-word approach has been the traditional method, however, more recently, research has demonstrated that children with ASD can learn to read via phonics (e.g., Ainsworth, Evmenova, Behrmann & Jerome, 2016). The current research (Chapters 4 and 5, respectively) sought to investigate both a word-recognition and a phonics-based approach in separate studies. Chapter 5 also examined a promising phonics-based CAI, Headsprout®, implemented by parents in the home environment to determine accommodations that were necessary for children with ASD to make successful progress. In addition, print motivation was analysed relative to a control group. The current thesis assessed reading abilities for children with ASD in addition to examining programmed instruction and its relative outcomes in both CAI and when delivered by different educators; parents and teachers.

6.2 Summary of Thesis Findings

Chapter 2 presents an exploratory online survey conducted with educators whose role was in implementing reading instruction for children with ASD. Sixty participants took part in this survey. The preliminary findings indicated that there were little or no reading assessments conducted within schools for children with ASD. The most widely used reading curriculum reported for children with ASD was ERP, although this may be due to the large response rates from schools using ABA as their predominant instructional methodology. The selections of curricula used in schools were found to be primarily based on a history of its use (i.e., “it has always
been used in the school”), and resources available to the school rather than evidence based-curricula. Despite increasing research highlighting CAI as a promising mode for teaching reading skills (e.g., Pennington, 2010), results from Chapter 2 indicated that less than half of the respondents used computers as an educational tool. This too may have been due to a lack of resources within school settings, however, no educator made reference to this in the comments. There was also a reported uncertainty as to whether or not children were motivated to use the reading curriculum, along with varying opinions regarding the suitability of the curriculum employed for children with an ASD diagnosis. Furthermore, the data collected tended to point towards subjective attitudes toward assessment and, in turn, curriculum selection and reading. This study was important in the context of the current thesis as it highlights a disparity between assessments and knowledge of reading abilities (the aim of Chapter 3) and research-based instruction and implementation (the aim of Chapters 4 & 5 in the context of CAI), thus directing the focus of the subsequent chapters.

Chapter 3 further advanced the investigation of reading instruction by investigating the reading abilities of 110 pre-school and school-aged children with ASD. A battery of standardised reading assessments were administered to identify specific reading subcomponent levels (those identified as important by the NRP, 2000, see Chapter 1). There were two groups of analyses divided by age; those under 5:11 years (Group 1) and those over 5:11 years (Group 2). Results demonstrated that even at a very early stage (as young as 3:10 years), deficits in pre-reading skills were present. This indicated the importance of the early administration of reading assessments, as well as teaching pre-reading skills in reading education. Results also demonstrated severe deficits in most reading
components across both age groups, with the exception of early indicators of word reading for Group 1, and reading rate for Group 2. Correlation analyses were conducted to assess relationships of reading components with particular characteristics, which indicted that autism severity and language abilities were associated with reading outcomes. Multiple regression analyses indicated that autism severity was predictive of language scores suggesting that individuals presenting with more severe symptoms of ASD demonstrated the most reading deficits. These are important findings as they highlight the urgency for establishing and implementing evidence-based reading curricula for this population.

The main body of research on the programmed instruction, ERP, was conducted over 50 years ago, predominantly with children with intellectual disabilities. To date, no empirical studies have been undertaken to assess the effectiveness of the curriculum for children with ASD, or on the second edition of ERP that was released in 2011. This finding directed the selection of ERP for Chapter 4, which addressed three broad research questions in relation to children with ASD. This chapter investigated the efficacy of ERP for teaching whole word reading in children with ASD, and the comparative efficacy of CAI in children with ASD, when compared to the Table-Top version of the same programme. Both teachers’ and participants’ perceptions of ERP were also assessed. A between-group design was used to evaluate each respective format, in a sample of 31 participants with ASD. The impact of each programmed instruction was evaluated with respect to dependent measures of targeted skills associated with ERP and scores on standardised norm-referenced measures of reading ability. Results revealed that ERP, both in its TTI and CAI format, successfully increased associated reading targets (i.e., ERP words) as tested by the EMT of children with ASD. However,
between-groups analyses demonstrated that there were statistically significant differences in favour of TTI, namely on the reading components of accuracy, rate and phonemic awareness. Social validity measures revealed that 80% of teachers reported positive attitudes towards ERP, with 70% indicating that they would like to continue its use. Ninety per cent of teachers strongly agreed that ERP was an acceptable and effective intervention for children with ASD and would recommend its use to others. When the nature of the study was revealed to teachers, it must be noted that some teachers anecdotally expressed a desire to switch to the CAI format, despite awareness of the current study’s results.

Given that Chapter 3 detected that reading skills, in particular phonemic awareness and comprehension, were extremely deficient in children with ASD, Chapter 5 aimed to examine the use of a phonics-based curriculum, Headsprout®, to supplement children’s typical reading instruction when implemented by parents in the home environment. This programmed instruction was selected as there has been, and continues to be, a recent upsurge in literature supporting its use with children with ASD. Much of the literature focuses on investigating the curriculum within case studies or SSRDs, although SSRDs are a robust behaviour analytic research methodology, however, a group analysis was beneficial in order to increase external validity. Additionally, to date, no research has included level 2 of the curriculum (i.e., HRC) or assessed print motivation (i.e., reinforcing value of print-material) relative to the Control Group at post-test. This study employed a between-groups design to examine the effects of this programme with 26 participants ($n = 13$, Experimental Group; $n = 13$, Control Group). The impact of the intervention was evaluated with respect to dependent measures of targeted skills associated with
Headsprout® and scores on standardised norm-referenced measures of reading ability.

Results indicated that a total of 7 out of the 13 participants required accommodations (i.e., additional teaching and support) external to the programme. These accommodations included additional DTT, desensitisation of programme-specific stimuli, supports to maintain attention, and contingencies of reinforcement. Within-group analyses demonstrated statistically significant differences between groups on measures of reading and targeted skills, namely, FSF, PSF and HER words and sounds and preferences for Sprout stories. In addition, there were decreases for word reading and PSF for the Control Group. Regarding print motivation, results revealed that only the print materials specific to the Headsprout®, demonstrated increases in reinforcement value at post-test for the Experimental Group. The following sections discuss the theoretical and applied implications of the findings of the current research in more detail.

6.3 Theoretical and Applied Implications

The current thesis has contributed to the literature on reading outcomes in children with ASD with important implications for both theory and application of reading curricula. For decades, the principles of ABA have identified procedures and systems for teaching children with varying abilities. The current findings of this thesis have further important implications for educational settings for children with ASD in that they provide more information about reading deficiencies that present in this population, and provides greater insight into the use of reading assessments and curricula selection in an Irish context. In addition, the findings provide an analysis of specific curricula that encompass procedures from behaviour analysis, as well as the additional supports required to supplement these curricula.
In relation to curriculum design and behaviour analysis, specifically programmed instruction, it is apparent that carefully sequenced, clear and explicit objectives and goals are central to reading outcomes for children at risk of reading difficulties. These programmed instructions are effective at a basic teaching level, basic word discrimination, (i.e., ERP), and also in higher-order phonics-based instruction, (i.e., Headsprout®). Findings from Chapter 5 indicate that not only is programmed instruction applicable to home environments, facilitated by parents, but when additional principles based on ABA are conducted in conjunction, barriers to learning can be overcome. Overcoming these difficulties in reading instruction may decrease the likelihood of future deficits in reading profiles, such as those demonstrated in Chapter 3. Together with the additional applications of ABA tactics, it is evident that when teaching is treated as a science, with consistency and intensity, far-reaching, socially significant outcomes can be achieved. The outcomes of the current research are invaluable in terms of informing how teachers and parents approach reading instruction. Having clear guidelines on what curricula can supplement reading acquisition and support emerging reading development is a substantial contribution of the current research.

In the selection of curricula, as well as selecting when to initiate reading instruction in children with ASD, the current research highlights the need to carefully consider Skinner’s (1957) verbal repertoires. Children need to demonstrate basic listener and speaker capacities in order to be successful on such programmed instruction. Therefore, teachers and parents need to consider these verbal behaviours as prerequisites to beginning reading instruction, and consider that some programmed instructions demand more complex listener skills than others. For Headsprout®, the ability to follow 2-step directions was required, whereas ERP’s
requirement was to follow 1-step directions. Therefore, listener repertoires need to be at a more advanced level, or directly targeted, if teachers or parents wish to select Headsprout® for teaching reading abilities.

In addition, the current thesis supports a programmed curricular sequence to teach reading. Furthermore, it was found that books related directly to the target CAI, Headsprout® were established as conditioned reinforcers at post-test relative to the Control Group. In interpreting these results, it is necessary to consider contingencies of reinforcement. Following intervention and the learning of new sounds, words and character name, the presence of Sprout Stories may have become an $S^D$ (i.e., a stimulus in the presence of which a particular response will be reinforced; Malott, 2007). This may account for the increased preference for Spout Stories following intervention, as participants could expect to receive reinforcement (e.g., social praise from parents or other family members) for the production of correct decoding skills. Conditioning print-based material has important implications because when children learn to enjoy books at an early stage, then reading becomes a preferred activity (Greer & Ross, 2008), thus exposing new learning opportunities and as well as expanding communities of reinforcers.

Within the current thesis, reading outcomes relating to ERP and Headsprout® were associated with improved reading performances using experimental designs, analysis and sample sizes not previously reported in the literature. Investigations of such curricula, within the current thesis, have provided evidence for the benefits associated with their incorporation into educational, as well as home settings and how they can be applied for children with ASD. The next subsections will outline some of the theoretical and applied implications further.
6.3.1 Reading Assessment

An unanticipated outcome from Chapter 2 was the finding that educators from the sample were using reading curricula that they believed were not suitable to the needs and abilities of children with ASD. This highlighted gaps in knowledge about reading outcomes and lack of assessments following exposure to curricula to monitor progress. Reading assessments are valuable as the results are evaluated and used to plan, support and measure children’s learning and progress in reading, as well as to identify those at risk of reading difficulties. When taken in conjunction with the findings of Chapter 3, this further emphasises that early assessment should be an important focus in reading education. In addition to this, previous research has found that early language skills are a foundation to reading outcomes (Davidson & Weismer, 2013). The current research suggests that it is important to disseminate the value of reading assessment and the need to utilise reading curricula that have empirical support for the ASD population. According to the respondents, those in need of reading intervention were identified via observation alone. However, this is insufficient considering the importance of determining where the reading difficulty lies. As discussed in Chapter 1, reading is a very intricate and complex skill with many layers of subcomponents (i.e., decoding of the symbol-letter relationships, accurate pronunciation, reading at an appropriate rate and finally reading comprehension). Therefore, it would be beneficial to identify exactly which component is most impaired so that individualised, skill-focused intervention can be put in place. For example, as found in Chapter 3, many children have severe deficits in phonological awareness, which is a pre-requisite skill to reading rate and reading comprehension (assuming the child is taught reading via phonics-based instruction). Therefore, if the child is presenting difficulties with word decoding, they are
inevitably going to have difficulties in reading rate. Moreover, if a child is having difficulties in the development of fluent rates of reading, loss of meaning of the text will likely result, impacting the overall comprehension of the text (e.g., Huemer & Mann, 2010). It is consequently essential to identify these skill deficits early in the child’s education, so that development of these specific skills can be promptly addressed. To support teachers in this, training in the areas of assessment and curriculum selection is warranted. Furthermore, evidence-based curricula, such as those in the current thesis, should be utilised in reading intervention and selected based on assessment of current abilities in reading, listener and speaker skills (as outlined in Chapter 1). This information should also support educators to identify when additional teaching/interventions are required.

More than half of Chapter 2’s respondents reported that they did not use any form of standardised reading assessments with children with ASD. This may be due to many factors, primarily, the nature of the instructions within standardised assessments. Difficulties with language are common among children with ASD and the instructions provided in standardised assessments may be too complex, especially for those with poor receptive abilities. Given that these instructions cannot be modified or individualised based on the child, the responses provided may not be representative of the child’s reading abilities. However, the use of standardised reading assessment does have its value. These assessments are developed based on normative samples of neurotypical children of the same age and therefore represent a comparative sample which translates into useable and understandable terms (e.g., reading-age approximates, percentiles). This could inform the use of reading-age appropriate readers and materials for reading instruction which would likely support accurate placement and success, as opposed
to materials based on grade-level or chronological age. Therefore, the use of standardised reading assessments should be encouraged, where possible, in the education of children with ASD. Additionally, quality assessments that are sensitive in detecting areas for instruction are also informative in order to understand the strengths and weakness (i.e., a reading profile) of this population. Educators should also make more use of curriculum-based measurement (CBM), which allows for repeated assessments over brief periods of time, permitting educators to monitor a student’s progress and to evaluate and compare the effects of academic interventions (Daly & Martens, 1994).

Furthermore, within the general comments of Chapter 2 (subsequent to the main survey items), respondents referred to the challenges of identifying assessments that were relevant to the needs and capacities of their children with ASD. In addition to the lack of standardised reading assessment, so too exists a lack of differentiating assessments to meet the learning and teaching needs of children with ASD. This finding was in line with a report commissioned by the NCSE (2016), which evaluated provisions for children with ASD. This report found that in Ireland, some primary schools’ assessments specific to ASD were “unacceptable”. With regards reading assessments, the implications of children’s co-occurring diagnoses or special educational needs require further elaboration in school documentation. Simple, practical assessments have been developed to screen pre-schoolers on print-concept knowledge (e.g., Ohio Department of Education, 2004), but these tools are not yet widely used by practitioners to improve educational planning (Dynia et al., 2016; Logan et al., 2014). Given that Chapter 3 found that pre-reading deficits are evident in children with ASD prior to beginning school, more awareness of what resources
are available needs to be disseminated to those working closely with children with ASD.

6.3.2 The ASD Reader

As autism is a spectrum disorder, it is therefore not surprising that there may also be variable or splintered skills in terms of reading abilities, presenting with strengths in one reading component, but weaknesses in others (e.g., Frith & Snowling, 1983; Mayes & Calhoun, 2003; Miniscalo & Sandberg, 2010). As discussed in Chapter 1, the difficulty children with ASD experience in comprehending language and social-communication skills places them at-risk for future reading comprehension problems (Leekham, 2007). The current research adds to the literature proposing general reading deficits within this population, with the foremost difficulties in the reading components of phonological awareness and reading comprehension. This underlines the necessity to investigate reading interventions that target these component skills, and indeed, all reading components for children with ASD. According to Whalon and Hart (2011), limited time is devoted to reading comprehension instruction in the early years of primary education classes, therefore educators should emphasis explicit language and reading comprehension, especially to children with ASD, in the early educational years. In Chapters 4 and 5, there were investigations of two different reading programmes. However, despite the statistically significant findings in a number of reading outcomes, scores on reading comprehension was not one of them. Therefore, it is highly recommended that the priority of educational instruction for children with ASD should be reading components related to language skills (i.e., phonological awareness, vocabulary), and other related foundational components that support the acquisition of reading comprehension (i.e., reading accuracy and reading rate). The
programmed instruction used within the current thesis, Headsprout® is one such resource for teachers and parents that can teach those outlined reading components.

6.3.3 Selecting Reading Curricula for Children with ASD

Few participants from Chapter 2 based their selection from empirical evidence on which curricula were effective for children with ASD. This result is concerning, as it may point to a paucity of dissemination of research within this field, and as a result, children could be missing out on potentially effective reading interventions. These findings also imply that educators may be relying on pseudoscientific means for the evaluation and selection of reading curricula for this population and that educational decisions are not data-driven. Instead, analysis of reading and curricula selection is subject to the varying educational backgrounds or experiences of the individual educator. It is therefore important, not only for educators of children with ASD to keep up-to-date with the research, but also for researchers to be more proactive in the dissemination of the outcomes of their findings in relation to reading curricula to parents, services or any other personnel that are associated with the education of this vulnerable population.

Increased availability and access to information regarding evidence-based reading curricula for children with ASD is important for teacher to support earlier access to reading interventions or the provision of additional supports. In the selection of specific approaches to reading (i.e., whole-word or phonics-based), it is worth considering that some children encounter difficulties with phonetic-based instruction even with intervention and attempts to remediate these deficits (Broun, 2004). In these instances, authors have recommended implementing whole-word recognition based reading curricula instead (Browder and Lalli, 1991; Burns, 2007; Burns and Sterling-Turner, 2010), such as ERP, as supplementing beginning reading...
curricula with word recognition or whole-word instruction may increase a child’s learning opportunities, improve their daily living skills, and reduce demand associated with learning to read. More research is needed to guide practices with whole-word reading in conjunction or as an alternative to phonics-based approaches.

Given that ERP was found to be the most commonly reported curriculum employed in Chapter 2 and as no previous research had been conducted with ERP and ASD in any presentation (i.e., TTI or CAI), this indicated that educators were selecting curricula without reference to the evidence-base. Despite this, the results from Chapter 4 indicated positive reading outcomes following ERP. This suggests that children in schools in Ireland appear to be receiving effective reading curricula, which is in line with supporting research (e.g., Yaw et al., 2011).

In selecting the curricula used within the current thesis (i.e., ERP or Headsprout®), it is not a case of either a whole-word approach or a phonics-based approach. It is highly dependent upon pre-existing reading levels of the individual child. To illustrate, the maximum grade-range that a child can achieve with ERP is a Grade 1. In contrast, Headsprout® can take a child up to as far as Grades 5 and has far more complex verbal directions and reading targets (e.g., making inferences from information provided in text). For these purposes, inclusion criteria for participants to access Headsprout® in Chapter 5 consisted of demonstrating 2-step listener directions which was not a requirement for ERP. Furthermore, in Chapter 4, there were over 80 participants screened for inclusion and many of these children could not be included as they were above the instructional limits of ERP (70% or more, 150 ERP words were in their word discrimination repertoire). Therefore, teachers and parents need to take into account the reading profile, and listener skills of the child, prior to selecting a reading curriculum. To illustrate, if results from reading
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assessment indicated that the child had some reader abilities, specifically, those beyond Grade 1, then ERP would not be the curriculum of choice.

Based on the outcomes of the current research and the profiles of participants necessary for inclusion in Chapters 4 and 5, it is recommended that a whole word programme is utilised first until the prerequisite skills for phonics instruction are present (i.e., the abilities to follow 2-step listener directions). To illustrate, reading comprehension instruction in ERP is at the most basic level, (i.e., matching a printed stimulus to corresponding words and phrases) whereas in Headsprout® comprehension instruction begins with matching the printed word to its auditory stimulus which, according to Greer & Ross (2008), demonstrates more sophisticated reading.

A central principle of the U.S., NCLB Act (2001) is that federal funds will support only those educational procedures, materials, and strategies that are supported by scientifically-based research. This requires educators, to use procedures and strategies, endorsed only by empirical findings and offers a great opportunity to bring evidence-based practices to elementary and secondary level classrooms (Yell, Drasgow & Lowrey, 2005). Irish government bodies could be advised to follow such protocols in the best interest of science and in support of better outcomes for children with ASD. Unless our understanding of the content and pedagogy of literacy are founded on research and best practice, reading outcomes may not improve (Reading Association of Ireland, 2011). Chapters 4 and 5 add to the literature on scientifically examining reading curricula (i.e., programmed instruction based upon the ABA principles) in order to support educators in following research-based practices.
6.3.3.1 The Use of CAI for Children with ASD

Despite the minimal use of CAI in schools for children with ASD, as indicated in Chapter 2, Chapter 4 identified the propensity of teachers to prefer the use of this modality rather than the typical teacher-delivered lessons. This may be as a result of perceived merit of the teaching capacities delivered by computers, in addition to the liberation of teacher-time, so they can attend to other children or focus on other educational activities.

Previous research has suggested that CAI is more suitable to educational outcomes and children with ASD (e.g., Moore & Clavert, 2000). However, contrary to other research (Williams et al., 2002), within Chapter 4, participants in the ERP-TTI condition out-performed participants in the ERP-CAI condition on a number of reading components, namely phonological awareness, reading accuracy and reading rate. This may be due to the automated antecedents and corrections delivered by the CAI. Teachers were in control and trained to administer antecedents or corrections in ERP-TTI and they had the ability reinforce efficient and accurate participant responding. To clarify, following a participant’s response, teachers were trained to provide reinforcement immediately or to wait up to three seconds for a response before administering the correction procedures. Conversely, within ERP-CAI, there was no criterion for latency between the child’s behaviour and response. Accordingly, this may have impacted on participants acquiring a higher and accurate rate of responding in ERP-TTI. Employing CAI over more traditional, teacher-led print based instruction may need to be reconsidered in applied settings. Even though CAI is cost-effective in terms of teacher-time and organisation input, it may not outweigh the gains available from contingent delivery and reinforcement of target reading behaviours.
While there were no additional accommodations necessary for ERP-CAI participants, the same cannot be said for the CAI of Headsprout®. Therefore, teachers may be under the general impression that CAI may be used in isolation, however this application of CAI alone may not teach basic reading abilities. Teachers and parents need to be active agents in monitoring and the provision of supplementary instruction, in addition to the CAI.

Despite the increasing research conducted with children with ASD and Headsprout®, it was apparent that the parents in the current research had never heard of the programme until they read the information documents or advertisements for the current research. Again, this suggests that there needs to be a wider dissemination of research-based reading programmes for children with ASD. If teachers and parents were aware of the most effective, available curricula, it could inform their choice and purchasing of academic resources both in classrooms and home environments.

6.3.4 Reading Curriculum Protocols

As previously outlined, in the U.S educational systems, according to the IDEA (2004), it is no longer acceptable to determine special education eligibility based on a child’s low academic scores. Therefore, if a child fails to acquire the target academic skills, the intervention itself must be analysed, along with the child’s response to the intervention. The current thesis presents four teaching strategies within Chapter 5 to remediate difficulties presented by the participants. However, many parents and teachers alike may have difficulty in adapting a curriculum to meet the individual child’s needs. This often requires specialist skills in strategic problem-solving to identify learning barriers during instruction and the selection of evidence-based strategies to remediate the learning problem. The professional
makes decisions about which tactics from the science of behaviour analysis may be applied based on observation and data, as the literature in ABA supplies a large number of research-based tactics to use with children as a first course of action. Such strategies may be identified and selected by a Behaviour Analyst; however, following training and clear guidelines, these strategies can be implemented by a parent or teacher in the absence of a specialist. The following section provides an account of the implementation of ERP and Headsprout®. These points were reported by educators throughout in the implementation of the curriculum, and/or from the PI’s direct observation of children’s engagement with the respective reading curricula.

The findings of Chapter 4 demonstrated that, even with brief delivery of reading instruction, with consistency, significant gains in reading outcomes can be obtained. Therefore, it is essential that educators schedule regular reading instruction into children’s school day. The findings of Chapter 5 also highlighted how instruction in the home environment, facilitated by parents can support reading outcomes. Accordingly, exposure to further reading curricula, even at a minimum of three times per week, was found to have significant positive outcomes for children with ASD. Consequently, consistency appears to be the key to ensure success in the implementation of reading curricula with this population.

6.3.4.1 Implementing ERP

Too often, educators consider behavioural issues (such as out of seat behaviour, talking out of turn) to be separate from the instructional programme or curriculum, making it easy to lose sight of the curricular factors (e.g., presentation, repetition of trials following incorrect responses, salience of antecedents) that may be contributing to problem behaviour. However, with regards ERP, it is important to
note that it was necessary to exclude participants from the ERP-TTI condition due to behavioural difficulties and motivational issues. For these participants, the motivational issues were evident across all their general table-top activities (e.g., mathematics), as well as for ERP-TTI. No behavioural difficulties were noted for participants in ERP-CAI.

The 10-minute lesson delivery was ample for the implementation of ERP (both presentations), as it was typically enough time to complete a minimum of two lessons and did not incur fatigue in participants. However, with ERP-TTI, preparation of lesson (picture/phrase cards, visors, word recognition book and recording of data) had to occur outside of the 10 minute period. Therefore, it is more time-intensive than ERP-CAI. Although ERP-TTI may be presented to small groups, most commonly (and per the current study), it requires full one-to-one teacher time. During this time, educators had to direct paraprofessionals to implement prepared instruction with the other children in the class, along with organisation of materials for its implementation. Conversely, the CAI version of ERP requires minimal teacher time, as materials were all digitally stored, thus eliminating the need for preparation and additional instructional time. These implications may have contributed to teacher’s responses in relation to CAI preference.

Some practical considerations in relation to ERP-CAI to note included the fact that there were no means for correction of errors in verbal productions. In contrast, in ERP-TTI, there is opportunity to immediately correct these errors in word productions due to the necessity of the educators’ presence with this presentation. Additionally, ERP-CAI does not track children’s duration of time on lessons, it is necessary to conduct this in conjunction with ERP-CAI.
Although not a focus of the study, it is important to note that these additional teaching accommodations were not associated or required with the ERP curriculum (outside of participant’s general access to reinforcers following instruction). ERP was specifically developed for children with disabilities, or for children that had previously failed to acquire reading skills in the traditional systems (e.g., through a phonics-based approach). It is evident that effective teaching is time intensive and requires extensive efforts by educators, and the organisational time and the data collection input require by ERP-TTI. However, this time was not necessary for ERP-CAI and although the results were less significant to those obtained through TTI; it still proved effective in teaching the target ERP words. Thus it required minimal teacher-time, yet provided positive results. ERP-CAI is a programme that may have great potential and utility in the classroom and indeed home settings and warrants further investigation to realise its full potential.

6.3.4.2 Implementing Headsprout® with Parents as Facilitators

As outlined in Chapter 1, programmed instruction is designed to minimise teacher errors through the use of scripted, carefully sequenced instruction with explicit reading outcomes. Consequently, these programmes can be used by any educator, including parents, which ultimately provides children with more learning opportunities and bridges the school-home educational gap.

Although accommodations in Chapter 5 were established by a certified behaviour analyst, with the continuation of research on Headsprout®, a “bank” of tactics or additional instructions necessary to overcome learning barriers for Headsprout® will become more accessible to educators of children with ASD and possibly other disabilities. This is important information for educators so that they can support their child’s learning with trialled and tested accommodations.
Continued research in this area will increase awareness of where common learning difficulties may arise in children with ASD, in addition to tactics that may be implemented for remediation of these difficulties. It is therefore, very apparent that educators cannot uptake a curriculum that has been developed for a neurotypical population and expect seamless learning. Educators must consult the research base to assess what the common learning difficulties are in association with the curriculum. Similarly, they must also be willing to address learning difficulties that are unique to each individual child (as seen in Chapter 5 with the conditioning procedure for characters and motivational elements in association with HRC).

Additional supports necessary for participants have previously been outlined in detail in Chapter 5, however, there are a number of further considerations which warrant discussion. Although it is important to note that the following issues did not impact on criteria for participants to proceed to subsequent episodes. There were sections of episodes that incorporated *Speak out Loud* activities. These activities required participants to vocalise the target sound/word upon instruction. However, Headsprout® software had no means of establishing correct or incorrect verbal responses. Therefore, to monitor this, it was necessary for parents to be active agents at all times throughout episodes to prompt participants to “speak out loud”. It was found that participants in Chapter 5 mostly needed general reminders for correction of mispronunciations. There were sometimes fleeting pauses during and following automated instruction, which limited the provision of being able to make responses. This latency meant participants would initially select the correct answer, but because the screen was not yet available for responses, participants ended up directing their responses to the other, incorrect exemplars. Parents needed to prompt participants to wait until the entire instruction had been finished. This indicated a
higher response effort required, with the necessity of parents to observe and oversee each episode. Perhaps with the future evolution of technology, Headsprout® could be enhanced with the incorporation of voice-recognition software that could detect (with a microphone) participant’s response to onscreen text. If no responses were detected, the automated software could re-issue the prompt to “speak out loud”.

Due to some scheduling difficulties encountered in homes during this research, it would be recommended that this curriculum be used at weekends, school holiday or as part of a “homework club”. In these clubs, parents could come as a group and learn how to implement the intervention as well as learn tactics to support their child’s progress and learning. Although parents were merely “facilitating” the curriculum, it was necessary for them to be active agents in this facilitation, which meant monitoring data from episodes, making sure children were speaking out loud, monitoring for the learning problems if children were not meeting criteria in episodes and delivering contingencies and additional supports where necessary. Consequently, specific training in relation to a “commitment to learning” from parents, is necessary, emphasising consistent delivery of the curriculum and guidelines on how to utilise the accommodations that are becoming evident both from this thesis and previous research (Grindle et al., 2013; Plavnick et al., 2016) to ensure that the time invested will be valuable. Notwithstanding this, from the findings of the current research, it is clear that parents can play a vital role as agents in implementing behaviour analysis in the educational process of their children.
6.3.4.3 Advantages and Disadvantages Associated with ERP and Headsprout Programmed Instruction

As mentioned previously, in the selection of either ERP or Headsprout® programmed instruction, individual reader and listener/speaker profiles need to be taken into account. However, given the potential for a child to demonstrate pre-reading behaviours at preschool, and possibly showing pre-requisites for both programmes’ instruction, it is worth discussing the advantages and disadvantages relative to each.

Lessons are much shorter in ERP than in Headsprout®, therefore, if there are concurrent diagnoses (as evident in Chapter 3) which may influence attention skills, brief and frequent (5 days, rather than 3 days) lessons may be more suitable for this child. Alternatively, if the reader is beyond the instructional limits of ERP, Headsprout® episodes could be conducted in shorter periods than is automatically administered as part of the programme. This is especially pertinent towards the end of the Headsprout® sequence, as, some episodes can last for 30 minutes or more. As mentioned previously, material organisation for ERP-TTI is time consuming and, as there are over 400 picture/phrase cards in total, it is quite easy to misplace, lose or damage these essential materials. This is not an issue for either ERP-CAI or Headsprout®. Furthermore, Headsprout® can be accessed in any location, as long as there is a working internet connection. ERP-TTI is a large box of materials that needs to be transported (if shared between classrooms) and ERP-CAI, is limited to installation on one computer or the necessity to insert the CD-ROM. This limits the accessibility of ERP outside of the classroom environment.

In terms of teaching targets, with ERP, the learning is capped at the target 150 words of the curriculum (as well as demonstrating comprehension of these
words). Conversely, as Headsprout® is phonics-based, it teaches the child how to sound-out words based on the letter-sound correspondences, therefore providing opportunities for skill generalisation as children should be able to “sound out” most words that have regular letter-sound correspondences. Learning opportunities are thereby limitless, given the abundance of print in our environment, leading to more opportunities to contact reinforcement for approximations to correct applications of the phonetic skills.

In relation to the presentation of the respective programmed instruction, stimuli associated with ERP-TTI may not be as reinforcing as ERP-CAI or Headsprout®. Both CAI methods (Headsprout® and ERP-CAI) have animations or “characters” within the episodes. Where more reinforcing stimuli are required (e.g., if motivation is a particular difficulty), the use of Headsprout® and ERP-CAI would be recommended. Although, with the current thesis, it must be considered that it may not be sufficient for HRC. However, in relation to the findings of Chapter 4, the lack of animated stimuli in ERP-TTI did not appear to be an issue as those children in ERP-TTI out-performed those in ERP-CAI (limitations and possibilities related to this finding are discussed later). Greer (2002) suggests that acquisition of prerequisite word-discrimination skills is important ahead of employing phonics-based approaches. Thus, based on this literature and the current study findings, it is recommended that ERP (TTI and/or CAI) should be implemented as a prerequisite to more complex reading approaches and/or phonics-based approaches, such as Headsprout®. Furthermore, if there are attention difficulties and the accommodations specified in Chapter 5 are not applied, ERP-CAI should be used.
6.4 Limitations and Future Directions

Several limitations and future directions have been discussed throughout this thesis. The following section elaborates on such limitations, highlighting directions for future research.

6.4.1 Investigating Further Reading Outcomes

As found in Chapter 3, and indeed other studies, the most consistently cited reading sub-component deficit is reading comprehension (e.g., Griswold at al., 2002; Nation et al., 2006; O’Connor & Hermelin, 1994; Wahlberg & Magliano, 2004). Despite this, there is limited research on interventions that can remediate this specific reading deficit. Headsprout®, namely the first level, HER, has been previously shown to be effective with children with ASD. However, comprehension skills are minor targets (towards the middle and end of this level). Therefore, the current research sought to extend previous findings and include the second level of the programme, HRC, which specifically targeted reading comprehension skills. However, no statistically significant increases in the Experimental Group were evident on reading comprehension relative to the Control Group. Further research with a larger number of participants with ASD accessing HRC, as well as investigations of other interventions that aim to teach comprehension skills are warranted. Another important direction for future work is the identification of specific impairments in comprehension, more specifically, identification of the sub-component of reading comprehension which is most impaired (e.g., making inferences, vocabulary). Furthermore, future research should undertake a component analysis of the curricula in order to determine the most effective instructional element for children with ASD. This would inform the development of reading
comprehension interventions which are more focused on the distinct learning problem.

Furthermore, studies have focused only on measures of literacy with those who are vocal-verbal (speak in order to communicate). Future research should investigate measures specially designed for non-verbal children (e.g., the Nonverbal Literacy Assessment; Baker et al., 2010). This would allow for a more representative sample of reading abilities in children with ASD, as currently there is not enough research to suggest that having ASD and being nonverbal rules out the possibility of having the ability to read, even if that ability cannot be assessed by traditional means (Arnold & Reed, 2016).

The current experiments on reading curricula were examined for approximately 10 weeks in duration, which is the equivalent to one full school semester. As there were significant results yielded within this time-frame, this demonstrated the effects possible within relatively short intervention periods. However, future research should examine longitudinal research to allow a full evaluation of both presentations of the curriculum. This would permit a more thorough understanding and would be more representative of the reading outcomes possible with exposure to all of ERP and Headsprout® lessons and may yield even greater reading scores in relation to standardised measures. Nonetheless, given the difficulties in making gains in standardised assessments, the findings were promising given that some standardised measures were positively impacted within such a short timeframe.

6.4.2 Responses to Programmed Instruction

Research has indicated that individuals with ASD are impaired in their abilities to generalise skills learned in instructional contexts to other environments,
people and materials (De Marchena, Eigsti & Yerys, 2015; Karkhanesh et al., 2010; Vismara & Rogers, 2010). In Chapters 4 and 5, there may have been issues with the transfer of stimulus control from a computerised interface to print-based assessment procedures. Future research should consider the use of computerised presentations of reading at pre- and post-test to account for issues of transfer from screen to paper (i.e., matching of assessment formats to conditions).

With reference to Chapter 4, results must be interpreted with caution, as there may be various factors to consider regarding these findings. Although, reinforcement was delivered on an FR1 schedule across both TTI and CAI, it must be considered that previous conditioning/learning histories with participant’s teachers may have positively impacted on responding. Increasing reading responses may be attributed to reinforcement presented by teachers, who were in most cases familiar to the participants within the condition, thus improving overall motivation and engagement with the lessons. The increase in phonemic awareness in the TTI group may have been attributed to the verbal interactions (i.e., vocal, non-automated antecedent and corrections of responses). This supports findings from Heimann et al. (1995), which demonstrated that teacher-child dialogues during the CAI condition contributed to gains in overall verbal scores (Ramdoss, 2011). For true comparisons, it is necessary for future research to control for this in accordance to the mode of reading instruction, and also to plan for transfer of stimulus control with regard to reading responses, from computer to print during assessments. Additionally, future research could use probes to evaluate the transfer from screen to print, as a test of generalisation. By teaching children pre-requisite reading skills through programmed instruction, there is scope for extension of these skills to generalised
reading repertoires, the outcomes of which could be further investigated in a longitudinal study.

With regard to specific targets of Headsprout® namely, Headsprout® words and sounds, certain elements may be beyond the parameters of the curriculum to build, for example, deriving new words from the sounds learned and constructing novel sentences whereby stories may be developed. Future research should investigate the utility of the target words from the curriculum in order to construct sentences and stories that may be made more unique and reinforcing to the individual child’s reading behaviours.

According to Plavnick et al. (2014), the feasibility of implementation of such scripted curricula is a marked selling point for teachers. Given their design and instructional features, scripted curricula based on ABA, like ERP and Headsprout®, offer promise for children with ASD. The current research has greatly contributed to the current knowledge base in terms of novel and socially valid research. Future research should continue to investigate programmed instruction, thus allowing teachers and parents to make informed decisions on reading instruction, and how they can support the development of reading repertoires for children with ASD.

6.4.3 Perceptions of Programmed Instruction

Analyses of perceptions and motivational factors for TTI versus CAI were reported through social validity measures in Chapter 4. A full analysis of participants’ preference for the respective conditions would have been beneficial in order to objectively assess varying motivational levels. In addition, teacher’s motivation to implement TTI should be examined, (by simply asking which they would prefer to implement), considering some teachers expressed interest in converting from TTI to CAI. A simple means of identifying preference for CAI or
TTI may be achieved through conducting preference assessments in which the child can choose between traditional, print-based or CAI instruction. Additionally, research examining the cost-benefit analyses of TTI versus CAI are warranted to examine whether the greater outcomes achieved during TTI are worth the additional teacher time necessary to organise the materials, administration and record reading behaviour. It may be most useful to employ CAI in conjunction with TTI and further research would be needed on the outcomes of TTI with the supplement of CAI.

Regarding the outcomes of Chapter 5, there were interesting results in terms of print motivation following exposure to the Headsprout. More research is necessary to explore this facet of reading in more depth, especially given the strong links to motivation and future reading outcomes (e.g., Oldfather & Wigfield, 1996; Scarsborough & Dobrich, 1994).

**6.4.4 Experimental Design**

While the current research represents a significant addition to the empirical evaluation of reading outcomes associated with CAI, further research is warranted to replicate and investigate each outcome further. An examination of maintenance and generativity were beyond the scope of this thesis. The abilities to retain and combine skills to form new, more complex skills are the optimal goals of instruction. One of the goals of behaviour analytic teaching programmes is to help individuals to gain functional skills that can be used regardless of situation (Kerr, Mulhern & McDowell, 2000). Therefore, in order to determine the impact of each reading curriculum on retention of reading skills, future studies should conduct follow up assessments in order to provide information on long-term maintenance of the acquired reading skill.
In relation to Chapter 4, a limitation was evident with the omission of a control group. As both groups received intervention, reading scores were seen to increase for both ERP-TTI and ERP-CAI. This suggests that the treatment was effective, but it is unknown to what extent. The addition of a TAU control group or a group receiving an alternative intervention unrelated to reading performances should be incorporated within future comparative reading research. This analysis would be helpful in determining how ERP-TTI produced superior results. Within the cluster design of Chapter 4, there were many schools clusters throughout the country which made the consistent implementation of fidelity checks very difficult. However, this was remediated in Chapter 5, with the use of remote video-fidelity checks making for a more efficient method.

### 6.4.5 Procedural Factors

With regard to Chapter 4 and 5, all participants were exposed to TAU within their respective educational settings, in conjunction with exposure to the reading curriculum. This may have impacted on reading outcome scores; however, as all groups had TAU, inferences can be drawn between groups. Future research should consider examining ERP and Headsprout in isolation from other reading instruction (i.e., TAU in school) in order to gain a more precise analysis of the associated reading outcomes. Furthermore, an examination of print motivation was conducted only in Chapter 5; it would have been useful to conduct similar assessments in Chapter 4, with the use of ERP and its accompanying stories. There were a number of limitations regarding sample sizes and characteristics in the current research. Sample sizes were relatively small for group designs, especially in relation to Chapter 2. There were a total of 60 respondents, which limits generalisability of the reading practices in schools for children with ASD. The high proportion of
respondents from schools employing an ABA approach may also be over-estimated with regard to current educational practices given the decrease in these educational settings (as described in Chapter 1). Future research should include a larger sample size which would provide further data on children’s educational and behavioural histories, as well as frequencies and intensity of reading instruction. Sample sizes were also smaller than anticipated for Chapter 4 and 5, this was due to attrition and short fallings of participants to meet the target exposure criteria of the curriculum. This proved more of a difficulty with Chapter 5, as busy-home lives, distractions from other siblings and unforeseen events were more common place, resulting in a more challenging “intervention environment”.

In addition, the widespread locations of participants throughout Ireland meant that provisions of the required supports were not immediate (due to travel requirements and scheduling times with families). However, as outlined within Chapter 5, an alternative for future studies to investigate could be homework clubs, where parents could gather as a group and implement the curriculum with fewer distractions, as well as having opportunities to communicate with each other and designated professionals about accommodations required. The small sample size of participants in Chapter 5 who were exposed to HRC may have impacted on the lack of significant findings for reading comprehension. As demonstrated in Chapter 3, this is a subcomponent that requires intervention and, therefore, future studies should examine HRC in a larger numbers of children with ASD.

Procedural fidelity checks for ERP lessons in Chapter 4 were low (6%). This was due to the widespread geographical locations of school clusters, across seven counties of Ireland, and the practically of regular school visits each week. As recruitment for Chapter 5 resulted in multiple locations, the objective was to advance
this low score of the previous chapter, with the use of video-calls to conduct fidelity checks. Although there was a significant increase in the fidelity checks, (17%), it remained below the aim of the research. This lower than anticipated number was due to scheduling difficulties between the PI and parents, and sometime due to technical issues with video-calls. Therefore, this may have impacted on the implementation of the reading curricula as per recommended guidelines. However, due to the nature of programmed instruction, especially in relation to CAI programmed instruction, antecedents and consequences are scripted and embedded within the design of the programmes, thus limiting teaching errors. Even so, this may have had an impact with regard to ERP-TTI and the consistent delivery of the necessary accommodations applied to Chapter 5 in the absence of the PI. Nevertheless, this is representative of everyday family circumstances and therefore, results demonstrate an important contribution to the literature and for clinicians towards designing interventions that have a contextual fit. This may be prevented in future research by contracting parents to minimal contact/intervention for a pre-specified times each week.

The online forum on social media was helpful for parents to contact the PI at a time that suited parents to discuss progress or minor learning issues with the PI (as well as each other). The accommodations, as described in Chapter 5, could not have been remediated through the online forum as it was necessary for the PI to travel to participant’s homes in order to support participants and parents. However, as Headsprout® is an internet-based CAI, this forum was very useful for promptly addressing of technical issues with the programme and would be highly recommended for future research with larger sample sizes, such as the current thesis.
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The context of the educational provisions for children with ASD must be considered in interpreting some findings from the current thesis. The Department of Education re-designated the pilot ABA schools in educational revisions for children with ASD following the implementation of Chapters 2 and 3. Thus results of Chapter 2 must be interpreted with caution as the findings from the survey were based on a time when ABA schools were in operation. Therefore, these results may not be current and may instead reflect subjective responses from educators implementing specific approaches. More up-to-date research needs to be conducted in the current educational settings for children with ASD in order to provide a current perspective of reading and assessment practices. However, from Chapter 4 onwards, these post-educational revisions were in place and research was conducted in the revised special schools, mainstream classes and ASD units.

6.5 Summary and Conclusion

It is becoming increasingly clear that, to ensure improvements in education for children with ASD in Ireland, it will be necessary to apply the principles and procedures derived from science, directly to teaching (Twyman et al., 2004). This thesis represents a comprehensive investigation of reading abilities and reading outcomes of ABA-based programmed instruction with children with ASD. The aim of the current research was to (i) investigate the extent of the use of reading assessments, reading curricula and CAI in Irish schools (ii) examine reading abilities in a large sample of children with ASD, (iii) compare CAI with TTI on a prevalent whole word reading curricula in children with ASD, (iv) to investigate the effects of CAI in the home environment facilitated by parents, (v) to assess the accommodations necessary to successfully progress through the curricula, with a
large sample size and, (vi) to examine print motivation following exposure to a reading intervention.

Reading acquisition is a complex process for which there is no single key to success (NRP, 2000). In addition, with regard academic achievement difficulties, previous studies have indicated that children with ASD may have unique challenges with reading comprehension (O’ Connor & Hermelin, 1994; O’ Connor & Klein, 2004) which requires further research to support the current challenges faced by educators (El Zein, Solis, Vaughn & McCulley, 2014). ASD is an increasingly prevalent developmental disorder that can affect children of all ethnicities and socioeconomic backgrounds and therefore it is important to find the most effective tools and resources in order for this population to become independently functioning members of society. While children with ASD share some common characteristics, they also display a wide variation in cognitive language and reading skills, as demonstrated in the current thesis. Overall, the current research suggests that the use of curricula based upon the principles of ABA to improve reading skills with children with ASD is a promising stream of research. Educators using CAI should carefully considered the existing research, abilities of their learner and the availability of resources, namely, time commitments and specialist support (where necessary) in their selection.

It can be overwhelming and difficult to select a reading curriculum that is not only suitable for an individual child but also has proven outcomes. With the rapid increase in the use of the internet by teachers and parents, on-going parent and teacher collaboration are essential. Training is an important priority as educators need specialist knowledge and understanding of specific needs of children with ASD (Guldberg et al., 2011). The current thesis demonstrated that the ERP programme is
effective in teaching early reading skills to children with ASD, despite the lack of research with this population. The results of the current thesis demonstrated the efficacy of each intervention, adding significantly to the literature examining evidence-based reading practices for children with ASD. This has considerable implication for applied settings, since it has been argued that the use of comprehensive and evidence-based curricula for children contribute to the prevention of academic failure (Johnson & Street, 2013). This thesis also demonstrated the impact that supplementary CAI Headsprout®, facilitated by parents, can have with children with ASD. It was demonstrated that with CAI exposure for as little as three times per week, with additional supports, children made significant progress in reading development and preference towards specific print-based materials increased.

This thesis adds to the growing body of reading literature, which supports the use of curricula based on the principles of ABA to increase reading performances. The current studies examined curricula that have not previously been investigated with the population of ASD, as well as expanding on previous research by employing group designs and standardised measures of assessments. Furthermore, as one of the difficulties in researching the effectiveness of interventions for those with ASD is the diverse abilities that present across the spectrum, individualised support was necessary for successful progress. Notwithstanding this, it was evident that with the implementation of ABA-based programmed instruction, educators are in a better position to give children the opportunity to engage with effective educational practices to meet their needs. In summary, the current thesis has significant and applied implications for the assessment, selection and delivery of reading curricula to promote important reading outcomes for children with ASD.
General Discussion

References


Åsberg, J., Kopp, S., Berg-Kelly, K., & Gillberg, C. (2010). Reading comprehension, word decoding and spelling in girls with autism spectrum disorders (ASD) or attention-deficit/hyperactivity disorder (AD/HD): Performance and predictors. *International 0.3109/13682820902745438


References


disabilities. *Exceptional Children, 72*, 392–408.

https://doi.org/10.1177%2F001440290607200401


https://doi.org/10.1177%2F001440290807400401


https://doi.org/10.1016/j.ridd.2004.11.015


https://doi.org/10.1177%2F0741932514534075


Chandler-Olcott, K., & Kluth, P. M. (2008). “Mother's Voice Was the Main Source of Learning”: Parents' Role in Supporting the Literacy Development of Students with

http://dx.doi.org/10.1080/19388071.2012.754520

https://doi.org/10.1007/s10803-007-0357-5


Constantinescu, C. (2015). *Assistive technology use among secondary special education teachers in a private school for students with specific learning disabilities: Types, levels of use and reported barriers* (Doctoral dissertation, University of Maryland, College Park).


References


223


Freeman, C. (2015). *Using Headsprout Early Reading with a child with Autism Spectrum Disorder: An examination of phonological awareness, participant engagement, and

http://hdl.handle.net/10464/6026


References


Heimann, M., Nelson, K. E., Tjus, T., & Gillberg, C. (1995). Increasing reading and
communication skills in children through an interactive multimedia computer
0162-3257/fl5/1000-(M5yS07.50/0

Helping Every Child to Read. (2017, January 12). Retrieved from:
http://www.helpingeverychildtoread.com/index.php/causes-of-difficulty/reading-
theories/whole-word-method

Henderson, W. The Effect of Headsprout Early Reading Program as an Intervention for
“At-Risk” Kindergarten Students. In *Teacher as Researcher: Action Research by
Elementary Teachers*, (pp. 84-92). USA: Lulu Press Inc.

students with autism using multimedia authoring software. *Focus on Autism and
Other Developmental Disabilities, 11*(2), 69-78.
https://doi.org/10.1177%2F108835769601100202

their children’s education?. *Review of educational research, 67*(1), 3-42.
https://doi.org/10.3102%2F00346543067001003

writing, 2*(2), 127-160. https://doi.org/10.1007/BF00401799

Hackett, J. (2017). Effects of Emergent Literacy Interventions for Pre-schoolers

Huemer, S. V., & Mann, V. (2010). A comprehensive profile of decoding and
comprehension in autism spectrum disorders. *Journal of Autism and


https://doi.org/10.1177%2F07419325040250020301


http://www.jstor.org/stable/42899164


https://doi.org/10.1177%2F073194871003300406


References


References


Leon, Marta, Victoria Ford, Hirofumi Shimizu, April Heimlich Stretz, Jay Thompson, Melinda Sota, Janet S. Twyman, and T. V. Joe Layng. "Comprehension by design:


References


http://dx.doi.org.libgate.library.nuigalway.ie/10.1080/13558000050138452


References


http://www.autism.org.uk/about/what-is/myths-facts-stats.aspx

perspective. Psychological bulletin, 125(3), 338.

Nation, K., Clarke, P., & Snowling, M. J. (2002). General cognitive ability in children with
reading comprehension difficulties. British Journal of Educational
Psychology, 72(4), 549-560. doi: 10.1348/00070990260377604

Nation, K., Clarke, P., Wright, B., & Williams, C. (2006). Patterns of reading ability in

developmental disorders. Topics in Language Disorders, 25, 21-32. doi:
10.1097/00011363-200501000-00004

National Council for Special Education; NCSE. (2016). An Evaluation of Educational
Provision for Students with Autism Spectrum Disorder in Ireland. Research

National Council for Special Education (NCSE;2006). Implementation report: Plan for the
phased implementation of the EPSEN Act 2004

National Reading Panel: National Institute of Child Health, & Human Development (US).
(2000). Teaching Children to Read: An Evidence-based Assessment of the
References

*Scientific Research Literature on Reading and its Implications for Reading Instruction.* USA: National Institute of Child Health and Human Development.


References


References


Reading Association of Ireland, (2011). Better Literacy and Numeracy for Children and Young People: A Draft Plan to Improve Literacy and Numeracy in Schools.
References


References

https://doi.org/10.1177%2F002221949703000302


doi: 10.1901/jaba.1996.29-451


https://doi.org/10.3102%2F00346543064004479


References


(Eds.), Behavioral foundations of effective autism treatment (pp. 297–319). NY: Cornwall-on-Hudson


https://doi.org/10.1177%2F001440291207800404

References


Appendix A

Print Version of the Online Survey

Chapter 2
Dear Educator,

I kindly ask you to take the time to answer some brief questions in relation to your class(es) of students ASD and reading factors. If you are uncertain about anything, or wish to ask any questions, please do not hesitate to contact the principal investigator:

Amanda Nally,
Tel: +353 87 950 7181
Email: a.nally1@nuigalway.ie

No identifying information will be gathered. All responses will be confidential.
1. The severity of the ASD class you teach are predominantly:

- [ ] Mild ASD
- [ ] Moderate ASD
- [ ] Severe ASD

*Comment:*

2. What are the age range of your ASD class?

3. What is/are the central teaching methodologies in your school?

- [ ] Applied Behaviour Analysis (ABA)
- [ ] Treatment and Education of Autistic and related Communication Handicapped children (TEACCH)
- [ ] Eclectic model
- [ ] Primary School Curriculum
- [ ] Other *(please specify)*

4. Are there any children in your class with no reading skills, if so what percentage?

5. Are there any children in your class who have no reading skills, but read via the use of signs, if so what percentage?

6. Are there any children in your class who have no reading skills but who demonstrate picture-word matching, if so, what percentage of the class/school?
7. What would you consider the predominant reading programme/curriculum?

- Edmark Reading Program®
- Reading Mastery®
- Jolly Phonics®
- Reader Series®, e.g. Starways®, Sunny Streets®, Reading Zone®
- Other (Please specify)

8. Why did you select this particular reading programme/curriculum?

- Research suggested it was best
- From previous experience with the programmes use
- Word of mouth from other educators
- The curriculum/programme has always been in use in the school
- Other (please specify)

9. Do you use a Computer-based reading programme?

- No
- Yes, it is used as the core reading programme
- Yes, but only as a supplement to the core reading programme (as outlined previously)
- Yes, but only for games and rewards with a minor learning element.
  Please specify the computer programme, if used in any of the above:

10. What (if any) reading assessments do you conduct to determine reading acquisition/level?

- No assessments are conducted.
- Reading skills are assessed prior to the programme onset
- Reading skills are assessed at the end of the school year (summative assessment)
- Reading skills are assessed during the reading programme (formative assessment)
  Other (please specify)

11. What standardised reading assessments (if any) do your use to assess reading skills/reading age?

- None.
- *The Drumcondra Test of Early Literacy® (DTEL)*
- *Mary Immaculate Reading Attainment Test® (MICRA-T)*
- *The Belfield Infant Assessment Profile® (BIAP)*
  Other(s). Please specify

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12. How do you identify struggling readers in your class?

☐ Through observation of academic (reading) performance throughout the school year
☐ Through formal reading assessments
☐ Through parental concerns
☐ There are no differentials made
☐ Other (please specify)

13. The reading programme used predominantly teaches the reading component skill(s) of:

☐ Whole word recognition
☐ Phonics
☐ Comprehension
☐ Reading Fluency

☐ Other (please specify)

14. The reading programme used predominantly does not address the reading component skill(s) of:

☐ Whole word recognition
☐ Phonics
☐ Comprehension
☐ Reading Fluency

☐ Other (please specify)

*Please indicate the degree to which you agree with the following statements:*

15. The reading programme is easy to implement

☐ Strongly Agree
☐ Agree
☐ Not Sure
☐ Disagree
☐ Strongly Disagree
16. The students enjoy and are motivated to use the programme/curriculum:

- Strongly Agree
- Agree
- Not Sure
- Disagree
- Strongly Disagree

17. The school would recommend this reading programme and continue to use it in the future

- Strongly Agree
- Agree
- Not Sure
- Disagree
- Strongly Disagree

Thank you!

Comment box: if you have any further comments or thought to relay on this topic or your experiences with a particular reading programme/experiences of teaching reading skills to students with ASD, it would be very much appreciated.
Appendix B

Sample of the PI Developed ERP Guides for Teachers

Chapter 4
Edmark Reading Programme, 2nd Ed, Level 1

Teachers Guide

Contact Principal Investigator: Amanda Nally for further questions. Tel: 087-9507181
Email: a.nally1@nuigalway.ie
Contents Overview

Lessons are numbered in sequential order (1-153) each teaching a single word. 
**Mastery test**- can be used as baseline, for IEPs and monitoring progress. 
**Lesson plan/ record book**- documentation of students’ achievement. 
**Reading & Social skills games**- aids students leaning and promotes generalisation of reading skills in a social setting. 
**The Rides**- story which is provided as a reward for completion of programme and incorporates all the word taught in level 1. 
**Word Signs DVD**- for use with students who have difficulties with verbal expressions.

Word Recognition (WR)

Learning Aim- student should learn to recognise and read the target words quickly and easily. The student repeatedly hears, sees, points to and reads the new words. Once a student can recognise and read a new word, they proceed to a new word and subsequent activity. 
**Objective**- students should point to and read aloud a word when it appears in a multiple-choice line

- Read aloud the entire line of text in a read-back line
- Point to and read words with –s, -ed and –ing endings

Presenting the WR activity

Place the blue display mask over the page, allowing the student to only see the current line through the transparent strip. Students are required to either make multiple-choice or read-back responses. For multiple-choice lines, the student points to the correct word and then reads it aloud. For read-back lines, the student reads aloud the word, phrase or sentence. In each lesson the new word appears on a line that had dashed lines in the other two columns to indicate a new word, e.g. --- sky ---

The line numbers contain answer codes that the teacher uses to cue a student’s response. For multiple-choice lines, the codes *a*, *b* and *c* indicate that the answer, *a* = the first word in the line of 3 is the answer and cue, *b* = the second word in the line as the answer/cue and *c* the third. For example if in the left of the page 9a was indicated followed by the words horse & yellow. 9 indicates that it is the successive 9th multiple-choice response of the programme and the letter *a* indicates that the teacher should cue (say) the word horse and the correct response should be the student pointing to and reading aloud the word horse.

Sample scripts in beginning WR

Teacher: **Point to the word horse**
Student: (points)
Teacher: very good.
Move the display mask to the next line. The next line has an asterisk- indicating that it is a read-back line
Teacher: **read**
Student: horse
Teacher: **very good**
The next lesson teaches plural endings –s. Place the display mask over the first line. Point to the sample on the left.
Teacher: **point to the s**
Student: (points)
Teacher: **very good** (point to the array of choices). **Find another s here and point to it**
Student: (points to the s in cars).
Teacher: **very good. The word is cars. You say it now**
Student: Cars.
Teachers: **very good**
Graphing monthly progress

Teachers are asked to record their student running accumulation of words learned for each part of the Edmark activities.

- The dates to be recorded are outlined on the bottom (X axis) of the graph - the last Friday of every month of the academic year.

- On the left side (Y axis) of the graph are the cumulative numbers of words learned.

- Plot each data value (words learned) per month - do this by drawing a dot vertical of the target month and horizontal from the number of words.

- On the final Friday of the following month after plotting a new value; connect both points (similar to ‘Dot-dot’ drawings).
Known among teachers as "the one that works," the **Edmark Reading Program** follows a carefully sequenced, highly repetitive sight-word approach. This approach offers the highest probability of success to those students who have never mastered beginning reading. The **Edmark Reading Program** uses small steps, consistent repetition, and positive reinforcement to help students experience immediate success.

As students complete the lessons in the **Edmark Reading Program, Level 1** they are continually given opportunities to choose the correct answer. If a student chooses an incorrect answer, the program automatically reduces the remaining number of incorrect answers. Students are always provided with positive reinforcement for choosing the correct answer.

The Windows/Macintosh version of the Edmark Reading Program includes all the original lessons from the print version, as well as these new features:

- 30 stories
- Comprehensive, printable record-keeping system to track student progress
- High-quality audio cues and reinforcement
- Single switch scanning
- A choice of interface: Standard (for visual interest and fun) or Simple (for students who are easily distracted)
- Optional host characters, Professor Seymour Words and the AlphaBeta 900 WordBot
- Printable Flash Cards and Signing Manual

The Windows/Macintosh version also allows students to complete lessons independently and enables teachers to provide individualized instruction for each student.

Click a lesson type from the menu on the left to find out more about what students learn with the **Edmark Reading Program, Level 1**.

**Pre-Reading**

In the Pre-Reading lessons, students increase basic matching and discrimination skills and practice top-to-bottom and left-to-right reading patterns. Recognizing matching shapes helps students identify letters and words in later lessons.

As students complete the simple matching exercises in the Pre-Reading lessons, they also practice following verbal instructions and making selections.

**Note:** Qualified students can skip the Pre-Reading lessons and begin the program with the Discrimination Test.
The Discrimination Test (Lessons 9 and 9A) reviews the Pre-Reading lessons, requiring students to match-to-sample letters, groups of letters, numbers, and words. As students match letters, they demonstrate the discrimination skills they learned in the Pre-Reading lessons.

Because there are a few dozen questions in the Discrimination Test, it has been divided into two parts to make it more manageable for students. Some students may wish to complete the first part of the test (Lesson 9) during one session and the second part (Lesson 9A) during another session.

**Word Recognition**
The Word Recognition lessons teach a total of 150 words. Words are presented one at a time. The first time a new word is introduced in a lesson, it is shown with dashes as the distracters. In later lessons, the distracters include nonsense words, and eventually real words.

Students practice pairing spoken and printed words until they can respond automatically and correctly to printed words. After 10 new words are introduced, a post-test is given.

**5-Word Practice**
After each five words taught, students are presented with a 5-Word Practice or a Post-Test. Students click a sign to hear a word read aloud. Then they click the corresponding printed word to place it on the sign.

**5-Word Review**
After practicing a group of five words, students are tested on the words in the group. Prior to the test, the "Call Your Teacher" screen appears to notify the teacher.

**Note:** A teacher must supervise the 5-Word Review to determine whether or not the student reads the words on the test correctly. If the student correctly reads the word, click the Y button or press the Y key. If the student incorrectly reads the word, click the N button or press the N key.

**10-Word Post-Exercise**
Appendix C

Fidelity Checks Documents

Chapter 4
## Edmark® Reading Programme Integrity checklist (TTI)

### General Observations

<table>
<thead>
<tr>
<th>Observation</th>
<th>Check Type</th>
<th>Present</th>
<th>Absent</th>
<th>Not Applicable</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are materials ready to use for the current lesson</td>
<td>All</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does the instructor complete all parts of the lesson</td>
<td>All</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uses lesson sequence format</td>
<td>All</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learners stay on programme- (redirection if off task)</td>
<td>All</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Review performance data and set to current lesson</td>
<td>All</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permits student to respond independently</td>
<td>All</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data is recoded after each response</td>
<td>All</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data is graphed at end of each session</td>
<td>All</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appropriate criterion used per lesson</td>
<td>All</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Lesson Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Check Type</th>
<th>Present</th>
<th>Absent</th>
<th>Not Applicable</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appropriate vocal cue is given</td>
<td>WR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pic. M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phr. M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allows participant to respond independently &amp; provides prompts where necessary</td>
<td>WR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pic. M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phr. M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uses Error Correction appropriately (allowing 3 seconds to respond before correction)</td>
<td>WR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pic. M</td>
<td></td>
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</tr>
<tr>
<td>Phr. M</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provide reinforcement (may be participant specific) for correct responses and lesson(s) completion</td>
<td>WR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pic. M</td>
<td></td>
<td></td>
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<tr>
<td>Phr. M</td>
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</table>

**Score**
<table>
<thead>
<tr>
<th>Check#</th>
<th>Instructor:</th>
<th>Date:</th>
</tr>
</thead>
</table>

**Edmark® Reading Software Integrity Checklist**

<table>
<thead>
<tr>
<th>Present</th>
<th>Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review performance data and set to current lesson</td>
<td>☐</td>
</tr>
<tr>
<td>Material is ready to use (headphones, volume level, and login detail)</td>
<td>☐</td>
</tr>
<tr>
<td>The learners stay on programme/ redirection if off task</td>
<td>☐</td>
</tr>
<tr>
<td>Reinforcement (child specific) for oral responding</td>
<td>☐</td>
</tr>
<tr>
<td>Have participants read stories when indicated by the programme</td>
<td>☐</td>
</tr>
<tr>
<td>Provide reinforcement (participant specific) for lesson(s) completion</td>
<td>☐</td>
</tr>
<tr>
<td>Attend to participant with appearance of icon ‘Call your Teacher’</td>
<td>☐</td>
</tr>
<tr>
<td>Participant data saved in individual participant folder, post session</td>
<td>☐</td>
</tr>
</tbody>
</table>

Score: ______________________

Percentage: ______________________
Appendix D

ERP Participant Certificates

Chapter 4
CERTIFICATE OF ACHIEVEMENT

THIS CERTIFICATE IS AWARDED TO

IN RECOGNITION OF

EXCELLENCE IN READING ON THE EDMARK READING PROGRAM

DATE

SIGNATURE
Please evaluate the intention for improving reading skills. Please circle the number that best describes your agreement or disagreement with each statement. Please answer each question.

<table>
<thead>
<tr>
<th>Edmark® Reading Programme</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Slightly Disagree</th>
<th>Slightly Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 This would be an acceptable intervention for students with reading difficulties</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2 The intervention was effective in changing the students reading behaviour</td>
<td></td>
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<tr>
<td>3 I would suggest the use of this intervention to other teachers</td>
<td></td>
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</tr>
<tr>
<td>4 Most teachers would find this intervention suitable for reading difficulties</td>
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</tr>
<tr>
<td>5 I would be willing to use this in the classroom setting in future</td>
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</tr>
<tr>
<td>6 The intervention would not result in negative side-effects for students (e.g., challenging behaviour)</td>
<td></td>
<td></td>
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<tr>
<td>7 The intervention would be an appropriate intervention for a variety of children</td>
<td></td>
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</tr>
<tr>
<td>8 The intervention is a good way to target reading skills</td>
<td></td>
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<tr>
<td>9 I liked the procedures used in the intervention</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10 Overall, the intervention was beneficial for the student</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 The intervention should provide a lasting improvement in reading for students</td>
<td></td>
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</tr>
<tr>
<td>12 Using the intervention should not only improve the students reading behaviour in school, but also in other settings (e.g., other classrooms, home).</td>
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<td>14 Other behaviours related to reading are also likely to improve in the classroom</td>
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<tr>
<td>15 Students were motivated to use the programme</td>
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</tbody>
</table>

Do you have any further comments in relation to this programme:
**Items may be read aloud to participants & allowed to verbally respond. Please record yes/no**

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>No response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. It’s important/good to learn how to read</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I enjoyed using the Edmark Reading Programme</td>
<td></td>
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<td></td>
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<tr>
<td>3. I can now read more words than before</td>
<td></td>
<td></td>
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<tr>
<td>4. I liked the pictures (or cartoons) on the programme</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I want to keep using Edmark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Do you find reading easier?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Learning to new words and phrases made me feel happy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. What was your favourite part of using Edmark?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. What was your least favourite part?</td>
<td></td>
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<tr>
<td>10. Is there anything else you would like to say about Edmark?</td>
<td></td>
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</tbody>
</table>
Appendix F

Headsprout® Protocol Overview for Parents

Chapter 5
Using the App:
Simply logon to the app store and search Kids A-Z

.. and continue from Step 4 of this guide!
Using a PC or laptop

1. Open up your internet browser (internet explorer/ Google chrome)


3. Click the Kids Login,

4. Teacher Username: amandanally

5. Click the green Go, click on the students name, click the green Go.
6. Finally click on the password selected by your child.

7.

This will bring you to the student page, find your name from the list and begin!
Why Use Headsprout Episodes

Headsprout brings a non-reader or beginning reader up to a mid-second-grade reading level through individualized online instruction that adapts to each learner in real time. Headsprout’s scientifically validated approach helps children learn critical skills that align with National Reading Panels core learning objectives, such as, phonemic awareness, phonics, oral reading, and reading comprehension.

In the episodes, children learn through direct experience that letters make sounds, sounds combine to make words, words combine to make sentences, and sentences combine to make stories. The basic component skills and strategies necessary for reading, such as phonemic awareness, print awareness, phonics, sounding out, and segmenting and blending, are explicitly mastered in a fun, interactive manner.

How to Use Headsprout Early Reading Episodes

The online episodes can be used in whatever environment best suits your child, whether at home, in your grannies or in the library. The episodes should allow students to work independently so independent learning is encouraged. Parents can listen for oral responses, provide encouragement, celebrate success, and offer support when needed. All that is needed to use the program is an internet-connected computer with the sound on, although headphones are recommended to prevent from distraction.

Frequency of use? Publishers of the programme found that steady use gets the best results, and learners enjoy the consistency and reliability. Please use this programme 3-4 times per week aiming to complete an episode per log on. Allocate 30 minutes of computer time for learners to complete each episode. Episodes can take as little as 10-20 minutes to complete, but students should be encouraged to learn at their own pace.

Speak out loud when this icon is on the screen. The little yellow face in the bottom right corner of the screen indicates an activity where the learner is expected to say sounds, words, or sentences out-loud.

Sprout Stories

Read all the books while progressing through the episodes. The books are ready to read online after the learner completes the corresponding episode. You can also print the books and use them in a reading activity or read them together at night.

These books are entirely readable when learner reaches the corresponding book: the book contains sight words taught in the online episodes and decodable words made of phonemes taught in the online episodes.
Some common areas of difficulties for learners with additional needs

As this programme was developed for typical children, there may be a need for adaption or additional instruction to support progression through the episodes, if you find that your child is getting stuck on an episode (e.g. learner has not progressed from a lesson within 1 week) additional support is necessary.

The following are some of the most common ‘tricky’ areas of the programme.

1. **Reminder to speak out loud.** Parents may need to sit with the child initially to prompt this behaviour when they are required to do so/

2. **Increasing motivation to complete episodes.** Additional motivators *may* be needed to encourage children to finish an episode, star charts which can be exchanged for individually determined reinforcers (e.g., a star given for each time they engage with the programme and after 4 starts they receive something they really like!).

3. **Staying on task.** If attention is fading, episode sitting may be broken up, e.g. two 10 minute sittings instead of 1 20 minute sittings to complete the episode that day.

4.

5. **Negation tasks.** Clicking on items that are NOT the picture/ sound may sometimes prove difficult for children (e.g., if it is not the sound you hear, click on the arrow’). Additional instruction in these tasks can take place outside of the programme, by using common objects that the child knows, ‘show me the one that is NOT the horse’ find the one that is NOT red’, when there is an array of common objects.

6. **Recall.** In more advance stages of the programme, it will require the learner to recall a sound and match it to correct sound in an array of similar sounds. (e.g., click on the one that said /b/). This can be practices outside of the programme using character pictures and using printed sounds underneath. Parent then asks, “*Which one said*…” and the learner must touch the correct character. Gradually fade out the text prompt.

Please contact researcher: Amanda Nally if you experience any difficulties/ have any learning issues or difficulties in meeting target frequency engaging with the programme.

Happy learning!
Appendix G

Fidelity Checks for Headsprout®

Chapter 5
Learner: Observer: Lesson #: Check #
Date: Observation duration: 

<table>
<thead>
<tr>
<th>Headsprout® Integrity checklist</th>
<th>Present</th>
<th>Absent</th>
<th>Not Applicable</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programme materials are ready to use (headphones, volume level, and login details)</td>
<td></td>
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<tr>
<td>Participant independently moves cursor/ mouse to response to the programme instruction.</td>
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<tr>
<td>Parent allows participant to complete episodes as independently as possible.</td>
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<tr>
<td>Instructor gives prompts only where necessary e.g. ‘follow the instructions/ speak out loud’.</td>
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<tr>
<td>Instructor prompts the student to get back on task/ provides assistance if necessary.</td>
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<tr>
<td>Reinforcement (may be participant specific) for completion of episode/ oral responding/ on task.</td>
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<tr>
<td>The participant reads a Sprout Story when applicable.</td>
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</table>

Score
Appendix H

Social Validity Measures

Chapter 5
Please evaluate the intervention for improving reading skills. Please tick under the statement that best describes your agreement or disagreement. Please answer each question.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Slightly Disagree</th>
<th>Slightly Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>This would be an <em>acceptable</em> intervention for children with reading difficulties</td>
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<td>2</td>
<td>The intervention was effective in changing my child’s reading behaviour</td>
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<td>3</td>
<td>I would suggest the use of this intervention to other parents</td>
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<td>4</td>
<td>Most parents would find this intervention <em>suitable</em> for reading difficulties of their children.</td>
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<td>5</td>
<td>I would be willing to use this in my home setting in future</td>
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<td>6</td>
<td>The intervention would not result in negative side-effects for my child</td>
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<td>7</td>
<td>The intervention would be an appropriate intervention for a variety of children</td>
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<td>8</td>
<td>The intervention is a good way to target reading skills</td>
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<td>9</td>
<td>I liked the procedures used in the intervention</td>
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<td>10</td>
<td>Overall, the intervention was beneficial for my child</td>
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<td>11</td>
<td>The intervention would provide a lasting improvement in reading for my child.</td>
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