The Efficacy of a Computer Based Reading Program for Increasing the Reading Comprehension Skills of Children with Autism

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Ko te ahurei o te tamaiti arahia ō tātou māhi

("Let the uniqueness of the child guide our work")

Whakataukī (Māori proverb)

Abstract

Reading comprehension skills are often impaired in children with autism. This multiple-phase single case design study sought to explore the impact of a computer assisted reading program, Reading Eggspress (RE), on the reading comprehension skills of four primary school aged children with autism (mean age 9 years, 10 months). Participants completed the Core Language Score subtests of the Clinical Evaluation of Language Fundamentals – Fifth Edition Australia and New Zealand (CELF-5 A&NZ) and the Neale Analysis of Reading Ability – Third Edition (NARA-3) prior to intervention to establish their overall language and literacy skills. Researcher developed reading comprehension probes (RCPs) were used to measure baseline scores and change during intervention phases. Participants engaged in two, four-week phases of a support program; phase A involved RE plus teaching use of a graphic organiser (GO) with texts at participants' reading levels and phase B involved RE alone. Participants, parents and teachers also completed pre- and post-intervention questionnaires as a measure of social validity.

Participants made gains on reading comprehension skills and use of GOs during the intervention. Three participants showed an increase on RCP scores once treatment commenced, however the variation between RCP scores within participants was large. There did not appear to be a difference between the treatment phases. Three out of four participants made percentile rank gains on NARA-3, with two of these likely reflecting genuine improvements. All parents and teachers gave overall positive responses on post-intervention questionnaires. Four parents and two out of four teachers reported 'very high' satisfaction with the support their child/student received during the course of the intervention. Participants themselves rated enjoyment of RE highly, although their reading self-efficacy and enjoyment ratings were varied.

This is the first study to evaluate RE with children with autism, and it appears to hold promise as a supplementary tool for improving reading comprehension skills, with or without additional instruction. This study adds to the literature supporting the potential of technology as a teaching tool for reading comprehension in some children with autism, particularly in its potential for engagement and motivation. Further examination of the psychometric properties of reading comprehension probe tasks is indicated.

Keywords: autism, reading comprehension, literacy, computer assisted instruction

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Introduction

Research has shown that children with the neurological condition autism experience weakness in the area of reading comprehension (Mayes & Calhoun, 2003; Minshew et al., 1994; Nation et al., 2006). To understand the factors that contribute to this specific difficulty it is important to be aware of the nature of autism as well as the cognitive foundations required for reading - a skill many people take for granted.

Autism

The 'discovery' of autism has been attributed to American psychiatrist Leo Kanner (1943) and Hans Asperger (1944). Kanner coined the term based on his observations of 11 children he was treating, who presented with a tendency for interest in objects rather than other people, a "need for sameness" and "resistance to unexpected change". Just a year after Kanner's seminal article was published, Austrian paediatrician Hans Asperger also reported on children with similar characteristics. The initial observations made by these two specialists in different areas of the world have started a growing interest in researching and understanding the nature of the condition. In recent decades, targeted research has helped uncover the challenges faced by people who have autism, as well as the features that may be considered unique strengths or positive attributes. International agencies have aimed to recognise the importance of having an inclusive society and celebrating the diversity of all people including those with disabilities like autism (United Nations, 2006). An increase in our understanding of autism has prompted action towards supporting the needs of individuals with autism and their families from early childhood through to adulthood.

There has been an increasing trend in autism prevalence estimates globally most likely due to changes in diagnostic criteria, availability of services and increased awareness of autism (Elsabbagh et al., 2012). As of 2016, there were an estimated 40,000 people living in Aotearoa New Zealand with a diagnosis of autism (Ministries of Health and Education, 2016), with an estimated 10,000 of these individuals being children (Bowden et al., 2020). As a signatory to the Convention on the Rights of Persons with Disabilities (United Nations, 2006), Aotearoa New Zealand aims to improve life outcomes for people with disabilities. As a part of this, inclusive education classrooms around the country are supporting children with autism to access education with neurotypical peers.

According to the Diagnostic and Statistical Manual of Mental Disorders - Fifth Edition (DSM-V; American Psychiatric Association [APA], 2013) 'Autism Spectrum Disorder' (ASD) is characterised by the presence of restricted, repetitive behaviours and interests, and social communication difficulties (use of language in social contexts). To meet the diagnostic criteria for ASD (hereon referred to as autism), the individual must exhibit persistent difficulties in both of these areas. Restricted, repetitive behaviour patterns or interests range from body movements to speech characteristics, difficulty adapting to change or transitions, strong preoccupation with specific interests, and sensitivity to certain sensory inputs (e.g., under- or over-responsive). The social communication difficulties present in autism include verbal and non-verbal behaviours such as initiating and maintaining interactions, responding appropriately to other people's communication attempts, using appropriate eye contact, and developing relationships with others (APA, 2013). With current knowledge to date, autism is considered to be a highly heterogeneous developmental condition. With the combination of restricted and repetitive behaviours and social communication difficulties at any level of severity, children with autism often require additional support to access the educational curriculum (S. H. Kim et al., 2018). For some children, highly structured and individualised education plans are necessary and they may require a setting with fewer other children and a higher adult to child ratio (e.g., in a 'special school'). Others are able to engage in mainstream settings, and may be described as being 'high functioning' despite potential environmental barriers to their learning (Ministries of Health and Education, 2016). It is likely that even for those students with autism who are considered to be 'high functioning', their academic performance in areas such as reading comprehension and mathematical problem solving is behind peers of the same age (see Troyb et al., 2014). Autism is a lifelong condition, and research indicates that many adults with autism continue to rely heavily on family and require high degree of support for education, employment and living arrangements (Howlin et al., 2004).

Three major social-cognitive challenges have been proposed to account for the difficulties often experienced by people with autism: Weak Central Coherence or WCC (Happé, 1996), Theory of Mind or TOM (Baron-Cohen, 1989) and Executive Functioning or EF (Ozonoff, 1997). Each of these help provide some explanation for the challenges associated with reading often observed in people with autism.

WCC refers to a tendency to focus on details and inability to bring individual elements together to form a whole. More recently this theory has been reframed as a strength of individuals with autism in terms of maintaining a highly selective focus (Happé & Frith, 2006). The authors suggest that the bias for detail is on one extreme end of the 'local-global processing continuum' but does not preclude them from being able to process at a global level. However WCC can still prove a barrier to comprehension for students with autism. To illustrate this point - in a story, a person with autism and a bias for detail may be able to recall specific events but demonstrate a tendency for very literal interpretation and difficulty understanding the 'big picture' or main idea of a text and integrating this information with existing background knowledge (Carnahan et al., 2011). This then impacts on the ability to comprehend written information at a paragraph or text level.

TOM refers to knowing that others know, want, feel or hold beliefs or being able to understand mental states (Baron-Cohen et al., 1985), such as being able to take the perspective of others in a given situation. For a person with autism in the context of reading this may present as difficulty identifying character emotions, motivations, and consequently reasons for events taking place, which is particularly pertinent when making sense of social cause and effect in fictional or narrative texts.

EF is a broad term defined as the mental functions by which people engage higher order cognitive processes needed for adapting for future goal planning (Hughes et al., 1994). It is associated with the frontal cortex and incorporates cognitive operations such as controlling impulses, planning, working memory, inhibition and cognitive flexibility (Hill, 2004). Happé and Frith (2006) suggest that EF may incorporate the concept of the previously mentioned 'central coherence', for example the processes involved when extracting global meaning from information in context. Many of these higher level cognitive processes function together during reading, allowing us to monitor our understanding as we read, make links between different parts of the text and synthesise information from the text with past experience. The impact of EF impairment may be observed in a child with autism in their difficulty managing information in their working memory (such as sequencing events in a text) or self-monitoring (such as identifying when they did not understanding something)(Happé & Frith, 2006).

The combination of these characteristics outlined above pose significant difficulties for education for children with autism.

Research into evidence based practices (EBPs) to support the learning and development needs of children with autism began in the 1960s in the US, in parallel with Cochrane Collaboration which initiated scientifically supported practices for medicine. Work that followed in the 1990s by the APA helped establish what the criteria for what would be considered 'EBP'. This prompted reviews of research that attempted to address the various challenges posed by autism. Due to lack of clarity around inclusion and exclusion of studies, the review process was criticised for excluding single case design (SCD) studies which are considered a valuable and important research methodology in this field. Since then, the process has been revised and more rigorous reviews are being conducted at a specialist organisational level (e.g., National Standards Project, National Autism Center, 2009). These specialist reviews are informing government policy to provide the most efficacious supports for individuals on the autism spectrum (e.g., National Reading Panel [NRP], 2000; discussed further in this chapter). From a broad perspective, areas of focus for research have included communication, behaviour and social competence which relate closely to the key characteristics of autism defined in the DSM-V diagnostic criteria. The outcome of a review of EBPs in autism indicated that the following treatment approaches were considered evidence based in achieving a broad range of learning outcomes: naturalistic intervention; modelling; technology-assisted instruction; and visual supports (see Wong et al., 2013 for a more complete list and thorough analysis of evidence). This body of evidence has provided an important foundation for research addressing areas of specific difficulty for children with autism, namely reading.

Oral Language

The close relationship between oral language skills and literacy skills is well documented (Snowling, 2005; Swanson et al., 2011). The Bloom and Lahey taxonomy of language (1978) is a helpful way to unpack the elements of comprising what is known as oral language. This model comprises three major elements which develop from early infancy: form, content and use. *Form* is composed of syntax, morphology and phonology. Syntax refers to the structure of language, for example by combining morphemes into phrases and later sentences (including embedded clauses) which we use to communicate

increasingly complex ideas as our language develops. The morphological element includes the parts of words that can change meaning, for example the regular past tense marker '-ed', and the rules governing how these can be combined. The phonological element relates to the rules around sounds of a language and how these can be combined, for example the understanding that a word can end but not begin with '-ng' in English. *Content* includes the vocabulary knowledge and semantic information contained in the linguistic units (morphemes) that make up a language. This includes word meanings, linguistic categories, word associations, literal and figurative language, for example the knowledge required to understand what is meant by 'feeling blue'. The last of the major elements is *use*, characterised by pragmatics or the social factors involved in oral language, for example knowing when to speak and how to moderate behaviour with different audiences.

Some children with autism develop oral language skills to a conversational level and participate in mainstream educational settings, however many experience difficulties in oral language development (Kjelgaard & Tager-Flusberg, 2001) in the domains of receptive and expressive language, specifically in vocabulary and syntax development (Norbury & Bishop, 2002). Reading comprehension difficulties are the result of this oral language weakness (Bishop & Snowling, 2004; Clarke et al., 2010), as well as the aforementioned social cognitive challenges and other factors beyond the scope of this literature review (e.g., behaviour, sleep).

Reading Development and Frameworks

The Bloom and Lahey (1978) model can be mapped fairly closely onto several frameworks for understanding the processes involved in reading. While it is generally considered that humans are 'hard wired' for learning language, the same does not apply to learning to decode and make meaning from text; reading is a secondary skill that must be explicitly taught to nearly all learners (Snow, 2019).

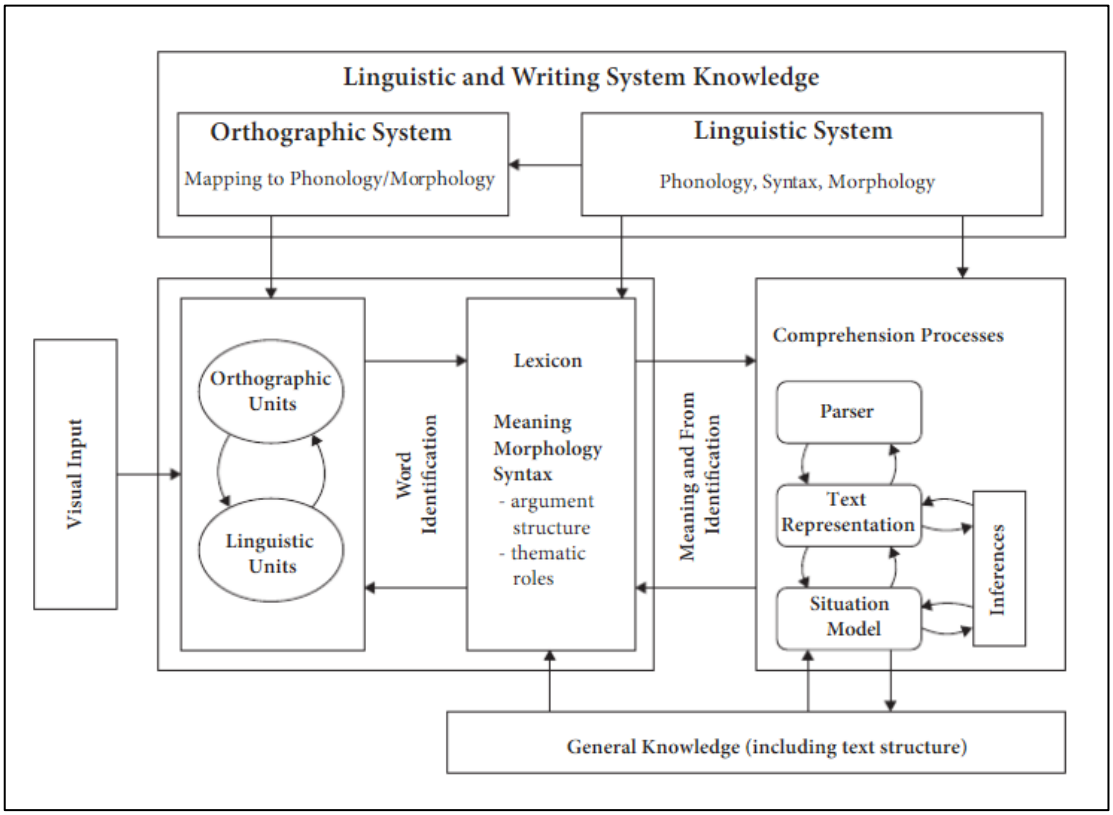
The Simple View of Reading (SVR; Gough & Tunmer, 1986), is a theory of reading development that divides reading into two skill areas: decoding (the ability to sound out letters to read a word and recognising whole words) and language comprehension (the ability to process and understand what has been read). Although the SVR model is a simplification of a complex process that involves a confluence of cognitive factors, it provides a helpful scaffold for understanding and treating reading difficulties in

children, including those with disabilities (Arciuli & Bailey, 2019; Bailey et al., 2017; Westerveld et al., 2017). In typical reading development, children start school with greater skill in oral language skills than literacy skills as they have not usually been taught to decode print yet. When children are learning to read, they are initially limited by their decoding skills. However once they begin to decode more automatically (usually by the fourth year of formal schooling), the relationship inverts somewhat, so that their reading comprehension is limited by oral language (Adlof & Hogan, 2019).

Although an elegant theory in its simplicity, SVR does not explain some of the intricacies involved in reading. Perfetti and Stafura (2014) claimed that "there is no theory of reading, because reading has too many components for a single theory" (p. 22). These authors instead proposed a 'framework' to allow study of specific processes within reading comprehension and how they interact. The Reading Systems Framework (RSF; Perfetti & Stafura, 2014, see Figure 1) is based on a 'language-cognitive' structure and comprises the orthographic system, the linguistic system and general knowledge. These form the three key 'knowledge sources' of reading comprehension. Within this framework it is proposed that the reader utilises basic cognitive and linguistic processes and activates interactions within these in order to draw meaning from a written text. An important subsystem in the RSF is the lexicon, which connects the word identification and comprehension systems (Perfetti & Stafura, 2014). Children with autism are likely to experience difficulty at the levels of general knowledge, linguistic knowledge, lexicon, and comprehension processes as the links between each of these components are potentially underdeveloped. The impact of these challenges are further exacerbated by limited experiences (Solish et al., 2010) and restricted interests (APA, 2013). The current study aimed to address these areas of breakdown for children with autism by incorporating metacognitive resources (reading checklist), visual supports (graphic organiser) and explicit teaching to reinforce the connections between components of the RSF reading framework.

Figure 1

Reading Systems Framework (Perfetti & Strafura, 2014).

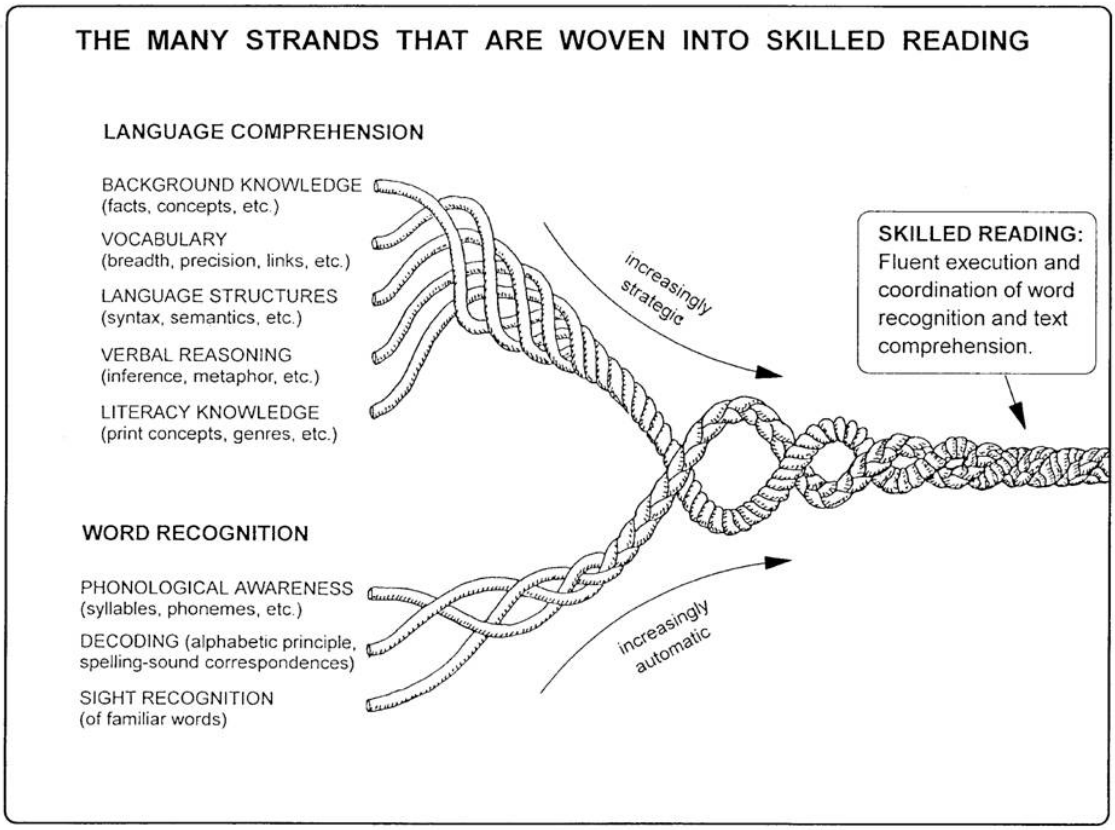


As demonstrated in the RSF, reading comprehension requires a reader to decode words, identify words, retrieve word meaning, understand sentence meaning, make inferences, monitor comprehension and integrate cumulative information as they read a text to build a coherent mental model. With practice these processes can be activated automatically by the reader, which then makes cognitive resources available for understanding the text. For those who are skilled in reading comprehension, engaging these processes happens automatically and without significant conscious effort. Those readers who are able to employ comprehension monitoring and understand text macrostructures (e.g., that a standard narrative is composed of an introduction, complication and resolution) are likely to be better comprehenders (Meyer & Ray, 2017).

Scarborough's (2001) Reading Rope model (Figure 2) is another example of how these elements contribute to automaticity and strategic reading. This model accounts for the above cognitive factors, but presents them as an intertwining rope that becomes more interwoven as reading develops.

Figure 2

Reading Rope Model (Scarborough, 2001)



The Reading Rope is a helpful visual tool to demonstrate the impact of average or strong ability in decoding/word recognition and poor reading comprehension skills. When a child presents with relatively stronger decoding skills, this can disguise comprehension problems. According to the Reading Rope model, this may stem from deficits in background knowledge, vocabulary, linguistic structures, verbal reasoning, literacy knowledge or a combination of these areas. This breakdown in understanding can create further problems. In a discussion paper, Woolley (2008) suggested that there is a link between reading failure and learned helplessness in relation to reading for those who have reading difficulties. Woolley proposed that these children tend to disengage with the following processes: 'forethought' (before reading), 'self-monitoring' (during reading) and 'reflection on learning' (after reading). Another potential explanation for low levels of monitoring and revision is the inability to recognise that text needs to be revised at all, such as when a reading error is made (Woolley, 2008). As such, intervention aiming to engage the child at all time points during reading is likely to increase their active involvement with

reading material. The current study attempted to engage the reader during these three time points and capture the element of self-efficacy through some of the items in the participant questionnaires, which will be discussed in detail further in this paper.

An important component that is not built into the SVR, RSF or Reading Rope models is motivation. Motivation has been found to play a substantial role in reading comprehension, particularly towards the later years of primary school (Hidi & Harackiewicz, 2000). Previous research (Baker & Wigfield, 1999; Wigfield & Guthrie, 1997) has extracted nine components of reading motivation: curiosity/interest; preference for challenge; involvement; self-efficacy; competition; recognition; grades; social interaction and work avoidance. Educational researchers have explored the concept of motivation further by interviewing students directly. Guthrie and colleagues (2007) developed a questionnaire based on these nine components and interviewed 31 fourth grade students using questions related to the key areas of motivation. They found a strong association between interest in the content of a text and cognitive recall and comprehension relating to that text. Other research has established that there is a reliable relationship between reading skill and motivation in children (Morgan & Fuchs, 2007).

Academic Challenges and Classroom Literacy Learning for Students with Autism

Poor childhood language and literacy skills are associated with greater risk of underachievement at school (Snowling et al., 2001) and into life beyond the school years (Johnson et al., 2010). Although there is a considerable degree of variability between individuals, children with autism are likely to face academic challenges (Ashburner et al., 2010; Keen et al., 2016). In children with 'high functioning' autism, a trend of discrepancy between IQ and academic performance has been reported in one study of 30 nine year olds; around 60% presented with low achievement in at least one academic area while conversely 60% presented with high achievement in at least one academic area (Estes et al., 2011). Estes et al. (2011) also found a significant relationship between better social functioning at age six and greater academic achievement at age nine, after controlling for non-verbal IQ. The restricted and repetitive behaviours and interests and the related WCC associated with the condition may also pose difficulties for meaningful learning (Happé & Frith, 2006), although incorporating special interests into new topics or activities has been shown to facilitate reading comprehension for some children with autism El Zein,

Solis, et al. (2016). It is well supported by the literature that a large proportion of those children with autism and reading difficulties will present reading comprehension difficulties in the presence of average or high level reading decoding skills (Arciuli et al., 2013; Mayes & Calhoun, 2003; Minshew et al., 1994; Nation et al., 2006) and will require targeted intervention to develop their reading skills. An autism diagnosis alone is not a predictor of reading comprehension difficulties, however it is a risk factor and is dependent on multiple other factors including autism symptomatology, language and cognitive skills (Brown et al., 2013; Keen et al., 2016; Lucas & Norbury, 2014).

During the primary school years, children progress from 'Learning to Read' to 'Reading to Learn'. By high school, the demands increase with students expected to be working more independently and learning from more complex texts (Paul et al., 2018). Legislation and policy changes around the world have seen a move towards children with autism receiving education in mainstream settings (for example the Education Act, 1989 (and subsequent amendments) in Aotearoa New Zealand; No Child Left Behind Act, 2001 in the US). This is supported by research that found better academic outcomes and greater IQ in students who were placed in inclusive schooling settings for primary and high school, compared with those who moved from inclusive to special education classrooms (S. H. Kim et al., 2018). Much research into reading comprehension in general education classroom practice has been directed by the NRP recommendations (NRP; National Institute of Child Health & Human Development [NICHD], 2000, US). The NRP report emphasised phonics, phonemic awareness, fluency, vocabulary, and reading comprehension strategies as key areas for successful reading instruction. The recommendations also broke reading comprehension instruction down further into vocabulary instruction, teaching comprehension strategies and text comprehension instruction. More recently these have been applied to research for supporting the literacy development of students with autism. In response to this pattern of reading comprehension difficulties many interventions have been developed, and some have been established as effective (e.g., Bailey et al., 2017; Bethune & Wood, 2013; Howorth et al., 2016). However, due to the heterogeneity of their reading and cognitive skill profiles it is unlikely that one reading comprehension intervention will suit all children with autism (Randi et al., 2010). Some selected studies will be discussed in detail in the next chapter.

As outlined above, there is evidence for a number of EBPs that support social communication and behaviour outcomes for children with autism and allow many to access educational supports alongside their neurotypical peers. However, despite the benefits of inclusive mainstream education settings for students with autism, they may not be receiving the level of support required to access the curriculum, specifically literacy skills. Accardo and Finnegan (2019) reported that teachers are often inadequately resourced to support these students, in part due to time constraints and lack of knowledge of best practices. The authors summarised the literature on EBPs (actions or procedures founded on rigorous scientific research) and 'effective practices' (proven to be 'effective' through quantitative studies but not yet reaching the 'evidence based' criteria) for students with autism and reading comprehension difficulties to date. They reported on the following instructional practices to be 'effective practices': anaphoric cuing; compare and contrast diagrams; cooperative learning; direct/explicit instruction; visual supports; question generation; read alouds; reciprocal questioning; story structure scaffolds; systematic prompting and combinations of the aforementioned. All of these practices were considered 'effective' however only systematic instruction and GOs were considered to have sufficiently met the criteria for EBPs. Results revealed that although teachers were prepared to use these strategies in their classrooms, their reported behaviour did not necessarily reflect this as they were not using them. Although the study did not capture why this was the case, the authors proposed that it may be due to a lack of knowledge of the strategies supported by the research, and/or lack of confidence in applying them to teaching their students with autism. Other professionals working in schools have reported feeling a lack of confidence in supporting the literacy skills of children with autism. Gillon and colleagues (2017) identified that internationally there is a need for further support for speech language therapists, who often work with children with autism addressing literacy difficulties. This indicates a clear justification for further research into educational practices that will support students with autism throughout their schooling.

Effective Scaffolding for Reading Comprehension

A number of systematic reviews have been conducted into reading comprehension interventions in children with autism. These have shed light on factors that are likely to support students with autism (Bailey & Arciuli, 2020; Chiang & Lin, 2007; El Zein et al., 2014; Finnegan & Mazin, 2016; Whalon et al., 2009), covering a broad time period of research (1980-2017). These systematic reviews have

identified many SCD studies, and a handful of quasi-experimental and group design studies using a wide range of target approaches and instructional strategies (vocabulary and comprehension, question generation and responding during reading, following written instructions and story retell). It is also evident that there is a considerable diversity of tools for measuring change in reading comprehension skills, including standardised assessments and researcher-developed tests. Methodological rigour and study quality were concerns noted in El Zein et al., (2014) and again in a review by Bailey and Arciuli (2020). Bailey and Arciuli's (2020) review into the quality of reading instruction interventions for children with autism focused on the quality of the extant literature in the area of reading instruction for children with autism. The authors identified studies that employed a skill or skills from the NRP report: phonics, phonemic awareness, fluency, vocabulary, or reading comprehension strategies. Four SCD studies with a focus on reading comprehension were identified: Zakas et al. (2013); Howorth et al. (2016) as well as the two studies included in Accardo & Finnegan's (2016) review (Bethune & Wood, 2013; Stringfield et al., 2011). Within these studies strategies included one or a combination of the following: comprehension monitoring, GOs, summarising, answering questions and generating questions. The authors concluded that the studies targeting reading comprehension instruction were of a 'weak' research report rating due to limited participant information and visual analysis limitations in the SCD studies. In the group study, they concluded that there was insufficient description of instruction for the purposes of replication. As such, there is a clear need for high quality, methodologically rigorous single case and group design research required in this area.

The methodological differences and small numbers of studies investigating reading comprehension interventions for children with autism make it difficult to draw conclusions about treatment effectiveness. Finnegan and Mazin (2016) concluded that the most effective of the above interventions is the use of GOs, and that supported electronic text alone (e.g., without teacher instruction) is unlikely to result in reading comprehension gains for children with autism. The results of the Finnegan and Mazin (2016) review must be considered with caution as it included varying measurement techniques which would have a potential impact on calculating effect sizes. The differences in measurement of reading comprehension (the dependent variable) between studies has implications for direct comparison,

for example some studies included only literal comprehension questions while others used literal and inferential questions. Some participants were required to answer questions without looking at the text while others were allowed to check the text before responding. Question type is another complicating variable between the studies as most used open-ended questions but others provided a choice of answers. Studies also differed on whether they required a verbal or written response to questions. Generally, the comprehension questions used in SCD studies were not well defined, making future replication difficult. The authors also acknowledged that the available evidence was limited, as only 15 papers were included in the review with the number of participants with autism totalling 88.

There was a degree of overlap for the reviews discussed above in terms of strategies and approaches to studies with a reading comprehension. Table 1 includes a summary of the evidence for these strategies and approaches.

Instructional Approaches

Graphic organisers (GOs) include a range of different visual supports such as wh- question organisers, story maps, Venn diagrams and character event maps. Based on moderate to high levels of effectiveness in improving reading comprehension demonstrated in a number of studies (Bethune & Wood, 2013; Carnahan & Williamson, 2016; Stringfield et al., 2011; Williamson et al., 2015), GOs have been established as an EBP. Use of GOs also shows some promise in developing independent student use, as evidenced by the results of Carnahan and Williamson (2013) and Stringfield et al. (2011). Knight and Sartini's (2015) review provides additional evidence for visual supports as an EBP in this area, and is further supported by the evidence of relative visual processing strengths (at least for simple stimuli) in autism (Neumann et al., 2011).

Direct Instruction (DI) is an intensive and highly structured approach to reading intervention based on behaviourist learning theory. Some evidence exists to support its use (Flores & Ganz, 2007, 2009). Flores and Ganz (2007) reported gains on all reading comprehension tasks (statement inference, using facts and analogies). Flores and Ganz (2009) also reported gains on all reading comprehension tasks (analogies, deductions and induction). Another study that employed DI (Kamps et al., 2016) showed gains in nonsense words and word reading accuracy on a curriculum-based word list and standardised measures (DIBELS oral reading fluency subtest and Word Identification subtest of the Woodcock

Reading Mastery Test), but no statistically significant gains in reading comprehension on a standardised test (Passage Comprehension subtest of the Woodcock Reading Mastery Test). Based on the small amount of current available evidence, DI may be an effective method for improving reading comprehension for some but not all children with autism (as with many existing instructional approaches).

Cooperative learning, described as 'students work[ing] together towards a common learning objective' (Finnegan & Mazin, 2016) has been employed in studies with children with autism paired or placed in groups with neurotypical peers (e.g., Kamps et al., 1989; Whalon & Hanline, 2008). The outcomes of these studies have shown an increase in correct responses to comprehension measures. Similarly to DI, the effectiveness on improving reading comprehension skills for children with autism should be made with caution due to the small numbers of studies.

Self-directed strategies are another method used for reading comprehension instruction with a focus on teaching skills to encourage independent engagement with text. Studies have shown positive outcomes for participants' reading comprehension scores with moderate to large effects (Asberg & Dahlgren-Sandberg, 2010; Howorth et al., 2016; O'Connor & Klein, 2004). Additional research would also be required to corroborate these results.

Supported electronic texts involves independent study using computer-assisted teaching. There is insufficient evidence for supported electronic texts alone improving reading comprehension, but a combination of supported electronic texts with other teaching components such as explicit instruction and repeated reading may be key in developing these skills in students with autism and reading comprehension difficulties. Some studies have started to investigate this approach using a group study design (e.g., Bailey et al., 2017), which shows promise as part of a targeted reading intervention program for this population.

Due to the small number of studies currently available, each of the above approaches could be suitable for remediating reading comprehension difficulties in some not all children with autism.

Table 1

Summary of Reading Comprehension (RC) Strategies and Evidence

Reading Strategy and Description	Supporting Research	Effectiveness	Comments
Graphic organisers: a visual tool used to express ideas and relationships. Includes 'wh' question organisers, story maps, Venn diagrams, character event maps. Deemed an 'Evidence Based Practice' (Finnegan & Mazin, 2016).	SCD studies: • Bethune and Wood (2013); • Carnahan and Williamson (2013); • Stringfield et al. (2011); • Williamson et al. (2015); • Zakas et al. (2013) Group study: Mashal and Kasirer (2011)	*Moderately to highly effective*	SCD studies resulted in improved scores in participant responses to RC questions. Use of GOs also shows some promise in developing independent student use. Mashal and Kasirer (2011) group study resulted in improvement in understanding 'conventional' but not novel metaphors.
Direct Instruction: intensive and highly structured approach to reading intervention based on behaviourist learning theory. Deemed an 'Effective Practice' (Finnegan & Mazin, 2016).	SCD: Flores and Ganz (2007); SCD: Flores and Ganz (2009); SCD: Kamps et al. (2016)	*Moderately to highly effective* *No statistically significant gains*	Not possible to determine effectiveness from few studies. No indication of skill generalisation to new text.
Cooperative learning: children working together to achieve a common learning goal. Children with autism paired or placed in groups with neurotypical peers. Includes 'question generation', 'reciprocal teaching', Reciprocal Teaching (RT)	SCD studies: • Kamps et al. (1989); • Kamps et al. (1994);	*SCDs: Ineffective to highly effective*	Some emerging evidence, but conclusions about effectiveness should be made with caution due to the small numbers of studies and variability of results.

instruction methods. Deemed an 'Effective Practice' (Finnegan & Mazin, 2016).	• Kamps et al. (1995); • Whalon and Hanline (2008); Group study: Turner et al. (2017)	*Group study: Medium to large effects*	
Self-directed strategies: focused on teaching skills to encourage independent engagement with text. Includes question-answer relationships, anaphoric cueing and TWA strategy. Deemed an 'Effective Practice' (Finnegan & Mazin, 2016).	Asberg and Dahlgren-Sandberg (2010); O'Connor and Klein (2004); Howorth et al. (2016)	*Small to large effects*	Variable effects but positive outcomes for participants' RC scores, conducted over short time frames skill generalisation to new texts implied as participants had new texts during data collection.
Supported electronic texts: independent study using computer-assisted teaching of reading. Deemed an 'Effective Practice' (Finnegan & Mazin, 2016).	SCD: Armstrong and Hughes (2012); SCD: Knight et al. (2015); Group study: Bailey et al. (2017)	*Ineffective to highly effective* *Large effect size*	Insufficient evidence for supported electronic texts alone improving RC, but inclusion of other teaching components like explicit instruction and repeated reading may help develop these skills in students with autism and RC difficulties.

Note. SCD = single case design. GO = Graphic Organiser. TWA = Think Before Reading, Think While Reading, and Think After Reading.

Computer Assisted Instruction

Technology has become more ubiquitous in the classroom setting, and in society in general. Consequently, computer assisted instruction (CAI) has become a more common teaching tool in a range of academic areas. There is evidence to suggest that CAI involving graphics, sounds and animations can enhance engagement in reading activities in children with autism (Moore & Calvert, 2000). Some promising initial research has emerged around the use of computer assisted programs for teaching students with autism in academic areas such as science (Knight et al., 2015), word identification (Coleman-Martin et al., 2005), and sight word reading (Yaw et al., 2011). Commercially and freely available computer assisted reading programs have been an area of interest for researchers in the field of autism. Initial research into the area focused primarily on decoding skills, such as the program 'Alpha' (Heimann et al., 1995) and the 'Nonverbal Reading Approach' (Coleman-Martin et al., 2005). More recently there has been greater emphasis on also investigating reading comprehension skills in this population. Some SCD research has been conducted to investigate the impact of CAI on increasing functional reading activities such as reading grocery store signs (Mechling et al., 2002).

This avenue has also been explored for teaching reading skills to primary school students with autism individually in the home setting with a CAI program targeting reading decoding and reading comprehension skills (Armstrong & Hughes, 2012; Bailey et al., 2017; El Zein, Gevarter, et al., 2016; Knight et al., 2015). Based on success with a reading comprehension program in the home setting, Arciuli and Bailey (2019) trialled a CAI reading program in small groups in the primary school environment which will be discussed in further detail later in this thesis. However, there remains limited evidence around the most effective computer based reading comprehension programs for students with autism in the middle and upper primary school years, who are expected to have transitioned from 'Learning to Read' to 'Reading to Learn' (Chall et al., 1990). Kim et al. (2017) identified that there is a gap in the literature on combining explicit instruction of reading comprehension strategies with CAI for students with learning disabilities. Additionally there is a clear need for further detailed exploration into which of the current evidence based practices CAI reading comprehension programs incorporate to support the learning of students with autism.

A summary of relevant computer based SCD and pretest-posttest control group design studies is included below in Table 2. Those studies that mainly involved preschool aged participants or that measured comprehension below sentence level were not included in this table. Again analysis of the existing literature on the topic clearly highlights the significant variability in research design, assessment tools, participant age ranges and reading abilities, among other factors.

El Zein, Gevarter and colleagues (2016) conducted an alternating treatment design study investigating the differences between a teacher directed (TDI) and iPad delivered reading comprehension intervention (IDI) called 'Space Voyager'. The study (summarised in Table 2) was held at a university clinic over four weeks. The 'Space Voyager' game used in the IDI condition involved participants identifying the main idea of a paragraph based on questions, with the game providing immediate feedback on results and moving the participant's virtual spaceship along to indicate progress. A main idea GO was used to display information visually. In addition a token economy system was implemented for each participant to reinforce positive behaviour. Each day participants were involved in a 35 minute lesson learning about identifying the main idea from a paragraph at their instructional reading level. Dependent variables measured were the number of correct responses to comprehension questions and frequency of task refusal during reading sessions. The former of these outcomes was measured using a 'curriculum-based measure probe', each of which was structured as four questions relating to a paragraph with three multiple choice response options. Task refusal was measured by instances of verbal or physical protest. Each of these variables was measured every session. Results indicated improvement on reading comprehension measures and reduced task refusal for all three participants. Interestingly, fewer occurrences of task refusal behaviour were observed during the IDI condition compared with the TDI condition, however the latter resulted in higher average reading comprehension scores. The findings corroborated the use of GOs, token economy systems and strategy instruction for supporting reading comprehension development in students with autism. A limitations of this study is that individual treatment components were not analysed. As such, it was difficult to draw conclusions about which particular aspects of the interventions were associated with positive effects. Additionally, the study design could have been strengthened with inclusion of a pre-intervention baseline phase although this is not

considered ‘necessary’ for this an alternating treatment study design (Portney & Watkins, 2008). The authors also acknowledged that social validity data obtained through interview of the participant’s parents would have strengthened the results directly observed in intervention sessions.

Knight et al. (2015) conducted a study with four students with autism aged between 11-14 using CAI, explicit instruction and prompting. The researcher’s main purpose was to evaluate the effects of CAI program ‘Book Builder’ (BB) on the science vocabulary and comprehension of the four participants. BB included explanatory texts, illustrations, translations, summaries, enrichment and instructional resources. The BB program did not include inbuilt feedback or reinforcement. The participants were exposed to three different treatment conditions: 1) BB alone; 2) BB plus explicit prompting; and 3) BB, explicit prompting and definitions of unknown words. Dependent variables were the number of correct comprehension questions on a researcher developed probe comprising seven questions (three vocabulary, three literal and one application question) and social validity questionnaires for participants and their teachers. The author found a positive relationship between condition 2 (BB and explicit instruction) and number of correct responses on the comprehension probe. On post-intervention questionnaires, teachers and students reported the program as practical and useful. In a research synthesis, El Zein and colleagues (2014) classified this study as ‘suggestive’ due to insufficient data points during some intervention conditions.

Armstrong and Hughes (2012) used CAI with five participants aged between 7-8 years with autism. The study involved two treatment conditions for participants: a storybook condition and a CAI condition. These conditions involved each story being read to the child twice by the researcher and by the CAI program ‘Wynn Wizard’, respectively. Participants engaged in sessions two to three times per week with a total of 20 sessions throughout the intervention phase. Dependent variables were the number of correct responses on a researcher developed probe comprised of 20 questions presented orally and scores out of 50 on a researcher-adapted story retell measure. Three out of five participants responded well to listening comprehension questions during both intervention conditions, while two maintained baseline level performance. Retell scores for both conditions were reported to be low. A limitation of this study is

the randomisation of treatment conditions each session, as this may have impacted the participants' ability to practice in each context.

The Canadian computer based reading program 'ABRACADABRA' (ABRA) incorporates word level reading instruction, fluency and comprehension instruction and adult led follow up activities, employing a systematic instruction approach. ABRA was the focus of a pretest/posttest control group design study by Bailey et al. (2017), which is also summarised in Table 2. The program resulted in statistically significant gains for participants in the treatment group when compared to a control group on standardised measures of word level reading accuracy, passage reading accuracy and reading comprehension. Some limitations of this study were that the study individual performance and strategies employed by participants was not reported. For a heterogeneous population, this data would be helpful for understanding how literacy programs can be tailored to individual students with different cognitive, language and reading profiles. Additionally, information about participants' classroom literacy environment was not collected. The same authors conducted the ABRA program in small groups in the school setting with children with autism over nine weeks, with positive gains observed on reading accuracy measures but no statistically significant change in reading comprehension skills (Arciuli & Bailey, 2019). This suggests that further research into the effectiveness of specific components of computer based reading instruction programs is warranted.

Table 2

CAI Reading Comprehension Interventions for Children with Autism

Author/s (Year)	Study Design	Participants	Intervention	Summary of Findings
El Zein, Gevarter et al. (2016)	SCD with alternating treatment	3 participants with autism aged between 9-12 years	Two intervention conditions were investigated: Intervention 1: teacher directed instruction Intervention 2: iPad delivered reading comprehension intervention	Improvement on reading comprehension measures and reduced task refusal. Findings support use of GOs, token economy systems and strategy instruction for supporting reading comprehension development in students with autism
Knight et al. (2015)	SCD with multiple probe with modified criteria	4 participants with autism aged between 11-14 years	Three intervention conditions using supported electronic text were implemented: Intervention 1: 'BookBuilder' (BB) program, Intervention 2: BB with addition of explicit instruction (teacher prompting), Intervention 3: BB, explicit instruction (teacher prompting and explanation of unfamiliar words)	Improvement in reading comprehension scores for 2/4 participants. Following modification to intervention (addition of explicit instruction), scores improved for 3/4 participants.
Armstrong and Hughes (2012)	SCD with randomised intervention	5 participants with autism aged between 7-8 years	1:1 instruction using supported electronic text: text-to-speech component of 'Wynn Wizard' program compared with instructor-led reading a story book aloud	3/5 participants responded well to reading comprehension questions during both conditions and for 2/5 scores remained stable. Generally scores for story retelling were low.

Bailey et al. (2017)	Pretest-posttest control group design	20 participants with autism aged between 5-12 years	One-to-one instruction using ABRACADABRA web-based reading program	Participants in the instruction group made gains on measures of reading accuracy and reading comprehension compared to those in the wait list control group.
Arciuli and Bailey (2019)	Pretest-posttest control group design	23 participants with autism aged between 5-9 years	Group instruction using ABRACADABRA web-based reading program	Participants in the instruction group made gains on measures of word- and passage-level reading accuracy compared to those in the wait list control group. Gains in reading comprehension were not statistically significant.

Note. SCD = single case design, GO = graphic organiser.

Critique of Reading Comprehension Measures

There have been numerous studies investigating reading comprehension in primary school age children with autism. For those studies that have involved pre- and post-intervention testing, standardised measurements of reading ability such as the Neale Analysis of Reading Ability-Third Edition (NARA-3; Neale, 1999) have been used (Bailey et al., 2017). For SCD studies, many researchers have used RCPs or 'curriculum based assessments' to measure change (Armstrong & Hughes, 2012; Carnahan & Williamson, 2013; El Zein, Gevarter, et al., 2016; Flores et al., 2013; S. Y. Kim et al., 2018). Some researchers have attempted to develop some psychometric properties for their RCPs by first testing questions with neurotypical peers (e.g., Armstrong & Hughes, 2012). However minimal detail was provided about the questions included in probes, how they were developed or whether they were judged to be consistent between probes. Flores and Ganz (2007) included some detail about the content of their sentence level RCPs which assessed the following skills: statement inference, using facts and using analogies. The authors provided examples of statements and recall questions that they asked participants, although they did not provide detail on how questions were developed. A search of the literature revealed that no studies to date have systematically and thoroughly evaluated the psychometric properties of their probes, with many only reporting the number of questions and answers provided rather than including a replicable schema for classifying questions. This poses several potential challenges. Firstly it makes replication of studies and comparison of results difficult, as probes are likely to vary when developed by different individuals. Secondly it is difficult to draw meaningful conclusions about participant gains within studies based solely on measures with unclear psychometric properties.

Social Validity

Social validity strengthens and supports single-subject research (Horner et al., 2005) as it provides a measurement of the social importance according to the research participants themselves (Wolf, 1978). In the context of SCD studies in reading, social validity questionnaires can give an indication of the impact on the child's reading in their everyday life, as well as the likelihood of continued engagement with an intervention by the participant themselves and others in their life. Some studies of reading interventions have included social validity questionnaires completed by participants (including

neurotypical peers), parents and teachers or a combination of stakeholders (Bethune & Wood, 2013; S. Y. Kim et al., 2018; Whalon & Hanline, 2008). Whalon and Hanline (2008) reported that participants enjoyed working with peers and felt that the intervention helped them understand what they read. Neurotypical peers involved in the study also reported that the program was helpful and that they enjoyed participating. Parents of participants with autism watched before and after treatment videos of their child reading and noted gains in one or more of the following: question formation, attention, reading rate, accuracy, expression and a decrease in prompting required. Bethune & Wood (2013) reported generally positive responses from teachers and child participants involved in their study in terms of helpfulness of the GO for improving reading comprehension. S.Y. Kim et al. (2018) reported responses from participants' behaviour therapists following their involvement in an intervention. One (out of five) gave a neutral response on an item regarding whether the treatment promoted independence in the student's independence with reading, while the remaining four gave positive responses. All five child participants responded that they enjoyed participating in the intervention and felt that it helped them 'understand the story better'. Although some researchers have used social validity questionnaires, these measures are not consistently included in studies of this type and have not been reported on in detail in systematic reviews on the topic. Further exploration of the social validity of reading interventions, especially considering the perspective of the person with autism (see Santhanam & Hewitt, 2020), is much needed.

Reading Eggspress

'Reading Eggspress' (RE) is a subset of animated e-books and associated literacy activities for students which is an extension of the 'Reading Eggs' program - a commercially available Australian program created by teachers, writers and software developers (https://readingeggspress.co.nz/). RE has been adopted in primary schools in Australia, Aotearoa New Zealand and other parts of the world to supplement classroom literacy instruction. RE is designed to teach literacy skills to primary school age students (ages 5.5-12 + years; NZ years 1-8) through a series of lessons developing phonics, vocabulary and comprehension. RE can be used on a computer using a mouse or iPad with the child touching the screen to progress through activities. The RE interface is colourful and includes some animated elements as well as sound effects when the student interacts with it. The design of RE has been based on

recommendations from the aforementioned NRP report (NRP; NICHD 2000). Reinforcement is built into the RE program within activities as well as for the amount of time spent on RE each week[1]. Animations and sound effects give the student regular knowledge of performance (e.g., a bell sound and a green tick appearing when responding correctly to a multiple choice question). They are also rewarded with 'eggy points' or digital trading cards after completing activities within each RE lesson. 'Eggy points' can then be used to buy items for a digital 'apartment'. As the reader progresses through the lessons, their personalised 'avatar' moves along a path resembling a game board. Together these features are used to increase reader engagement and motivation.

A brief placement test is used on the first interaction with the program, determining the student's individual reading level (however this can be later manually changed by the teacher/parent based on their progress). The program then guides students through fiction and nonfiction texts which can be read at the student's pace, with the option to have an adult voice reading the text. The student is then able to navigate through books and literacy activities, and each lesson is asked a series of multiple choice comprehension questions relating to the lesson's 'focus book'. If they achieved less than 80% correct they are offered another attempt and are unable to progress to the next lesson until passing the test. Throughout the program, cartoon videos of between 2-4 minutes are used as a tool to explicitly model strategies such as identifying important details in a text ('wh' concepts like who, what, where, when). The videos introduce and build on concepts covered in other parts of the program and often use metacognitive strategies such as 'thinking aloud' to demonstrate how a strategy was used. RE has a focus on reading comprehension questions (literal, inferential and critical) in the following key areas: identifying main idea and supporting details; comparing and contrasting; sequencing events; cause and effect; fact and opinion; understanding character; making connections; drawing conclusions; point of view; predicting; summarising and word study. Literal questions, which require the reader to find explicitly stated information in a text, are taught first as they are considered to place less pressure on the child's 'cognitive load'. In general, concepts and vocabulary introduced at earlier levels of RE are simpler, and become increasingly complex as the

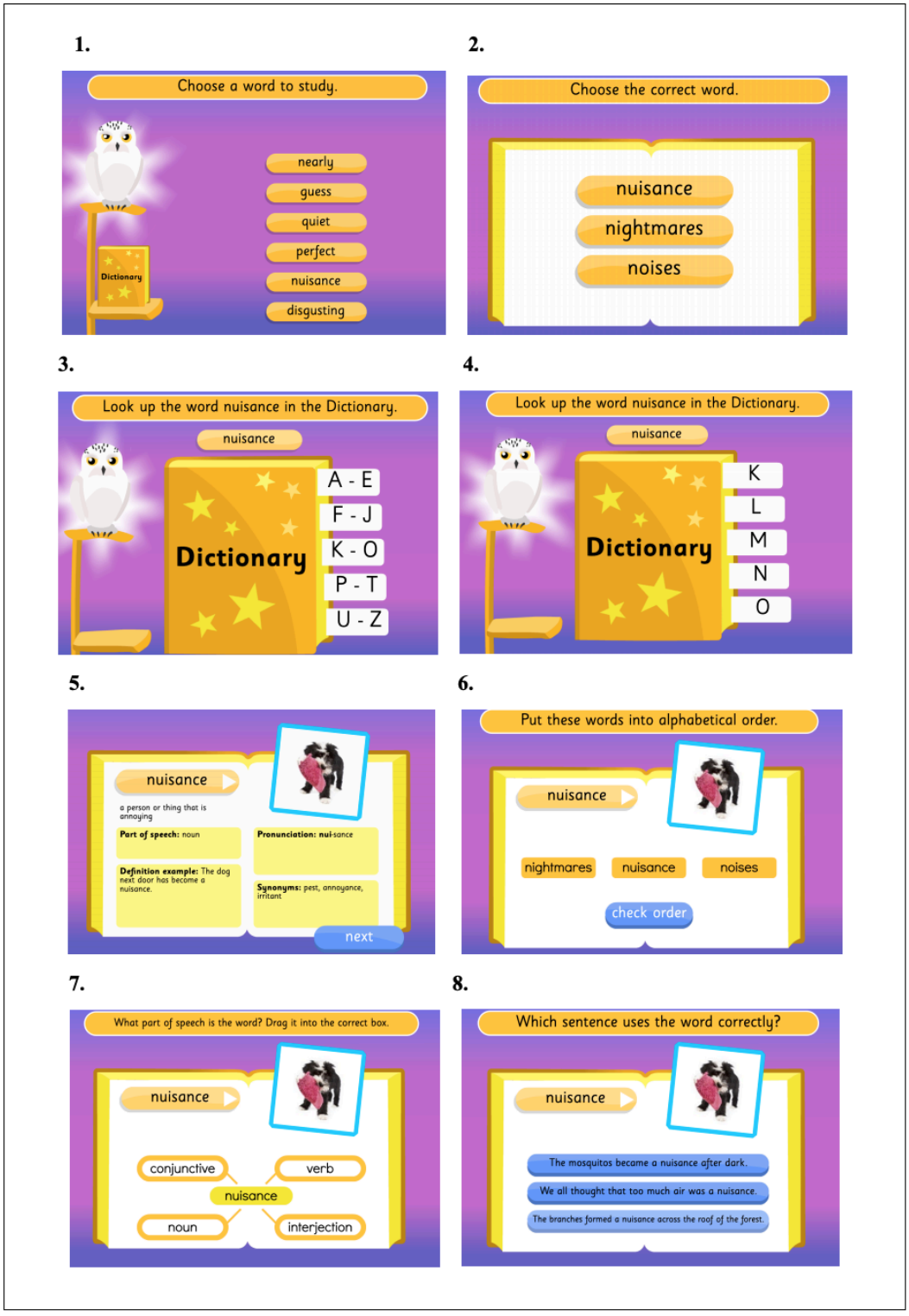
[1] The trophy system of reinforcement was used to reward weekly time spent on RE. This was not applicable to participants in this study as the time spent on RE was below that required for awarding of trophies.

student's skill level improves and they progress through the lessons. Opportunities for repetition are built into the program to reinforce ideas. RE is reportedly designed to incorporate elements from research on reading pedagogy. These include 'explicit teaching of reading strategies; modelling strategies in action; collaborative strategy implementation, guided practice and transfer of responsibility to students; and independent use of the strategy' (Duke & Pearson, 2002). These concepts are aligned with the 'gradual release of responsibility' approach to teaching which will be discussed further in the Method section of this thesis. RE also purports to use 'close reading' as a method of instruction, which involves short passages of text with intense focus, complex texts requiring several readings, exploratory study of text and questions relating to text. RE selected texts with a range of content and genres to appeal to the preferences of a large group of children, to maximise opportunity to engage and consequently motivate readers. The combination of these elements is designed to provide students with sufficient opportunity practice and develop skills in meaningful learning contexts. After every five lessons readers complete a test comprised of ten multiple choice questions that acts as an ongoing formative assessment. Performance and progress can be monitored by the student's teacher on a separate log in.

When analysed using the lens of the Reading Rope model (Scarborough, 2001), RE targets several key components. This can be demonstrated in the steps involved a RE 'dictionary' activity (see Figure 23, in which the reader selects a word to study from a list (step 1). The reader is then given an opportunity to find the word using alphabet knowledge (steps 2-4), learn additional semantic, phonological and morphological features of the word (step 5), put the words in alphabetical order (step 6), identify the relevant part of speech (step 7) and choose a sentence using the word correctly (step 8). Steps 5-8 also include a related image. Following this activity, the reader would then complete an activity involving reading the word in the context of a fiction or nonfiction text. This sequence of steps within the one activity helps develop the links between the Reading Rope 'strands' of background knowledge, vocabulary and language structures (particularly at the semantic level). The process reinforces the connections between these elements through multiple exposures to a target word and its associations, making it easier to recall and use in context. This is particularly key for children with autism, given the known vocabulary deficits (Kjelgaard & Tager-Flusberg, 2001). It is also established that vocabulary is a predictor for reading comprehension at the passage level for this population (Lucas & Norbury, 2014).

Figure 3

Screenshot of RE 'Dictionary' Vocabulary Activity



Some preliminary research has been conducted on the implementation of RE in primary school classrooms in a rural area of South Carolina, US with struggling readers (Lowery, 2017). This study

involved a comparison of two second grade classes under different reading instruction conditions: one using a small group reading intervention context and another using a small group reading intervention supplemented by RE. The RE treatment group received one hour of RE intervention each week over a period of six weeks while the other group acted as the control group, measuring change in reading skills using a pre- and post-intervention assessment. Following the intervention the author reported an increase in reading proficiency for the RE treatment group while for the control group, there was no change between pre- and post-assessment. The author concluded that although a good supplement to reading instruction, the RE program should not be used in place of teacher instruction. This study demonstrated change in reading proficiency in the treatment group using descriptive statistics. The strength of the results would have been increased with a rigorous analysis of the amount of change and level of significance. There was also minimal exploration of the elements within RE that may have impacted individual students' reading progress in reading accuracy and/or comprehension, such as reinforcement, video tutorials and modelled examples.

The Current Study

It is well established that children with autism are at risk of reading comprehension difficulties (Nation et al., 2006) and there is a need for increased knowledge in effective strategies for supporting these children at school (Accardo & Finnegan, 2019). Since autism was first described in the mid 20th century (Asperger, 1944; Kanner, 1943), our understanding of the condition has developed and there has been a shift towards greater inclusion of people with autism, including in the education sphere especially as the global prevalence has increased. Research has uncovered more details about autism and reading comprehension difficulties, including intervention approaches that are likely to remediate some of these challenges (Wong et al., 2013). Many of these include oral language components, due to the close relationship between oral language and literacy (Snowling, 2005; Swanson et al., 2011). Reading frameworks (Gough & Tunmer, 1986; Perfetti & Stafura, 2014; Scarborough, 2001) can be used to describe the nature of the specific difficulty with reading comprehension that is often present in autism. However these frameworks do not account for all factors involved in reading – one key factor that is overlooked is motivation (Wigfield et al., 2016). Academic challenges experienced by people with autism

can be linked to their behavioural and social communication difficulties, and children with autism often require some targeted intervention to develop their reading skills. Research has shown that they may not be receiving the support needed in mainstream settings due to teacher time constraints and lack of knowledge of best practices (Finnegan & Mazin, 2016). There are a number of systematic reviews summarizing the evidence base on RC in children with autism, however it is difficult to draw conclusions about effectiveness of RC interventions due to studies using different methodological differences (e.g., measurement techniques) and small number of studies, making comparison between studies difficult. Gaps also remain in our understanding of how to develop reading comprehension probes, variability amongst probes across the literature and variability of inclusion of social validity measures.

CAI has been employed as an educational tool for children with autism and has shown promise as a supplementary literacy support. RE is a CAI reading program used in many schools worldwide that targets several key elements required for effective reading instruction. Some preliminary research for RE as a tool for children at risk of poor reading outcomes exists, however the program has not yet been evaluated for students with autism between the ages of 8 and 11 years. There is a need for further investigation into the efficacy of specific programs with students with autism in the middle to later primary school years, as students are expected to be reading with increasing levels of independence. Investigating the adoption of evidence based practices and effective practices into educational technologies such as CAI will ultimately support the literacy development of students with autism. This study proposed to contribute to filling a gap in the research by using a combination of formal pre- and post-assessment tools, researcher developed RCPs and social validity questionnaires to measure participants' response to a reading comprehension intervention using CAI and explicit teaching of a reading comprehension strategy. The current study was designed to answer the following research questions:

1. Does participation in an eight week reading comprehension intervention program result in significant improvements in reading comprehension for four children aged 8-11 years with autism?

2. Is there a difference in participant reading comprehension scores between the reading comprehension intervention conditions in phase A and phase B for four children aged 8-11 years with autism?
3. Does the use of explicit instruction of reading strategies during reading for four children aged 8-11 years with autism result in a change in participants' use of strategies?
4. Does participation in an eight week reading intervention study result in a reported increase in enjoyment of reading for four children aged 8-11 with autism and reading comprehension difficulties?

It was hypothesised that this reading comprehension intervention would result in improvement in reading skills (e.g., Bailey et al., 2017; El Zein, Gevarter, et al., 2016); that there would be greater improvement during phase A than phase B (Knight et al., 2015); that explicit instruction would result in a change in strategy use during reading (Bethune & Wood, 2013; El Zein, Gevarter, et al., 2016); and that there would be a positive change in participant attitude towards reading following participation in the intervention (e.g., Bethune & Wood, 2013, Knight et al., 2015).

Method

Purpose

This study sought to explore the effects of a multiple phase reading intervention on the reading comprehension performance of four primary school students with autism. The primary objective of this study was to determine the impact of RE on participants' reading comprehension skills.

Ethics

Ethics approval for this study was obtained from the University of Canterbury Educational Research Human Ethics Committee. The letters of approval have been attached (see Appendices 1 and 2). Prior to commencement of the study as part of the Māori engagement process, the Kaiārahi[2] Māori Research for the University of Canterbury and the Ngāi Tahu Consultation and Engagement Group (NTCEG) were consulted to ensure culturally responsive practice. The letter of response from the

[2] A person who acts as a guide (in this context for fostering bicultural competence and confidence).

NTCEG can be found in Appendix 3. Prior to commencing the study the researcher contacted the parent company of RE, 3P Learning, who gave permission for the program to be used in research.

Participants

The study was conducted during the first and second terms of the school year. Recruitment was conducted via a social media website for an Aotearoa New Zealand disability organisation, by means of a flyer outlining the purpose of the study and inclusion criteria. Recruitment emails were also sent out to principals and special needs coordinators at local schools within 15km of the main university campus.

Inclusion criteria required that child participants: a) demonstrated reading comprehension difficulties (as reported by their parent/caregiver and/or class teacher), b) had a diagnosis of autism spectrum disorder (ASD), c) communicated in full sentences and understood verbal instructions, d) were able to attend to a reading program for at least 20 minutes at a time, e) were aged between 8-11 years, f) attended a mainstream primary school, g) resided in a metropolitan region of Aotearoa New Zealand, h) did not exhibit behaviours which may harm themselves or others, and i) were not using the 'Reading Eggspress' program during the school terms one and two of 2020. Study information sheets for school principals, participating teachers, parents/whānau[3], and participants, and consent/assent forms for participants can be found in Appendix 4.

Six potential participants went through an initial interview process to confirm eligibility, however two verbally declined to participate in the study and thus were excluded. Four children aged between 8-11 years with autism and reading comprehension difficulties (n=4; 2 male and 2 female) met the inclusion criteria. Adult participants included the child participants' parents/caregivers (n=4) and class teachers of the participants with autism (n=4). Pseudonyms were assigned to each participant to protect their identity. All parents involved provided informed written consent for themselves and their child to participate, and child participants provided informed written assent. Teachers provided informed written consent to participate themselves. At the conclusion of the study, each child participant was given a shopping voucher valued at $20 for their contribution to the research.

[3] Extended family.

Lucy

Lucy was 10 years and 11 months old at the start of the study. She was of New Zealand European ethnicity. She attended a mainstream school and was reported to receive 30 minutes of TA support at school per week. She had previously attended speech therapy sessions targeting her phonological awareness skills. Lucy's mother reported that at the time of the study she completed ten minutes of independent reading at home each day. Lucy did not present with any avoidance behaviours during intervention sessions.

Derek

Derek was 9 years and 6 months old at the start of this study. He was of New Zealand European and Korean ethnicities. He attended a mainstream school and received five hours of individual teacher's aide (TA) support each week. During the study he was also attending a one hour weekly social skills group run by a speech language therapist. Derek did not present with any avoidance behaviours during intervention sessions.

Fred

Fred was 9 years and 4 months old at the start of this study. He was of New Zealand European ethnicity. He attended a mainstream school and received two hours of individual TA support each week. During the treatment phase of the study, Fred presented with some task refusal behaviours, however with support and encouragement from the researcher he was typically able to complete activities. As evident in his standardised test results, Fred presented with comparatively better reading comprehension skills than reading accuracy skills. However as his reading comprehension skills were still 'below average' he was considered an appropriate candidate for the study. Fred was taking medication for ADHD at the time of the study.

Sally

Sally was 9 years and 8 months at the start of the study. She was of Māori and New Zealand European ethnicities. She attended a mainstream school and received two and a half hours of individual TA support each week. Sally did not present with any behaviours that impacted her participation during

intervention sessions. Sally was not taking medication for Attention Deficit Hyperactivity Disorder (ADHD) at the time of the study.

All participants spoke English as their first language, and one participant (Fred) had some exposure to German at home. Further details of participants can be found below in Table 3.

Table 3

Participant Details

Participant	Age (years; months)	Reading Level [a] [b]	School Year	Diagnoses (Details)
Lucy	10;11	Sapphire	6	ASD (2013 Ministry of Education Early Intervention Service)
Derek	9;6	Orange	5	ASD; Mild Intellectual Disability (2014 private paediatrician; 2019 local DHB)
Fred	9;4	Turquoise	5	ASD; Dyspraxia; ADHD; visual processing difficulties suspected dyspraxia; (2020 local DHB; 2019 local DHB; 2017 private disability clinic; 2017 private disability clinic; 2017 private disability clinic)
Sally	9;8	Gold	5	ASD, Mild ADHD (2015 local DHB)

Note. ADHD: Attention Deficit Hyperactivity Disorder; ASD: Autism Spectrum Disorder; DHB: District Health Board.

[a] Based on teacher report of reading level based on the New Zealand Ministry of Education 'colour wheel' System.

[b] Reading age ranges for the above reading levels are 6;6-7;0 years for Orange, 7;0-7;6 years for Turquoise, 8;0-8;6 years for Gold and 11;0-12;0 years for Sapphire.

Experimental Design and Dependent Variables

This study employed a multiple phase SCD with repeated measures replicated across participants. SCD studies have been identified as a valuable contribution to health science research, as they enable researchers to capture individual performance in response to intervention (Portney & Watkins, 2008). Blampied (2001) argued that SCD research is ideal for application of science in a clinical context, for four

reasons: it involves science at the individual level, it allows for monitoring of change over time, it accommodates the uniqueness of each participant and that it promotes clinician accountability. SCD involves a small number of participants, making it an ideal research design for this particular study as the autism population is highly heterogeneous. This enables detailed analysis of each participant's response to the intervention.

This study consisted of pre-assessment, baseline, intervention (phase A and phase B), and post-assessment phases. Intervention starting phases were randomly allocated with two participants following the order four weeks of phase A then four weeks of phase B (Lucy and Fred), and the other two participants (Derek and Sally) following the reverse intervention phase order. Randomisation of phase order in AB designs was implemented as it is considered to strengthen SCD studies by reducing the likelihood of carryover effects (Lobo et al., 2017). The dependent variables measured were: 1) change in standardised test reading comprehension scores, 2) number of correct responses to RCPs, 3) level of independence using a comprehension strategy, and 4) reported change in attitude to reading.

Setting and Materials

Procedures

The study was carried out by a speech language therapist with more than five years of experience working with children with disabilities in private practice and not-for-profit settings. The intervention was designed to supplement regular classroom instruction for students with autism. Intervention sessions took place twice a week for 45 minutes each (plus 15 minutes for sessions also involving a reading comprehension probe) in a quiet room at a university speech and hearing clinic or at participants' school or home over a period of eight weeks (with a nine week break[4]) using the previously described computer based reading RE program. There was a target of 12 hours total of intervention. The actual total dosage of

[4] Due to Covid19, there was a period of complete lockdown including school closures and mandatory self-isolation of the researcher. This resulted in a nine week hiatus approximately in the middle of the treatment phase of this study, however it is worth noting that there was no participant attrition despite the interruption. Although every effort was made to keep participant timelines as similar as possible, each was at a slightly different stage of the intervention at the time of the interruption. See Appendix 6 for details of individual participant timelines.

treatment including RE and teaching for each participant was as follows: Lucy – 8.6 hours[5], Derek – 13.1 hours, Fred – 11.7 hours, Sally – 11.5 hours. The discrepancy in time may be due to the RE program's internal timing mechanism for measuring time spent, as this may have included non-treatment time (e.g., child choosing item for their RE 'apartment'). Each part of the session was also timed using a timer application on the researcher's phone. RE was presented in landscape orientation on a 12-inch Apple iPad Pro, with a protective case and tablet stand. Participants were positioned sitting at a desk with the researcher seated next to them so that the screen was visible to both researcher and child. All intervention sessions were video recorded using the same equipment and procedures as the baseline sessions. Sessions were terminated if participants demonstrated noncompliance for more than five minutes or if they indicated they were unable to continue (for example, if they felt unwell). Fred had one instance of an incomplete session during phase A, and Sally had two missed sessions due to illness during phase A (one of which was rescheduled).

Measures

Standardised Assessments. Prior to commencement of intervention participants completed language and reading assessments. The assessment battery was designed to take into consideration participant language skills, social and communication skills as well as reading ability. Assessment of participant's language skills was conducted due to the strong relationship between language skills and reading comprehension ability (for more detail see meta-analysis by Brown et al., 2013). The Core Language Scale (CLS) Subtests of the Clinical Evaluation of Language Fundamentals – Fifth Edition Australia and New Zealand (CELF-5 A&NZ; Wiig et al., 2017) was completed to determine each participant's language ability. The CELF-5 A&NZ is a comprehensive language and communication assessment tool for ages 5-21 years, which can be used to determine the presence and nature of a language disorder and plan for treatment. It has been standardised with a sample of over 1000 students in Australia and Aotearoa New Zealand, including clinical groups such as children with autism, learning disability (reading and writing) and language disorder. The CELF-5 A&NZ internal consistency

[5] RE total recorded time for Lucy may have been lower due to the program timer turning off during 'idle' time, which may have included when Lucy was reading longer texts.

reliability coefficient ranged between .81 (good) and .99 (excellent) for individual subtests, and .93 (excellent) or above for index scores. In a systematic review of the psychometric properties of a range of child language assessments, the CELF-5 (although not the A&NZ edition) was rated 'good' for internal consistency, test-retest reliability, inter-rater reliability, content validity, and structural validity (Denman et al., 2017), although the authors noted that further research using methodologically rigorous design and reporting for review of psychometric properties of tests is warranted. The subtests used in the current study together make up a CLS score: *Word Classes (WC)*, *Formulated Sentences (FS)*, *Recalling Sentences (RS)* and *Semantic Relationships (SR)*. The *WC* subtest measures the ability to understand connections between associated words. The *FS* subtest measures the ability to create sentences that are semantically and grammatically correct using a given word. The *RS* subtest measures the ability to accurately recall sentences of varying lengths. The *SR* subtest measures the ability to understand sentences that include meaning-based connections (e.g., comparisons, location/direction, sequence).

Forms A and B of the NARA-3 were used to measure reading accuracy, reading comprehension and reading rate as pre- and post-assessment measures, respectively. The NARA-3 is a reading assessment tool that has been standardised on Australian children aged 6-12 years. The NARA-3 manual does not report on inclusion of children with disabilities such as autism in the standardisation sample, and does not report standard scores in the assessment manual. In an evaluation of the NARA-3 by Cain and Oakhill (2006), the authors highlight some limitations of the tool such as the 'hidden processing demands' of the open-ended question format. However they concluded that despite the limitations it can be a valid measure that enables accurate assessment of reading accuracy and reading comprehension, and identify those individuals with a discrepancy between these skills.

Parents also completed the Communication and Socialisation domains of the Survey Form (Parents) from the Vineland Adaptive Behaviour Scales - Second Edition (VABS-2; Sparrow et al., 2005) prior to the treatment phase of the study (see Appendix 5 for results). Previous research has uncovered a strong relationship between reading performance on the NARA-III and parent report on the VABS-2 for children with autism (Arciuli et al., 2013). The VABS-2 was standardised on 3,695 American individuals aged birth to 90 years. The sample included a clinical group of children and adolescents with diagnoses of

intellectual disability, autism, ADHD, emotional disturbance, specific learning disability, or visual and hearing impairment. A systematic review and psychometric evaluation of adaptive behaviour scales was completed by Floyd et al. (2015). Using a three-point scale ranging from 'inadequate' to 'adequate', the authors reported the following in relation to the VABS-2 Survey Form's psychometric properties: content validity ('good'), inter-rater reliability ('adequate'), internal consistency, and test-retest reliability coefficients ('inadequate'). Aside from some potential psychometric weaknesses, another limitation of this tool is the results reported in the autism clinical group. The age range is very broad (3-15 years of age) and thus may not reflect the range of differences in ability between individuals in the group. Despite the limitations of the VABS-2, some studies support its use in research with the autism population (Anagnostou et al., 2015).

The pre-intervention language assessments indicated that Lucy and Fred's CELF-5 Core Language Scores were in the 'borderline language disorder' range, Derek's was in the 'very low' range and Sally's was in the 'severe language disorder' range. Derek, Fred and Sally's VABS-2 Communication subdomain scores fell in the 'moderately low' range, while Lucy's was in the 'adequate' range. Lucy and Sally's VABS-2 Socialisation subdomain scores fell in the adequate range, while Derek and Fred's fell in the 'moderately low' range. Detailed scores for each individual participant can be found in Appendix 5.

Reading Comprehension Probes. ***Rationale.*** The second dependent variable was reading comprehension scores. At the time of this study there were few available validated reading comprehension measures of the length required for brief and regular RCPs required for this SCD. Researcher developed tools have been utilised in other studies (e.g., El Zein, Gevarter, et al., 2016; Flores & Ganz, 2007). In a US study, Armstrong and Hughes (2012) reported that their researcher-developed probe was validated on general education peers, however the details of this process were unclear, and the text content was considered likely to be culturally unfamiliar (e.g., coyotes) so this tool was not used. Instead for the current study, the researcher developed RCPs using grade matched 'readers' based on the New Zealand Ministry of Education 'colour wheel' reading levels as per those of a study of a similar design (Bethune & Wood, 2013). For the purposes of possible future replication, the process of developing RCPs is described in detail here.

Development of the RCPs. RCPs were based on predetermined books at participants' current 'colour wheel' reading level. Each participant's RCP level was determined through discussion with their parent and class teacher prior to the study commencing. Both fiction and nonfiction texts were included to reflect the diversity of texts the participants would be exposed to at school, and included content culturally relevant and familiar to an Aotearoa New Zealand reader. A written instruction was included on the top of each RCP directing the child to select the best answer. Each RCP contained four or five literal and five or six inferential comprehension questions, out of a total of ten questions. Questions were developed for each text by the researcher using three criteria: Blank's levels of questioning (Blank et al., 1978), Bloom's Taxonomy (Bloom et al., 1956) and whether they were literal (answer can be found directly in the text) or inferential (requires other information not explicitly stated in the text). Blank's levels of questioning were developed to provide a schema for understanding the cognitive demands of different types of questions, based on child language development. There are four levels of Blank's questions (Blank et al., 1978; see Appendix 8 for a description and examples of each type). Bloom's Taxonomy (Bloom et al., 1956) is a widely used hierarchy of questions used from primary to tertiary education contexts to develop learners' higher order thinking. Due to the multiple choice structure of the RCP and the primary school age target level, only the first two classification levels of Bloom's Taxonomy (*Knowledge* and *Comprehension*) were utilised (see Appendix 9 for examples). Many of the available Blank's and Bloom's question examples were not compatible with a multiple choice format (e.g., they are open-ended), so other sources were used for reference and phrasing of questions. These sources included the US website ReadWorks (www.readworks.org), which has been used in previous reading comprehension SCD research (Howorth et al., 2016), and the established Aotearoa New Zealand reading comprehension assessment resource, the electronic version of Assessment Tools for Teaching and Learning (e-asTTle; https://e-asttle.tki.org.nz/).

To check the target levels of the RCPs were adhered to, interobserver agreement (IOA) was conducted on 25% of the questions a speech language therapist / postgraduate research student who was independent of the research. The rater was trained by the researcher on rating RCP questions and was blind to the researcher's ratings for each question. The rater read through questions and noted their ratings on a data sheet, which were later compared with the researcher's ratings of the same 25% of questions.

Point-to-point inter-rater reliability for each element of RCP questions was as follows: RCP Blank's Questions Levels - 70%, RCP Bloom's Taxonomy Levels - 80%, RCP Literal/Inferential - 86%.

Response options were presented in multiple choice format and included a *key* (the correct answer), and three *distractors* (response alternatives). Of the distractors, two were fairly plausible answers and one was a less plausible answer. Depending on the content of the question, distractors included phonological (e.g., sounded similar to key) or semantic elements (relates to an event in the book but not the answer required). To reduce patterns that may have led participants to the correct answer, location of the key was randomised between questions in each probe (e.g., alternating randomly between a, b, c or d) and the length of each possible answer was kept relatively consistent. To optimise learning conditions (see cognitive load theory research e.g., Sweller, 1988), general question structure was kept simple and *negatives* (e.g., Which of the following are not true?) were avoided to limit additional pressure on working memory. Each probe contained one question about identifying the main idea ('*What is the book mostly about?'*). It is acknowledged that item format can influence test performance for primary school aged children in general education, for example the trend of higher performance on multiple choice questions than open-ended questions (see Woodcock et al., 2019). However to maintain consistency across RCP conditions and for the sake of consistency of marking and to reduce the cognitive demand for the participants, it was decided that multiple choice questions would be used for the current study.

RCP Delivery. Probes took place throughout the duration of the intervention, for every baseline session and at the beginning of every second intervention session (target total of 12 per participant). The researcher asked the children if they had read the book prior to starting and if the child was familiar with a text, an alternative was chosen. Participants were presented with a RCP (presented on A4 pages), the associated book, and a pencil. They were instructed to read the book, then do the quiz. If they had difficulty with questions, they were encouraged to 'have a go'. Although it was intended that no assistance would be provided, there were several instances during two baseline RCPs with Fred when the researcher provided help by reading some of the questions and answers aloud to maintain his engagement. A token economy was also used to encourage and motivate Fred during sessions.

Strategy Use: Graphic Organisers. The second target behaviour and dependent variable was participants' use of a strategy while reading a book, measured using a data collection sheet. This strategy was combined with explicit instruction in use of the GO, based on evidence from a synthesis of previous studies (El Zein et al., 2014). Each child's skill level was determined through information gathered during standardised reading assessment and they were matched with a reading comprehension goal and strategy for treatment phase A. Goals were based on developing independence using a GO to identify important parts of fiction and nonfiction texts. As recommended in the research (see Finnegan & Mazin, 2016), the participants were matched with a GO appropriate to their level of learning and support needs. As such, Derek was instructed in the use of a 'wh' GO, and the remaining participants were instructed in use of a 'main idea' GO, based on those developed by researchers Bethune and Wood (2013) and El Zein, Gevarter, et al. (2016) respectively. GOs were printed on A4 laminated paper (see Appendix 7) in a horizontal orientation. The researcher transcribed responses onto the laminated GO with a whiteboard marker during sessions, and this was not considered in rating participants' independence with the task. Use of the GO was targeted during the 20 minute teaching component of the phase A sessions with an aim of two opportunities per session. This was achieved for all except two instances (Lucy session 1 of phase A and Fred session 4 of phase A). In these instances there was only a single opportunity to complete the GO as time taken to complete it would have been more than five minutes over the teaching component of the session. Depending on the length of the text being used for instruction, the strategy would be applied at passage level or text level (e.g., the whole book); for longer texts the focus tended to be on a passage within the larger text. The researcher took data on the level of support the participant required on each instance of completing the GO (modelled, guided, or independent). A rating of 'modelled' was given if the researcher introduced the strategy to the participant describing its overall purpose, what each GO section was for, and then demonstrated how to use the GO with an example from the text. A rating of 'guided' was given in the instances where the participant verbally completed the main components of the GO (2/3 for main idea GO and 2/4 or 3/4 for wh GO). A rating of 'independent' was given when the participant verbally completed the GO (including generating a plausible main idea statement for the main idea GO) without support from the clinician.

Reliability

IOA was conducted on videos of 25% (eight total) of randomly selected phase A sessions for each participant for the dependent variable of strategy use. The independent rater (the same speech language therapist / postgraduate research student who completed IOA on RCP questions) was trained by the researcher on rating participant strategy use. The rater was blind to child's age, reading level of the text and session number. IOA was calculated using the formula: total number of agreements/total number of agreements + total number of disagreements x 100. IOA for strategy use was 93.75%.

Questionnaires. Social validity data was collected through pre- and post-intervention questionnaires completed by the participant, parent/caregiver or whānau, and teachers. The child questionnaires were based on questionnaires provided to children in previous studies of a similar nature (see Bethune & Wood, 2013). Questionnaire items related to reading habits, reading self-efficacy, and enjoyment of reading including some items from the Reader Self-Perception Scale 2 developed by Henk et al. (2012).

Participant questionnaire one (C1) consisted of one question (item) relating to frequency of reading, two items relating to reading self-efficacy (beliefs about their reading capability) and one item relating to enjoyment of reading. Items used a Likert scale format to indicate level of agreement (e.g., *Not at all; Not much; I don't agree or disagree; Yes a bit; Yes a lot*). Participant questionnaire two (C2) comprised the same items as C1, plus four statements about their experience of RE and the researcher's instruction lessons.

Although not directly used as a measure of efficacy of the reading comprehension intervention, family and teacher input about each participant's reading habits were collected before and after the program. The pre-intervention parent/caregiver/whānau questionnaire (W1) included seven items about home reading habits and an open text comments section (eight items in total). The post-intervention parent/caregiver/whānau questionnaire (W2) included the same eight items as the pre-questionnaire, as well as a statement about satisfaction with the intervention which had a five-point Likert scale (ranging from *'very dissatisfied'* to *'very satisfied'*).

The pre-intervention teacher questionnaire (T1) comprised five items about the participant's school reading habits, as well as four items with open text comments about reading support and classroom instruction (nine items in total). The post-intervention teacher questionnaire (T2) included seven of the same items as the pre-questionnaire, and a statement about satisfaction with the intervention with the same structure as W2. Items and participant responses for all questionnaires can be found in Appendix 10.

Phases

Baseline. Four baseline sessions were conducted for each participant in a two week period before intervention. For each baseline session, participants were asked to read a short book at their current reading level, and answer some questions in an RCP (described in further detail below). They were not provided with any feedback from the researcher. Baseline sessions were video recorded using a 10-inch Apple iPad Air 2 on a tablet stand that captured footage of the child reading and completing tasks. Participant reading behaviours (e.g., refers back to the text when answering questions) during baseline were observed and used by the researcher to select a reading comprehension strategy to be taught during phase A. Of these, GOs were selected out of five potential strategies (*DI, cooperative learning, GOs, self-directed strategies and supported electronic text* from Finnegan & Mazin review, 2016) as they have been established as an evidence-based practice.

Intervention Phase A. For the first 20 minutes of each phase A session the researcher delivered a lesson on using a GO with a book at the child's reading level using explicit instruction which has been used in previous research on reading supports for children with autism (e.g., Bethune & Wood, 2013). 'Explicit teaching', a teacher-led approach, and is defined by Rupley et al. (2009) as "imparting new information to students through meaningful teacher-student interactions and teacher guidance of student learning" (p. 126). "At the heart of the direct instruction method are explicit explanations, modelling or demonstrating, and guided practice" (p. 127). Another important feature of this approach is the 'gradual release of responsibility' (model → guided → independent), which aims to reduce the amount of teacher support as the student becomes more independent with a skill. Before introducing the GO each phase A session, the researcher also read through a reading checklist with participants based on that developed by

S.Y. Kim et al. (2018). This checklist included metacognitive strategies and questions for before, during, after reading (see Figure 4).

Figure 4

Reading Checklist

Before Reading (We Predict)
• Look at the cover (fact or fiction?) • Read the title • What do you think the book will be about? • Why do we ask questions when we read?
During Reading (We Ask Questions)
• Did I read or hear any words I don't know? • Can I find the who, what, when, where and how? • Can I find some details?
After Reading (We Summarise)
• What was the book mostly about? • What did we learn?

Lessons followed a consistent structure, with the concept of 'gradual release of responsibility' applied across sessions as participants gained confidence with using strategies more independently. Participants were given two opportunities per phase A session to complete an activity (e.g., complete a GO) at passage or book level. Following GO instruction, participants completed 25 minutes of supported navigation through RE lessons. At the end of the session, they were rewarded with five minutes playing a preferred iPad game or selecting items to buy with 'eggy points' within RE. At the completion of sessions involving a RCP, participants were given a choice of a small toy (such as a rubber bouncy ball or LEGO pieces) to take home.

Intervention Phase B. Intervention phase B involved 45 minutes of supported navigation through RE lessons on the iPad, followed by five minutes playing a preferred iPad game or selecting items to buy with 'eggy points' within RE as a reward. All lessons had a reading comprehension strategy focus such as identifying the main idea and details, answering literal questions, comparing and contrasting or making inferences. Some sessions started with a short animated video during which metacognitive strategies are demonstrated with explicit examples from a text and a character explaining. RE activities typically involved seven or eight 'pre-activities' such as the previously described dictionary activity, before finishing the lesson with 'chapter reading' (an extract from a larger text). At the end of reading passages a quiz was completed, consisting of ten multiple choice questions or 16 for the more advanced readers. See https://www.youtube.com/watch?v=jJXCFc_Zfjc for a demonstration video of RE activities. As with phase A, at the completion of sessions involving a RCP, participants were given a choice of a small toy.

Data Analysis

RCPs data were graphed for each individual and visual analysis was conducted to observe trends over time. Visual analysis was chosen as this is a commonly used approach for small data sets, such as those used in SCD studies (Portney & Watkins, 2008). For the current study, mean performance during each phase was also measured, graphed and compared within participants. The mean and range were also reported for each participant. There are a range of statistical methods which can be implemented in SCD studies to calculate effect sizes and these provide a more objective interpretation than visual analysis alone (Şen & Şen, 2019). These include percentage of non-overlapping data points (PND) and percentage of data points exceeding the median of the baseline level (PEM). A disadvantage of the PND approach is a higher chance of making a Type II error (when it is concluded that no significant effect is present, when in fact there is). It also requires that the data set contains no baseline ceiling data points, however these were present for some participants in the current study. Ma (2006) proposed PEM as an alternative method to PND that has less chance of making a Type II error, although a limitation of PEM is that it does not consider the magnitude of data points above the mean. PEM was applied in this study (see Şen & Şen, 2019 for steps in using PEM to calculate effect size). It uses the following criteria to report the level

of effectiveness of an intervention: 50% or lower = 'ineffective'; 51-70% = 'mildly effective'; 71-90% = 'moderately effective', 91-100% = 'highly effective'.

Treatment Fidelity

To ensure that procedures were carried out as intended, the same independent rater who conducted reliability ratings also conducted treatment fidelity ratings on 25% of phase A data. The independent rater was trained in completing a fidelity checklist (Appendix 12) for each video. The checklist included nine items, and required the rater to indicate whether the step in the procedure took place or not (+/- or N/A if not applicable). Item 5 of the fidelity checklist included tallying instances of support during a random five minute sample from the video. ('Support' for the purposes of this measure was considered verbal input from the researcher to the participant to reinforce a component of the lesson, encourage them or provide help when they were having difficulty with a task). It was expected that at least three instances of support occurred during this time; for each video three to six (median five) instances were recorded by the independent rater. Intervention fidelity was then calculated by the number of steps on the checklist accurately implemented divided by the total number of steps, multiplied by 100. Ratings for all videos were 100%, which indicated very high treatment fidelity.

Reading Eggspress Progress

RE provides a summary of student performance within the program for teacher and parent reference. The measure of change used is 'Lexile level' based on The Lexile™ Framework (LF) which is a widely used text measurement approach for books from the beginning of primary to end of high school. A report available on the RE website indicates that every text in the RE has been independently rated using the Lexile measure (Reading Eggspress Comprehension Program Scientific Research Base; Russo & Pike, 2014). The use of the LF is a source of contention in the education field and it has received some criticism for limiting the choices of readers and the cost (Krashen, 2002) as well as issues with semantic theory, syntactic theory, and psychometric properties (Smith et al., 2016). However the details of this ongoing debate are beyond the scope of this paper.

In the cases where participants achieved 80% or more on three consecutive RE lessons and the content was deemed 'too easy' the researcher moved them to a higher level (consistent with their NARA-

3 ‘age equivalent’ level). This occurred for two participants - Lucy and Sally. Based on information recorded within the RE program, each child made different progress throughout the intervention: Lucy’s RE start and end points were lessons 121-128 (started at level 1), Derek’s were 1-21, Fred’s were 1-47 and Sally’s were 31-47 (started at level 1). Average Lexile level of books read during the program was as follows: Lucy – 760; Derek – 320; Fred – 495; and Sally – 458.

Treatment Confounds

All four participants completed all eight sessions of phase B, however two out of four participants completed all eight sessions of phase A, with Sally missing one and Fred missing part of one session (both due to illness). It should also be noted that during the Covid19 break, Fred had a change in medication to manage his ADHD.

Results

This study sought to explore the efficacy of a CAI-based intervention program on the reading comprehension skills of four children with autism between ages 8-11 years. Each participant’s response to the intervention program was measured using RCPs, standardised scores, level of independence with a reading strategy (GO), and questionnaire responses.

Performance on Standardised Reading Test

Once intervention sessions had been completed, each participant’s literacy skills were retested using Form B of the NARA-3. Pre- and post-intervention raw reading comprehension, reading accuracy and reading rate scores and corresponding confidence bands for NARA-3 are reported in Table 4. Each participant’s results are reported below.

Table 4

NARA-3 Pre- and Post-Intervention Raw Scores and Confidence Bands

Participant	Pre-Intervention RC (CB)	Post-Intervention RC (CB)	CB Overlap/ No overlap	Pre-Intervention Accuracy (CB)	Post-Intervention Accuracy (CB)	CB Overlap/ No overlap	Pre-test Intervention Rate (CB)	Post-test Intervention Rate (CB)	CB Overlap/ No overlap
Lucy	17 (14.1-19.9)	18 (14.9-21.1)	Overlap	44 (35.1-52.9)	52 (42.8-61.2)	Overlap	66 (55.9-76.1)	60 (49.3-70.7)	Overlap
Derek	7 (4.1-9.9)	14 (10.9-17.1)	No overlap	45 (36.1-53.9)	46 (36.8-55.2)	Overlap	102 (91.9-112.1)	67 (56.3-77.7)	No overlap
Fred	14 (11.1-16.9)	21 (17.9-24.1)	No overlap	29 (20.1-37.9)	35 (25.8-44.2)	Overlap	41 (30.9-51.1)	40 (29.3-50.7)	Overlap
Sally	15 (12.1-17.9)	15 (11.9-18.1)	Overlap	52 (43.1-60.9)	48 (38.8-57.2)	Overlap	62 (51.9-72.1)	66 (55.3-76.7)	Overlap

Note. RC = reading comprehension; CB = confidence bands. Scores reported here are raw scores to enable calculation of confidence bands. Confidence bands based on the 68% level reported in NARA-3 examiner's manual.

Lucy. Lucy's results showed an increase of one on her post-intervention reading comprehension raw score, however this corresponded to a decrease in percentile rank (from 15th to 13th). This placed her in the 'below average' range for reading comprehension at both pre- and post-intervention. There was an overlap in confidence bands in pre- and post-intervention scores, indicating that the change in score is more likely to be due to error of measurement.

Fred. Fred's NARA-3 results reflected gains made during the reading intervention program. His reading comprehension raw score increased by seven between pre- and post-assessment, and by 13 on percentile rank (from 23rd to 36th). This placed him in the 'below average' range for reading comprehension at pre-intervention and within 'average' post-intervention. There was no overlap in confidence bands in pre- and post-intervention scores, indicating that the change in reading comprehension was likely a genuine improvement in performance.

Derek. Derek achieved raw scores and corresponding percentile ranks above his pre-intervention level for the reading comprehension subskill. His reading comprehension raw score increased by seven between pre- and post-assessment, and by nine on percentile rank (from 1st to 10th). These pre- and post-intervention scores are classified as within 'very low' range for reading comprehension. There was no overlap in confidence bands in pre- and post-intervention scores, also indicating that the change in reading comprehension was likely a genuine improvement in performance.

Sally. Sally achieved raw scores and corresponding percentile ranks above her pre-intervention level for the reading comprehension subskill (from 17th to 23rd). This placed her in the 'below average' range for reading comprehension at pre-intervention and within 'average' post-intervention. As with Lucy's pre- and post-intervention scores there was an overlap in confidence bands, indicating that the change in score is more likely to be due to error of measurement.

Performance on Reading Comprehension Probes (RCPs)

The first research question sought to answer whether participation in the reading intervention program would result in a significant change in RC skills, as measured by RCPs and a standardised reading assessment (NARA-3). The second research question aimed to determine whether there was a

different in reading comprehension scores between phase A (RE and explicit instruction) and phase B (RE), as measured by RCP scores. Figure 5 contains graphs of each participant's individual performance on RCPs across the course of the study. On the graphs below, intervention occurred between sessions 5-12. Visual analysis of these graphs indicated large variability in performance on RCPs for all four participants. There was no observable change during the intervention phases of the study, with minimal change from phases A to B (difference 0-0.75), regardless of order of exposure. See Table 5 for a summary of number of fiction and nonfiction texts and participant mean scores for each type. On further detailed inspection there was some difference between RCP performance on fiction vs nonfiction texts. Of note, performance appeared to be better for fiction texts for two out of four participants (Derek and Sally), whereas for the other two (Lucy and Fred) the opposite was true.

Figure 5

Participant RCP Scores

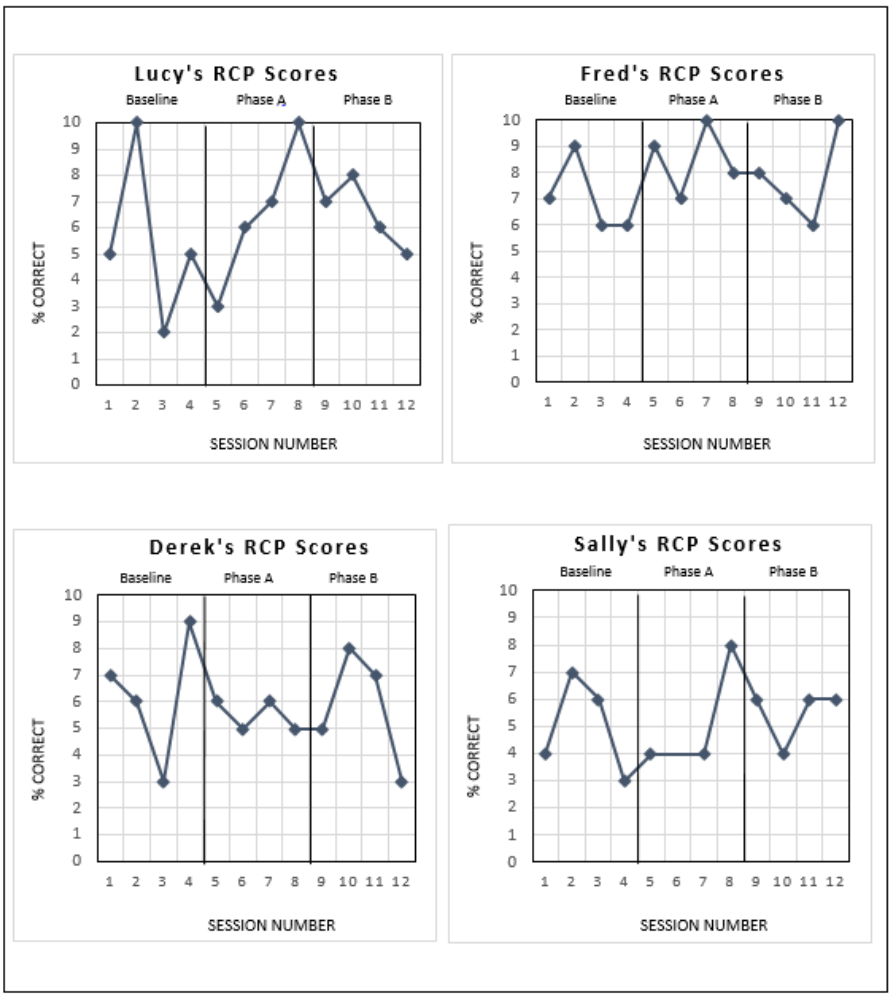


Table 5

Number of Fiction/Nonfiction Reading Comprehension Probe Texts

Participant	Number of Fiction Texts (mean questions correct)	Number of Nonfiction Texts (mean questions correct)
Lucy	9 (5.8)	3 (7)
Derek	7 (6.6)	5 (4.8)
Fred	6 (6.8)	6 (8.7)
Sally	4 (6.75)	7 (4.4)

For each participant, four data points were collected during baseline which provided sufficient data to produce an average (mean; M). Three participants answered a total of 120 multiple choice questions (MCQs) over the course of the study (12 x 10 MCQs), and one participant (Sally) answered a total of 110 questions (one session missed due to illness). During baseline, a decreasing trend was observed for two participants (Fred and Sally) however was not possible to establish a stable or decreasing baseline trend prior to the treatment phase starting for the other two participants. Previous SCD studies investigating reading comprehension have also documented some variability during baseline (Howorth et al., 2016; S. Y. Kim et al., 2018; Knight et al., 2015). Table 6 summarises participant mean RCP scores during each phase (baseline, phase A and phase B).

Table 6

Mean RCP Scores

Participant	Baseline *M (R)*	SD	Intervention Phases			
			Phase A *M (R)*	SD	Phase B *M (R)*	SD
Lucy	5.5 (20-100)	3.317	6.5 (30-100)	2.887	6.5 (50-80)	1.291
Questions answered correct (%)	22/40 (55)		26/40 (65)		26/40 (65)	
Derek	6.25 (30-90)	2.500	5.5 (30-80)	0.577	5.75 (50-60)	2.217
Questions answered correct (%)	25/40 (63)		23/40 (58)		22/40 (55)	
Fred	7 (60-90)	1.414	8.5 (60-100)	1.291	7.75 (60-100)	1.708
Questions answered correct (%)	28/40 (70%)		34/40 (85)		31/40 (78)	
Sally	5 (30-70)	1.826	5.5 (40-60)	1.000	5.3 (40-80)	2.309
Questions answered correct (%)	20/40 (50)		22/40 (55)		16/30 (53)	

Note. M = mean; R = range (recorded as percentages); SD = standard deviation.

Lucy. Lucy's results indicate an increasing trend once treatment commenced. Her average RCP scores were maintained during phases A and B (M = 6.5). Based on RCPs, Lucy achieved a PEM score of 75%; within the *'moderately effective'* range.

Derek. Derek demonstrated a decreasing trend in his reading comprehension scores once treatment commenced. During phase A, his average RCP scores were slightly lower during phase A (M =

5.5)[6] than during phase B (M = 5.75). Derek PEM score was 25%, which this measure classifies as *'ineffective'*.

Fred. Fred's average RCP scores during phase A (M = 8.5) were slightly higher than during phase B (M = 7.75). There was a general increasing trend in his reading comprehension scores once treatment commenced. Based on RCPs, Fred achieved a PEM score of 87.5%; within the *'moderately effective'* range.

Sally. Sally's average RCP scores during phase were slightly higher during phase A (M = 5.5) than during phase B (M = 5.3). Based on RCPs, Sally scored a PEM 80%; within the *'moderately effective'* range.

Performance on Strategy Use

The third research question sought to determine whether there would be a difference in reading comprehension scores in a condition of RE only compared with explicit instruction in strategy use plus RE. Strategy use was measured over the eight phase A sessions. Results are summarised in Table 7.

Table 7

Participant Strategy Use

Session Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Participant								
Lucy	M	G, G	M, M	G, G	G, M	G, M	G, G	G, G
Derek	M, G	G, G/I	I, G	G, G	G/I, I	I, I	G/I, G	I, I
Fred	G, G	M, G, G	G	M, G	G, G	G, I	I, I	I, I
Sally	M, G	G, G	G, G	G, G	G, G	I, I	*	G, G

Note. M = modelled, G = guided, I = independent. * = missed session.

[6] It was also noted that on Derek's final RCP, he appeared to read and complete it quickly rather than reading all possible multiple choice answers before choosing each response. This may have influenced his low final score.

Three out of four participants were instructed in use of the main idea GO, and one participant in use of the 'wh' GO. Two out of four participants (Fred and Derek) progressed to using the GO independently on two opportunities in the final phase A session. Lucy and Sally progressed to using the GO with guidance by the final phase A session. Sally began to approach independence by session six, however she returned to requiring guidance after missing a session.

Social Validity

The fourth research question sought to determine whether participation in the reading comprehension intervention program would result in increased self-reported enjoyment of reading for child participants. This was measured using questionnaire responses from participants about reading habits, reading self-efficacy and reading enjoyment prior to intervention and again at the conclusion of intervention. Questionnaires from parents and teachers about the child's reading were also collected. Responses are summarised below. Items of all pre- and post-intervention questionnaires can be found in Appendix 10, and post-intervention questionnaire comments from parents and teachers in Appendix 11.

Questionnaires Responses

Lucy. In the pre-intervention questionnaire, Lucy indicated she read *'rarely'*. She responded with *'I'm not sure'* and *'yes a bit'* to the reading self-efficacy items. She responded with *'not much'* to the reading enjoyment item. In the post-intervention questionnaire Lucy reported an increase in reading frequency. Her responses to reading self-efficacy items were ambivalent. Lucy also responded with uncertainty about whether RE or the researcher's lessons helped her to understand what she read. However, she indicated that she enjoyed using RE and would like to keep using it at home.

In the pre-intervention parent questionnaire, Lucy's mum responded with 2 (between *'does not enjoy reading at all'* and *'neutral'*) for her child's experience of reading at home. To the reading habits items 'How much does your child read at home?' and 'My child chooses books to read at home' she responded with *'sometimes'*. She indicated that Lucy read the following at home: fiction books, non-fiction books, magazines, websites/apps with factual info, websites/apps with reading games. She added an extra comment that Lucy *'will choose magazines first'*. For the reading enjoyment statements, 'My child and I spend time reading together', 'My child enjoys when we read together' and 'I enjoy when my

child and I read together', Lucy's mum indicated *'neutral'*, *'strongly disagree'* and *'agree'*, respectively. She added the comment *'used to but doesn't want to anymore'* for the item about spending time reading together. In the post-intervention parent questionnaire, Lucy's mum rated Lucy's experience of reading at home, as *'neutral'*; a one-point increase compared with the pre-questionnaire. For the items asking how frequently Lucy reads at home and whether she chooses books to read at home she indicated *'strongly agree'*; also, a one-point increase. For 'types of texts', Lucy's mum noted the same as previously with the addition of graphic novels. She rated the items parent and child read together and child's enjoyment of reading together with *'agree'*, reflecting increases of one and three points respectively. Her rating of parent enjoyment of reading together was maintained. Her rating of the satisfaction with the support her child received during the reading comprehension intervention was *'very satisfied'*.

In the pre-intervention teacher questionnaire, when asked to rate Lucy's enjoyment of reading, her teacher rated her at 2, one point above *'does not enjoy reading at all'*. He indicated that Lucy read at school *'sometimes'*, and chose books to read during free time *'rarely'*. He marked 'N/A' for Lucy borrowing books from the school library as it was closed for refurbishment during the period of the study. He indicated that Lucy read fiction books, used websites/apps with factual information and websites/apps with reading games. For other details around additional support for reading, Lucy's teacher noted that she was also using the 'Lexia' computer reading program and had 'checks' from a TA (0.5 hours per week). Lucy's teacher reported her to be at the 'Sapphire' level of the colour wheel (11-12 years age range). This level was slightly above her age at the time the study commenced. He described reading instruction for his class as having a 'group focus' with '1:1 lessons to hear and discuss decoding strategies'. He added that Lucy is 'very quiet - she presents with little confidence but in 1:1 [reading] probes and discussion shows ability at her 11 year level'. In the post-intervention teacher questionnaire Lucy's teacher rated her at 4 for enjoyment of reading, a two-point increase compared with the pre-questionnaire. For frequency of reading he indicated that Lucy read at school *'often'* (a three-point increase), and for choosing books to read during free time he indicated *'sometimes'* (a one-point increase). Response to the text types item remained the same as the pre-questionnaire. For satisfaction with the support the participant received during the intervention, Lucy's teacher indicated *'unsure'*. He verbally qualified this response to the researcher saying the felt he couldn't answer this having not directly observed the sessions. He rated

Lucy's reading level as 11.5-12.5 years based on a school assessment (Progressive Achievement Test; PAT[7]), corresponding to the 'Sapphire' level of the colour wheel and six months beyond, which overlaps with her pre-intervention level.

Derek. In the pre-intervention questionnaire, Derek indicated he read *'every day'*. To the reading self-efficacy items, he responded with *'yes a bit'* or *'yes a lot'*. He also responded with *'yes a lot'* to the reading enjoyment item. In the post-intervention questionnaire Derek gave the same responses for items as in the corresponding reading frequency and enjoyment items from the pre-intervention questionnaire. He indicated *'yes a lot'* and *'yes a bit'* for the reading self-efficacy items (a one-point increase in self-reported improvement in reading in general, and a one-point decrease in self-reported understanding of what he read). Derek responded with *'yes a lot'* to the following items: enjoyment of the RE program, RE helped with understanding what was happening in books, and the researcher's lessons helped with understanding what was happening in books. He indicated he would like to continue to use RE at home.

In the pre-intervention, Derek's mum indicated *'really enjoys reading'* for her child's experience of reading at home. To the items 'How much does your child read at home?' and 'My child chooses books to read at home' she responded with *'often'*. She indicated that Derek read fiction books at home. Derek's mum *strongly agreed* with all three statements about enjoyment of reading. She indicated that he was receiving 4-5 hours per week of additional support for reading at the commencement of the study. In the post-intervention questionnaire, she indicated the same response for home reading items and text types. For items all enjoyment of reading items, she indicated *'agree'* (one-point decrease from pre-intervention questionnaire). For level of satisfaction with the support Derek received during the intervention, she indicated *'very satisfied'*.

In the pre-intervention teacher questionnaire, Derek's teacher rated him at 4 (*'enjoys reading'*) for enjoyment of reading. For school reading habits items, she indicated *'sometimes'*. She reported he read fiction and non-fiction books at school and had five hours of TA support each week. She reported that Derek was at the 'Orange' level of the colour wheel (6.5-7 years age range) and that she was using the 'Sharp'[8] reading framework for classroom literacy instruction. In the post-intervention teacher

[7] For further information see: https://www.nzcer.org.nz/tests/pat-reading-comprehension-and-vocabulary
[8] Reading framework for guided reading (differentiated teaching in small groups) https://www.sharpreading.com/

questionnaire, she rated Derek's enjoyment of reading as *'really enjoys'*; a one-point increase. For two of the school reading habits items she responded with *'often'*, a two-point increase. The school reading habits other item remained at *'sometimes'* and text types remained as reported in the pre-intervention questionnaire. For level of satisfaction with the support the participant received during the intervention, Derek's teacher indicated *'very satisfied'*. She reported he was at the 'Silver' level of the colour wheel (8.5-9 years age range), four levels above his pre-intervention level.

Fred. In the pre-intervention questionnaire, Fred indicated that he read *'often'*. He responded with *'yes a bit'* to the statement 'I am getting better at reading in general'. To the statements 'I understand what I read better than I could before' and 'I enjoy how I feel when I read' he responded with *'yes a lot'*. In the post-intervention questionnaire Fred indicated a one-point increase for reading frequency and self-efficacy responding that he read *'every day'* and felt that he was getting *'a lot'* better at reading in general. He gave the same responses for one self-efficacy item and the enjoyment item as in the corresponding questions from the pre-intervention questionnaire. He responded with *'yes a lot'* to the following items: enjoyment of the RE program, RE helped with understanding what was happening in books, the researcher's lessons helped with understanding what was happening in books, and responded that he would *'maybe'* like to use RE at home.

In the pre-intervention parent questionnaire, Fred's mum indicated *'neutral'* for her child's experience of reading at home. To the home reading habits items she responded with *'occasionally'*. She indicated that Fred read the following at home: fiction books, non-fiction books, magazines, websites/apps with factual information and websites/apps with reading games. Fred's mum *strongly agreed* with the reading enjoyment statements. Fred was reportedly receiving two hours per week of TA support for reading at the commencement of the study. In the post-intervention parent questionnaire, she rated reading frequency and home reading habits items the same as in the pre-intervention questionnaire. She rated the reading enjoyment items with *'strongly agree'* or *'agree'* (a one-point decrease for the child enjoyment item). Her rating of the support Fred received during the reading comprehension intervention was *'very satisfied'*.

In the pre-intervention teacher questionnaire, Fred's teacher rated his enjoyment of reading at 3 or *'neutral'*. She reported his frequency of reading at school as *'often',* that he chose to read books for free

time *'rarely'* and that he borrowed books from the library *'sometimes'*. Fred's teacher reported that he read the following text types: fiction, non-fiction books ('*especially about animals'*), websites/apps with reading games. In terms of additional reading support, she reported he had two hours of TA support each week with 'some reading also some work of spelling and writing'. Fred's teacher reported him to be at the 'Turquoise' level of the colour wheel (7-7.5 years age range). She described her classroom reading instruction as follows: 'Beginning week 7 - reading with reading group - guided with direct instruction three to four 15-20 min sessions per week. Running Daily 5[9] program, children listen to reading (EPIC![10]), buddy read, read to themselves'. The researcher clarified with the teacher that by 'direct instruction' she was referring to explicit teaching rather than the structured behavioural DI approach. In the post-intervention teacher questionnaire Fred's teacher indicated a two-point increase in his reading enjoyment (*'really enjoys reading'*). She reported his frequency of reading at school was maintained at *'often'*, and that he chose to read books for free time *'sometimes'* and that he borrowed books from the library *'often'*. Fred's range of text types was increased to include websites/apps with factual information. For level of satisfaction with the support Fred received during the intervention, Fred's teacher also indicated *'very satisfied'.* She reported Fred to be at the 'Silver' level of the colour wheel (8.5-9 years age range) at the time of completing the post-questionnaire, three levels above his pre-intervention level.

Sally. In the pre-intervention questionnaire, Sally indicated she read *'sometimes'*. Her reading self-efficacy responses were mixed: to the statements 'I am getting better at reading in general', 'I understand what I read better than I could before' and 'I enjoy how I feel when I read', she responded with *'yes a bit'*, *'I don't agree or disagree'* and *'I'm not sure'*, respectively. In the post-intervention child questionnaire Sally responded with *'rarely'* to the reading frequency item, *'I'm not sure'* and *'not much'* to the reading self-efficacy items and *'not at all'* to the reading enjoyment item, which appears to indicate a decrease in reading self-efficacy and enjoyment. She responded with *'yes a lot'* to the following items: about enjoyment of the RE program and RE helped with understanding what was happening in books. She indicated *'yes a lot'* to the researcher's lessons helped with understanding what was happening in books and that she would like to continue using the RE program at home if she had some help.

[9] A reading framework aimed at increasing independence with reading: https://www.thedailycafe.com/content/what-daily-5
[10] A digital reading platform for children: https://www.getepic.com/

In the pre-intervention parent questionnaire, Sally's mum indicated *'neutral'* for her child's experience of reading at home. To the items 'How much does your child read at home?' and 'My child chooses books to read at home' she responded with *'sometimes'*. She indicated that Sally read the following at home: fiction books, non-fiction books, magazines, websites/apps with factual information and websites/apps with reading games. For the following statements, 'My child and I spend time reading together', 'My child enjoys when we read together' and 'I enjoy when my child and I read together', Sally's mum indicated *'neutral'*, *'agree'* and *'strongly agree'*, respectively. In the post-intervention parent questionnaire, she rated Sally's experience of reading at home, as *'neutral'* and for the item asking how frequently Sally reads at home she indicated *'sometimes'*, which were maintained from the pre-intervention questionnaire. For choosing to read books at home she indicated *'occasionally'* (a one-point decrease). For types of texts, Sally's mum selected fiction books and websites/apps with reading games - two fewer different text types compared with questionnaire one. She rated the items parent and child read together as '*neutral'* and the child's enjoyment of reading together with *'agree'* (maintained from the pre-intervention questionnaire). Her rating of parent enjoyment of reading together showed a one-point decrease to *'agree'*. Her rating of satisfaction with the support Sally received during the reading comprehension intervention was *'very satisfied'*.

In the pre-intervention teacher questionnaire, Sally's teacher rated her enjoyment of reading at 3 or *'neutral'*. She indicated that Sally read books *'often'*, and chose to read books during free time *'sometimes'*. It was noted that the school library was closed, but that Sally chose books from the classroom *'occasionally'*. The text types were recorded by her teacher as fiction and non-fiction. At the start of the study, Sally was receiving 2.5 hours of TA support per week. General classroom literacy instruction involved explicit instruction, Daily 5 and guided reading. She was reading at the 'Gold' level of the colour wheel (8-8.5 years age range). In the post-intervention teacher questionnaire Sally's teacher's response to reading enjoyment and frequency items remained the same as the corresponding items in the pre-questionnaire. She was reported choose books to read during free time *'rarely'*, a one-point decrease from the pre-questionnaire. For the borrowing books items, Sally's teacher indicated *'sometimes'*, and added that she *'enjoys picture books more'*. In addition to fiction and non-fiction texts,

Sally was reportedly also reading using websites/apps with reading games. Sally's teacher indicated 4 *'satisfied'* for the support Sally received during the reading comprehension intervention. She reported Sally to be at the 'Silver' level of the colour wheel (8.5-9 years age range) at the time of completing the post-questionnaire, one level above her pre-intervention level.

Results Summary

Although scores were highly variable for all four participants, visual inspection of RCP data showed that three out of four participants made a small increase in RCP scores once treatment commenced (Lucy, Fred, Sally). One participant showed a small decrease once treatment commenced (Derek). A different group of three participants made an increase in participant raw scores and percentile ranks on the NARA-3 (Derek, Fred, Sally). One out of four participants received a lower score on the NARA-3 (Lucy). Participant questionnaires indicated mostly positive results from three out of four participants in relation to reading habits (Derek, Fred, Sally), and two out of four in relation to reading self-efficacy (Derek and Fred). One participant responded with uncertainty on reading habits and self-efficacy items (Lucy). Two out of four participants reported an increase in reading frequency (Lucy and Fred). Two out of four reported a lower rating in understanding what they read (Derek and Sally). All four participants reported they enjoyed using RE, while three felt RE and lessons with the researcher helped them to understand what they read (Derek, Fred and Sally). Three participants (Lucy, Derek and Sally) indicated they would like to continue using RE and two indicated 'Yes if I have help' (Derek and Sally). Overall, these results provide supporting evidence for the efficacy of the intervention for improving the reading comprehension skills of some children with autism. Parent and teacher questionnaire responses showed a high level of satisfaction, providing an additional indication of the acceptability of the intervention program. Table 8 provides an overall summary of participant results described above.

Table 8

Summary of Participant Overall Results

Participant	Lucy	Derek	Fred	Sally
Tool	**Outcomes**			
RCPs	Gain	No gain	Gain	Gain
PEM Result	Moderately effective	Ineffective	Moderately effective	Moderately effective
NARA-3 Reading Comprehension	No gain	Gain	Gain	Gain
Strategy Use	Gain	Gain	Gain	Gain
Questionnaire Responses:				
Child	Ambivalent	Positive	Positive	Mixed
Parent	Positive	Positive	Positive	Positive
Teacher	Positive	Positive	Positive	Positive

Note. Gain = reported when improvement of one point (e.g., question correct, percentile rank or level of support needed). Questionnaire results based on post-intervention questionnaires: negative (majority of items rated 'disagree'/'occasionally'/'unsatisfied' or below); ambivalent (majority of items rated 'unsure'/'maybe'); positive (majority of items rated 'sometimes'/'agree'/'satisfied' or above); or mixed (even spread of positive and negative/ambivalent ratings).

Discussion

The purpose of this study was to explore the effects of a supplementary CAI program and explicit instruction on the reading comprehension performance of four children with autism between 8-11 years. A search of the literature did not reveal any studies that investigated the efficacy of the RE program with this population. The aims of the study were to determine: a) the impact of RE and strategy teaching on participants' reading comprehension skills; b) whether there was a difference in participant response to intervention between phase A and phase B; c) whether instruction of reading strategies resulted in a change in participants' use of strategies; and d) whether participation in intervention resulted in a reported increase in enjoyment of reading. It was hypothesised that participation in this intervention would result in improvement in reading comprehension skills, that there would be greater improvement during phase A than phase B, that explicit instruction would result in a change in strategy use during reading, and that

participants would report a change in attitude towards reading following participation in the intervention program. This chapter contrasts the findings with previous literature, before going on to consider practice implications, study limitations and directions for future research.

Impact on Reading Comprehension Skills

The first research question was measured using reading comprehension raw scores and percentile ranks on a standardised test (NARA-3) and RCP scores. In this study, three out of four participants made gains on the NARA-3 on both of these measures, which is consistent with previous studies exploring the efficacy of CAI with children with autism (Armstrong & Hughes, 2012; Bailey et al., 2017; El Zein, Gevarter, et al., 2016; Knight et al., 2015). Derek remained in the same severity range for reading comprehension ('very low') but progressed from the 1st to the 10th percentile rank from pre- to post-assessment. Fred and Sally moved from 'below average' to the 'average' range on percentile rank. An increase in percentile rank is a good indication of positive change following intervention beyond that expected from maturation, especially considering this was relative to same age peers that made up the NARA-3 standardisation sample. This is particularly notable as this was a relatively low intensity intervention due to the nine week Covid19 interruption, and three participants still made gains on a standardised test even under less-than-ideal circumstances. However, when taking confidence bands into consideration, only two participants demonstrated sizeable improvement based on this measure (Derek and Fred). Conversely, one participant (Lucy) appeared to perform more poorly on her post-intervention NARA-3 assessment; she made an improvement on raw scores but this corresponded to a lower percentile rank. This was despite apparent functional improvements on other measures (RCPs, parent and teacher questionnaires). Instances of a lack of response to intervention have been observed in previous SCD research in this area (Armstrong & Hughes, 2012; Knight et al., 2015), and have been tentatively attributed to lower relative working memory. Working memory measures were not included in the assessment protocol for this study, hence it is not possible to determine whether this is a contributing factor. However there are a number of potential explanations for Lucy's poorer NARA-3 performance. One important consideration is the format of the NARA-3 assessment tool. There was a change in behavioural expectations from the intervention to the assessment, as during intervention Lucy was able to read text silently during GO instruction and while using RE, and was receiving a more balanced

combination of praise and corrective feedback from the researcher. This is in contrast to the expectations of the test which was dominated by 'live' corrective feedback as well as the requirement of reading the texts aloud. The change (in expectations and feedback) may have posed a challenge for Lucy as it falls within EF and restricted, repetitive behaviours – both known areas of difficulty in autism. In addition, other variables such as motivation, mood and interest in the content may have played a role (Baker & Wigfield, 1999; Wigfield & Guthrie, 1997). There is some emerging research showing that children with autism have difficulty integrating visual and verbal information at the same time (multisensory integration) compared to neurotypical peers (Brandwein et al., 2013; Stevenson et al., 2014), which has potential implications for cognitive and social development. It may also be that a higher 'dosage' of intervention (e.g., approximately 16 total hours as per Knight et al., 2015) would have resulted in greater gains for this participant.

These findings highlight that for some individuals, standardised measures alone may not be sufficient for measuring change in the complex skill of reading comprehension over a relatively short period of intervention, and dynamic assessment may be more appropriate (Dockrell & Marshall, 2015). The debate around the appropriateness of tools like the NARA-3 for measuring a complex skill like reading comprehension is not new. The NARA as a tool for assessing reading comprehension has drawn criticism, for example Spooner and colleagues (2004) raised a concern that reading comprehension scores rely too much on word reading ability. To account for this in my study, RCPs using books at each participant's reading level were developed to attempt to capture changes in reading comprehension over the course of this intervention.

Impact on RCP Scores

Three out of four participants made gains of varying degrees on RCPs once treatment commenced (Lucy, Fred, and Sally). On PEM measures, Lucy, Fred and Sally all showed results within the 'moderately effective' range, while Derek's results indicated that the program was 'ineffective'. This is in line with previous studies involving a similar age group that showed gains on researcher-developed RCPs (El Zein, Gevarter, et al., 2016). All three participants in the El Zein, Gevarter et al. (2016) study made gains on their RCP measures. However it is noted that some key differences exist between this study and

others, including larger design features such as intervention dosage and participant age range, as well as more specific details such as the number of questions and format of RCPs. El Zein, Gevarter et al. (2016) for example used only four reading comprehension questions with three multiple choice response options for each probe. Fewer response options may have made the RCPs 'easier' in that it increases the chance of correct guesses.

Interestingly the participants who made gains on RCPs were a different three participants to those who made gains on the NARA-3. This may reflect the reliability shortcomings of the RCP tool, as it was also difficult to establish a stable baseline with this measure.

Differences between Phase A and Phase B

The second research question was measured by comparing RCP scores between each treatment phase. There was an increase in RCP scores once treatment commenced for three out of four participants, and a contratherapeutic trend for the remaining participant. On visual inspection of data across all phases performance on RCP varied considerably within each participant, suggesting that this measure may be too sensitive to fluctuations in reading performance. This is supported by the high variability during the baseline phase. It was also noted that participants' motivation appeared to impact their RCP performance; on some days they moved through answering questions less carefully than others. Future studies of this type may need to adopt a more dynamic and holistic model of assessment (Dockrell & Marshall, 2015) that incorporates other person-related factors such as motivation and interests, and accounts for normal performance fluctuations.

Three participants made small but positive changes from baseline to intervention on RCPs. The difference in mean scores between phases A and B were minimal (0-0.75) for all participants, suggesting that the addition of instruction at the beginning of phase A sessions did not make a considerable change to participant response to intervention. It is possible that for those participants that made treatment gains on the RCPs, the features of RE (such as the inbuilt tutorials that employ metacognitive strategies such as 'thinking aloud') compensated for the lack of explicit instruction in phase B. Development of metacognitive strategies may be particularly important for children with autism, as preliminary evidence

suggests that metacognitive monitoring processes (the ability to accurately represent your own mental states) are an area of weakness (Grainger et al., 2016).

Although the treatment conditions of this study were different, the results contrast with El Zein, Gevarter et al.'s (2016) study that compared a teacher-directed condition with an iPad-assisted reading condition. El Zein, Gevarter et al. (2016) found that participants made reading comprehension gains in both treatment conditions but responded better to teacher-directed instruction. In the current study, the similar response to both treatment conditions suggests that CAI in the context of reading may be a suitable supplement for some individuals with autism to learn and practice such strategies. It is difficult to determine whether phase A or B was more effective due to the large variability in RCPs. However the strategy use improvement demonstrates children can learn through EI even though this is not reflected in RCP scores.

Impact on Reading Strategy Use

The third research question was measured by change in each participant's use of a GO. The use of explicit instruction in how to use GOs was the key difference between phase A and B intervention sessions. This explicit instruction approach resulted in positive change across the phase A sessions for all participants; two participants were using GOs independently by the last session, and two were using them with guidance. These findings support the existing literature which indicate GOs can be an effective resource for teaching children with autism to find important information in a text (Bethune & Wood, 2013). Bethune and Wood's (2013) procedure required participants to sort words into corresponding categories on the GO for literal information in texts. Instead in the current study, participants were required to identify salient information in the text and then tell the researcher who wrote it down. It is possible that for children with autism, a GO takes advantage of the 'bias for detail' and visual processing as areas of strength. This may apply well to reading in terms of locating information in text. Some learners will evidently need for guidance for exploring text meaning and generalising GOs to new texts, especially when combining information from details to form a 'main idea' as this ability relies on central coherence.

Impact on Reported Reading Enjoyment

Two out of four participants gave overall positive responses between the pre- and post-intervention questionnaires, while one gave ambivalent responses (Lucy) and another mixed (Sally). The positive responses to the self-efficacy item around improvement in reading 'in general' for the two male participants (Derek and Fred) can tentatively be seen as an indication of generalisation of skills to other texts. Interestingly, parents and teachers reported overall positive outcomes for participants following the intervention. Some patterns that also emerged were decrease in reading self-efficacy for two participants (Derek and Sally). The level of agreement on questionnaires for each participant, parent and teacher group will be explored below.

Lucy

Lucy's self-reported enjoyment and reading self-efficacy did not align with her parent and teacher's ratings; her ratings were ambivalent for reading frequency, enjoyment and self-efficacy. This discrepancy between ratings could be in part due to 'social desirability bias' (Moon et al., 2016) and 'confirmation bias' on the part of the parent and teacher. Social desirability bias is a phenomenon in the social sciences that describes a tendency for survey respondents to answer in a way that they believe will be well received by others (Paulhus, 1991). Confirmation bias refers to the interpretation of information in a way that fits within our existing beliefs (Nickerson, 1998). The expectation of the child making gains from participating in an intervention study may have led the parent and teacher to perceive a positive change. However informal evidence suggests that there was positive change for Lucy albeit not in her standardised reading comprehension scores: her mum made additional observations of her child's reading habits and shared these with the researcher. This included photographs of Lucy 'reading for pleasure' (consistent with post-intervention questionnaire comments) which Lucy's mum reported was behaviour Lucy hadn't shown prior to her involvement in the study.

Derek

Derek's self-reported increase in general improvement in reading, and slight decrease in understanding what he read 'better than before' could be due to increased awareness of his reading ability. Although not a negative response, it is possible that following the intervention Derek was taking

more notice of his improvement and becoming more aware of what he was not understanding. Derek responded enthusiastically in the post-intervention questionnaire, choosing the highest rating for all items but one reading self-efficacy item. This corresponded relatively well to parent and teacher post-intervention questionnaire responses which were also overall positive. There was a one point decrease in rating of all reading enjoyment items from Derek's mother.

Fred

Fred's overall responses in the post-intervention questionnaire indicate improvement in his reading self-efficacy, which may have in turn influenced the self-reported increase in reading frequency due to an increase in motivation. Fred rated all items at the highest level, with the exception of the final item about continuing to use RE at home, to which he responded 'maybe'. This was consistent with parent and teacher ratings, which reflected a change in Fred's reading enjoyment and possibly in turn his reading habits (e.g., reading at home and borrowing books from the library often). Fred's teacher's comment that he was demonstrating a 'really positive attitude' towards reading and that he considered it as one of his hobbies after the intervention also supports this.

Sally

Sally appeared to indicate a decrease in confidence and enjoyment of reading based on the post-intervention questionnaire items about reading enjoyment and self-efficacy. However she indicated a high to very high level of enjoyment of the RE program and usefulness of the researcher's reading lessons. This negative response to the self-efficacy items may be an indication of Sally's perception of her skills as a reader. Based on the known relationship between reading skills and motivation (Morgan & Fuchs, 2007), Sally may respond well to continued CAI literacy support to build her confidence and motivation. It is interesting to note that both Sally and Fred had diagnoses of autism and ADHD but Fred responded better to the intervention. This could be in part due to Fred's stronger language skills, his relative strength in reading comprehension compared with reading accuracy observed at the beginning of the intervention. The medical management of his ADHD symptoms may have also contributed to his better response to the treatment. Literacy intervention with a focus on improving EF skills (such as working memory, self-monitoring and self-talk) has been proposed as a remediation option that should be further explored for

children with ADHD (Gray & Climie, 2016). Additionally, reading comprehension interventions in children with autism targeting metacognitive skills have also been shown to help develop awareness of the need to self-monitor (Turner et al., 2017). An intervention utilising CAI such as that used in the current study may therefore be a suitable avenue for some children with autism and ADHD as it would address EF difficulties, a feature present in both conditions.

Children with Autism and Engagement with RE

From observations made throughout the intervention as well as responses on the post-intervention questionnaire, all participants appeared to engage well with RE. The components that facilitated this engagement were the reward systems (e.g., collecting 'eggy points' or digital trading cards after completing activities within each RE lesson), the built-in animations and sound effects. These factors could contribute to greater engagement in reading for children with autism and reading comprehension difficulties. The questionnaire results provide insight into the perspective of the participants themselves, and suggest that reading comprehension results may have been influenced by reading self-efficacy and intrinsic motivation. Studies have shown that these factors can be increased through targeted intervention (Wigfield et al., 2004). CAI such as RE may be the key for children with autism like Sally who demonstrate lower reading self-efficacy, especially as they may need more extrinsic motivation while they build their confidence which is built into RE through the reward systems and knowledge of performance throughout activities.

Some challenges were observed with RE during this study. With the participant controlling the speed of moving through RE activities, some teaching opportunities were missed. For example, if a participant selected the wrong answer to a quiz question but didn't return to that question or the related text as they achieved 80% correct and were then automatically moved on by the program. Some additional behavioural modifications to the implementation of this program such as visuals (S.Y. Kim et al., 2018) may help to account for this.

Implications for Practice

Taken together, these results suggest that a reading comprehension intervention involving individual strategy teaching and RE may be an effective supplement to classroom instruction for primary

school age children aged between 8 and 11 years with autism and reading comprehension difficulties. On standardised tests, two of the four participants made significant gains in reading comprehension. For this group, CAI plus explicit instruction did not appear to result in reading comprehension gains compared to the CAI alone condition. It is important to note that these findings were based on the condition of CAI with prompting and encouragement from the researcher and not independent use of CAI. It is unclear if participants would benefit to the same degree if completing the program completely independently (without support). Findings from the participant questionnaires in particular provide evidence of the likely acceptability of the program, and its potential for motivating readers of the middle primary school age range. The results also corroborate previous research highlighting the challenges of assessing reading comprehension. It has been acknowledged in the literature that finding an accurate measurement of a complex skill like reading comprehension poses a significant challenge to researchers and educators (Clarke et al., 2010). As such, it is critically important that the team of people around the child with autism monitor their reading progress and develop individualised literacy goals, including strategies to increase reading self-efficacy. Efforts must continue to be made to bridge the research-to-practice gap to ensure reading instruction includes EBPs such as GOs which have proven efficacy for supporting children with autism.

Based on the positive responses from the participants in this study, there is promise in utilising CAI in targeted literacy interventions for educators, clinicians and parents alike. Speech language therapy support for children with communication disorders is essential, even in such times when other services are being put on hold like during a global pandemic (Tohidast et al., 2020). Delivery of intervention using CAI may be especially relevant when flexible remote learning options are required (e.g., schooling from home during a period of lockdown). CAI offers a partial solution for those families who require alternatives to in-person treatment.

Limitations

One challenge with the design of this study is that it is difficult to determine which component/s of the intervention was most effective in creating change in reading comprehension as it was delivered as a package. This has also been noted as a limitation in previous research (S. Y. Kim et al., 2018). The randomisation of order of treatment conditions was used to account for this. Additionally, the study was

completed alongside classroom literacy instruction, so in the absence of a control group the changes observed cannot be attributable to the intervention with certainty. However the NARA-3 normative group (to which the participants' scores were compared) were also receiving classroom reading instruction which mitigates this to some degree. The interruption of the Covid19 pandemic and subsequent lockdown was a confounding variable over which the researcher had no control. The impact this had on each participant's reading progress is unknown. It is acknowledged, however, that this presented a sizeable break in the continuity of the intervention and may have had an impact on the efficacy of the intervention. In addition to this, Fred's improvements may be attributable in part to the change in medication which occurred during the break period. Future studies could report on context, compliance, and competence fidelity (as per Bailey et al. 2017). Explaining the details of GO explicit instruction would aid in future replications. Due to the language demands of this intervention, these results may not be generalisable to other children with autism, especially those with lower language skills. Additionally, more specific questionnaire items may have captured more detail about participant's opinions of the GOs. Lucy's teacher commented in the post-intervention questionnaire that he was 'unsure' of level of satisfaction with the intervention, which highlighted that there may be value in greater active involvement of teachers (and parents) in future intervention studies. The design of this study could be improved by including a maintenance phase to determine whether the skills were carried forward after intervention had stopped. The RCP as a tool could be further refined. Although IOA reliability for the RCPs increases their strength as an assessment tool, RCP results must be interpreted with caution as the psychometric properties were not extensively investigated and reported due to time constraints. It is also possible that although RCPs captured some change, they may be more effective when used over a longer period of time. However children may tire of the 'testing' nature of repeated probes and as such results may not be indicative of their actual ability (as was witnessed in Derek's low final RCP score).

Future research

One area that was not explored in this study that warrants further investigation is differences in reading comprehension between female and male children with autism. Research suggests that in neurotypical children there is a trend of girls reporting higher reading motivation than boys (Wigfield et al., 2016); almost the opposite of the pattern found in the current study. Due to the heterogeneity of

autism and the resulting unique individual learning profiles of children with autism, SCD research is an approach that continues to provide valuable information about how children respond to interventions such as the focus of this study. There is a clear need, however, for researchers to use a consistent framework within which to explore the efficacy of interventions, so that meaningful conclusions can be drawn when aggregating the data in systematic reviews, for instance. This is starting to be more frequently cited in the literature (Bailey & Arciuli, 2020; Kim et al., 2017). There is considerable potential in technology as an avenue for literacy instruction to supplement classroom teaching for children with reading difficulties, and children more generally. Future research could continue to explore CAI and reading instruction EBPs with larger participant numbers. Pilot group studies and a future randomised controlled trial (RCT) would help to explore this area further (although Rosenbek (2016) claims that robustly designed single subject studies may be of more clinical value of than RCTs due to detailed reporting of participant characteristics, for instance). Further independent research into the efficacy of reading programs is important for ensuring educators, clinicians and parents have access to high quality information with which to base decisions about reading resources for all children, but particularly those who require additional support.

Conclusion

To my knowledge, this was the first study which evaluated the efficacy of RE in school age children with autism and reading comprehension difficulties. Some key findings emerged from this study. Firstly, three out of four participants made small gains on reading comprehension scores on RCPs. Three out of four participants also made gains on standardised measures of reading comprehension, with two of these results likely representing a genuine change in ability relative to age matched peers. Secondly, there was no apparent improvement on RCP scores during phase A (RE plus explicit instruction condition) compared to phase B (RE only). This suggests that explicit instruction built into CAI such as RE (with moderate adult support) may be sufficient in improving reading comprehension difficulties for children with autism without explicit instruction of use of a GO. Thirdly, participants all made improvements in use of a GO with books. This is in line with previous studies, and provides additional support for use of these resources in programs for children with autism and reading difficulties. Lastly, questionnaire responses from participants, parents and teachers were overall positive. This suggests that a reading comprehension program involving a CAI such as RE would likely be considered highly acceptable and

thus continue to be used as a supplementary literacy support. This study provides further support for the need for dynamic and ongoing assessment of reading comprehension as a skill (Woolley, 2008), as well as careful consideration of motivational factors and ways to actively engage the reader.

References

Accardo, A. L., & Finnegan, E. G. (2019). Teaching reading comprehension to learners with autism spectrum disorder: Discrepancies between teacher and research-recommended practices. *Autism, 23*(1), 236-246. https://doi.org/10.1177/1362361317730744

Adlof, S. M., & Hogan, T. P. (2019). If we don't look, we won't see: Measuring language development to inform literacy instruction. *Policy Insights from the Behavioral and Brain Sciences, 6*(2), 210-217. https://doi.org/10.1177/2372732219839075

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Anagnostou, E., Jones, N., Huerta, M., Halladay, A. K., Wang, P., Scahill, L., Horrigan, J. P., Kasari, C., Lord, C., Choi, D., Sullivan, K., & Dawson, G. (2015). Measuring social communication behaviors as a treatment endpoint in individuals with autism spectrum disorder. *Autism, 19*(5), 622-636. https://doi.org/10.1177/1362361314542955

Arciuli, J., & Bailey, B. (2019). Efficacy of ABRACADABRA literacy instruction in a school setting for children with autism spectrum disorders. *Research in Developmental Disabilities, 85*, 104-115. https://doi.org/10.1016/j.ridd.2018.11.003

Arciuli, J., Stevens, K., Trembath, D., & Simpson, I. C. (2013). The relationship between parent report of adaptive behavior and direct assessment of reading ability in children with autism spectrum disorder. *Journal of Speech, Language, and Hearing Research, 56*(6), 1837-1844. https://doi.org/10.1044/1092-4388(2013/12-0034)

Armstrong, T. K., & Hughes, M. T. (2012). Exploring computer and storybook interventions for children with high functioning autism. *International Journal of Special Education, 27*(3), 88-99. Retrieved from: https://eric.ed.gov/?id=EJ1001062

Ashburner, J., Ziviani, J., & Rodger, S. (2010). Surviving in the mainstream: Capacity of children with autism spectrum disorders to perform academically and regulate their emotions and behavior at

school. *Research in Autism Spectrum Disorders, 4*(1), 18-27. https://doi.org/10.1016/j.rasd.2009.07.002

Asperger, H. (1944). Die „Autistischen psychopathen" im kindesalter. *Archiv für Psychiatrie und Nervenkrankheiten, 117*(1), 76-136. Retrieved from: https://link.springer.com/article/10.1007/BF01837709

Bailey, B., & Arciuli, J. (2020). Reading instruction for children with autism spectrum disorders: A systematic review and quality analysis. *Review Journal of Autism and Developmental Disorders, 7*, 127–150. https://doi.org/10.1007/s40489-019-00185-8

Bailey, B., Arciuli, J., & Stancliffe, R. J. (2017). Effects of ABRACADABRA literacy instruction on children with autism spectrum disorder. *Journal of Educational Psychology, 109*(2), 257-268. https://doi.org/10.1037/edu0000138

Baker, L., & Wigfield, A. (1999). Dimensions of children's motivation for reading and their relations to reading activity and reading achievement. *Reading Research Quarterly, 34*(4), 452-477. https://doi.org/10.1598/RRQ.34.4.4

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind". *Cognition, 21*(1), 37-46. https://doi.org/10.1016/0010-0277(85)90022-8

Baron-Cohen, S. (1989). The autistic child's theory of mind: A case of specific developmental delay. *Journal of Child Psychology and Psychiatry, 30*(2), 285-297. https://doi.org/10.1111/j.1469-7610.1989.tb00241.x

Bethune, K. S., & Wood, C. L. (2013). Effects of wh-question graphic organizers on reading comprehension skills of students with autism spectrum disorders. *Education and Training in Autism and Developmental Disabilities, 48*(2), 236-244. Retrieved from: https://www.jstor.org/stable/23880642

Bishop, D. V., & Snowling, M. J. (2004). Developmental dyslexia and specific language impairment: Same or different? *Psychological Bulletin, 130*(6), 858-886. https://doi.org/10.1037/0033-2909.130.6.858

Blampied, N. M. (2001). The third way: Single-case research, training, and practice in clinical psychology. *Australian Psychologist, 36*(2), 157-163. https://doi.org/10.1080/00050060108259648

Blank, M., Rose, S. A., & Berlin, L. J. (1978). *The language of learning: The preschool years.* Grune & Stratton.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain.* David McKay Company.

Bloom, L., & Lahey, M. (1978). *Language development and language disorders*. Wiley.

Bowden, N., Thabrew, H., Kokaua, J., Audas, R., Milne, B., Smiler, K., Stace, H., Taylor, B., & Gibb, S. (2020). Autism spectrum disorder/takiwātanga: An integrated data infrastructure-based approach to autism spectrum disorder research in New Zealand. *Autism*, 1362361320939329. https://doi.org/10.1177/1362361320939329

Brandwein, A. B., Foxe, J. J., Butler, J. S., Russo, N. N., Altschuler, T. S., Gomes, H., & Molholm, S. (2013). The development of multisensory integration in high-functioning autism: High-density electrical mapping and psychophysical measures reveal impairments in the processing of audiovisual inputs. *Cerebral Cortex, 23*(6), 1329-1341. https://doi.org/10.1093/cercor/bhs109

Brown, H. M., Oram-Cardy, J., & Johnson, A. (2013). A meta-analysis of the reading comprehension skills of individuals on the autism spectrum. *Journal of Autism and Developmental Disorders, 43*, 932–955. https://doi.org/10.1007/s10803-012-1638-1

Cain, K., & Oakhill, J. (2006). Assessment matters: Issues in the measurement of reading comprehension. *British Journal of Educational Psychology, 76*(4), 697-708. https://doi.org/10.1348/000709905X69807

Carnahan, C. R., & Williamson, P. S. (2013). Does compare-contrast text structure help students with autism spectrum disorder comprehend science text? *Exceptional Children, 79*(3), 347-363. https://doi.org/10.1177/001440291307900302

Carnahan, C. R., Williamson, P. S., & Christman, J. (2011). Linking cognition and literacy in students with autism spectrum disorder. *Teaching Exceptional Children, 43*(6), 54-62. https://doi.org/10.1177/004005991104300606

Chall, J. S., Jacobs, V. A., & Baldwin, L. E. (1990). *The reading crisis: Why poor children fall behind*. Harvard University Press.

Chiang, H.-M., & Lin, Y.-H. (2007). Reading comprehension instruction for students with autism spectrum disorders: A review of the literature. *Focus on Autism and Other Developmental Disabilities, 22*(4), 259-267. https://doi.org/10.1177/10883576070220040801

Clarke, P. J., Snowling, M. J., Truelove, E., & Hulme, C. (2010). Ameliorating children's reading-comprehension difficulties: A randomized controlled trial. *Psychological Science, 21*(8), 1106-1116. https://doi.org/10.1177/0956797610375449

Coleman-Martin, M. B., Heller, K. W., & Cihak, D. F. (2005). Using computer-assisted instruction and the nonverbal reading approach to teach word identification. *Focus on Autism & Other Developmental Disabilities, 20*(2), 80-90. https://doi.org/10.1177/10883576050200020401

Denman, D., Speyer, R., Munro, N., Pearce, W. M., Chen, Y.-W., & Cordier, R. (2017). Psychometric properties of language assessments for children aged 4–12 years: A systematic review. *Frontiers in Psychology, 8*(1515). https://doi.org/10.3389/fpsyg.2017.01515

Dockrell, J. E., & Marshall, C. R. (2015). Measurement issues: Assessing language skills in young children. *Child and Adolescent Mental Health, 20*(2), 116-125. https://doi.org/10.1111/camh.12072

Duke, N. K., & Pearson, P. D. (2002). Effective practices for developing reading comprehension. In A. E. Farstrup & S. J. Samuels (Eds.), *What research has to say about reading instruction* (3rd ed.). International Reading Association.

Education Act, (1989). http://www.legislation.govt.nz/act/public/1989/0080/latest/whole.html

El Zein, F., Gevarter, C., Bryant, B., Son, S.-H., Bryant, D., Kim, M., & Solis, M. (2016). A comparison between iPad-assisted and teacher-directed reading instruction for students with autism spectrum disorder (ASD). *Journal of Developmental and Physical Disabilities, 28*(2), 195-215. https://doi.org/10.1007/s10882-015-9458-9

El Zein, F., Solis, M., Lang, R., & Kim, M. K. (2016). Embedding perseverative interest of a child with autism in text may result in improved reading comprehension: A pilot study. *Developmental Neurorehabilitation, 19*(3), 141-145. Retrieved from: https://www.tandfonline.com/doi/pdf/10.3109/17518423.2014.915893?needAccess=true

El Zein, F., Solis, M., Vaughn, S., & McCulley, L. (2014). Reading comprehension interventions for students with autism spectrum disorders: A synthesis of research. *Journal of Autism and Developmental Disorders, 44*(6), 1303-1322. https://doi.org/10.1007/s10803-013-1989-2

Elsabbagh, M., Divan, G., Koh, Y.-J., Kim, Y. S., Kauchali, S., Marcín, C., Montiel-Nava, C., Patel, V., Paula, C. S., Wang, C., Yasamy, M. T., & Fombonne, E. (2012). Global prevalence of autism and other pervasive developmental disorders. *Autism Research, 5*(3), 160-179. https://doi.org/10.1002/aur.239

Estes, A., Rivera, V., Bryan, M., Cali, P., & Dawson, G. (2011). Discrepancies between academic achievement and intellectual ability in higher-functioning school-aged children with autism

spectrum disorder. *Journal of Autism and Developmental Disorders, 41*(8), 1044-1052. https://doi.org/10.1007/s10803-010-1127-3

Finnegan, E., & Mazin, A. L. (2016). Strategies for increasing reading comprehension skills in students with autism spectrum disorder: A review of the literature. *Education & Treatment of Children, 39*(2), 187-220. https://doi.org/10.1353/etc.2016.0007

Flores, M. M., & Ganz, J. B. (2007). Effectiveness of direct instruction for teaching statement inference, use of facts, and analogies to students with developmental disabilities and reading delays. *Focus on Autism and Other Developmental Disabilities, 22*, 244-251. https://doi.org/10.1177/10883576070220040601

Flores, M. M., & Ganz, J. B. (2009). Effects of direct instruction on the reading comprehension of students with autism and developmental disabilities. *Education and Training in Developmental Disabilities, 44*(1), 39-53. Retrieved from http://www.jstor.org/stable/24233462

Flores, M. M., Nelson, C., Hinton, V., Franklin, T. M., Strozier, S. D., Terry, L., & Franklin, S. (2013). Teaching reading comprehension and language skills to students with autism spectrum disorders and developmental disabilities using direct instruction. *Education and Training in Autism and Developmental Disabilities, 48*(1), 41-48. Retrieved from: http://ezproxy.canterbury.ac.nz/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2013-07402-004&site=ehost-live

Floyd, R. G., Shands, E. I., Alfonso, V. C., Phillips, J. F., Autry, B. K., Mosteller, J. A., Skinner, M., & Irby, S. (2015). A systematic review and psychometric evaluation of adaptive behavior scales and recommendations for practice. *Journal of Applied School Psychology, 31*(1), 83-113. https://doi.org/10.1080/15377903.2014.979384

Gillon, G., Hyter, Y., Fernandes, F. D., Ferman, S., Hus, Y., Petinou, K., Segal, O., Tumanova, T., Vogindroukas, I., & Westby, C. (2017). International survey of speech-language pathologists' practices in working with children with autism spectrum disorder. *Folia Phoniatrica et Logopaedica, 69*(1-2), 8-19. https://doi.org/10.1159/000479063

Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading and reading disability. *Remedial and Special Education, 7*, 6-10. https://doi.org/10.1177/074193258600700104

Grainger, C., Williams, D. M., & Lind, S. E. (2016). Metacognitive monitoring and control processes in children with autism spectrum disorder: Diminished judgement of confidence accuracy. *Consciousness and Cognition, 42*, 65-74. https://doi.org/10.1016/j.concog.2016.03.003

Gray, C., & Climie, E. A. (2016). Children with attention deficit/hyperactivity disorder and reading disability: A review of the efficacy of medication treatments. *Frontiers in Psychology, 7*, 1-6. https://doi.org/10.3389/fpsyg.2016.00988

Guthrie, J., Hoa, A., Wigfield, A., Tonks, S., Humenick, N., & Littles, E. (2007). Reading motivation and reading comprehension growth in the later elementary years. *Contemporary Educational Psychology, 32*, 282-313. https://doi.org/10.1016/j.cedpsych.2006.05.004

Happé, F., & Frith, U. (2006). The weak coherence account: detail-focused cognitive style in autism spectrum disorders. *Journal of Autism and Developmental Disorders, 36*(1), 5-25. https://doi.org/10.1007/s10803-005-0039-0

Happé, F. G. (1996). Studying weak central coherence at low levels: Children with autism do not succumb to visual illusions. A research note. *Journal of Child Psychology and Psychiatry, 37*(7), 873-877. https://doi.org/10.1007/s10803-005-0039-0.

Heimann, M., Nelson, K. E., & Tjus, T. (1995). Increasing reading and communication skills in children with autism through an interactive multimedia computer program. *Journal of Autism & Developmental Disorders, 25*, 459-480. https://doi.org/10.1007/BF02178294

Henk, W. A., Marinak, B. A., & Melnick, S. A. (2012). Measuring the reader self-perceptions of adolescents: Introducing the RSPS2. *Journal of Adolescent & Adult Literacy, 56*(4), 311-320. https://doi.org/10.1002/jaal.00144

Hidi, S., & Harackiewicz, J. M. (2000). Motivating the academically unmotivated: A critical issue for the 21st century. *Review of Educational Research, 70*(2), 151-179. https://doi.org/10.3102/00346543070002151

Hill, E. L. (2004). Executive dysfunction in autism. *Trends in Cognitive Sciences, 8*(1), 26-32. https://doi.org/10.1016/j.tics.2003.11.003

Horner, R., Carr, E., Halle, J., McGee, G., Odom, S., & Wolery, M. (2005). The use of single-subject research to identify evidence-based practice in special education. *Exceptional Children, 71*, 165-179. https://doi.org/10.1177/001440290507100203

Howlin, P., Goode, S., Hutton, J., & Rutter, M. (2004). Adult outcome for children with autism. *Journal of Child Psychology and Psychiatry, 45*(2), 212-229. https://doi.org/10.1111/j.1469-7610.2004.00215.x

Howorth, S., Lopata, C., Thomeer, M., & Rodgers, J. (2016). Effects of the TWA strategy on expository reading comprehension of students with autism. *British Journal of Special Education, 43*(1), 39-59. https://doi.org/10.1111/1467-8578.12122

Hughes, C., Russell, J., & Robbins, T. W. (1994). Evidence for executive dysfunction in autism. *Neuropsychologia, 32*(4), 477-492. https://doi.org/10.1016/0028-3932(94)90092-2

Johnson, C. J., Beitchman, J. H., & Brownlie, E. (2010). Twenty-year follow-up of children with and without speech-language impairments: Family, educational, occupational, and quality of life outcomes. *American Journal of Speech-Language Pathology*. https://doi.org/10.1044/1058-0360(2009/08-0083)

Kamps, D., Heitzman-Powell, L., Rosenberg, N., Mason, R., Schwartz, I., & Romine, R. S. (2016). Effects of reading mastery as a small group intervention for young children with ASD. *Journal of Developmental and Physical Disabilities, 28*(5), 703-722. https://doi.org/10.1007/s10882-016-9503-3

Kamps, D., Locke, P., Delquadri, J., & Hall, R. V. (1989). Increasing academic skills of students with autism using fifth grade peers as tutors. *Education and Treatment of Children*, 38-51.

Kamps, D. M., Barbetta, P. M., Leonard, B. R., & Delquadri, J. (1994). Classwide peer tutoring: an integration strategy to improve reading skills and promote peer interactions among students with autism and general education peers. *Journal of Applied Behavior Analysis, 27*(1), 49-61. https://doi.org/10.1901/jaba.1994.27-49

Kamps, D. M., Leonard, B., Potucek, J., & Garrison-Harrell, L. (1995). Cooperative learning groups in reading: An integration strategy for students with autism and general classroom peers. *Behavioral Disorders, 21*(1), 89-109. Retrieved from: http://www.jstor.org/stable/23888333

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2*(3), 217-250. Retrieved from: http://mail.neurodiversity.com/library_kanner_1943.pdf

Keen, D., Webster, A., & Ridley, G. (2016). How well are children with autism spectrum disorder doing academically at school? An overview of the literature. *Autism, 20*(3), 276-294. https://doi.org/10.1177/1362361315580962

Kim, M. K., McKenna, J. W., & Park, Y. (2017). The use of computer-assisted instruction to improve the reading comprehension of students with learning disabilities: An evaluation of the evidence base according to the what works clearinghouse standards. *Remedial and Special Education, 38*(4), 233–245. https://doi.org/10.1177/0741932517693396

Kim, S. H., Bal, V. H., & Lord, C. (2018). Longitudinal follow-up of academic achievement in children with autism from age 2 to 18. *Journal of Child Psychology and Psychiatry, 59*(3), 258-267. https://doi.org/10.1111/jcpp.12808

Kim, S. Y., Rispoli, M., Lory, C., Gregori, E., & Brodhead, M. T. (2018). The effects of a shared reading intervention on narrative story comprehension and task engagement of students with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 48*(10), 3608-3622. https://doi.org/10.1007/s10803-018-3633-7

Kjelgaard, M. M., & Tager-Flusberg, H. (2001). An investigation of language impairment in autism: Implications for genetic subgroups. *Language and Cognitive Processes, 16*(2), 287-308. https://doi.org/10.1080/01690960042000058

Knight, V. F., & Sartini, E. (2014). A comprehensive literature review of comprehension strategies in core content areas for students with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 45*(5), 1213-1229. https://doi.org/10.1007/s10803-014-2280-x

Knight, V. F., Wood, C. L., Spooner, F., Browder, D. M., & O'Brien, C. P. (2015). An exploratory study using science etexts with students with autism spectrum disorder. *Focus on Autism & Other Developmental Disabilities, 30*(2), 86-99. https://doi.org/10.1177/1088357614559214

Krashen, S. (2002). The Lexile framework: The controversy continues. *California School Library Journal, 25*(2), 29-31. Retrieved from: http://sdkrashen.com/content/articles/lexile2.pdf

Lobo, M. A., Moeyaert, M., Baraldi Cunha, A., & Babik, I. (2017). Single-case design, analysis, and quality assessment for intervention research. *Journal of Neurologic Physical Therapy, 41*(3), 187–197. https://doi.org/10.1097/NPT.0000000000000187

Lowery, L. D. (2017). *Effects of Reading Eggs on Reading Proficiency Levels.* Doctoral dissertation, University of South Carolina. Retrieved from: https://scholarcommons.sc.edu/etd/4151

Lucas, R., & Norbury, C. F. (2014). Levels of text comprehension in children with autism spectrum disorders (ASD): The influence of language phenotype. *Journal of Autism and Developmental Disorders, 44*(11), 2756-2768. https://doi.org/10.1007/s10803-014-2133-7

Ma, H. H. (2006). An alternative method for quantitative synthesis of single-subject researches: percentage of data points exceeding the median. *Behavior Modification, 30*(5), 598-617. https://doi.org/10.1177/0145445504272974

Mayes, S. D., & Calhoun, S. L. (2003). Ability profiles in children with autism: Influence of age and IQ. *Autism, 7*(1), 65-80. https://doi.org/10.1177/1362361303007001006

Mechling, L. C., Gast, D. L., & Langone, J. (2002). Computer-based video instruction to teach persons with moderate intellectual disabilities to read grocery aisle signs and locate items. *The Journal of Special Education, 35*(4), 224-240. https://doi.org/10.1177/002246690203500404

Meyer, B. J., & Ray, M. N. (2017). Structure strategy interventions: Increasing reading comprehension of expository text. *International Electronic Journal of Elementary Education, 4*(1), 127-152. Retrieved from: https://www.iejee.com/index.php/IEJEE/article/view/217

Ministries of Health and Education. (2016). *New Zealand Autism Spectrum Disorder Guideline (2nd Edition)*.

Minshew, N. J., Goldstein, G., Taylor, H. G., & Siegel, D. J. (1994). Academic achievement in high functioning autistic individuals. *Journal of Clinical and Experimental Neuropsychology, 16*(2), 261-270. https://doi.org/10.1080/01688639408402637

Moon, C., Snodgrass, M. R., Meadan, H., Akamoglu, Y., & Halle, J. W. (2016). Understanding communication intervention for young children with autism and their parents: Mixing behavioral and social validity findings. *Journal of Developmental and Physical Disabilities, 28*(1), 113-134. https://doi.org/10.1007/s10882-015-9468-7

Moore, M., & Calvert, S. (2000). Brief report: Vocabulary acquisition for children with autism: Teacher or computer instruction. *Journal of Autism and Developmental Disorders, 30*(4), 359-362. https://doi.org/10.1023/A:1005535602064

Morgan, P. L., & Fuchs, D. (2007). Is there a bidirectional relationship between children's reading skills and reading motivation? *Exceptional Children, 73*(2), 165-183. https://doi.org/10.1177/001440290707300203

Nation, K., Clarke, P., Wright, B., & Williams, C. (2006). Patterns of reading ability in children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 36*(7), 911-919. https://doi.org/10.1007/s10803-006-0130-1

National Autism Center. (2009). *National Standards Report*.

National Institute of Child Health and Human Development. (2000). *Report of the National Reading Panel: Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction.* U.S. Government Printing Office.

Neale, M. D. (1999). *The Neale Analysis of Reading Ability.* (3rd ed., Australian Standardisation). Camberwell, Victoria, Australia: ACER Press.

Neumann, N., Dubischar-Krivec, A. M., Poustka, F., Birbaumer, N., Bölte, S., & Braun, C. (2011). Electromagnetic evidence of altered visual processing in autism. *Neuropsychologia, 49*(11), 3011-3017. https://doi.org/10.1016/j.neuropsychologia.2011.06.028

Nickerson, R. S. (1998). Confirmation bias: A ubiquitous phenomenon in many guises. *Review of General Psychology, 2*(2), 175-220. Retrieved from: http://search.proquest.com.ezproxy.canterbury.ac.nz/docview/1490466939?accountid=14499

No Child Left Behind Act (2001) (US). https://www2.ed.gov/nclb/landing.jhtml

Norbury, C. F., & Bishop, D. V. (2002). Inferential processing and story recall in children with communication problems: a comparison of specific language impairment, pragmatic language impairment and high-functioning autism. *International Journal of Language and Communication Disorders, 37*(3), 227-251. https://doi.org/10.1080/13682820210136269

O'Connor, I. M., & Klein, P. D. (2004). Exploration of strategies for facilitating the reading comprehension of high-functioning students with autism spectrum disorders. *Journal of Autism and Developmental Disorders, 34*(2), 115-127. https://doi.org/10.1023/B:JADD.0000022603.44077.6b

Ozonoff, S. (1997). Components of executive function in autism and other disorders. In J. Russell (Ed.), *Autism as an executive disorder* (pp. 179-211). Oxford University Press.

Paul, R., Norbury, C., & Gosse, C. (2018). *Language disorders from infancy through adolescence: Listening, speaking, reading, writing, and communicating* (5th ed.). Elsevier/Mosby.

Paulhus, D. L. (1991). Measurement and control of response bias. In J. P. Robinson, P. R. Shaver, & L. S. Wrightsman (Eds.), *Measures of personality and social psychological attitudes* (pp. 17-59). Academic Press. https://doi.org/10.1016/B978-0-12-590241-0.50006-X

Perfetti, C., & Stafura, J. (2014). Word knowledge in a theory of reading comprehension. *Scientific Studies of Reading, 18*(1), 22-37. https://doi.org/10.1080/10888438.2013.827687

Portney, L., & Watkins, M. (Eds.). (2008). *Foundations of clinical research: Applications to practice (3rd ed.)*. Pearson Prentice Hall.

Randi, J., Newman, T., & Grigorenko, E. L. (2010). Teaching children with autism to read for meaning: Challenges and possibilities. *Journal of Autism and Developmental Disorders, 40*(7), 890-902. https://doi.org/10.1007/s10803-010-0938-6

Rosenbek, J. C. (2016). Tyranny of the randomised clinical trial. *International Journal of Speech-Language Pathology, 18*(3), 241-249. https://doi.org/10.3109/17549507.2015.1126644

Rupley, W. H., Blair, T. R., & Nichols, W. D. (2009). Effective reading instruction for struggling readers: The role of direct/explicit teaching. *Reading & Writing Quarterly, 25*(2-3), 125-138. https://doi.org/10.1080/10573560802683523

Russo, A., & Pike, K. (2014). *Reading Eggspress Comprehension Program Scientific Research Base*.

Santhanam, S. P., & Hewitt, L. E. (2020). Perspectives of Adults With Autism on Social Communication Intervention. *Communication Disorders Quarterly, 0*(0), 1525740120905501. https://doi.org/10.1177/1525740120905501

Scarborough, H. S. (2001). *Connecting early language and literacy to later reading (dis)abilities: Evidence, theory, and practice.* Guilford Press.

Şen, N., & Şen, S. (2019). Calculation of effect size in single-subject experimental studies: Examination of non-regression-based methods. *Journal of Measurement and Evaluation in Education and Psychology, 10*(1), 30-48. https://doi.org/10.21031/epod.419625.

Smith, M., Turner, J., Sanford-Moore, E., & Koons, H. H. (2016). The Lexile framework for reading: An introduction to what it is and how to use it. Pacific Rim Objective Measurement Symposium (PROMS) 2015 Conference Proceedings.

Snow, P. (2019). Dear parents: Welcome to the confusing world of reading instruction. http://pamelasnow.blogspot.com/2019/08/dear-parents-welcome-to-confusing-world.html

Snowling, M. J. (2005). *Literacy outcomes for children with oral language impairments: Developmental interactions between language skills and learning to read*. Lawrence Erlbaum Associates Publishers. https://doi.org/10.4324/9781410612052

Snowling, M. J., Adams, J. W., Bishop, D. V., & Stothard, S. E. (2001). Educational attainments of school leavers with a preschool history of speech-language impairments. *International Journal of Language & Communication Disorders, 36*(2), 173-183. https://doi.org/10.1080/13682820010019892

Solish, A., Perry, A., & Minnes, P. (2010). Participation of children with and without disabilities in social, recreational and leisure activities. *Journal of Applied Research in Intellectual Disabilities, 23*(3), 226-236. https://doi.org/10.1111/j.1468-3148.2009.00525.x

Sparrow, S. S., Cicchetti, D. V., & Balla, D. A. (2005). *Vineland Adaptive Behavior Scales, Second Edition: Survey Forms Manual.* Circle Pines, MN: American Guidance Service Publishing.

Spooner, A., Baddeley, A., & Gathercole, S. (2004). Can reading and comprehension be separated in the Neale Analysis of Reading Ability? *The British Journal of Educational Psychology, 74*, 187-204. https://doi.org/10.1348/000709904773839833

Stevenson, R. A., Segers, M., Ferber, S., Barense, M. D., & Wallace, M. T. (2014). The impact of multisensory integration deficits on speech perception in children with autism spectrum disorders. *Frontiers in Psychology, 5*, 379. https://doi.org/10.3389/fpsyg.2014.00379

Stringfield, S. G., Luscre, D., & Gast, D. L. (2011). Effects of a story map on accelerated reader postreading test scores in students with high-functioning autism. *Focus on Autism and Other Developmental Disabilities, 26*(4), 218-229.

Swanson, E., Wanzek, J., Petscher, Y., Vaughn, S., Heckert, J., Cavanaugh, C., Kraft, G., & Tackett, K. (2011). A synthesis of read-aloud interventions on early reading outcomes among preschool through third graders at risk for reading difficulties. *Journal of Learning Disabilities, 44*, 258-275. https://doi.org/10.1177/0022219410378444

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*(2), 257-285. https://doi.org/10.1207/s15516709cog1202_4

Tohidast, S. A., Mansuri, B., Bagheri, R., & Azimi, H. (2020). Provision of speech-language pathology services for the treatment of speech and language disorders in children during the COVID-19 pandemic: Problems, concerns, and solutions. *International Journal of Pediatric Otorhinolaryngology, 138*, 110262. https://doi.org/10.1016/j.ijporl.2020.110262

Troyb, E., Orinstein, A., Tyson, K., Helt, M., Eigsti, I.-M., Stevens, M., & Fein, D. (2014). Academic abilities in children and adolescents with a history of autism spectrum disorders who have achieved optimal outcomes. *Autism, 18*(3), 233-243. https://doi.org/10.1177/1362361312473519

Turner, H., Remington, A., & Hill, V. (2017). Developing an intervention to improve reading comprehension for children and young people with autism spectrum disorders. *Educational and Child Psychology, 34*(2), 13-26. Retrieved from: https://www.researchgate.net/publication/317175967_Developing_an_intervention_to_improve_reading_comprehension_for_children_and_young_people_with_autism_spectrum_disorders

United Nations. (2006). *Convention on the Rights of Persons with Disabilities*. http://www.un.org/disabilities/

Westby, C. (2017). Marion Blank's levels of language abstraction. *Word of Mouth, 29*(1), 12-15. https://doi.org/10.1177/1048395017726551e

Westerveld, M. F., Paynter, J., Trembath, D., Webster, A. A., Hodge, A. M., & Roberts, J. (2017). The emergent literacy skills of preschool children with autism spectrum disorder. *Journal of Autism and Developmental Disorders, 47*(2), 424-438. https://doi.org/10.1007/s10803-016-2964-5

Whalon, K., & Hanline, M. F. (2008). Effects of a reciprocal questioning intervention on the question generation and responding of children with autism spectrum disorder. *Education and Training in Developmental Disabilities, 43*(3), 367-387. http://www.jstor.org/stable/23879798

Whalon, K. J., Al Otaiba, S., & Delano, M. E. (2009). Evidence-based reading instruction for individuals with autism spectrum disorders. *Focus on Autism and Other Developmental Disabilities, 24*(1), 3–16. https://doi.org/10.1177/1088357608328515

Wigfield, A., Gladstone, J. R., & Turci, L. (2016). Beyond Cognition: Reading Motivation and Reading Comprehension. *Child Development Perspectives, 10*(3), 190-195. https://doi.org/10.1111/cdep.12184

Wigfield, A., Guthrie, J., Tonks, S., & Perencevich, K. (2004). Children's motivation for reading: Domain specificity and instructional influences. *Journal of Educational Research, 97*, 299-310. https://doi.org/10.3200/JOER.97.6.299-310

Wigfield, A., & Guthrie, J. T. (1997). Relations of children's motivation for reading to the amount and breadth or their reading. *Journal of Educational Psychology, 89*(3), 420. https://doi.org/10.1037/0022-0663.89.3.420

Wiig, E. H., Secord, W. A., & Semel, E. (2017). *Clinical Evaluation of Language Fundamentals: Fifth Edition, Australian and New Zealand Standardised Edition (CELF-5 A&NZ).* Pearson Clinical Assessment.

Williamson, P., Carnahan, C. R., Birri, N., & Swoboda, C. (2015). Improving comprehension of narrative using character event maps for high school students with autism spectrum disorder. *The Journal of Special Education, 49*(1), 28-38. https://doi.org/10.1177/0022466914521301

Wolf, M. M. (1978). Social validity: The case for subjective measurement or how applied behavior analysis is finding its heart. *Journal of Applied Behavior Analysis, 11*(2), 203-214. https://doi.org/10.1901/jaba.1978.11-203

Wong, C., Odom, S. L., Hume, K., Cox, A. W., Fettig, A., Kucharczyk, S., Brock, M. E., Plavnick, J. B., Fleury, V. P., & Schultz, T. R. (2013). *Evidence-based practices for children, youth, and young adults with autism spectrum disorder*. Frank Porter Graham Child Development Institute. http://autismpdc.fpg.unc.edu/sites/autismpdc.fpg.unc.edu/files/2014-EBP-Report.pdf

Woodcock, S., Howard, S., & Ehrich, J. (2019). A within-subject experiment of item format effects on early primary students' language, reading, and numeracy assessment results. *School Psychology, 35*. https://doi.org/10.1037/spq0000340

Woolley, G. (2008). The assessment of reading comprehension difficulties for reading intervention. *Australian Journal of Learning Difficulties, 13*(1), 51-62. https://doi.org/10.1080/19404150802093729

Yaw, J. S., Skinner, C. H., Parkhurst, J., Taylor, C. M., Booher, J. J., & Chambers, K. (2011). Extending research on a computer-based sight-word reading intervention to a student with autism. *Journal of Behavioral Education, 20*(1), 44-54. https://doi.org/10.1007/s10864-010-9118-1

Zakas, T.-L., Browder, D. M., Ahlgrim-Delzell, L., & Heafner, T. (2013). Teaching social studies content to students with autism using a graphic organizer intervention. *Research in Autism Spectrum Disorders, 7*(9), 1075-1086. https://doi.org/10.1016/j.rasd.2013.06.001

Appendices

Appendix 1

Human Ethics Committee Approval Letter 1

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN ETHICS COMMITTEE

Secretary, Rebecca Robinson
Telephone: +64 03 369 4588, Extn 94588
Email: human-ethics@canterbury.ac.nz

Ref: 2019/71/ERHEC

6 November 2019

Natalia Henderson-Faranda
School of Psychology, Speech and Hearing
UNIVERSITY OF CANTERBURY

Dear Natalia

Thank you for providing the revised documents in support of your application to the Educational Research Human Ethics Committee. I am very pleased to inform you that your research proposal "The Efficacy of a Computer Based Reading Program for Increasing the Reading Comprehension Skills of Students With Autism" has been granted ethical approval.

Please note that this approval is subject to the incorporation of the amendments you have provided in your emails of 15th and 31st October, and 6th November 2019.

Should circumstances relevant to this current application change you are required to reapply for ethical approval.

If you have any questions regarding this approval, please let me know.

We wish you well for your research.

Yours sincerely

pp. R. Robinson

Dr Patrick Shepherd
Chair
Educational Research Human Ethics Committee

Please note that ethical approval relates only to the ethical elements of the relationship between the researcher, research participants and other stakeholders. The granting of approval by the Educational Research Human Ethics Committee should not be interpreted as comment on the methodology, legality, value or any other matters relating to this research.

F E S

Appendix 2

Human Ethics Committee Approval Letter 2 (Amendment)

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

HUMAN ETHICS COMMITTEE

Secretary, Rebecca Robinson
Telephone: +64 03 369 4588, Extn 94588
Email: human-ethics@canterbury.ac.nz

Ref: 2019/71/ERHEC Amendment 1

17 December 2019

Natalia Henderson-Faranda
School of Psychology, Speech and Hearing
UNIVERSITY OF CANTERBURY

Dear Natalia

Thank you for your request for an amendment to your research proposal "The Efficacy of a Computer Based Reading Program for Increasing the Reading Comprehension Skills of Students With Autism" as outlined in your email dated 12th December 2019. I am pleased to advise that this amendment has been considered and approved by the Educational Research Human Ethics Committee.

Please note that should circumstances relevant to this current application change you are required to reapply for ethical approval.

If you have any questions regarding this approval, please advise.

We wish you well for your continuing research.

Yours sincerely

pp R. Robinson

Dr Trish McMenamin
Deputy Chair
Educational Research Human Ethics Committee

Please note that ethical approval relates only to the ethical elements of the relationship between the researcher, research participants and other stakeholders. The granting of approval by the Educational Research Human Ethics Committee should not be interpreted as comment on the methodology, legality, value or any other matters relating to this research.

F E S

Appendix 3

Ngāi Tahu Consultation and Engagement Group Letter

Ngāi Tahu Consultation and Engagement Group

Tuesday 22 October 2019

Tēnā koe Natalia Henderson-Faranda

RE: The efficacy of a computer based reading programme for increasing the reading comprehension skills of students with autism.

This letter is on behalf of the Ngāi Tahu Consultation and Engagement Group (NTCEG). I have considered your proposal and acknowledge it is a worthwhile and interesting project and you are clear about how you ought to take participants' (cultural) needs into account if and when applicable.

Given the scope of your project, no issues have been identified and further consultation with Māori is not required.

Thank you for engaging with the Māori consultation process. This will strengthen your research proposal, support the University's Strategy for Māori Development, and increase the likelihood of success with external engagement. It will also increase the likelihood that the outcomes of your research will be of benefit to Māori communities. We wish you all the best with your current project and look forward to hearing about future research plans.

The Ngāi Tahu Consultation and Engagement Group would appreciate a summary of your findings on completion of the current project. Please feel free to contact me if you have any questions.

Ngā mihi whakawhetai ki a koe

Henrietta Carroll (on behalf of the NTCEG)

Kaiarāhi Maori Research
Research & Innovation | Te Rōpū Rangahau
University of Canterbury | Te Whare Wānanga o Waitaha
Phone +64 3 369 0143, Private Bag 4800, Christchurch | Ōtautahi
henrietta.carroll@canterbury.ac.nz
http://www.research.canterbury.ac.nz

Appendix 4

Study Information Sheets, Consent Forms and Assent Form

Natalia Henderson-Faranda
School of Psychology, Speech and Hearing
Email: nrh60@uclive.ac.nz
13/11/2019
HEC Ref: 2019/71/ERHEC

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

An invitation to participate in a study 'The efficacy of a computer based reading program for increasing the reading comprehension skills of students with autism.'

Kia ora (*Principal Name*),

My name is Natalia Henderson-Faranda, a speech language therapist conducting a research study as part of my Masters in Speech and Language Sciences at the University of Canterbury. The focus of my study is evaluating the impact of a computer based reading program 'Reading Eggspress' on the reading comprehension skills of children aged 8-10 with autism. This study will take place during term 1 of the 2020 school year. You have received this information sheet as one of your students has agreed to participate in my study.

Participating students will be required to:

- complete a two hour assessment session at the University of Canterbury Speech and Hearing Clinic.
- attend 3-5 sessions scheduled over a two week period to gather baseline information about their reading comprehension skills (15 minutes each).
- attend 16 intervention sessions (45 minutes-1 hour each), conducted twice a week over eight weeks.
- complete a brief written questionnaire about reading at the start and end of the study.
- complete a 1 hour post-intervention assessment session at the University of Canterbury Speech and Hearing Clinic.

This will amount to a total of 20.5 hours of involvement for each participant.

I am seeking permission from you to contact (*student name*)'s class teacher to also participate. For this study they will be asked to complete two short questionnaires (one at the start of intervention, and another at the end) as a measure of the social validity of the program. Including my initial explanation of the study, the total time commitment for teachers is likely to be 20-30 minutes.

Location of sessions

The location of the intervention sessions will be individually negotiated with each family and teacher to reduce the class time missed and travel time for families, whilst also maintaining a treatment intensity at levels to support learning. Where possible sessions will take place at the University of Canterbury Speech and Hearing Clinic, Ilam outside of school hours (e.g. after school or weekends). Where this is not possible, parents and the student's class teacher will be involved in discussions weighing up the benefits vs. risks of timing of intervention sessions, including the amount of school time missed and parent availability. A joint decision will be made in the best interests of the student, who will also be included in these decisions where parents deem it appropriate. Sessions will not be scheduled during class time without the agreement of all parties that this option is in the student's best interests. Any missed or partially completed intervention sessions will not be able to be rescheduled due to the time constraints of this study.

Participation and potential risks

Participation in this study may involve potential risks. These include:

- The student experiencing stress or anxiety related to reading or assessment tasks, and having to complete tasks in a specified time period. These risks will be mitigated by ensuring tasks are set at each student's ability, encouragement from the researcher, including breaks in the sessions and having a game reward at completion of set tasks during each session. If at any point the student appears excessively stressed or tired, the session will be ended.
- There is also a risk of the student missing school or being taken out of class to attend intervention sessions. This will be accounted for by conducting sessions outside of school time where possible, however the benefits and risks of this will be discussed with the student, their class teacher and parent/caregiver before the student starts the study to ensure a suitable timetable for all. The student will continue to receive classroom literacy teaching as per usual, and they will not miss any other special education services during participation in the study.
- Due to the small number of participants included in the study there is a possibility that the student's results may be identifiable by people who know them personally. However the likelihood of this will be reduced by using pseudonyms in any publications and not providing names of participants' schools or the campus location of the university clinic.
- Some sessions may occur within school time which could be noticed by peers who may then guess that the sessions are remedial. Attempts will be made to ensure missed school time is minimised (e.g. scheduling most or all sessions after school) to reduce this potential impact.

There is a possibility of differences in parent and teacher report, which may cause concern for teachers. This will be mitigated by explanation of the potential reasons for the discrepancy, including the differences between the home and school settings in terms environmental, social, motivation and other factors.

There is also a potential risk of exacerbation of parent/caregiver grief relating to their child's difficulties. This will be mitigated by building a trusting relationship with whānau members, participants and teachers through whakawhāunangatanga, providing support and empathy when delivering assessment results and information about their child's performance, and acknowledging concerns when they arise. For anyone requiring additional support for their mental health, information about relevant service options will be provided including phone numbers for mental health support (Lifeline: 0800 543 354), parent support (Parent Line: 0800 568 856) and further information about autism (Autism NZ: 0800 288 476).

The parent/caregiver will receive a $20 Westfield voucher in recognition of their contribution to the study (one per family). Participation is voluntary and participants and their parents/caregivers and teachers have the right to withdraw at any stage without penalty. If teachers are to withdraw their consent, all data teachers provided will be omitted for that participant, however the child and family will be able to continue their involvement in the study.

Data management and complaints procedure

To ensure confidentiality of data, video recordings, assessment results and any data relating to participants' progress in the program will be securely stored on a university computer with a password protected log in only accessible to the researcher and project supervisors, Dr. Jayne Newbury and Dr. Dean Sutherland. Hard copies of the results will be stored in a locked file in a lockable room only accessible to the aforementioned researcher and project supervisors.

The results of the project may be published but at no stage will any identifying information relating to participants be described. Reporting of results following the completion of the program will use pseudonyms (code names) so that participants cannot be identified. All data will be held and kept securely for 5 years but destroyed after this point as per standard University of Canterbury procedures. A thesis is a public document

and will be available through the UC Library.

This project is being carried out as a requirement for a Master of Science (MSc) in Speech and Language Sciences by Natalia Henderson-Faranda under the supervision of Dr. Jayne Newbury and Dr. Dean Sutherland, who can be contacted at jayne.newbury@canterbury.ac.nz (phone: +64 3 369 5798) and dean.sutherland@canterbury.ac.nz (phone: +64 3 369 5090). They will be pleased to discuss any concerns you may have about participation in the project. This project has been reviewed and approved by the University of Canterbury's Educational Research Human Ethics Committee, and participants should address any complaints to The Chair, Educational Research Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

If you are happy with the above, please pass on the following Teacher Information Sheet and Consent Form to (***student's name***)'s teacher.

Ngā mihi,

Natalia Henderson-Faranda
Speech Language Therapist
MSc Speech and Language Sciences
University of Canterbury

Natalia Henderson-Faranda
School of Psychology, Speech and Hearing
Email: nrh60@uclive.ac.nz
13/11/2019
HEC Ref: 2019/71/ERHEC

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

An invitation to participate in a study 'The efficacy of a computer based reading program for increasing the reading comprehension skills of students with autism.'

Information Sheet for Teachers

Kia ora, my name is Natalia, a speech language therapist conducting research as part of my Masters in Speech and Language Sciences at the University of Canterbury. You have received this information sheet as one of your students has agreed to participate in my study. The focus of my study is evaluating the impact of a computer based reading program 'Reading Eggspress' on the reading comprehension skills of children aged 8-10 with autism. Intervention sessions will take place during term 1 of the 2020 school year.

To participate in the study each student must meet the following criteria:

- Have difficulties with understanding what they read
- Have a diagnosis of autism spectrum disorder (ASD)
- Have the ability to communicate in sentences and understand verbal instructions
- Have the ability to attend to a reading program for at least 20 minutes at a time
- Be aged between 8-10 years
- Attend a mainstream primary school
- Reside in Christchurch, Canterbury, New Zealand
- Not exhibit behaviours which may harm themself or others
- Not be using the 'Reading Eggspress' program during Term 1 of 2020

Participating students will be required to:

- complete a two hour assessment session at the University of Canterbury Speech and Hearing Clinic. The assessment and intervention sessions will be video recorded using the secure clinic recording system for the purposes of measuring participants' reading comprehension strategy use and attention to task, and ensuring accuracy of assessment scoring. Video recordings will only be viewable to the research team (e.g. researcher and supervisors)
- attend 3-5 sessions scheduled over a two week period to gather baseline information about their reading comprehension skills (15 minutes each).
- attend 16 intervention sessions (45 minutes-1 hour each), conducted twice a week over eight weeks.
- complete a brief written questionnaire about reading at the start and end of the study.
- complete a one hour post-intervention assessment session at the University of Canterbury Speech and Hearing Clinic.

This will amount to a total of 20.5 hours of involvement for each participant.

Your valuable input about your student's reading habits and abilities is requested through **completion of two short questionnaires** (one at the start of intervention, and another at the end), which I will provide to you. These should take 5-10 minutes each to complete. If you do not wish to participate in the study or choose to withdraw your consent to participate at any point, the child and family will still be able to continue their involvement in the study.

Location of sessions

The location of the intervention sessions will be individually negotiated with each family and yourself to reduce the class time missed and travel time for families, whilst also maintaining a treatment intensity at levels to support learning. Where possible sessions will take place at the University of Canterbury Speech and Hearing Clinic, Ilam outside of school hours (e.g. after school or weekends). Where this is not possible, you and the student's parents will be involved in discussions weighing up the benefits vs. risks of timing of intervention sessions, including the amount of school time missed and parent availability. A joint decision will be made in the best interests of the student, who will also be included in these decisions where parents deem it appropriate. Sessions will not be scheduled during class time without the agreement of all parties that this option is in the student's best interests. If we have agreed some sessions will take place during school hours, I will request your help to determine the best timing and a space within the school to work with the student. This will not take place unless all parties specifically agree to the timing and frequency of missed class time. Any missed or partially completed intervention sessions will not be able to be rescheduled due to the time constraints of this study.

Outline of study

The study will also involve an initial 30 minute questionnaire with parents/caregivers/whānau members to discuss the child's communication, social and reading abilities. Parents and class teachers will be asked to complete a brief questionnaire about reading prior to the start of intervention sessions, as well as at the completion of the study. Prior to involvement in the intervention, students will have their language and reading skills assessed using the Clinical Evaluation of Language Fundamentals – Fourth Edition (CELF-4) and Neale Analysis of Reading Ability – Third Edition (NARA-3) respectively.

There will be two intervention phases, with a duration of four weeks each. Your student will be randomly allocated to a group, so may start with phase one or phase two.

Phase one sessions will involve:

- your student independently completing tasks using the computer based reading program 'Reading Eggspress' for 45 minutes on a desktop computer or laptop.

Phase two sessions will involve:

- I will provide 15 minutes of paper-based explicit instruction of reading comprehension concepts matched with the child's ability. These include explanation and discussion of new vocabulary, understanding 'wh' concepts, finding information in a text, identifying the main idea and making inferences.
- your student will have 'wh' graphic organisers (outlining who, what, where, when, why) introduced and demonstrated to them for use during all reading activities.
- this will be followed by independent completion of tasks using the computer based reading program 'Reading Eggspress' for 30 minutes on a desktop computer or laptop.

Participation and potential risks

Participation in this study may involve potential risks. For the student, these include:

- Stress or anxiety related to reading or assessment tasks, and having to complete tasks in specified time period. These risks will be mitigated by ensuring tasks are set at each child's ability, encouragement from the researcher, including breaks in the sessions and having a game reward at completion of set tasks each session. If at any point the student appears excessively stressed or tired, the session will be ended.
- There is also a risk of your student missing school or being taken out of class to attend intervention sessions. This will be accounted for by conducting sessions outside of school time where possible, however the benefits and risks of this will be discussed with you and their parent/caregiver before your student starts the study to ensure a suitable timetable for all. Your student will continue to receive

classroom literacy teaching as per usual, and they will not miss any other special education services during participation in the study.

- Due to the small number of participants included in the study there is a possibility that the student's results may be identifiable by people who know them personally. However the likelihood of this will be reduced by using pseudonyms in any publications and not providing names of participants' schools or the campus location of the university clinic.
- Some sessions may occur within school time which could be noticed by peers who may then guess that the sessions are remedial. Attempts will be made to ensure missed school time is minimised (e.g. scheduling most or all sessions after school) to reduce this potential impact.

There is a possibility of differences in parent and teacher report on the child's ability, which may cause concern for teachers. This will be mitigated by explanation of the potential reasons for the discrepancy, including the differences between the home and school settings in terms environmental, social, motivation and other factors.

There is a potential risk of exacerbation of parent/caregiver grief relating to their child's difficulties. This will be mitigated by building a trusting relationship with whānau members, participants and teachers through whakawhāunangatanga, providing support and empathy when delivering assessment results and information about their child's performance, and acknowledging concerns when they arise. For anyone requiring additional support for their mental health, information about relevant service options will be provided including phone numbers for mental health support (Lifeline: 0800 543 354), parent support (Parent Line: 0800 568 856) and further information about autism (Autism NZ: 0800 288 476).

The parent/caregiver will receive a $20 Westfield voucher in recognition of their contribution to the study (one voucher per family). Participation is voluntary and participants, parents/caregivers/whānau members and teachers have the right to withdraw at any stage without penalty. If you withdraw your consent to participate, all data you have provided will be omitted for that student, however the student and family will still be able to continue their involvement in the study.

Data management and complaints procedure

To ensure confidentiality of data, video recordings, assessment results and any data relating to participants' progress in the program will be securely stored on a university computer with a password protected log in only accessible to the researcher and project supervisors, Dr. Jayne Newbury and Dr. Dean Sutherland. Hard copies of the results will be stored in a locked file in a lockable room only accessible to the aforementioned researcher and project supervisors.

The results of the project may be published but at no stage will any identifying information relating to participants be described. Reporting of results following the completion of the program will use pseudonyms (code names) so that participants cannot be identified. All data will be held and kept securely for 5 years but destroyed after this point as per standard University of Canterbury procedures. A thesis is a public document and will be available through the UC Library.

The project is being carried out as a requirement for a Masters of Science (MSc) in Speech and Language Sciences by Natalia Henderson-Faranda under the supervision of Dr. Jayne Newbury and Dr. Dean Sutherland, who can be contacted at jayne.newbury@canterbury.ac.nz (phone: +64 3 3695798) and dean.sutherland@canterbury.ac.nz (phone: +64 3 369 5090). They will be pleased to discuss any concerns you may have about participation in the project.

This project has been reviewed and approved by the University of Canterbury Educational Research Human Ethics Committee, and participants should address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

If you agree to participate in the study, you are asked to complete the consent form and return to Natalia Henderson-Faranda at nrh60@uclive.ac.nz.

Ngā mihi,

Natalia Henderson-Faranda
Speech Language Therapist
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UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

The efficacy of a computer based reading program for increasing the reading comprehension skills of students with autism.

Consent Form for Teachers

- ☐ I have been given a full explanation of this project and have had the opportunity to ask questions.
- ☐ I understand what is required of me and my student, and agree to take part in the research.
- ☐ I understand that participation is voluntary and I may withdraw at any time without penalty. Withdrawal of participation will also include the withdrawal of any information already provided should this remain practically achievable. The final date for withdrawal of your data from the study is 20/03/2020.
- ☐ I understand that any information or opinions I provide will be kept confidential to the researcher and her supervisors and that any published or reported results will not identify the participants. I understand that a thesis is a public document and will be available through the UC Library.
- ☐ I understand that all data collected for the study will be kept in locked and secure facilities and/or in password protected electronic form and will be destroyed after the completion of the study.
- ☐ I understand that my student will be video recorded during this study. I have been fully briefed about how this video data will be securely stored and who will have access to this video.
- ☐ I understand the risks associated with taking part and how they will be managed.
- ☐ I understand that I can contact the researcher Natalia Henderson-Faranda or supervisors Dr. Jayne Newbury (jayne.newbury@canterbury.ac.nz) and Dr. Dean Sutherland (dean.sutherland@canterbury.ac.nz) for further information. If I have any complaints, I can contact the Chair of the University of Canterbury Educational Research Human Ethics Committee, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz)
- ☐ I would like a summary of the results of the project.
- ☐ By signing below, I agree to participate in this research project.

Name:_____ Signed:_____ Date:

Email address (in case of future contact):

Natalia Henderson-Faranda
School of Psychology, Speech and Hearing
Email: nrh60@uclive.ac.nz
13/11/2019
HEC Ref: 2019/71/ERHEC

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CHRISTCHURCH NEW ZEALAND

An invitation to participate in a study 'The efficacy of a computer based reading program for increasing the reading comprehension skills of students with autism.'

Information Sheet for Parents/Caregivers/Whānau Members

Study summary

Kia ora, I am a speech language therapist conducting research as part of my Masters in Speech and Language Sciences. I am inviting you, your child and your child's teacher to take part in my study. The focus of my study is to evaluate the impact of a computer based reading program 'Reading Eggspress' on the reading comprehension skills of children aged 8-10 with autism. This study will take place during term 1 of the 2020 school year.

To participate your child will:

- Have difficulties with understanding what they read
- Have a diagnosis of autism spectrum disorder (ASD)
- Have the ability to communicate in sentences and understand verbal instructions
- Have the ability to attend to a reading program for at least 20 minutes at a time
- Be aged between 8-10 years
- Attend a mainstream primary school
- Reside in Christchurch, Canterbury, New Zealand
- Not exhibit behaviours which may harm themself or others
- Not be using the 'Reading Eggspress' program in Term 1 2020

What will be required of you

- A **30 minute questionnaire** conducted over the phone or in person using questions from the Vineland Adaptive Behaviour Scales - Second Edition (VABS-II) to gather information on your child's communication, social and reading abilities. You will be provided a copy of the record form with your responses from the discussion and asked to review these and provide any alterations within 10 days. If your child meets the study criteria for participation, they will be invited to complete a **2 hour assessment session** at the University of Canterbury Speech and Hearing Clinic. You will need to be present at this assessment.
- Scheduling of 3-5 x 15 minute 'baseline' assessments of your child's reading comprehension skills.
- Attendance with your child to 16 sessions and a total of **20.5 hours of involvement.** Any missed or partially completed intervention sessions will not be able to be rescheduled due to the time constraints of this study.
- Completion of a brief parent/caregiver questionnaire about reading prior to the start of intervention sessions, as well as at the completion of the study.

Please note that you will be required to transport your child to and from any assessment and intervention sessions taking place at the clinic, and will be requested to attend all sessions at the clinic for the full session duration. You will also be required to participate in discussion with myself and your child's teacher about timing of sessions.

What will be required of your child

- Completion of a **2 hour pre-intervention assessment session** at the University of Canterbury Speech and Hearing Clinic.
- Participation in 3-5 x 15 minute 'baseline' assessments of your child's reading comprehension skills.
- Participation in **45 minutes-1 hour** intervention sessions **conducted twice a week** at times that will be negotiated with you and the child's teacher (if in school time), amounting to **16 sessions** and a **total of 20.5 hours of involvement for your child**.
- Completion of a brief written questionnaire about reading at the start and end of the study.
- Completion of an **assessment session** at the University of Canterbury Speech and Hearing Clinic.

What the intervention involves

There will be two intervention phases, with a duration of four weeks each. Your child will be randomly allocated to a group, so may start with phase one or phase two.

Phase one sessions will involve:

- your child independently completing tasks using the computer based reading program 'Reading Eggspress' for 45 minutes on a desktop computer or laptop.

Phase two sessions will involve:

- I will provide 15 minutes of paper-based explicit instruction of reading comprehension concepts matched with the child's ability. These include explanation and discussion of new vocabulary, understanding 'wh' concepts, finding information in a text, identifying the main idea and making inferences.
- your child will have 'wh' graphic organisers (outlining who, what, where, when, why) introduced and demonstrated to them for use during all reading activities.
- this will be followed by independent completion of tasks using the computer based reading program 'Reading Eggspress' for 30 minutes on a desktop computer or laptop.

What will be required of your child's classroom teacher

- Completion of a brief written teacher questionnaire at the beginning and end of the study about reading and impressions of the effectiveness of the program.

Your child's teacher will be approached for consent to participate in the study. If your child's teacher declines to participate or later withdraws consent, all data they have provided will be omitted for that participant, however you and your child will still be able to continue your involvement in the study.

Location of sessions

The location of the intervention sessions will be individually negotiated with you and your child's teacher to reduce the class time missed and travel time for families, whilst also maintaining a treatment intensity at levels to support learning. Where possible sessions will take place at the University of Canterbury Speech and Hearing Clinic, Ilam outside of school hours (e.g. after school or weekends). Where this is not possible, I will discuss the benefits and risks of timing of intervention sessions, including the amount of school time missed and your availability with you and your child's class teacher. A joint decision will be made in your child's best interests and your child will also be included in these decisions if you deem it appropriate. Sessions will not be scheduled during class time without the agreement of all parties that this option is in your child's best interests. School based sessions will only take place if you specifically agree to the timing and frequency of missed class time, and will be discussed with you and your child. Any missed or partially completed intervention sessions will not be able to be rescheduled due to the time constraints of this study.

Participation and potential risks

As parent/caregiver you will receive a $20 Westfield shopping voucher in recognition of your contribution to the study (one voucher per family). Participation is voluntary and you have the right to withdraw your child at any stage without penalty. You may ask for your raw data to be returned to you or destroyed at any point. If you withdraw, I will remove information relating to your child. However, once analysis of raw data starts on 20/03/2020, it will become increasingly difficult to remove the influence of your data on the results. I request that you please notify me before this date. After 20/03/2020 it will no longer be possible to remove your child's data from the Masters thesis, however it will be excluded from publication in journal articles and/or conference presentation material.

Potential risks of participating in the study to your child include:

- Stress or anxiety related to reading or assessment tasks, and having to complete tasks in specified time period. These risks will be significantly reduced by ensuring tasks are set at your child's ability, encouragement is provided by the researcher, inclusion of breaks and having a game reward at completion of set tasks each session. If at any point your child appears excessively stressed or tired, the session will be ended.
- There is also a risk of your child missing school or being taken out of class. This will be accounted for by conducting sessions outside of school time where possible, however the benefits and risks of this will be discussed with you and their teacher before your child starts the study to ensure a suitable timetable. Your child will continue to receive classroom literacy teaching as per usual, and they will not miss any other special education services during participation in the study.
- Due to the small number of participants included in the study there is a possibility that your child's results may be identifiable by people who know them personally. However the likelihood of this will be reduced by using pseudonyms in any publications and not providing names of participants' schools or the campus location of the university clinic.
- There may be potential social risks associated with involvement in this study. Some sessions may occur within school time which could be noticed by peers who may then guess that the sessions are remedial. Attempts will be made to ensure missed school time is minimised (e.g. scheduling most or all sessions after school) to reduce this potential impact.

There is a possibility of differences in parent and teacher report, which may cause concern for teachers. This will be mitigated by explanation of the potential reasons for the discrepancy, including the differences between the home and school settings in terms environmental, social, motivation and other factors.

There is a potential risk that you may experience feelings of grief relating to your child's difficulties. If these concerns arise you can speak with Natalia, the primary researcher. There are also support services that can help you:

If you require mental health support, please call Lifeline on 0800 543 354. For parent support, please call the Parent Line on 0800 568 856. For further information about autism, please contact Autism NZ on 0800 288 476.

Data management and complaints procedure

To ensure confidentiality of data, video recordings, assessment results and any data relating to your child's progress in the program will be stored on a university computer with a password protected log in only accessible to the researcher and project supervisors, Dr. Jayne Newbury and Dr. Dean Sutherland. Hard copies of the results will be stored in a locked file in a lockable room only accessible to the aforementioned researcher and project supervisors. All sessions will be video recorded using the secure clinic recording system for the purposes of possible additional data analysis (e.g. attention to task) and ensuring accuracy of assessment scoring.

The results of the project may be published but at no stage will any identifying information relating to participants be described. Reporting of results following the completion of the program will use pseudonyms (code names) so that participants cannot be identified. All data will be held and kept securely for 5 years but destroyed after this point as per standard University of Canterbury procedures. A thesis is a public document and will be available through the UC Library. Please indicate to the researcher on the consent form if you would like to receive a copy of the summary of results of the project.

The project is being carried out as a requirement for a Masters' of Science (MSc) in Speech and Language Sciences by Natalia Henderson-Faranda under the supervision of Dr. Jayne Newbury and Dr. Dean Sutherland, who can be contacted at jayne.newbury@canterbury.ac.nz (phone: +6433695798) and dean.sutherland@canterbury.ac.nz (phone: +6433695090). They will be pleased to discuss any concerns you may have about participation in the project. This project has been reviewed and approved by the University of Canterbury Educational Research Human Ethics Committee, and participants should address any complaints to The Chair, Human Ethics Committee, University of Canterbury, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz).

If you agree to participate in the study, you are asked to complete the consent form and return to Natalia Henderson-Faranda at nrh60@uclive.ac.nz.

Ngā mihi,

Natalia Henderson-Faranda
Speech Language Therapist
MSc Speech and Language Sciences
University of Canterbury

Natalia Henderson-Faranda
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The efficacy of a computer based reading program for increasing the reading comprehension skills of students with autism.

Consent Form for Parents/Caregivers/Whānau Members (1 of 2)

- ☐ I have been given a full explanation of this project and have had the opportunity to ask questions.
- ☐ I understand what is required of me and agree to take part in the research.
- ☐ I understand that participation is voluntary and I may withdraw at any time without penalty. Withdrawal of participation will also include the withdrawal of any information already provided should this remain practically achievable. The final date for withdrawal of your data from the study is 20/03/2020.
- ☐ I understand that any information or opinions I provide will be kept confidential to the researcher and her supervisors and that any published or reported results will not identify the participants. I understand that a thesis is a public document and will be available through the UC Library.
- ☐ I understand that all data collected for the study will be kept in locked and secure facilities and/or in password protected electronic form and will be destroyed after the completion of the study.
- ☐ I understand the risks associated with taking part and how they will be managed. I am aware that support services available are listed in the attached information sheet.
- ☐ I understand that I can contact the researcher Natalia Henderson-Faranda or supervisors Dr. Jayne Newbury (jayne.newbury@canterbury.ac.nz) and Dr. Dean Sutherland (dean.sutherland@canterbury.ac.nz) for further information. If I have any complaints, I can contact the Chair of the University of Canterbury Educational Research Human Ethics Committee, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz)

- ☐ By signing below, I agree to participate in this research project.

Name:_____ Signed:_____ Date:

Email address (in case of future contact):

- ☐ Please tick this box if you would like a summary of the results of the project.

Natalia Henderson-Faranda
School of Psychology, Speech and Hearing
Email: nrh60@uclive.ac.nz

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The efficacy of a computer based reading program for increasing the reading comprehension skills of students with autism.

Consent Form for Parents/Caregivers/Whānau Members (2 of 2)

- ☐ I have been given a full explanation of this project and have had the opportunity to ask questions.
- ☐ I understand what is required of my child if I agree to let him / her take part in the research.
- ☐ I understand that participation is voluntary and I may withdraw my child at any time without penalty. Withdrawal of participation will also include the withdrawal of any information already provided (including information provided by my child's teacher) should this remain practically achievable. The final date for withdrawal of your data from the study is 20/03/2020.
- ☐ I understand that my child's teacher may withdraw their information but myself and my child can still continue to participate in the study.
- ☐ I understand that any information or opinions I provide will be kept confidential to the researcher and her supervisors and that any published or reported results will not identify the participants. I understand that a thesis is a public document and will be available through the UC Library.
- ☐ I understand that all data collected for the study will be kept in locked and secure facilities and/or in password protected electronic form and will be destroyed after the completion of the study.
- ☐ I understand that my child will be video recorded during this study. I have been fully briefed about how this video data will be securely stored and who will have access to this video.
- ☐ I understand the risks associated with taking part and how they will be managed.
- ☐ I understand that I can contact the researcher Natalia Henderson-Faranda or supervisors Dr. Jayne Newbury (jayne.newbury@canterbury.ac.nz) and Dr. Dean Sutherland (dean.sutherland@canterbury.ac.nz) for further information. If I have any complaints, I can contact the Chair of the University of Canterbury Educational Research Human Ethics Committee, Private Bag 4800, Christchurch (human-ethics@canterbury.ac.nz)
- ☐ By signing below, I agree to allow my child to participate in this research project.

Name:_____ Signed:_____ Date:

Email address (in case of future contact):

Natalia Henderson-Faranda
School of Psychology, Speech and Hearing
Email: nrh60@uclive.ac.nz

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Information Sheet for Children

Kia ora!

My name is Natalia Henderson-Faranda. I am a researcher from the University of Canterbury. A **researcher** is someone who asks **questions** and tries to find out some **answers**. I have lots of questions about how children read. I will be doing a **'study'** to try and find some answers! I hope that my study can help children to **understand** what they read.

Would you like to be involved in this study?

What will the study involve?

- If you want to be a part of my study, you will attend 2 sessions per week for 8 weeks using a computer program called 'Reading Eggspress'. You will get to watch some videos, listen to and read some stories and answer some questions.
- Some sessions will be held at the University Speech Clinic, but sometimes I might visit you at school or at home. Your parent/caregiver and teacher will also be doing the study.

Do I have to take part?

- You don't have to do the study if you don't want to. You can stop participating in the study (or take a break) at any point if you start it.
- Any information about you and your reading will be kept safe and not shared with others. Your name won't be kept where anyone else will see it – instead you will get a code name!

What will I get from doing the study?

- You will do some fun activities on a computer or iPad and learn some strategies to help you read!

If you have any questions about the study, you can ask me or your parent/caregiver.

Natalia Henderson-Faranda
School of Psychology, Speech and Hearing
Email: nrh60@uclive.ac.nz

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Children's Assent Form

Only sign this form if you agree with these statements:

- The project that Natalia wants to do about reading has been explained to me.
- I know I don't have to be a part of it if I don't want to.
- If I have any questions I can ask one of my parents/caregivers.
- I know that I will be video recorded during the sessions.
- I can stop participating in the study at any point.
- I am happy to be part of the 'Reading Eggspress' project with Natalia.

If you would like a summary of the results of this study, please tick this box ☐

Write your name here:_____

Please give this form back to your parent/caregivers.

Appendix 5

Pre-Intervention Language and Social-Communication Abilities Assessment Results

Participant	CELF-5 Core Language Score	VABS-2 Communication Subdomain	VABS-2 Socialisation Subdomain
Lucy	8	18	42
Derek	1	4	4
Fred	14	12	7
Sally	2	10	23

Note. Scores above are expressed as percentile ranks (normal range: 18-83).

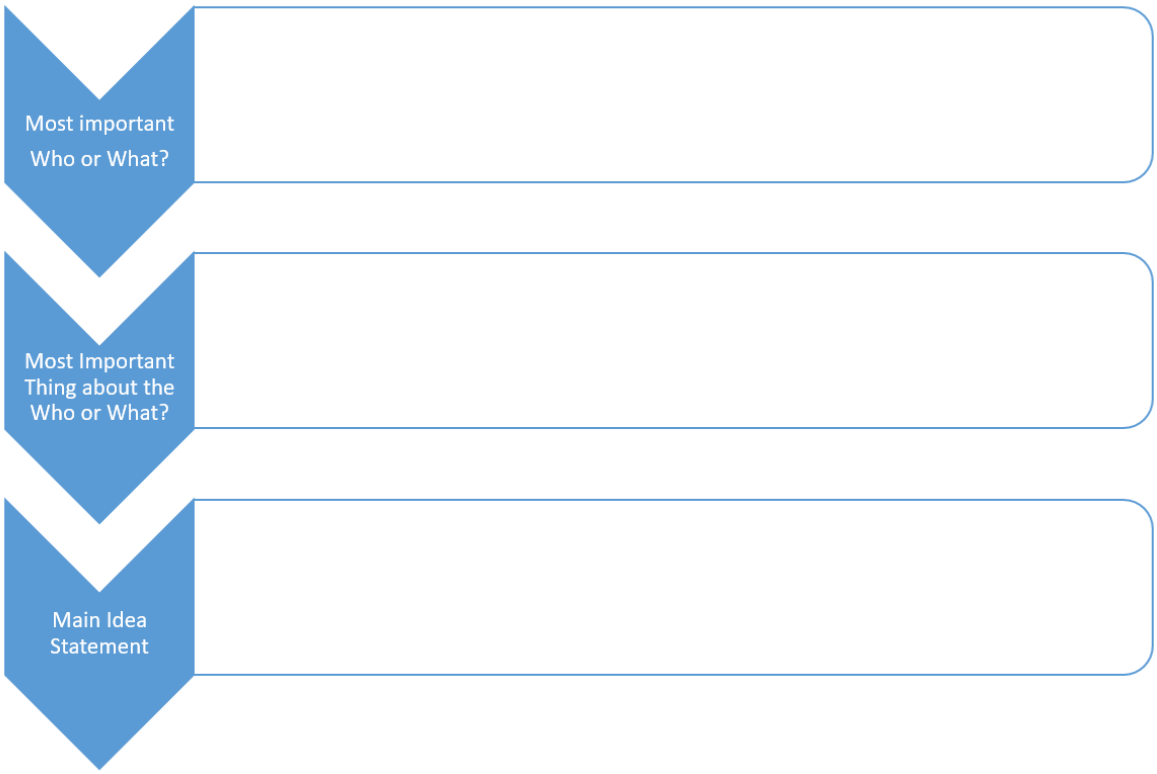
Appendix 6

Changed Participant Intervention Timelines due to Covid19

Participant	Timeline
Lucy	Phase A: sessions 1-7 twice weekly, nine week break (Covid19), session 8
	Phase B: sessions 1-8 twice weekly
Derek	Phase A: sessions 1-8 twice weekly, phase B session 1, nine week break (Covid19)
	Phase B: sessions 2-8 twice weekly
Fred	Phase A: sessions 1-8 twice weekly
	Phase B sessions 1-2, nine week break (Covid19), sessions 3-8 twice weekly
Sally	Phase B: sessions 1-6 twice weekly, nine week break (Covid19), sessions 7-8 twice weekly
	Phase A: sessions 1-8 twice weekly

Appendix 7

Main Idea GO and Wh GO



Who? (person)	Where? (place)	What? (thing)	What doing? (event)

Appendix 8

Blanks Level Questions

Blank's Level	Description	Examples
Level 1	Language relating to the child's everyday world (here and now).	Find one like this Show me what you heard Show me what you touched What did you hear? What did you touch? What is this? Say this… What did you see?
Level 2	Information is provided to the child, but not directly apparent. The child has to choose what to attend to (e.g., shape, size, object function).	Find one that can… What is happening? What things…? Who? What? Where? Finish this… Tell me its… Find one that is … and … How are these different? Name something that is a…
Level 3	Language requires the child to think and reorder the information provided. They must consider and evaluate basic facts before responding.	Find one to use with this What will happen next? What could he say? Do this, then this Make these into Tell me how to… What happened to all of these? Tell this story How are these the same? Find the ones that are not… Find things that are not… Name something that can…but is not a Name something that is not a… What is a…? Say this…
Level 4	The child has to use reasoning beyond what they can see, hear. They are required to draw on past experiences, make connections, consider causes and effects as well as justify their decision.	Where will…? What will happen if…? Why will…? Why wouldn't it…? Why would it…? What made it happen? What could you do? What could she do? What could we use? Why should we use that? Why is… made of that? How can we tell? Why is this called…? Why can't we…?

Note. Question examples from Westby, C. (2017). Marion Blank's Levels of Language Abstraction. *Word of Mouth*, *29*(1), 12–15. https://doi.org/10.1177/1048395017726551e

Appendix 9

Bloom's Taxonomy Examples

Bloom's Taxonomy Level	**Description**	**Examples**
Level 1: Recall/ Knowledge	Exhibits memory of previously learned material by recalling fundamental facts, terms, basic concepts and answers about the selection.	What is . . . ? How is . . . ? Where is . . . ? When did _____ happen? How did _____ happen? How would you explain . . . ? Why did . . . ? How would you describe . . . ? When did . . . ? Can you recall . . . ? How would you show . . . ? Can you select . . . ? Who were the main . . . ? Can you list three . . . ? Which one . . . ? Who was . . . ?
Level 2: Comprehension	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptors and stating main ideas.	How would you classify the type of . . . ? How would you compare . . . ? contrast . . . ? Will you state or interpret in your own words . . . ? How would you rephrase the meaning . . . ? What facts or ideas show . . . ? What is the main idea of . . . ? Which statements support . . . ? Can you explain what is happening . . . what is meant . . .? What can you say about . . . ? Which is the best answer . . . ? How would you summarize . . . ?

Note. Question examples from: https://www.bloomstaxonomy.org/Blooms%20Taxonomy%20questions.pdf

Appendix 10

Child, Parent and Teacher Questionnaire Items

Child Questionnaires	Parent Questionnaires	Teacher Questionnaires
Items in C1 and C2 Do you read a lot during your day? *(Rarely* to *Yes, every day)* I am getting better at reading in general. *(Not at all* to *Yes a lot)* I understand what I read better than I could before. *(Not at all* to *Yes a lot)* I enjoy how I feel when I read. *(Not at all* to *Yes a lot)* **Items in C2** Did you like completing the 'Reading Eggspress' lessons? (*Not at all* to *Yes a lot*) I think the 'Reading Eggspress' program helped me understand what was happening in the stories I read. *(Not at all* to *Yes a lot)* I think that Natalia's lessons helped me understand what was happening in the stories I read. *(Not at all* to *Yes a lot)* I would like to keep using the 'Reading Eggspress' program at home *(No; Maybe; Yes if I have some help; Yes)*	**Items in W1 only** Does your child currently receive additional support at school for reading? Please provide details: *(Open text)* **Items in W1 and W2** On a scale of 1-5, please rate your child's experience of reading at home. *(1=Does not enjoy* to *5=Really enjoys)* How much does your child read at home? *(1=Never* to *5=Often)* My child chooses books to read at home. *(1=Never* to *5=Often)* My child reads (please circle all that apply): *(Fiction books, nonfiction books, magazines, websites/apps with factual info, websites/apps with reading games)* My child and I spend time reading together (this could be 10 minutes a week or more). *(1=Strongly disagree* to *5=Strongly agree)* My child enjoys when we read together (e.g., child reading to parent, parent reading to child, or alternating). *(1=Strongly disagree* to *5=Strongly agree)* I enjoy when my child and I read together (e.g., child reading to parent, parent reading to child, or taking turns to read). *(1=Strongly disagree* to *5=Strongly agree)* **Items in W2 only** Please rate your satisfaction with the reading comprehension support your child received through this intervention study. *(1=Very unsatisfied* to *5=Very satisfied)*	**Items in T1 only** Additional support for reading *(Open text)* Type of support and hours/week *(Open text)* **Items in T1 and T2** Student's experience of reading at school *(1=Does not enjoy* to *5=Really enjoys)* How much does this student read at school? *(1=Never* to *5=Often)* This student chooses to read books during free time. *(1=Never* to *5=Often)* This student borrows books from the school library. *(1=Never* to *5=Often)* This student reads (please circle all that apply): *(Fiction books, nonfiction books, magazines, websites/apps with factual info, websites/apps with reading games)* Student's Reading Level *(Open text)* **Items in T2 only** Please rate your satisfaction with the reading comprehension this student received through this intervention study. *(1=Very unsatisfied* to *5=Very satisfied)*

Appendix 11

Parent and Teacher Open Text Comments (Post-Intervention Questionnaire)

Participant	Parent Comments	Teacher Comments
Lucy	*Lucy's reading has improved a great deal since beginning the program. She has moved up a reading level at school and her teacher has commented on the improvement. She has been reading for pleasure lately and has nearly read all of the 'Diary of a Wimpy Kid' books.*	(No comment made)
Derek	*I personally do not prefer online program rather than reading the actual books but I can see him improving reading and will continue using the program at home.*	*Derek has made excellent progress over the time of the program.*
Fred	*I am impressed with the patience and understanding (the researcher) showed towards Fred - thank you.*	*Fred is reading at mid level 2 of the New Zealand Curriculum. Just before lockdown, he sat a Reading Comprehension PAT test and scored a stanine 5. In a recent Probe reading oral analysis his reading age was between 8-9 Years old. He was reading with fluency and was able to retell the main ideas from the text. He scored 8/8 in the comprehension questions.* *Fred really enjoyed working through the programme. He is now displaying a really positive attitude towards reading and even mentioned to me that he now classes reading as one of his 'hobbies'.*
Sally	*Sally really enjoyed working with (the researcher). And enjoyed the experience and she would do it again without hesitation.*	*Sally has returned each time happy and looks forward to her sessions. It was great to see Sally excited about her learning in these sessions.*

Appendix 12

Fidelity Checklist (Intervention Phase A)

Date	Student	Session Code

Objective/Activity	**Recording**		
1. The researcher introduced visual timetable to child.	+	-	N/A
2. The researcher introduced or reviewed reading checklist.	+	-	N/A
3. The researcher and the child completed teaching activity which included: - book preview - reading book/text together - summarising text at the end	+	-	N/A
4. The researcher used modelling, guidance or nil/minimal prompting to complete the graphic organiser to summarise the text.	+	-	N/A
5. The researcher provided support during 25 minutes of Reading Eggspress activities. (Tally instances of support in random five minute sample of Reading Eggspress time)	+	-	N/A
6. The researcher and child completed 25 minutes of Reading Eggspress (+ or – 2 mins).	+	-	N/A
TOTAL: ( )/( ) = ( )			