

**A COGNITIVE STRATEGY TO IMPROVE READING
COMPREHENSION AND MENTAL STATE ATTRIBUTION
IN CHILDREN WITH AUTISM SPECTRUM DISORDER**

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By Sophia Worel-Dahl

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Abstract

Background: The skill to attribute mental states to the self and others, or Theory of Mind (ToM), is a problem seen universally amongst children with autism spectrum disorders (ASD) and may also affect the ability to make inferences about characters while reading narrative text.

Aim: The aim of this study was to teach four male participants with ASD an explicit cognitive strategy to answer inferential questions and provide feedback regarding their answers to improve their reading comprehension and ToM.

Method: A single case study ABC design was used to assess the effect of the intervention. The participants read five short narrative passages each session for 20 sessions, and answered one factual and one inferential question following each passage. Specific feedback was used to respond to the answers of each question in the intervention phase. Pre- and post-intervention levels of reading comprehension and ToM were measured.

Results: All four participants improved their reading comprehension in a pre and post-intervention test and three of the four participants improved their ToM understanding, although their ability to answer inferential questions involving ToM did not improve greatly.

Limitations: Limitations of the study include not asking enough inferential questions involving ToM each session. During post-hoc analysis of the results it became clear that the participants could have benefited from more practice of using the strategy. Individual reading ability should have been assessed before the intervention began to determine the appropriate reading level at the beginning of the intervention.

Conclusions: The explicit cognitive strategy had limited effect on participant's ability to answer inferential questions involving ToM; however the participants improved their scores on pre and post-intervention tests of reading comprehension and ToM. These results suggest

that making inferences in text may involve ToM and that the problems seen in the reading comprehension profiles of children with ASD may be attributed to their limited ToM skills.

Chapter 1

Introduction

The following chapter will provide a general overview of ASD, the characteristics that make this disorder unique and the challenges that children with ASD face in everyday life. An explanation will be given of the theoretical frameworks that have been developed to provide insight into the cognitive processing styles of children with ASD, how they influence academic achievement, especially reading comprehension. Aspects that influence successful reading comprehension will then be explored and the concept of inferential comprehension will be clarified. Finally, differences in reading ability in children with ASD compared with typically developing peers will be described and the concept of Theory of Mind and how this may influence deficits in inferential comprehension will be explored.

Autism Spectrum Disorders

Autism spectrum disorder is a developmental disorder characterised by impairment in communication and social relationships in conjunction with cognitive processing deficits (American Psychiatric Association, 2013). The current Diagnostic and Statistics Manual (DSM-V) now uses the umbrella term autism spectrum disorder to describe and diagnose what was known in the DSM-IV as autistic disorder, Asperger syndrome and pervasive developmental disorder not otherwise specified (PDD-NOS; American Psychiatric Association, 2000). The prevalence of ASD is at least 65 per 10,000 people in the population, and possibly as high as 110 per 10,000. Boys are more commonly affected than girls (El Zein, Solis, Vaughn, & McCulley, 2014).

Children who meet the diagnostic criteria for ASD show a range of strengths and weaknesses and their intellectual abilities can range from very low to well above average. Individuals with ASD who demonstrate average or above average intelligence and language

ability are often referred to as being 'high-functioning' (Randi, Newman, & Grigorenko, 2010) but these people can still experience severe social and academic impairment.

Children with ASD may have a variety of communication deficits; especially language delay. While many children with ASD never develop verbal language at all, among those who do, verbal ability is highly variable; ranging from normal to severely impaired (Norbury & Nation, 2011). The developmental trajectories and individual profiles of those who do develop language are varied, but even in children who are high-functioning, language development is commonly delayed. These delays are always accompanied by problems with comprehension; strange utterances and articulation; and illogical grammar (Boucher, 2012). Once they reach school age, most children with ASD who have developed some kind of oral language continue to have problems with comprehension, semantics, and morphology, but their articulation and syntax tends to improve. Lack of spoken language and comprehension can lead to problems with inappropriate verbal responses or difficulty sustaining a conversation, which can lead to problems in social skills (Boucher, 2012).

Social skills comprise particular verbal or non-verbal behaviours which are needed in order to establish social relationships and interpersonal communication. Examples of social skills include: reciprocal smiling; appropriate eye contact; posing or answering questions; and giving compliments (Boucher, 2012). The development of good social skills has been linked to positive personal growth, especially in terms of establishing peer relationships, achieving academic success and experiencing good mental health (Rao, Beidel, & Murray, 2008). Children with high-functioning ASD have impaired social skills and these impairments affect adequate development in all areas of life; such as school, emotional regulation, and interpersonal relationships (Rao et al., 2008). Social interaction impairment seen in children with ASD can include eye to eye gaze, body language, misreading nonverbal interactions and having difficulty forming friendships (American Psychiatric Association, 2000). They may

also lack social or emotional reciprocity and may not spontaneously seek to share delight, activities or accomplishments with others (Frith, 2003).

There are three core frameworks that have been developed to provide an insight into the cognitive processing styles of children with ASD: Executive Function; Central Coherence; and Theory of Mind (ToM). Each model addresses exclusive components of ASD and when jointly taken into account, can help give reasons for the mental processing style so frequently seen in people with ASD (Carnahan & Williamson, 2010).

Executive Functions are cognitive processes that regulate and control specific cognitive skills. These skills include: making plans; changing topics; giving and maintaining attention; problem solving; flexibility of thinking (Myers & Challman, 2010); working memory; moral reasoning; and self-regulation (Mash & Wolfe, 2010). Impaired Executive Functions are the reason for stereotyped behaviour and the narrow interests typically seen in individuals with ASD (Frith, 2003).

The term Central Coherence is based on the inclination of humans to understand stimuli in a global way that takes the wider situation into account (Mash & Wolfe, 2010). It is believed that people with ASD have weak Central Coherence, which means that they tend not to see the global context, instead, focusing on individual details (Myers & Challman, 2010). For example, when typically developing children do a jigsaw puzzle they focus on placing the individual pieces in the right place to complete the bigger picture; however, some children with ASD just enjoy fitting each piece together, even if there is no picture on the puzzle (Frith, 2003).

Theory of Mind is the cognitive ability to understand mental states such as the beliefs, desires, intentions and emotions of others (Baron-Cohen, 2001b). As a group, people with ASD have a reduced ability to take the view of others and to understand that other people

have intentions, awareness, and beliefs that may differ from their own (Myers & Challman, 2010).

Reading Comprehension

Deficits in communication, social skills and specific cognitive processing styles can all effect academic achievement, which varies widely within the autism spectrum. Students often present with a large difference between their anticipated skill level based on intellectual functioning and their actual success in spelling, reading, or basic number skills (Cronin, 2014). One area of academic achievement that nearly all children with ASD have lower achievement levels in, compared to anticipated ability, is reading comprehension (Brown, Oram-Cardy, & Johnson, 2012). Recent research has identified that children with ASD have inconsistencies in reading comprehension that differ from their intelligence (Åsberg, Kopp, Berg-Kelly, & Gillberg, 2010; Cronin, 2014; O'Connor & Klein, 2004). This is concerning because children who do not develop adequate literacy skills, will have many problems performing at school, functioning socially, and amongst in society generally (Woolley, 2011).

Reading is a complicated skill to master and proficiency relies on a number of processes that interrelate with each other: therefore, there are a number of reasons reading skills may not develop (Norbury & Nation, 2011). To be able to comprehend text depends on the reader's combined knowledge of printed words and language skills and their ability to actively relate that knowledge and to interpret and apply the information presented in written texts to what they know of the world (Carnahan & Williamson, 2010).

The Simple View of Reading

There are many different models that have been designed to define and understand reading comprehension. One commonly used model is The Simple View of Reading, which declares that reading comprehension is the outcome of word decoding and oral language

skills (Åsberg et al., 2010; Cronin, 2014; Woolley, 2011). There are several different skills that contribute to successful decoding and language comprehension. Word reading is attributed to text decoding, while successful listening comprehension stems from language ability. Although word reading and listening comprehension skills are separate from one another, problems in these areas can affect successful reading comprehension (Hogan, Bridges, Justice, & Cain, 2011).

Before successful word reading can be achieved, three basic skills need to be developed. These are sight word reading, decoding, and fluent reading of connected text (Cronin, 2014). When children first learn to read, comprehension is reliant on decoding skills. As children learn, these skills develop and become instinctive. Thus language skills start to be a more significant predictor of comprehending what they are reading (Hogan et al., 2011). Language skills best determine the level of reading comprehension proficiency in typically developing children. Oral language skills are acquired before learning to read; therefore, it is likely that reading ability is an outcome of children's strengths and deficits in language (Cronin, 2014). The connection between decoding and language comprehension alters with age. As children grow older, meta-cognitive strategies such as inference are a much more significant influence on reading success than phonological knowledge (Woolley, 2011).

A variety of language skills influence reading comprehension indirectly by influencing listening comprehension. Good listening comprehension involves the ability to make a mental representation of a story and use this to make sense of the story (Woolley, 2011). Vocabulary and grammar are referred to as lower level language skills which support word comprehension and sentence understanding in a story and create a basis on which to build higher level language skills (Norbury & Nation, 2011). These advanced language skills include comprehension monitoring, text structure knowledge, and inferential comprehension, and are required to create a mental representation intended by the text (Hogan et al., 2011).

Comprehension monitoring combines the skill to reflect on one's own understanding of a text and any irregularities within a text. For example, children who can read well usually know whether they understand what they read or hear and, when they experience a problem, they use a range of strategies to strengthen their comprehension (Hogan et al., 2011). Text structure refers to the type of text, for example narrative or expository text, and how the text is arranged, such as relationships across sentences and paragraphs (Hogan et al., 2011). The combination of prior knowledge of text structure contributes to the establishment of a larger mental representation of what is being read and expectations of elements in text to help guide comprehension. Brown et al. (2012) refer to semantic and interpersonal knowledge as being important in understanding text structure and combining it with prior knowledge. Semantic knowledge is the skill to know word meanings, and interpersonal knowledge refers to social cognition, which includes knowledge of human needs, emotions, behaviour, and mental states. Inferential comprehension helps the reader to complete a story and contemplate a deeper mental representation that goes further than the literal meaning of the text, which is easier to do. To reliably infer meaning from text requires the ability to access background knowledge. This is a highly complex cognitive skill, but one that proficient readers do automatically and constantly while reading. Poor readers fail to sufficiently make inferences, which results in weak mental representation of the text and lack of comprehension. (Åsberg et al., 2010; Bishop & Norbury, 2002).

Inference generation and understanding is necessary for successful reading comprehension (Clinton et al., 2012), because the reader must be able to fill gaps in the text and imagine situations outside the literal meaning of the words, thus building a complex mental representation. The reader needs to access their own background knowledge relating to the topic they are reading and apply their knowledge in a logical and rational way (Hogan et al., 2011).

There are many different types of inference (Woolley, 2011) and three distinct types are usually used by readers to help them correctly comprehend text. These are: cohesive; knowledge based; and evaluative inferences (Hogan et al., 2011). Cohesive inference is the ability to connect linguistic knowledge and to make connections between different sentences and clauses contained by the text. Knowledge based inference requires the reader to access background knowledge to acquire a logical and accurate mental representation of the text's content. To make an evaluative inference, the reader accesses background knowledge to make associations linking events of a story so that they can understand the motivation of characters and predict what the characters will do based on their emotional states. Knowledge based and evaluative inferences help readers to fill gaps and build comprehension of the text. Usually children find it easier to make text-connecting inferences than gap-filling inferences (Cain & Oakhill, 1999; Hogan et al., 2011). Most of the reading research does not differentiate between the different types of inference children make or the different types of inference they struggle with.

The Assessment of Reading Comprehension

There are many different ways to assess reading comprehension. Methods commonly used in research include: cloze tasks; true/false sentence recognition; multiple choice; and open-ended questions. Cloze tasks consist of sentences where a word has been removed and a substitute word to fill the gap has to be chosen, usually from 3-5 options. In the true/false sentence recognition assessment, several sentences follow a text that requires the reader to establish whether they are true or false in connection with what they have just read. Multiple choice tasks require the reader to select the correct answer to a question from several different options (Cain & Oakhill, 2006). Open-ended questions are used in many standardised assessments which consist of a basic structure where, after reading a text, students are asked questions to assess their recall and understanding of those texts. This

assessment process can be used to measure skills related to reading comprehension, such as inference making. However, the reader has to formulate a verbal response to the questions, and this extra cognitive effort may be difficult for children with expressive language problems, and their comprehension skills may be underestimated. There are significant differences in the ways reading comprehension and the skills related to comprehension are assessed and measured, such as inference generation, (Cain & Oakhill, 2006).

Reading Comprehension and ASD

Many children with ASD have impaired reading comprehension (Cronin, 2014), and there is extreme variability within this population when it comes to strengths and weaknesses in reading. Some of the variation of reading ability can be attributed to individual differences in oral language ability (Norbury & Nation, 2011). When compared to children with specific language impairment, children with ASD and language impairment demonstrate greater proficiency at word-level reading and exhibit superior decoding skills (Tager-Flusberg, 2006). Even within the ASD-language impaired group there is significant variation in ability, which suggests that language impairment alone cannot account for the variability in decoding and comprehension ability seen within this population (Norbury & Nation, 2011).

Some children with ASD have strengths in decoding words and can do so with superior precision and skill compared to typically developing children of the same age and ability (Attwood, 2000; Cronin, 2014; Norbury & Nation, 2011; O'Connor & Klein, 2004). Because children with ASD have strengths in decoding and sight word reading, does not mean that they comprehend what they are reading. This strength in decoding and deficit in comprehension has been coined hyperlexia in the literature (Cronin, 2014).

Other reasons that may account for the differences in reading comprehension skill relate to the social and cognitive discrepancies that are typical for people with ASD (Norbury

& Nation, 2011). Together, Executive Function, weak Central Coherence and Theory of Mind suggest that children with ASD have problems in organising, connecting, and monitoring the content of text, as well as understanding social situations and the emotions of others (Williamson, Carnahan, Birri, & Swoboda, 2014). These theories enable an understanding of the vital factors that are related to reading comprehension problems in children with ASD (Gately, 2008). For example, Executive Function problems are higher-level cognitive processes such as inflexibility, difficulties in planning and in self-monitoring. Two components of Executive Functioning connected to reading comprehension are decreased verbal working memory and the inability to plan and organise information. Both may reduce the individual's ability to comprehend written text successfully (Weissinger, 2013). Weak Central Coherence may make summarising important aspects and interpreting central themes in stories difficult (Frith & Happé, 1994; Williamson et al., 2014).

It is well documented throughout the literature that children with ASD have problems understanding the mental states of others (Baron-Cohen, 2001a). The same processes used to understand the mental states of people in daily life may also be used to understand characters in narrative stories (Weissinger, 2013), therefore, problems in ToM may hinder the development of social information that is acquired through reciprocal social interaction and is essential for making applicable inferences when reading (Carnahan & Williamson, 2010). Children with ASD also have better literal comprehension skills than inferential comprehension skills, and find it easier to answer factual rather than inferential comprehension questions (Cronin, 2014). For example, White, Hill, Happe and Frith (2009) established that children with ASD were better at making inferences about natural incidents from expository texts, but they had problems producing inferences about human behaviour and emotions in narrative texts. When combined with reading narrative text, inferential ability may be especially impaired in children with ASD. Deficits in ToM may reduce

comprehension when inferences must be made in text to understand social situations within the stories and the emotions and behaviour of the story characters, all which are necessary for successful understanding of what they are reading (Åsberg et al., 2010; Bishop & Norbury, 2002).

Theory of Mind

Theory of Mind refers to the understanding of mental states and the ability to understand the mental states of others. It is the implicit and unconscious ability to understand and reason about the intentions, imagination, emotions (Baron-Cohen, 2001a), beliefs, knowledge, desires (Wellman, 2012) and thoughts of the self and others (Hutchins & Prelock, 2008). ToM (sometimes referred to in the literature as ‘mentalizing’ or ‘mind blindness’) gives us the capacity to measure associations between external conditions and internal states of mind (Frith, 2003). Having ToM means one has the skills to be able to contemplate the contents of one’s own mind, and those of others (Baron-Cohen, 2001b). Every typically developing child gains this mental ability from an early age, and continues to possess and use it with varying degrees of skill throughout their lives (Baron-Cohen, 2001a).

Developmental Stages of Theory of Mind in Typically Developing Children

There are different phases in the development of ToM that have been hypothesized by researchers although there remains controversies over what those phases are and when they take place. The first proposed phase begins between 6-12 months of age, when children start to engage in episodes of joint attention (Miller, 2006). This is established through gaze following, pointing, and communicative gestures. Joint attention results in an awareness of the surroundings and others’ intentions, and often includes shared enjoyment and shared emotions (Hutchins & Prelock, 2008). The second phase is the ability to understand that people can have different desires from one’s own. This usually occurs with the onset of

verbal language at approximately 13-24 months (Miller, 2006). The third phase begins at approximately 3 years of age and is the ability to understand that people do not have the same beliefs, even different beliefs about the same circumstance. At around this age, children also develop the ability to understand that seeing leads to knowing, or that something can be true, but someone else might not know that (Wellman, 2012).

The traditional hallmark achievement is false-belief, which is the fifth phase of ToM development, and is the ability to understand that something can be true, but someone else might falsely believe something different (Wellman, 2012). It usually develops around age 4-5 years (Hutchins & Prelock, 2008). The most advanced stage of ToM development is the ability to understand hidden emotion. This ability usually develops between ages 6-7 and means that someone may feel one way, but display a different emotion (Wellman, 2012). This is also referred to as second-order false-belief and is a more advanced insight of mind that requires the ability to “think about what other people are thinking” (Hutchins & Prelock, 2008, p. 344).

Most researchers now believe that understanding false-belief is just one of the many aspects of ToM development, and that ToM develops within a reliable sequence (Peterson, Wellman, & Liu, 2005). Children with ASD follow a slightly different progression of ToM development. Although the onset is usually delayed, the sequence mirrors that of typically developing children until the false-belief stage is reached, where research indicates that false-belief is more difficult than hidden emotion for children with ASD to understand (Peterson et al., 2005).

Measuring Theory of Mind skills

Despite false-belief being the most difficult aspect of ToM for children with ASD to master, it is the most common task used in research to measure ToM understanding. Wimmer

and Perner (1983) were the first to develop the false-belief task. They recognised that typically developing children from age four could understand that another person can have a false-belief and predict their behaviour appropriately (Wimmer & Perner, 1983). Their false-belief task was adapted by Baron-Cohen, Leslie, and Frith (1985) in their landmark study that identified that children with ASD show a considerable deficit in ToM understanding. The test they developed was called The Sally-Anne False-Belief Task. In this task a child is presented with two dolls, one called Sally, the other called Anne. The child is then shown that Sally has a basket, and Anne has a box. The researcher plays out the following scenario: Sally has a ball that she puts into her basket before leaving the room. While Sally is gone, Anne takes Sally's ball out of the basket and puts it in her box. Sally comes back into the room and wants to play with her ball. The child is asked '*where will Sally look for her ball?*' The answer to this is the basket. This is where Sally put the ball, and because she did not see it being moved, she believes that the ball is still where she put it. Children with ASD fail to understand that Sally has a false-belief; therefore, if Sally did not see the ball being moved to the box, she must still believe that it is in the basket. The answer of a child with ASD would typically be '*in the box*' because this is where they know it is (Frith, 2003).

Milligan, Astington and Dack, (2007) identify four different categories of false-belief tasks. These are: change of location; unexpected-identity; deception task; and belief-emotion. The Sally-Anne task is a change of location task and is the most commonly used in research on ToM. Since the Sally-Anne task was first developed, there have been many different versions of it used for identifying false-belief understanding in children with ASD. Examples include the Maxi Task and The Bears Task, both of which follow the same procedure as The Sally-Anne Task. Unexpected-identity tasks are also often used, the most common of which is The Smarties Test. This test consists of a Smarties box, where instead of containing lollies, the box contains a pencil. As with the Sally-Anne task, children are asked what they think is

in the box, and are then shown that it contains a pencil, not lollies. They are next asked what someone else would think was in the box; the correct answer being Smarties. Children with ASD usually answer incorrectly, believing that other people know what they know and will therefore think that the box contains a pencil (Frith, 2003).

There are many other types of unexpected-identity tasks that researchers have developed, all involving a similar structure to The Smarties Test. However, most false-belief tests are not tested for their psychometric properties, such as reliability or validity, and are not used for diagnostic purposes. Grant, Grayson, and Boucher (2001) assessed the reliability and validity of one change of location task (Sally-Anne Task) and three different unexpected-identity tasks. They found that all four false-belief tests had high reliability, good consistency, but low convergent validity. They concluded that the tasks varied from each other in many ways, including their wording, items or props used, or the actions the child must complete. Therefore they appear not to be measuring exactly the same thing and may produce slightly different results as they require different cognitive skills (Grant et al., 2001).

The fixation with false-belief may conceal the importance of other ToM development (Wellman, Cross, & Watson, 2001). Earlier achievements in ToM acquisition such as joint attention and emotional recognition are often described as prerequisites to the more complex ToM characterised by false-belief achievement (Hutchins & Prelock, 2008), but are rarely tested. In response to this problem, Happé (1994) developed an alternative to the false-belief task. She developed a series of stories that provided a means to test the ability to understand mental states. These stories came to be known as the *Strange Stories*. They consist of eight short stories that a participant reads and is afterwards asked a question to explain why something was not literally true, although the character in the story says the opposite. Successful answers need to assign mental states such as desires, beliefs or intentions to the characters in the story (Happé, 1994).

Many children with ASD repeatedly fail false-belief tasks that can be passed by typically developing children who are much younger (Baron-Cohen et al., 1985). Happé (1995) discovered that once children with ASD reach a verbal mental age of 11 years they have an 80% chance of passing a false-belief task, compared to 5 years for typically developing children; therefore, many children with ASD cannot be tested with regular false-belief tasks, because they lack the cognitive and verbal skills that are necessary to answer the questions (Peterson et al., 2005). Language ability may play an important part in the development of false-belief understanding (Milligan et al., 2007). However, weak oral language skills such as poor vocabulary, are shown by some, but definitely not all, children with ASD (Åsberg et al., 2010; Bishop & Norbury, 2002), whereas ToM deficits are universal among children with ASD (Tager-Flusberg, 2007).

There has been a plethora of research over the last 30 years investigating ToM deficits in children with ASD, with most studies testing various false-belief tasks on various populations. As discussed above, ToM is important for making inferences in real life about the mental states of others, and may also be important for making inferences while reading. However, limited research has actually been conducted to try and teach ToM to children with ASD. The following chapter will review the current literature on interventions to teach ToM skills to children with ASD, followed by a review of interventions aimed at improving reading comprehension skills.

Chapter 2

Literature review

Interventions for Theory of Mind

Interventions for Theory of Mind are treatments or therapies that target skills which lead to successful acquisition of ToM. A successful intervention may improve the problems in social interaction and communication that are so debilitating for children with ASD. To date there has been no review of interventions for ToM, even though the first study endeavouring to teach ToM was published in 1995. A literature search was conducted to establish what type of interventions had been developed to teach ToM to children with ASD. Studies for the review were included if they reported an applicable intervention linked to ToM or taught specific strategies that may build ToM skills such as social skills and measured ToM ability post-intervention. The studies needed to be published in a peer reviewed journal from 1995 to 2013 and include participants who had been diagnosed with ASD and were aged between 6-18 years. Three main types of ToM intervention were established after reviewing the literature. These were: social skills training; emotional regulation skills; and direct strategy instruction of ToM itself such as teaching false-belief. These studies will be described in more detail below.

Interventions to Teach Social Skills

Impairment of social skills is seen as the primary symptom of ASD. Social skills are defined as “specific behaviours that result in positive social interaction and encompass both verbal and non-verbal behaviours necessary for effective interpersonal communication” (Rao et al., 2008, p. 353). Examples of appropriate social skills include: making eye contact and smiling when talking with others; asking and answering questions; and giving and receiving compliments during social interaction. These social interactions lead to positive interpersonal

relationships, peer inclusion, higher academic achievement and better mental health; therefore, when children have problems with social skills it affects all areas of academic, emotional and social development. Children with ASD typically have problems with making eye contact, initiating social exchanges, understanding emotions, displaying empathy for others and understanding verbal and non-verbal communication (Rao et al., 2008). This deficit in appropriate social skills can be explained by ToM. Interventions often focus on teaching specific social skills, such as listening or conversational skills, with the hope that these will improve overall social skills and thus improve ToM. Less often interventions aim to teach explicit social cognition skills that lead to ToM, such as correctly combining, understanding and reacting to social cues (Kandalaft, Didehbani, Krawczyk, Allen, & Chapman, 2013).

Specific social skills thought to influence one's ability to understand mental states were taught to nine male adolescents aged between 13.5-14 years (Ozonoff & Miller, 1995). These were focused on improving social interactions, conversation, perspective-taking and explicit ToM skills. The intervention programme occurred weekly for 4 ½ months and each session lasted for 90 minutes. Each social skill was discussed among participants and researchers in a group before being modelled by the researchers through role-play. Participants next created their own role-play of the skill which was videotaped and watched. The first group of skills was designed to teach basic communication such as how to maintain interesting conversations, or how to understand non-verbal signals and emotional expressions. In the second group of skills, the researchers concentrated on teaching perspective taking and direct false-belief skills. For example, participants were taught that visual perspectives may differ, and beliefs could also vary (someone can know something that another person does not). Lessons in advanced perspective taking were also included such as imagining that one person can think about what another person thinks (Ozonoff &

Miller, 1995). Results indicated that performance on the ToM measures greatly improved for 4 of the 5 participants' in the treatment group between pre- and post-intervention. Ratings of participant's social skills by parents and teachers did not change from pre-treatment to post-treatment. This study found that tactics for solving false-belief tasks can be taught. However, the ability to use the new skills in everyday conversations and interactions continued to be limited as rated by participants' parents and teachers (Ozonoff & Miller, 1995).

Multimedia animated film clips formed the focus of a social skills training programme to teach ToM skills and social interactions to an 11 year old male with ASD. The intervention consisted of 45 sessions and at each session the participant was taught one ToM skill and one social skill. The skills taught followed a sequence in a hierarchy corresponding to the complexity of the task. The hierarchy began with identifying desire-based emotions, identifying basic belief, expressing one's own emotions, controlling anger, advanced level ToM, and conversational interactions. Results indicated that the programme provided considerable progress in the attainment of ToM and appropriate social skills during each phase of testing, with the mean number of social interactions increasing from 5.7 during the baseline phase to 18.4 during the training phase. Scores on the ToM measure also improved greatly by 35.9% from pre-test and post-test (Feng, Lo, Tsai, & Cartledge, 2008).

A group treatment programme was used to teach 40 children aged 8-13 years specific social skills relating to ToM, including emotional awareness. Firstly, skills needed to develop ToM were taught, including listening to others; learning to assess a social situation; and learning to recognise others' intentions and emotions of other people. Following this, fundamental ToM skills were taught such as thinking about how other people feel and think, and ways deceit and deception are used. The final set of social skills related to practicing mental state attribution to others. ToM was measured using the ToM test which includes precursor skills to ToM such as emotional recognition, elementary skills including false-

belief and advance ToM including second order false-belief and humour. Results indicated that the conceptual understanding of ToM improved among participants but no treatment effect was found on the simpler ToM understanding such as perception, imitation, emotional recognition, or advanced ToM skills. Neither emotional awareness nor empathy scores improved (Begeer et al., 2011).

Interventions to Teach Emotion Recognition Skills

Evidence suggests that children with ASD have problems recognising emotion shown through facial expressions. Emotion recognition skills are believed to be an important part in the growth of more intricate social skills leading to ToM understanding. Williams, Gray and Tonge (2012) developed a DVD programme called *Transporters* featuring cars with faces of people, to teach children with ASD emotion recognition skills. The intervention was tested in a randomised controlled trial of 55 children aged between 4-7 years with low range cognitive ability. Participants watched the DVD at home every day for four weeks and their skills in identifying basic emotions, mindreading and ToM tasks were measured at the beginning and end of the intervention and at the 3-month follow-up. Learning about emotions through the DVD produced minimal generalisation to ToM tasks or to increased emotion recognition (Williams et al., 2012).

Interventions to Teach Direct ToM skills

Teaching direct ToM skills such as false-belief to children with ASD may provide them with another method of interpreting mental states. Children with ASD are able to learn strategies well because they have cognitive strengths for rote-learning and repetition. They also benefit from visual instruction which many ToM interventions include. They can then apply the strategies directly to other situations that require ToM. Several studies have also tried to teach direct strategies for thinking about thoughts using photographic or visual

representations of thoughts. This includes using thought bubbles or thoughts as pictures in the head to provide a way to think about mental representations (Wellman et al., 2002). These strategies will be described in more detail below.

Thought Bubbles. Thought bubbles like those used in cartoons and comics were used to teach 7 children with ASD a picture-in-the-head analogy to help them understand mental states (Wellman et al., 2002b). Using a Sally-Anne figure, instruction included demonstrations of how to use the concept of thought bubbles and how they can be used to depict the thoughts of a person. The programme consisted of six stages. Stage 1 introduced thought bubbles to the participant, stage 2 focused on thoughts about objects which although cannot be seen, will remain as they are. Stage 3 focused on thoughts about items which cannot be seen but have changed location, stage 4 taught thoughts about objects that are out of sight but stay put, stage 5 taught false-belief thoughts about hidden objects that have been moved and stage 6 used Sally-Anne false-belief tasks but did not include thought bubbles (Wellman et al., 2002b). The researchers found that all the participants progressed as far as stage 3, and five children progressed to stage 6. Pre-test and post-test results of false-belief tasks indicated a significant change from 14 per cent correct answers to 86 per cent correct answers of the post-test false-belief task (Wellman et al., 2002b). Results showed that successful completion of the intervention only produced moderate generalisation to other ToM tasks. The same thought bubble analogy was used in a follow-up study with 10 different participants but the intervention was also personally tailored to each child's individual interests. Results were much better compared to the first study with eight of the participants proceeding as far as stage 3. Tests on false-belief understanding changed from 30 per cent correct at pre-test, to 80 per cent correct at post-test (Wellman et al., 2002b).

A recent study re-visited the concept of thought-bubbles for teaching ToM to 24 children with ASD (Paynter & Peterson, 2013). Participants were given training on how to

represent beliefs using cartoon bubbles. Materials consisted of two-dimensional cardboard bubble cut-outs. The procedure followed that of Wellman et al. (2002b) and consisted of five graduated training stages that mirror the ToM developmental stages devised by Wellman et al. Pre and post-tests of the ToM scale (Peterson et al., 2005) and 6 false-belief tasks were administered to assess gains in ToM understanding. Results indicated that gains were made by participants in the false-belief tasks, which also generalised to other ToM concepts on the ToM scale. Improvement was shown post-test and maintained at follow-up three weeks later (Paynter & Peterson, 2013).

Photos in the Head. To help them understand false-belief, eight children with ASD were taught a strategy that photos are like thoughts inside someone's head (Swettenham et al., 1996). The average age of participants was 11:6. Teaching participants the strategy took place over five days at the participants' schools with one session per day and each session was approximately 40-60 minutes in length. The analogy that 'photos are like thoughts inside someone's head' was taught by cutting a slot in the top of a life-size manikin head, and placing a photo actually inside the manikin's head.

The intervention was divided into 4 stages: stage 1 consisted of teaching simple rules of the photo analogy; stage 2 taught simple strategies for answering false-belief tasks; stage 3 taught exact instructions connecting the photo to mental states; and stage 4 taught strategies to link photos to actions. All 8 participants passed stage 1, and 7 participants passed stage 4, but all participants failed stage 2 and 3. Four false-belief tests were given pre- and post-intervention to assess whether participants were able to generalise the strategies taught. The rate of participants who passed the false-belief tasks increased at post-test for three of the four false-belief tasks. Results from this study indicate that when children with ASD are explicitly taught the strategy to identify the connection between photos and action they were

able to predict behaviour, but none of the participants were capable of using photos to infer mental states, in spite of being explicitly taught how to do this (Swettenham et al., 1996).

Using the photos-in-the-head analogy, Fisher and Happé (2005) taught ten participants aged between 6 and 15 years old a strategy to think about beliefs as photos inside the head based on that used by Swettenham et al., (1996). Training included one-on-one instruction using illustrated stories, dolls with slots in their heads and Polaroid photos. The training sessions lasted for 25 minutes per day for 5-10 days. Results indicated that performance on a range of false-belief tasks improved significantly from pre- to post-test and some participants were able to use the strategy to solve different false-belief scenarios. However, teacher rating of real life ToM use did not change (Fisher & Happé, 2005).

Direct False-Belief Training. False-belief was taught directly to children with ASD, Down's Syndrome, and a group of three year old typically developing children using an intensive digital adaptation of the Sally-Anne false-belief task. The chronological age range of the group with ASD was 5:6 -15:10 years, their non-verbal mental age ranged from 3:9-4:9, and their verbal mental age ranged from 3:1-4:2. Each group consisted of eight children, with each group matched for verbal mental age. Non-verbal mental age was matched closely as possible across the three groups (Swettenham, 1996b).

The Sally-Anne false-belief games incorporated music, text and cartoons and were controlled by the participant using a computer mouse. The games consisted of two people, a door where the people in the game either left or entered, and two places where the ball was hidden. Instructions were presented on the screen as well. Correct responses to the question "where does Sally think the ball is?" resulted in music playing and a message appearing on the screen saying "yes, well done." If the participant chose the incorrect response, a message appeared saying where Sally thought the ball was and to try again. If the third response was also incorrect a direct instruction was given to look in the correct place. The participant could

only continue with the game if the correct location was chosen (Swettenham, 1996b). A participant's progress was measured by false-belief tasks, including the Sally-Anne false-belief computer game without instructions, the Sally-Anne False-Belief Dolls Task, The Smarties Task, The False Breakfast Task, and The ToM Task. All three groups showed stable growth in the amount of correct trials needed to complete the training programme.

Participants from the group with ASD were able to transfer their skills to the post-tests of false-belief understanding using the Sally-Anne Tests but did not score as well on the other false-belief tasks. The authors state that it is unclear why the skills taught during the computer programme did not transfer to the other false-belief tasks, but concluded that it may be that they actually did not learn the notion of false-belief; instead they acquired a substitute strategy to answer the questions correctly, or they may have learned the Sally-Anne task by heart (Swettenham, 1996b).

Summary of Theory of Mind Research

In total there were eight studies involving a total of 173 participants who had a diagnosis of ASD and were aged from 6 to 18 years of age included in this literature review (for a summary see Tables 1-3). There were three different types of instructional strategies used. These included teaching ToM via social skills, emotional recognition and direct methods such as thought bubbles, pictures in the head, or explicit false-belief training. The number of training sessions ranged from five to 16 sessions, and the total number of sessions ranged from five to 53.

Three interventions aimed to teach ToM via social skills training (Begeer et al., 2011; Feng et al., 2008; Ozonoff & Miller, 1995). Effect sizes of ToM tests were large in size and ranged from $d = 1.4$ - 1.6 . Only one study (Feng et al., 2008) produced large effects on the measure of social skills ($d = 2.20$). Effect sizes of the other two studies of social skills tests ranged from small ($d = 0.09$) to medium ($d = 0.36$). One study aimed to teach ToM via

emotional recognition training (Williams et al., 2012). Poor effects were found for both the ToM measurement ($d= 0.19$), and the emotion recognition task ($d= 0.09$). There were five studies that taught direct strategies to improve ToM and all five studies measured ToM acquisition using a false-belief ToM measure. Two studies aimed to teach ToM directly using a photos in the head strategy (Fisher & Happé, 2005; Swettenham et al., 1996). Effect sizes of false-belief ToM understanding were large for both studies ($d= 0.6$; $d= 2.33$). Two studies also aimed to teach ToM using a thought bubble strategy (Paynter & Peterson, 2013; Wellman et al., 2002b), and also demonstrated large effect sizes ($d= 1.93$; $d= 2.41$). Swettenham (1996b) taught false-belief strategies directly and achieved highest calibre effects ($d= 2.59$).

The studies included in this literature review demonstrate that it is possible to teach children with ASD strategies to improve ToM. In 6 of the studies, ToM was only measured by a series of false-belief tasks. Two social skills studies used an alternative ToM measurement that included a wider range of ToM skills. However, the authors in the studies all state problems with generalisation of ToM skills to untaught false-belief tasks once the intervention was concluded. Differences in outcome measurements may show a lack of generalisation of skills past the exact taught items, with many authors concluding that the participants' rote-learn strategies, but then cannot apply these strategies to different or real-life situations. As the false-belief tasks measure slightly different things, and require different cognitive abilities, using a range of different false-belief tasks may not be the most optimum test to measure ToM ability. ToM can be taught to children with ASD and yet there is no evidence of research being conducted to address teaching ToM to improve other areas in life such as education.

Table 1*Summary of Interventions to Teach Social Skills*

Study	Participants and Setting	Purpose	Instruction Method	Experimental Design	Measurement	Results	Effect Size
Ozonoff & Miller (1995)	9 males ASD Age range: 13.5-14 years Classroom	To teach social skills and assess whether they can increase skills necessary to infer mental states of others	The social skills training programme consisted of weekly sessions each 90 minutes long. Social skills taught were: basic interactional and conversational skills; perspective taking and theory of mind; and second order perspective taking. Group discussion, role-play and modelling were used and videos were made of participants role-play	No-treatment control design.	False Belief Tasks Social Skills Rating System (parent & teacher)	Overall performance composite of ToM measures show increase over time from pre-post intervention for treatment group. No significant effects were found in parent or teacher rating of social skills	ToM composite effect sizes $d= 1.6$ Social skills: Parent report $d= 0.2$ Teacher report $d= 0.09$

Table 1*Summary of Interventions to Teach Social Skills (continued)*

Study	Participants and Setting	Purpose	Instruction Method	Experimental Design	Measurement	Results	Effect Size
Feng et al., (2008)	1 male ASD Age: 11 years IQ= 85 In the school facilitated by one teacher and including five additional peers	To assess the how a ToM and social skills training programme might affect the ToM skills and social relationships	Training took place four times per week for 40 minutes. The intervention was separated into two stages, each containing one ToM part and one social skills part. The programme was developed in a graded order depending on how hard the material was. All the materials were animated using multimedia to deliver visual cues to enable learning. All situations used reflected situations the participant would face in his daily life	Single subject multiple-probe design across behaviours and settings	Test of Theory-of-Mind Frequency and percentage of social interactions	ToM and social skills programme delivered considerable advances in the achievement of ToM and suitable social skills	ToM $d= 1.4$ Social skills $d= 2.20$

Table 1*Summary of Interventions to Teach Social Skills (continued)*

Study	Participants and Setting	Purpose	Instruction Method	Experimental Design	Measurement	Results	Effect Size
Begeer et al., (2011)	40 children ASD Age: 8-13 years Small group setting	To increase the ToM skills and empathy in children with High Functioning ASD	Intervention included 53 structured sessions in groups. To begin precursors to ToM were taught (perception, imitation, emotion recognition, pretence), then participants moved on to elementary ToM understanding (belief and false belief understanding), and advanced ToM understanding (second order reasoning and the use of irony and humour)	Randomised controlled trial	The Theory of Mind Test. Levels of Emotional Awareness Scale for Children Index of Empathy for Children and Adolescents The Children's Social Behaviour Questionnaire	Overall conceptual understanding of ToM improved compared to control group, but elementary understanding of self-reported empathetic skills or parental reported social behaviour did not improve	ToM total $d= 1.49$ LEAS-C $d= .36$ Index of Empathy $d= 0.02$ CSBQ $d=0.14$

Table 2*Summary of Interventions to Teach Emotion Recognition Skills*

Study	Participants and Setting	Purpose	Instruction Method	Experimental Design	Measurement	Results	Effect Size
Williams, Grey, Tonge (2012)	55 children ASD Intervention n= 28 (89.3% male) (Transporters DVD) Control n= 27 (Thomas the Tank Engine DVD) Age: 4-7 years Intervention took place at the participant's home	To teach children with ASD emotion recognition skills using a DVD programme called <i>Transporters</i> featuring vehicles with human faces	The intervention and the control group each watched different DVD's at home for 15 minutes per day for 4 weeks.	Randomised controlled trial	NEPSY-II affect recognition NEPSY-II TOM Tasks	Learning about emotions through the DVD produced minimal generalisation to ToM tasks or to increased social skills in the intervention group	NEPSY-II Identifying emotions <i>d</i> = 0.19 Matching emotions <i>d</i> = 0.18 ToM verbal score <i>d</i> = 0.09 ToM contextual <i>d</i> = 0.36

Table 3*Summary of Interventions to Teach Direct Theory of Mind Skills*

Study	Participants and Setting	Purpose	Instruction Method	Experimental Design	Measurement	Results	Effect Size
Wellman et al., (2002)	7 males with ASD Age: 8-18 years (m = 11:2) MA: 4:0-6:6 years (m= 5:6) Teaching and testing were conducted individually in a quiet room	To use thought bubbles to teach children with ASD a picture-in-the-head strategy to help them understand mental states	Teaching the intervention required up to five sessions, approximately 30 minutes per day. Participants were trained with cardboard figures of a doll (Sally-Anne), and cardboard cut-outs of objects (ball, hat, apple). The intervention consisted of 6 stages, and participants had to pass a stage before moving on to the next	Within subjects design	ToM: a series of false-belief tests; Sally-Anne, The Smarties Task, 'Bears', and Seeing-Knowing task	Pre-test and post-test results of false-belief tasks indicate a significant change from 14 per cent correct answers to 86 per cent correct answers of the post-test false-belief task	Sally-Anne $d = 1.93$ Smarties task $d=1.43$ Bears $d=2.07$ Seeing-Knowing task $d= 0.95$

Table 3*Summary of Interventions to Teach Direct Theory of Mind Skills (continued)*

Study	Participants and Setting	Purpose	Instruction Method	Experimental Design	Measurement	Results	Effect Size
Paynter and Peterson (2013)	24 children with ASD Age: 4-12 years Participant's school	Participants were taught to use cartoon bubbles to signify beliefs with the hope that this would increase ToM development	Using two dimensional stimuli participants were taught how cartoon thought bubbles can stand for beliefs. Five training stages were developed to mirror ToM development.	Randomised controlled trial	Sally-Anne false-belief Task ToM scale	Improvements in the false-belief tasks, and generalised to the ToM scale. Gains were maintained at follow-up three weeks later	Total false-belief $d=2.41$ Total ToM Scale $d=1.13$

Table 3*Summary of Interventions to Teach Direct Theory of Mind Skills (continued)*

Study	Participants and Setting	Purpose	Instruction Method	Experimental Design	Measurement	Results	Effect Size
Sweettenham et al., (1996)	8 children with ASD. Age range = 8:9-14:4 years VMA = 5:0-6:0 years A quiet room in the school	To teach a specific strategy that people have photos in their heads to help children solve ToM tasks	The intervention took place for 40-60 minutes for 5 days. A hole was cut in the top of a life size manikin head which enabled photos to be inserted to literally demonstrate photos in the head. Photos of objects were prepared beforehand. Each child was taught a number of rules linking the photo to mental states	Within-Subjects design.	The Sally-Anne False-Belief Task. The Smarties Task. The Appearance-Reality Task. The Seeing-Leads-to-Knowing Task	Three of the post-test false-belief tasks were successfully completed by more participants compared to pre-test except for the Appearance-Reality Test which had no change. None of the participants were capable of using photos to infer mental states	Composite score of ToM transfer tasks $d=2.33$

Table 3

Summary of Interventions to Teach Direct Theory of Mind Skills (continued)

Study	Participants and Setting	Purpose	Instruction Method	Experimental Design	Measurement	Results	Effect Size
Fisher & Happé (2005)	27 children ASD Age: 6-15 years VMA: over 4:3 years Individual training	To teach the photos-in-the-head analogy to understand false-belief	Training took place for 5-10 days for 25 minutes each day. The intervention consisted of five stages, each containing a demonstration and questions to ensure the tasks were understood. Two dolls with slots cut in their heads were used to explain the 'picture in the head' analogy. The photos were then inserted into their heads	Randomised controlled trial	Sally-Anne & Smarties False-Belief Tasks ToM: Penny Hiding Deception Task Seeing Leads to Knowing Children's "Reading the Mind in the Eyes" Task	Both intervention groups improved on the ToM measures, while the control group showed no improvement	ToM group pre-post $d = 0.6$ pre-follow-up $d = 0.2$

Table 3

Summary of Interventions to Teach Direct Theory of Mind Skills (continued)

Study	Participants and Setting	Purpose	Instruction Method	Experimental Design	Measurement	Results	Effect Size
Sweettenham (1996)	8 children with ASD 8 children with Down's Syndrome 8 typically developing three year olds Setting not stated	To assess the effect of teaching false-belief tasks using a computerised version of the Sally-Anne false-belief task to children with ASD, Down's Syndrome, three year old typically developing children	The intervention phase consisted of 8. All the false-belief tasks were given pre-and post-intervention. Follow up occurred with the same false-belief tasks three months after the end of the intervention. Two types of computer games were used, each incorporated written instructions that appeared on the monitor which the researcher read aloud to the participant	Within-subjects design	False-belief computer games. Sally-Anne false-belief dolls task. The Smarties Task. The False Breakfast Task. The Tom Task	Participants with ASD were able to transfer their skills to the post-tests of false-belief understanding using the Sally-Anne Tests but did not score as well on the other false-belief tasks	Overall ToM score comparing ASD group and Down syndrome group $d=2.59$

Teaching Reading Comprehension to Children with ASD

In the past, research has focused on reducing challenging behaviour and improving communication skills in children with ASD rather than developing interventions to increase academic achievement (El Zein et al., 2014). Among the academic difficulties that children with ASD may have, problems with reading comprehension are prevalent (Attwood, 2000; Cronin, 2014; Norbury & Nation, 2011; O'Connor & Klein, 2004). There are many studies that have focused on improving reading comprehension for children with learning disabilities (Stagliano & Boon, 2009) and typically developing children (Takala, 2006), but comparatively few studies have been conducted specifically with children with ASD (Randi et al., 2010).

A comprehensive search of intervention studies was conducted using electronic databases such as EBSCO and Google Scholar. Search terms included combinations of descriptors (autism, ASD, reading comprehension, intervention, reading intervention). The studies needed to be published in a peer reviewed journal from 2003-2013. Further selection criteria included interventions to target reading comprehension skills, and teach a specific strategy to improve reading comprehension skills. A total of four studies met these selection criteria. Several literature reviews were also identified, and in light of the limited research in this area will be discussed below.

Several literature reviews on reading comprehension interventions for children with ASD have been conducted (Chiang & Lin, 2007; Randi et al., 2010; Whalon, Al Otaiba, & Delano, 2009). Many studies that include children with ASD are often instructional approaches to teach reading comprehension, and not interventions that teach a specific strategy to target the particular reading comprehension difficulties of individual students (Randi et al., 2010). For example, Chiang & Lin (2007) identified four studies that were developed to teach students to analyse text comprehension, while the additional studies

focused on sight word comprehension. A more recent literature review was conducted of eleven evidence-based studies that aimed to teach children with ASD reading, including comprehension (Whalon et al., 2009). The researchers state that many interventions that have been helpful in increasing reading skills for typically developing children have also been adapted for children with ASD; however, there has been considerably less research focused on teaching strategies to children with ASD to improve reading comprehension (Whalon et al., 2009).

Whalon and Hanline (2008) developed an intervention involving reciprocal questioning and a story map framework strategy to increase reading comprehension ability in three boys with ASD who were aged between 7 and 8 years old. Each child was assigned to one of three general education peers, and they were taught the intervention in cooperative pairs in a special education classroom (Whalon & Hanline, 2008). Participants' reading comprehension ability was assessed at the beginning of the study using the Oral Reading Fluency (ORF) and the Retell Fluency (RF) subtests of the Dynamic Indicators of Basic Early Literacy (DIBELS). The RF is deemed to confirm whether the ORF score reveals overall reading ability including comprehension. "The RF score should be approximately half of the ORF score to be considered a good indicator of overall reading ability" (Whalon & Hanline, 2008, p. 369). The scores of the participants in this study were considerably less than half of their ORF scores indicating major reading comprehension problems. For example, one participant aged 7 years 5 months, read 78 words per minute on the ORF subtest which is well above average for his age (44 words per minute). However, on the RF subtest, his recall of the content contained only five words connected to the story.

The intervention took place 4 days per week lasting 40 minutes and averaged between 26-31 sessions. Participants had access to the following materials: copies of a narrative storybook which were read aloud; self-monitoring checklist; story cards including parts of a

story, matching picture, and general question; question cards (i.e., who, what, when, where, why and how); and a Velcro storyboard (Whalon & Hanline, 2008). Students were taught to match note cards to the appropriate element of a story card to make sure they had adequate understanding of the elements a story is made up of, for example; setting, characters, events, problem, and solution. They then were taught to ask or respond to questions relating to these elements using question word cards. These included using 'where' questions to ask or respond to questions about setting, 'who' questions to ask or respond to questions about characters, 'why' questions to ask or respond to questions about events or problems, and 'what' questions to ask or respond to questions about solutions (Whalon & Hanline, 2008). Correct responses to these questions were included as the dependent measures, but the researchers did not differentiate between factual and inferential question responses.

Instruction began by verbally guiding the participants through each procedure needed to answer a question while reading. When a question was asked, the researcher placed the story card showing the related part of a story on the storyboard followed by the suitable question card. Participants were then instructed to ask a question using the question card. After session two, the researcher provided scaffolding to participants which included verbal prompting, modelling and corrective feedback when the child gave a wrong answer to a question (Whalon & Hanline, 2008). Corrective feedback to the child's response included using the child's response in the correct context, and then modelling the correct response.

Percentage of non-overlapping data (PND) was estimated for each study, based on the highest baseline point in the initial baseline phase. PND is computed as the percentage of phase B data above the single highest phase A data point. PND can range from 0% to 100%. Analysis guides indicate a score of >70% for effective interventions, 50% to 70% for questionable effectiveness, and <50% for no observed effects (Parker, Vannest, & Davis, 2011). Results for this study indicated the intervention was highly effective for all three

participants who all showed 100% PND for correct responses to comprehension questions (Whalon & Hanline, 2008).

Limitations of this study include no post-intervention administration of the DIBELS subtests to measure change in ORF or RF and the researchers did not differentiate between the responses to factual or inferential questions, therefore the results may be skewed towards basic factual recall and comprehension, and it is difficult to make assumptions of the effect of the intervention on a participant's higher level processing of inferential reasoning.

Stringfield et al. (2011) studied the effects of a story map graphic organiser on the reading comprehension of three boys with ASD who were aged between 8 and 11 years. The study utilised a multiple baseline across participants design and consisted of a total of 42 sessions. Reading comprehension was assessed pre-intervention using a standard running record and an Accelerated Reading (AR) programme, both of which were used to assess reading comprehension in the curriculum at the school. The running record assessed the participants' word errors and self-corrections while reading a story aloud, their responses to five questions about the story, and their ability to immediately retell the story, including certain story elements. A scoring guide was used that indicates six levels of comprehension. The AR programme is a computer software programme that assesses the student's comprehension of the texts and monitors student reading level administering quizzes to the students and provides instant feedback.

Pre-intervention reading comprehension ability of each participant was considerably lower than typically aged peers. For example, the first participant, Keith was aged 11 years, his AR reading level was 1.5-1.8 out of 6 and his running record was scored 16. Typically developing children in the same grade score 4.5-4.8 on the AR and 27 on the running record. However, he was capable of repeating specific material from the AR texts such as characters and settings. Kristopher was aged 8, his AR reading level was 2.5-2.8 (expected grade level

performance: 3.5-3.8) and running record was 20 (expected grade level: 24). He was able to remember most of the words from the text and provided correct answers to the AR questions connected to setting, characters, time and place, but had difficulty integrating distinct types of information. James was also 8 years old, his AR score was 1.5-1.8 (expected grade level: 3.5-3.8) and running record was 15 (expected grade level: 24). James correctly responded to fact based questions on characters, sequences, and the main ideas of the story (Stringfield et al., 2011).

Once the study began, participants read curriculum based books that they also read in the classroom. Outcomes of percentage correct of unprompted questions were measured with AR story quizzes which were presented orally by the classroom teacher. The baseline phase consisted of the participants reading a story, and the teacher then asking questions of the quiz. No prompts or assistance were given to the participants. Once the intervention phase began participants were taught to use a story map to help them understand the elements of a story (e.g., characters, time, place, beginning, middle, and end). They read a story and were then instructed to give information to complete the story map. Teachers used a prompting schedule if participants did not respond to the instructions. The prompting schedule was initiated if participants gave an incorrect response or did not respond at all to instructions or quiz questions. This consisted of repeating the question or instruction, verbally reminding them to look at the story map, pointing to the exact box on the story map that had the answer, underlining the correct answer, or reading the answer aloud to the participant. Participants were given 30 seconds to respond to the prompt before the teacher moved on to the next one. After the story map was complete, participants were verbally asked questions from the quiz. The maintenance phase consisted of similar procedures to the baseline phase, but participants were permitted to choose to use the story map.

Results from the study indicate that the percentage of correct (unprompted) responses to the quiz questions improved for all three participants after they were taught how to operate the story map. All the participants met the target criterion (i.e., three continuous days of 80% story map completion and 100% on quizzes) during the intervention and maintenance phases. Keith's average score of correct answers improved from 12% correct during baseline, to 89% during intervention, and 91.42% during the maintenance phase. Kristopher improved from 22.5% to 80% between baseline and intervention phases, and maintained this at 92%. James improved from 13.3% during baseline to 77.5% during the intervention phase, and maintained this at 93.3% correct answers during the final phase. Percentages of non-overlapping data (PND) scores from the quizzes were in the effective to highly effective range (100, 90, and 88% for all three participants; Stringfield et al., 2011).

This study is limited by only factual questions being asked to assess comprehension. It only assessed the minimal level of literal comprehension that participants possessed and higher order thinking or inferential comprehension was not assessed. Also, despite performing well below expected grade level, each participant appeared to already have the basic skill level needed to answer comprehension questions as indicated by the pre-intervention reading comprehension descriptions the authors gave. For example, each participant was able to correctly identify specific elements of a story such as characters and setting and therefore answer the factual questions related to these aspects (although actual scores of questions answered are not given in the study). The study shows that the participants learnt to use a story map well, but as there was no post-test measurement of reading comprehension ability using the AR reading levels and the running record, it is difficult to conclude whether the intervention actually helped to improve reading comprehension.

Another intervention strategy involved teaching a version of the Reread-Adapt and Answer-Comprehend (RAAC) strategy to three young adults (21 years of age) with ASD and intellectual disability, who were reading at the level of a typically developing 5-7 year old (Hua et al., 2012). RAAC is a programme that addresses the reading fluency and comprehension of students. The process consists of pre-reading questions that are connected to parts of the story and then reading the text several times to a tutor who corrects decoding errors. The pre-read comprehension questions are then asked. Previous studies using the RAAC method with children who had an intellectual disability found that students' fluency and skill at answering factual and inferential comprehension questions improved (Therrien, Wickstrom, & Jones, 2006).

Oral reading fluency (ORF) was assessed using the DIBELS at pre- and post-test to measure the participant's reading level, two participants were reading at a 8-9 year old level and one was reading at a 11 year old level. Researchers wrote 27 short narrative stories to match the reading ages of the participants. The stories were short and could be read in 1 to 1.25 minutes. This study used a multiple baseline across participants design, and consisted of a baseline phase, followed by an intervention phase. During the baseline period (6-18 sessions) participants were timed while reading a passage aloud. Errors were also recorded by the researcher. Once reading had ended the researcher took the story away and requested that the student read and answer four factual and four inferential questions out loud. The participants' answers were transcribed, but no feedback was given.

The intervention phase consisted of between nine and 21 sessions. Participants began by reading one inferential and three factual comprehension questions: these were; "who is the main character? Where and when did the story take place? What did the main character do? And how did the main character feel?" (Hua et al., 2012, p. 137). The participants then read a story three times. The researcher gave feedback following each decoding error using a model-

prompt-check method following each passage. Feedback was provided on fluency, accuracy, and prosody. After they had finished they were asked the comprehension questions. Prompts and feedback were supplied if participants had problems answering them. Following this training session, the participants were assessed on untrained questions, including four factual and four inferential story-specific comprehension questions. No prompts or feedback were given and responses were recorded and scored by the researcher (Hua et al., 2012).

Results indicated that all participants improved their oral reading fluency immediately after receiving the RAAC intervention. For example, Mike scored 98 on the ORF measure before the intervention began and 120 at post-test. Ben scores 79 at pre-test and 90 at post-test, and Jay scored 50 at pre-test and 82 at post-test. Participants responded to more comprehension questions correctly during the intervention phase than at the baseline phase and were able to answer more inferential questions correctly post intervention compared to baseline (Hua et al., 2012). For example, during the baseline phase Mike's mean score of correctly answered inferential questions increased from 1.50 to 2.57 in the intervention phase. Likewise, Ben increased from 3.17 to 3.44, and Jay increased from 1.44 to 2.40. It seems that the two participants (Mike and Ben) who had the highest reading ability to begin with (age 11-12) benefited most from the intervention as they had the greatest increase in correctly answered total factual and inferential comprehension questions during baseline and intervention phases. Mike increased from an average of 4.17 to 6.00 and Ben increased from 6.00 to 7.04. Jay also increased but only from 3.44 to 4.96.

Mucchetti (2013) adapted a teacher-led shared reading intervention for four non-verbal children with ASD who were aged between 6 and 8 years of age. Participants were taught to use an answer board with text, pictures, symbols and items that they could touch to help them answer comprehension questions. The participants' developmental level and cognitive ability was assessed with the Mullen Scales of Early Learning (Mullen, 1995). The

subscales of visual reception, receptive language and expressive language were used. Cognitive ability and developmental level of all four participants was delayed. Participants' skills of visual reception ranged from 1:9-2:3 years, receptive language ranged from 10 months to 2:3 years, and ability in expressive language ranged from 10 months to 2:2 years.

During baseline, sessions were conducted with one participant and the classroom teacher. The teacher read the stories to the student out loud as they normally would. The teacher asked comprehension questions after finishing reading the applicable page of the story. Six questions were asked in total for every session, and all questions were factual, consisting of 'what', 'where', and 'who' type questions. Correct answers to the comprehension questions were assessed during each session. "A correct response was defined as the student saying, pointing to, or touching the correct response after the story comprehension question was asked and shown" (Mucchetti, 2013, p. 365). An answer board with pictures and text was offered to students to convey their answers and teachers gave the participants standard praise to all answers.

During the intervention phase teachers were taught to apply the shared reading activities corresponding to a task analysis. The stories were then read aloud by the teacher but were modified using visual aids, three dimensional items, and abridged text. During each story six comprehension questions were asked, as in the baseline phase. Students were supplied with an answer board showing the text, picture symbols, and objects that were identical to the ones used in the books to communicate their responses to the comprehension questions. Teachers prompted participants when they were answering the questions and if the participant unsuccessfully answered the question, the teacher physically took the student's hand to touch the correct item or answer (Mucchetti, 2013).

All four participants increased story comprehension once the intervention was implemented compared to baseline (Mucchetti, 2013). Participant one averaged two correct

answers to the comprehension questions during baseline, which increased to 4.33 correct answers in the intervention phase. Participant two increased from 1.5 to 4.8 correct responses. Participant three increased from 1.17 correct responses during baseline to 4.2 during the intervention phase. Participant 4 increased from 1.44 to 4.75 correct responses. The story comprehension of all four participants continued to be stable during the intervention phase, and they all showed 100% PND between the baseline and intervention phases (Mucchetti, 2013). Given the students' cognitive and verbal ability it may not have been appropriate to ask inferential questions. Basic comprehension begins with literal comprehension and typically developing children of a similar non-verbal age would have not been able to answer such questions.

Summary of Reading Comprehension Research

There were four studies identified in the literature that aimed to teach a reading comprehension strategy to children with ASD (see Table 4 for a summary of the interventions included in this review). These studies involved a total of 13 participants including 12 boys and one girl. Their ages ranged from 6-21 years. Five different types of instructional strategies were used. Two studies used story maps (Stringfield et al., 2011; Whalon & Hanline, 2008), Mucchetti (2013) used shared reading and visual supports in the form of an answer board for comprehension questions. Whalon and Hanline (2008) also used a reciprocal questioning strategy, and Hua et al., (2012) used an adapted version of the RAAC strategy. The number of training sessions ranged from six to 21 sessions and the total number of sessions ranged from 15-42.

All four studies utilised a single subject multiple baseline across participants design. To assess effectiveness of the different interventions the PND for each instructional method was calculated. Reciprocal questioning and story maps (Whalon & Hanline, 2008), as well as shared reading and visual answer board (Mucchetti, 2013) were highly effective interventions

with 100% PND. The story map strategy implemented by Stringfield et al., (2011) was also very effective with 83.33% PND. However, the RAAC strategy (Hua et al., 2012) demonstrated no observed effect with 21.47% PND.

The RAAC intervention may not have been as effective in developing higher level comprehension skills because re-reading builds on the skills of children with ASD for rote learning and decoding. Answers to comprehension questions were highly variable, perhaps demonstrating that participants were not using a reliable strategy to formulate answers. However, it was the only study that assessed inferential questions separately from factual questions. The RAAC intervention may not have appropriately addressed inferential comprehension which is a complex skill and potentially participants would need to be taught specific skills to improve their deficit in inferential comprehension before they could reliably answer the inferential questions. The other three studies may have demonstrated better effects because they used visual strategies including story maps, answer boards, and props in the stories, these build on the strengths of children with ASD who can benefit from visual learning aids. Combining visual strategies with specific interactive strategies in one intervention may have also been beneficial because it covers a broader base of skills to learn. They also used either feedback or prompting for participants throughout the intervention phases.

Hattie (2009) states that feedback is among the most influential ways to achieve academic success. Meta-analyses of feedback strategies show strong effects ($d = 0.73$). The most effective types of feedback give cues or support to the learner (Hattie, 2009) that provide exact knowledge associated to the task or process of learning. Successful feedback should guide students to understand what is understood and what is intended to be understood (Rosenshine, Meister, & Chapman, 1996). This can be done in a number of ways, for example, helping students come to another view point, giving conformation that they are

correct or incorrect, and suggesting that more information needs to be obtained to understand particular information (Hattie, 2009).

A review of studies on instruction of questions generation found four studies that used explicit feedback (Rosenshine et al., 1996). In these studies they found that feedback usually occurred during dialogue and guided rehearsal of question production. Feedback normally occurred as hints, questions, and suggestions (Rosenshine et al., 1996). Feedback was included as part of an intervention to teach three children with ASD to answer inferential ‘why’ questions. Demonstration of adequate comprehension while reading usually requires the ability to answer inferential ‘why’ questions. Three boys aged between 7- 13 years were taught to do so using three formats; (a) three picture series showing connected events, (b) stories read out loud, and (c) general information questions (Hundert & van Delft, 2009). Feedback included social reinforcement when a participant responded correctly and a two-step error correction procedure was used to correct mistakes. If the participant answered the question incorrectly the second time it was asked, the researcher gave a possible answer as an example of an accurate response. All participants learnt to successfully answer inferential ‘why’ questions within the formats they had been trained in (Hundert & van Delft, 2009).

Table 4*Summary of Interventions to Teach Reading Comprehension*

Study	Participants and Setting	Purpose	Instruction Method	Experimental Design	Measurement	Results	Effect Size
Whalon & Hanline (2008)	3 children with ASD Small group setting in special education classrooms. Each participant was matched with a general education peer	To increase reading comprehension by teaching three children with ASD and their mainstream peers to answer and produce questions about a story they read together	Guided reciprocal questioning, self-monitoring, and visual cues were used to teach participants to ask and respond to questions using a story map framework. Sessions took place four days a week for approximately 40 minutes	Single subject multiple baseline across participants	Dynamic Indicators of Basic Early Literacy Subtests: Oral Reading Fluency and Retell Fluency pre-intervention Correct response to factual and inferential questions	All three participants generated and responded to more questions during reading after the implementation of the intervention. Rates of unprompted question generation increased for all participants	Unprompted responses to peer generated questions: 100% PND for all three participants

Table 4*Summary of Interventions to Teach Reading Comprehension (continued)*

Study	Participants and Setting	Purpose	Instruction Method	Experimental Design	Measurement	Results	Effect Size
Stringfield et al., (2011)	3 males with ASD Aged 8-11 years School classroom Individual instruction	Use a story map to help understand elements of asking and answering questions	Participants were trained to use a story map to help them comprehend the elements of a story (e.g., characters, time, place, beginning, middle, and end). They read a story, and were then instructed to give information to complete the story map. Teachers used a prompting schedule if participants did not respond to the instructions. The prompting schedule was initiated if participants gave an incorrect answer or did not respond at all to instructions or quiz questions	Single subject multiple baseline across participants	AR reading tasks Running record measured pre-intervention Correct answers to AR quiz factual questions	Percentage of correct (unprompted) answers given to the quiz questions improved for all three participants after they were taught how to use the story map	Quiz questions responses: 88-100% PND (highly effective)

Table 4

Summary of Interventions to Teach Reading Comprehension (continued)

Study	Participants and Setting	Purpose	Instruction Method	Experimental Design	Measurement	Results	Effect Size
Hua et al.,(2012)	3 young male adults with Autism and intellectual disability Aged 21 years Individual sessions held in university offices	To assess the efficacy of the modified RAAC intervention on reading fluency and comprehension	Participants read aloud four comprehension questions at the beginning of each session. They were reminded to reply to these questions at the end of the session. Students read a passage aloud three times and mistakes were recorded. Following errors were corrected using a model-prompt-check procedure. The text passage was removed and participants were then asked the four generic questions followed by eight passage specific comprehension questions	Multiple baseline across participant design	Dynamic Indicators of Basic Early Literacy Skills: Oral reading fluency (ORF) measured pre- and post-intervention Number of Factual and Inferential questions answered correctly	Participants responded to more comprehension questions correctly and were able to answer more inferential questions correctly post intervention but effects were marginal. ORF improved substantially for all three participants	PND of questions answered correctly: Mike: 33.3% Ben: 20% Jay: 11.1%

Table 4*Summary of Interventions to Teach Reading Comprehension (continued)*

Study	Participants and Setting	Purpose	Instruction Method	Experimental Design	Measurement	Results	Effect Size
Mucchetti (2013)	4 children with ASD. 3 male and 1 female. Aged 6:11-8:6 Individual sessions at school with the classroom teacher	Assess engagement and story comprehension of teacher-led, shared reading	Three different stories read out loud by the classroom teacher to the participant. Three stories were read out loud by the teacher and modified using visual supports. Six questions were asked after each story, and all questions were factual. Students were given an answer board showing text, picture symbols, and objects to help them with their answers	Multiple baseline design across participants.	Peabody Picture Vocabulary Test Leiter-R, Mullen scales of early learning to assess language and cognitive abilities. Factual comprehension questions only	Results indicated that all participants increased story comprehension and task engagement once the intervention was implemented compared to baseline	PND= 100% effective for story comprehension questions

Limitations of Reading Comprehension and Theory of Mind Research

Considering the review of studies and the literature presented in the previous sections it is clear that there are a number of issues to be considered. Firstly, there are very few studies that have successfully taught ToM to individuals with ASD compared to studies that try to test ToM understanding (Tager-Flusberg, 2007). Previous attempts to teach ToM have focused on supplying examples of ToM problems such as false-belief tasks in the hope participants will learn the required rules about mental state attribution through repetition.

Although many children with ASD successfully learn strategies taught to them in the studies, they appear to be unable to generalise what they have learned to other ToM tasks in another situation. It appears that children with ASD may rote-learn a strategy that has been taught and the solutions are ‘hacked out’ to pass false-belief tasks (Paynter & Peterson, 2013), but it is not clear whether these tasks provide a satisfactory substitute for dealing with ToM problems or transfer to daily life (Swettenham, Baron-Cohen, Gomez, & Walsh, 1996).

Nearly all the studies presented in the literature review used false-belief as the standard of ToM ability; however, in terms of ToM development, false-belief is the hardest aspect to master for children with ASD (Wellman & Liu, 2004; Wellman, 2012). Only one of the studies (Paynter & Peterson, 2013) tested to find out the developmental level their participants were functioning at and whether their intervention increased their developmental level of ToM. Along with ToM developmental level, many of the studies did not also assess whether the material they were using was appropriate to the participants’ ToM and academic functioning. Like many ToM interventions, studies of reading comprehension consist of many instructional methods that focus on applying skills, rather than teaching strategies to support the cognitive procedures involved in reading comprehension (Randi et al., 2010).

All four studies included in this literature review of reading comprehension asked participants factual questions and assessed correct responses to these questions to measure reading comprehension. Two studies also asked inferential questions (Hua et al., 2012; Whalon & Hanline, 2008), but only one (Hua et al., 2012) differentiated between correctly answered factual and inferential questions. Inferential comprehension requires higher cognitive processes and a more advanced level of comprehension. Therefore, the strategies needed to make inferences are different from those needed to understand literal information. It is unlikely that the strategies taught in the studies mentioned above adequately address the skills needed to make inferences, and because the ability to infer is a vital part of reading comprehension they do not adequately teach reading comprehension skills. It is possible that teaching strategies to make inferences could lead to improvement in social skills and life in general because once learned, the strategies may help children with ASD to make inferences in real life and thus improve ToM.

Research Questions and Aim

Given the gaps and limitations of previous research raises the question of whether children with ASD can be taught to make inferences and whether teaching children to answer inferential questions can increase reading comprehension and ToM.

This study will investigate the following three research questions:

1. Can teaching a strategy to answer inferential questions to children with ASD, improve their ability to answer inferential questions that involve ToM?
2. Does teaching this strategy improve their reading comprehension on a standardised test pre-and post-intervention?
3. Does teaching this strategy also improve their ToM as measured on a pre-and post-intervention test?

The purpose of the first research question is to determine whether a strategy can be taught to children with ASD to improve their ability to answer inferential questions that involve ToM. The second research question proposes whether through teaching this strategy, participants can generalise the skills learnt to a test of reading comprehension, and whether these skills will change their reading comprehension as indicated on the PA Test of Reading Comprehension. The third research question proposes to measure whether the ability to use the strategy to answer inferential questions from written text can increase understanding of ToM.

The aim of this research is to increase the reading comprehension skills of children with ASD by teaching them how to answer inferential questions using an explicit strategy combined with feedback from the researcher. It is hoped that this approach to teaching reading comprehension will increase the ToM skills of children with ASD and that the ability to understand inferences in written text can positively affect ToM.

Chapter 3.

Method

Research Design

To explore the designated research questions the current study employed an ABC design replicated across participants, consisting of the baseline phase, intervention phase and return-to-baseline phase. The design showed the effect of the intervention on each participant's response to the questions connected to the selected reading passages (Whalon & Hanline, 2008). Single-subject design is well suited to the practical requirements of applied research and does not require the withdrawal of intervention procedures which can have ethical problems when using young participants (Cooper, Heron, & Heward, 2007). Single-subject design is often used with participants with ASD as the intervention can be tailored to the individual's needs (Odom, Collet-Kilngenberg, Rogers, & Hatton, 2010).

Ethics

Approval for conducting this study, including its design, methodology, recruitment strategies and measures, was obtained by the University of Canterbury Educational Research Human Ethics Committee. Written informed consent was gained from each school (including signatures from each teacher, Principal, and Board of Trustees), the participant, and the participant's parent or caregiver. The consent process emphasised that participation in the study was voluntary and participants could withdraw from taking part in the study at any time. All the data and individual information would be kept confidential at all stages of the project and data could be withdrawn if requested. Risk to participants would be kept to a minimum at all times.

Selection Criteria

Participants were included in this study if they were attending a primary school (year 1-6) at the time of recruitment. To be eligible children also had to have a diagnosis of ASD, be able to read at the level of a 6 year old, and would also benefit from help with reading comprehension as identified by special education support services at the schools.

Recruitment

Before participant recruitment and data collection began, ethical approval was sought and obtained from The University of Canterbury Educational Research Human Ethics Committee. Four participants for this study were recruited through two special education teachers who had contact with the teachers and schools. The special education teacher approached the schools and met with the principal and teachers, explained the purpose of the study and asked if they had any children enrolled with a diagnosis of ASD whom they thought could benefit from being part of the study. The information and consent forms were given to the principal and teachers who contacted the parents of students, who met the selection criteria, by phone or e-mail. If the parents agreed for their child to take part, the teachers gave them the information and consent forms. After the parents had given their consent, they were instructed to explain the study to their child and what the study involved. If the child agreed to take part they were asked to sign their own consent form. Their parent/caregiver also signed a consent form and returned both forms to the teacher who gave them to the researcher. All the consent forms for each individual participant were collected before the commencement of the study.

Participants

The participants attended two different primary schools from Christchurch, New Zealand. They were all boys and had a diagnosis of ASD and had been diagnosed for four or

more years. They were aged between 7 years four months and 11 years one month at the time of the study. Two participants (Chris and Jeremy) had co-morbid diagnosis of dyspraxia and Chris also had a co-morbid diagnosis of ADHD.

Setting

One participant (Chris) attended school #1. The study was conducted in the teacher's office in the classroom, during the time of day when the class was involved in silent reading. The other three participants attended school #2. The study was conducted in the special education classroom at this school. This was an open plan classroom, and other special education students were also being taught there. For one participant (Jeremy) several sessions were also conducted at his home because at the time of the study he was only attending school for half days. For each session, the researcher and the participant sat at a table where participants were able to choose how close to the researcher and in which chair they sat. Each session lasted approximately 30 minutes.

Materials

Reading passages were adapted from the Science Research Associates (SRA) Specific Skill Series, Identifying Inferences (Wittenberg, 1997). The SRA Series consists of many different stories at different reading levels. All the passages used were narrative texts and were one or two sentences long. Each passage was individually selected to ensure it contained enough information for the participant to answer one factual and one inferential question about the passage. Examples of several SRA passages and the factual and inferential questions associated with the passages that were used during the intervention phase of the study are included below in Table 5. O'Connor and Klein (2004) used the SRA books in their study which aimed to identify different strategies for teaching reading comprehension to children with ASD. In the current study, the SRA passages were left in plain sight of the

participants while they were answering the questions. This enabled them to refer back to the story if they needed help to answer the questions.

Table 5

Examples of Science Research Associates (SRA) Passages and Researcher Developed Factual and Inferential Questions used During the Intervention Phase of the Study

SRA Passage	Factual Question	Inferential Question
Maria bought some wood and a bag of nails. She went to her backyard and began to build a dog house. When the doghouse was finished, she painted it bright red. Maria put the doghouse next to her garage.	What colour did Maria paint the dog house?	Why did Maria build a dog house?
Mother and the children got into the car. They were going to visit their grandparents. Then mother got out of the car and went back into the house. When she returned, she was carrying an umbrella.	Who were Mother and the children going to visit?	Why did Mother go back and get an umbrella?
"My dog is called Jumbo because he is so big," said Ralph. "My friend calls her cat Fluffy because its fur is so soft". "Those are good names," said Tom. "Last week I got a pet dog. I think a good name for him would be lightning."	Why is Ralphs' dog called Jumbo?	Why does Tom think lightning would be a good name for his dog?
"Come over to my house," said Frank. "I have a new pet bird." Lee went with Frank into his house. But when they looked for the bird, it was gone! They only found the bird's cage with its door open.	What did Frank want to show Lee?	What had happened to the bird?

Measures

Repeated Measures

The ability of the participants to comprehend the passages and make inferences about the text was assessed by asking one factual and one inferential question after each passage from the SRA books. After the participant read an SRA passage the researcher asked a factual question or an inferential question. The questions were also written below the reading passage so participants could refer back to it if necessary. Whether a factual or inferential question was asked first was randomly assigned so that participants did not assume it would always be the same pattern. The answers given by the participants to the factual questions were scored as either correct or incorrect. The answers given by the participants to the inferential questions were scored as follows; answers with understanding or partial or possible answer (UP); attempts to answer the question (A), or includes questionable understanding or irrelevant detail; does not answer or answers “I don’t know” (DNA). A flow chart describing the scoring system is included in Appendix 1.

Asking questions is a common form of measurement to assess reading comprehension ability (Hua et al., 2012; Mucchetti, 2013; Stringfield et al., 2011; Whalon & Hanline, 2008). The passage-specific factual and inferential comprehension questions were developed by the researcher using the following definition (Davey & McBride, 1986):

Correct responses to factual questions can be underlined directly in the text without requiring the integration of information from multiple sentences. Correct responses to inferential questions either cannot be located in the text or require integration of information from multiple sentences. (p. 257)

Pre-Post Measures

Test of Reading Comprehension

The Progressive Achievement Test (PAT) subtests of comprehension (New Zealand Council for Educational Research, 2008) were used to assess the reading comprehension ability of the participants at pre and post-test. The PAT are the most regularly used standardised measures of achievement used throughout schools in New Zealand (Chapman, 1988), and two different versions of the test are supplied that correlate, which mean that scores can be compared even over a short period of time. The tests consist of seven stories that students read silently. Each story is followed by a series of multiple choice questions designed to measure comprehension, and the participants were given a standardised booklet in which to write their answers. The tests are designed to be completed in 45 minutes. All the participants were timed and completed the test within this time limit. The PAT comes with detailed implementation and scoring instructions and these were followed each time it was administered.

Test of Theory of Mind

A Theory of Mind test called *Strange Stories* (Happé, 1994; White, Hill, Happé, & Frith, 2009) was given pre and post-intervention to measure the participants understanding of mental states. The *Strange Stories* include eight mental state stories with an inferential question and scoring system following each story. When answering the questions, participants score two points if their answer provides an explanation for their inference (explaining 'why'), one point for referring to the facts in the story as part of their answer, and zero points for referring to non-specific information (White et al., 2009). An example of one of the stories is displayed below (White et al., 2009):

Helen waited all year for Christmas, because she knew at Christmas she could ask her parents for a rabbit. Helen wanted a rabbit more than anything in the world. At last Christmas Day arrived, and Helen ran to unwrap the big box her parents had given her. She felt sure it would contain a little rabbit in a cage. But when she opened it, with all the family standing around, she found her present was just a boring old set of encyclopaedias, which Helen did not want at all! Still, when Helen's parents asked her how she liked her Christmas present, she said, "It's lovely, thank you. It's just what I wanted. Why did she say this?" (p. 1110).

According to White et al., (2009) the *Strange Stories* correlate strongly with a ToM battery which includes seven tasks used by Wellman and Liu (2004) and five standard false-belief tasks such as the Sally-Anne and Penny Hiding tasks (Baron-Cohen et al., 1985). The ToM battery contains stories where a character and the child have different desires or beliefs; where a character has a lack of knowledge, a false belief, (Wellman & Liu, 2004) or a false belief about another character's false belief; or where a character wants to construct a false belief in others (White et al., 2009). There was found to be a significant positive association linking the ToM battery and the mental state stories ($r = .42, p = .001$) which also demonstrates the validity of both instruments and shows that they are both measuring the same fundamental ability. This study uses the eight *Strange Stories* to measure the participants' understanding of Theory of Mind. The participants' responses and descriptions to the questions were recorded and scored according to the description above.

Procedures

Each participant began the baseline phase by reading passages at the lowest SRA level. At each session they increased a level until they began to find the material too difficult and they began to answer the factual and inferential questions incorrectly. Different SRA passages were used for each session to minimise practice effects and to prevent the

participants from memorising the passages or questions. During each session of the study the participants were asked to read 5 level specific SRA passages. After each passage one factual and one inferential question was asked and their responses were recorded. These answers were then coded and analysed. This is how inferential understanding was measured. Factual questions were asked as well as inferential questions to act as positive reinforcement to the participant. Children with ASD find it much easier to answer factual comprehension questions than inferential comprehension questions, so are more likely to get the factual questions correct (O'Connor & Klein, 2004) and the positive reinforcement should build motivation to continue reading.

Baseline

The baseline phase consisted of four sessions where the participants understanding of inferences and reading level using the SRA passages was assessed. The researcher met each participant every day and five SRA passages were read each session. Twenty SRA passages were read in total, and one factual and one inferential question was asked after each passage. On the first day the participant read passages from the easiest SRA level (Prep Level). On the second day they read passages from Level A. On the third day the participants read passages from Level B and on the fourth day they read passages from Level C. Following the fourth session responses were analysed to assess the reading level they were reading at. A participant demonstrated adequate comprehension of the passages when more than 70% of the inferential questions were answered correctly. Because of this it was determined that all participants would begin the intervention phase on Level B. This criterion was also used to increase the reading level throughout the intervention phase. If the reading material became too difficult it could cause the participant to become frustrated and they would need to focus on decoding the text rather than understanding it (Hulme & Snowling, 2011).

The fifth session of the baseline phase assessed reading comprehension and ToM understanding, using the reading comprehension sub-tests from the Progressive Achievement Test (PAT) series (New Zealand Council for Educational Research, 2008) and the *Strange Stories*. The pre-test measures were given immediately before the intervention phase and lasted approximately one hour. To avoid fatigue the participants were given a break of 10 minutes between each test.

Intervention

The intervention phase was twelve sessions long and focused mainly on teaching the participants an explicit strategy to help them accurately answer questions about what they read. Participants were taught a three-step strategy to help identify whether the question is factual or inferential and how they could best answer these questions. The steps were as follows;

Step 1. Can I find the answer in the story?

Step 2. YES: it is a factual question. I can circle the answer in the story.

Step 3. NO: it is an inferential question. I need to find the clues in the story to answer the question. Underline the clues to help answer the question.

The process for reading, asking and answering questions and scoring questions was the same as baseline, except that while the participants used the strategy described above, the researcher gave feedback to guide their answers. A procedural flow chart was used to maintain consistency of responses and feedback by the researcher as shown in Figure 1 below. The participants were asked to read out loud level-appropriate stories from the SRA passages. The researcher then asked a question and instructed the participant to use the three-step strategy to help them answer the question. If the participant gave an incorrect answer the researcher asked them to explain their response. If the response was possible the answer was

treated as correct. If the answer was not possible the researcher explained why. If the participant was unable to explain their answer the researcher modelled a response using the three-step strategy by saying “this is a hard question, this is how I would answer it...” If the participant gave an unexpected response the researcher said “that’s interesting! I will need to talk about that with my teachers.” If the participant answered the question correctly using the three-step strategy the researcher responded with feedback, saying “I agree” and then asked the participant the reason for their answer, by asking “what makes you think that?” The participant’s explanation and whether the answer was correct or incorrect were recorded and the next question relating to the story was asked. At no point throughout the intervention phase was the participant told whether their answer was incorrect or correct, but praise such as “good” or “good work” was used, usually to indicate that the participant could finish explaining and move onto the next passage.

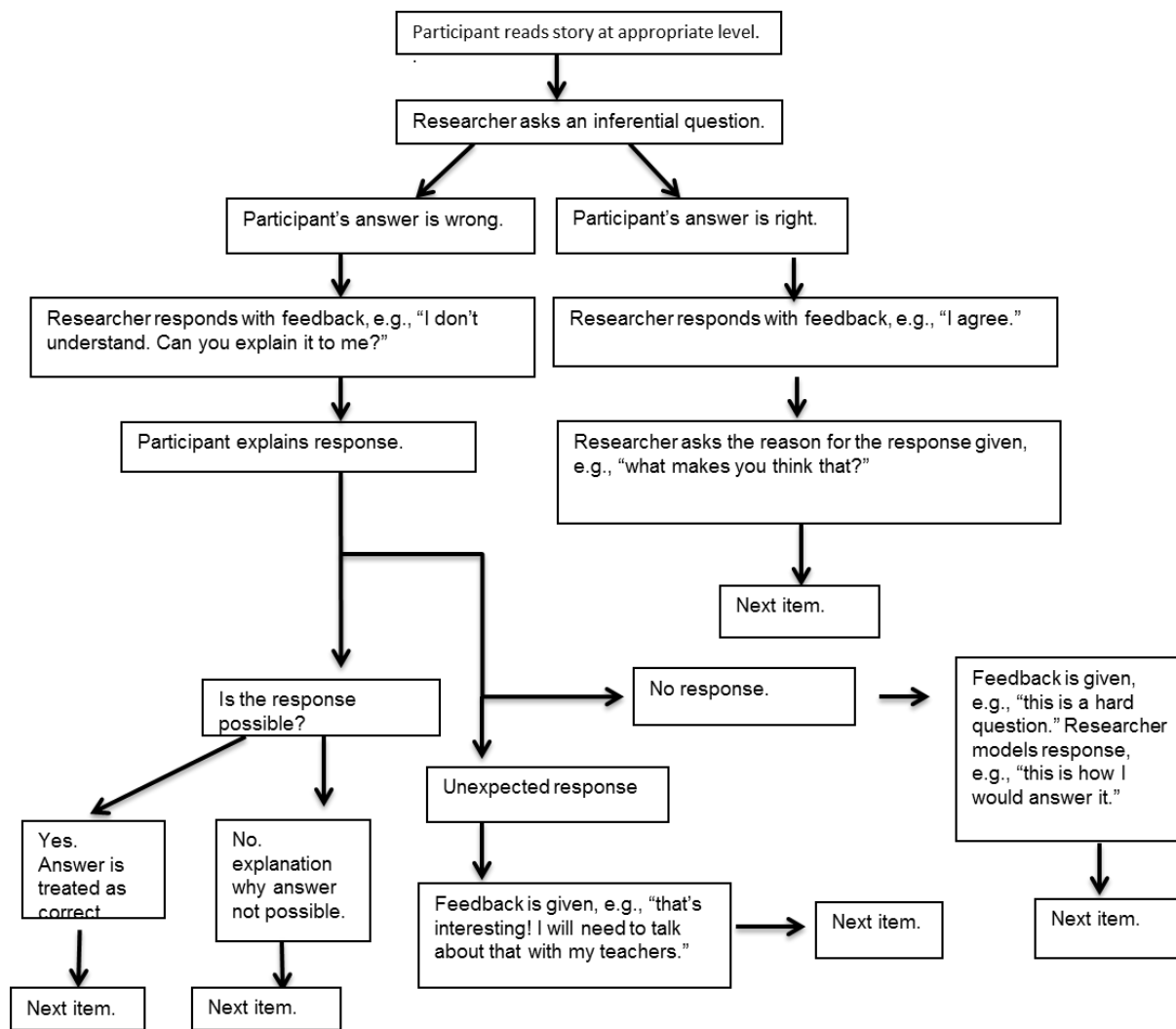


Figure 1: Procedural flow chart used in the intervention phase for researcher responses and feedback to participants. Procedural flow chart used in the intervention phase for researcher responses and feedback to participants.

Return-to-Baseline-Phase

The return-to-baseline phase consisted of four sessions and the same procedure as the baseline phase was used except that the participants continued to read passages at the level achieved during the intervention phase. No instruction, feedback or three-step strategy was provided at this time. The post-test measures were given five days after the intervention phase ended.

Data Summarisation and Coding

Post-hoc analysis of the types of questions asked occurred because it became clear during analysis that not all the inferential questions that were asked included the need to attribute mental states to answer the question. Therefore the inferential questions were divided into plain inferential questions and ToM inferential questions (those that needed the participant to use ToM to answer them correctly).

To code the different types of questions the researcher read the passage, then read the question following the passage (see flow chart in appendix 2). If the answer to the question was in the story, then the question was a factual question and was coded “F”. If this factual question included emotions or thoughts it was excluded. If the answer to the question was not in the story, the next step was to determine if the question was about two or more people or could be answered yes or no. If that was the case then it was also excluded. At this point the question could be identified as being an inferential question, but to determine whether it involved ToM the question was analysed to see if it involved human mental states, such as intentions; imagination; emotions; beliefs; knowledge; desires; thoughts of self; predicting behaviour of others; or requiring the understanding of other peoples’ lives. If the answer included any one of these factors, it was identified as a ToM inference and was coded “ToM”. If the answer did not require the participant to attribute mental states from the story it was identified as a plain inference and was coded “I”.

The answers the participant's gave to the ToM inferential questions were scored in the same way as the plain inferential questions, but to be scored as a correct answer the participants needed to answer the questions with reference to one or more mental states and include information from the story.

Reliability

Interrater reliability of the question types and answers was established by a fellow psychology graduate student who used the flow charts in figures 2 and 3 to code 20% of the answers and 13% of the questions collected from participant data. The questions and answers were chosen randomly. The collection of questions to code consisted of 8 ToM questions, five inferential question and seven factual questions. The answers to code consisted of ten answered with understanding (UP), and three answered with attempt (A).

Interrater reliability was calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100 (Cooper et al., 2007). Reliability of the coded answers was 84.6%, and reliability of the coded questions was 80%.

Data Analysis

The progress and results from the individual sessions with each participant was charted and illustrated with Excel. The data was graphed and visually analysed by investigating the degree as well as variability of change to determine intervention effects.

Chapter 4

Results

All four participants completed 20 sessions of the study. During every session each participant read a total of five passages aloud, and answered five factual and five inferential. The inferential questions were analysed post intervention and divided into non-ToM inferential questions and ToM inferential questions. The results of individual responses to the ToM inferential questions which were answered correctly by each participant, compared to the number of ToM inferential questions asked each session, are shown in Figures 2-4 below. Visual analysis was used to determine change over time within each phase of the intervention for each individual participant. Figure 6 shows the responses of all four participants together to determine change over time between phases and across all four participants. Finally, the results of the pre-and-post measures of reading comprehension and ToM are displayed.

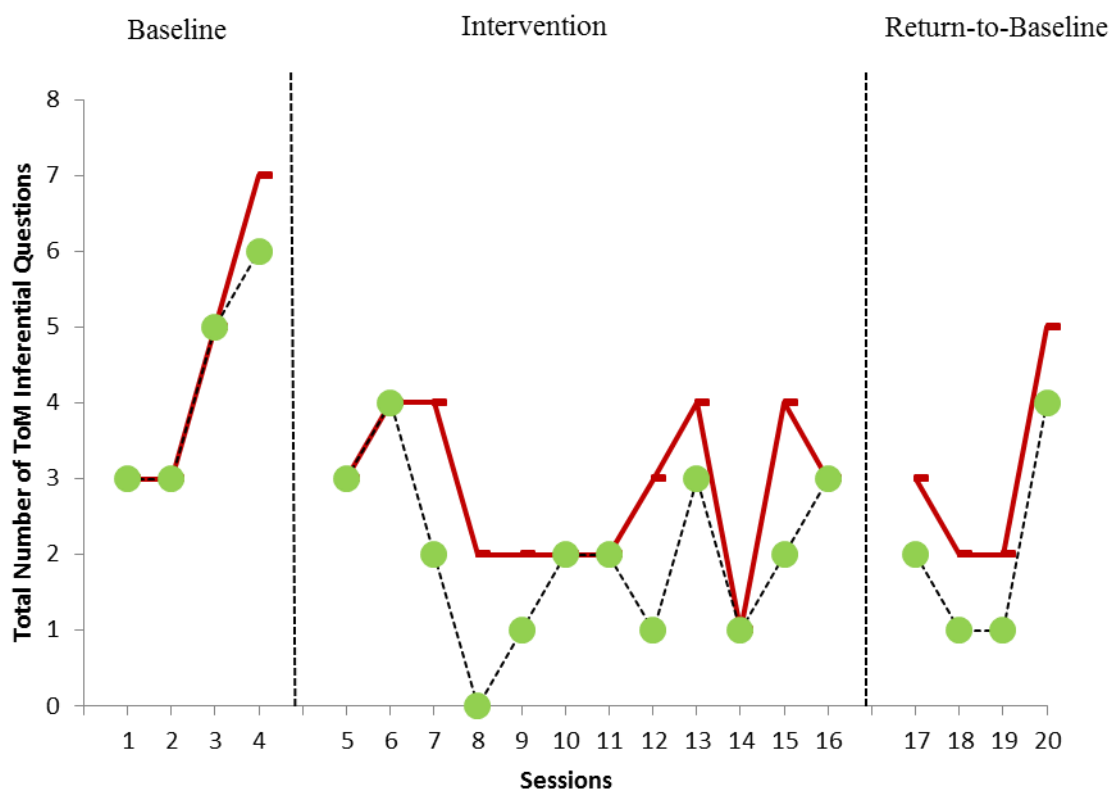


Figure 2: The number of Theory of Mind Questions asked each session (red bars) and the number of questions Chris answered correctly (Solid green circles) in successive sessions across the three experimental phases.

The results of the total number of ToM inferential questions asked per session compared to the number of ToM questions Chris answered correctly are shown in Figure 2. The baseline phase shows an accelerating trend in the number of questions asked as well as the number of questions Chris answered correctly. During baseline he made one mistake in session 4. Chris began the intervention phase reading SRA passages at Level B, and moved to Level C on the second session of the intervention phase. He stayed at Level C for the remainder of the study. As shown in Figure 2, Chris made many errors during the intervention phase and the overall trend for the number of questions asked and answered correctly was flat. In the return-to-baseline phase the trend is also flat, and Chris made one error during each session.

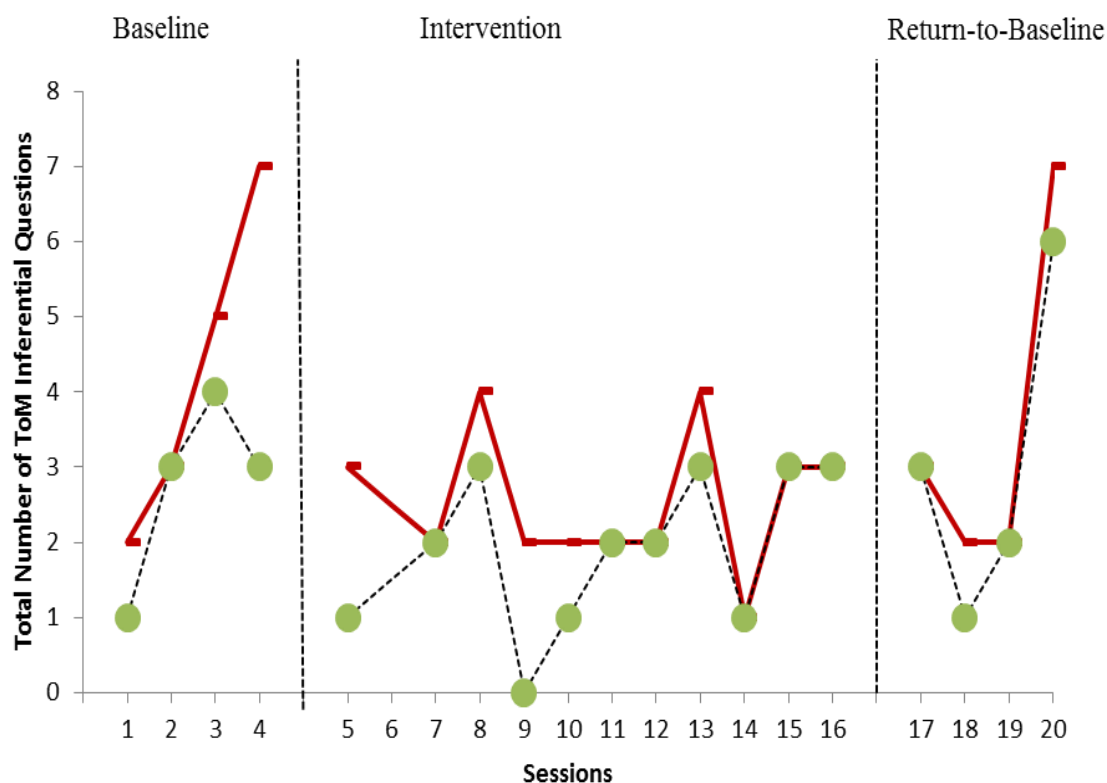


Figure 3: The number of Theory of Mind Questions asked each session (red bars) and the number of questions Patrick answered correctly (Solid green circles) in successive sessions across the three experimental phases.

An accelerating trend in the number of questions asked during the baseline phase, as well as in the number of questions answered correctly can be seen in Figure 3. However Patrick made six errors during this phase. The trend in the intervention phase is relatively flat in terms of both the number of questions asked and answered correctly. Although the trend is flat Patrick answered all the questions correctly during the final three sessions. Patrick began the intervention phase reading Level B passages, and continued at Level B until session seven when he moved to Level C. He promptly did not answer any of the questions correctly but slowly increased his correct responses. He continued to read at Level C for the rest of the study. No ToM questions were asked in session six. The return-to-baseline phase shows an accelerating trend in the number of questions asked but a flat trend in the number of questions

answered correctly. Patrick answered 100% of the questions correctly in two sessions and made two errors.

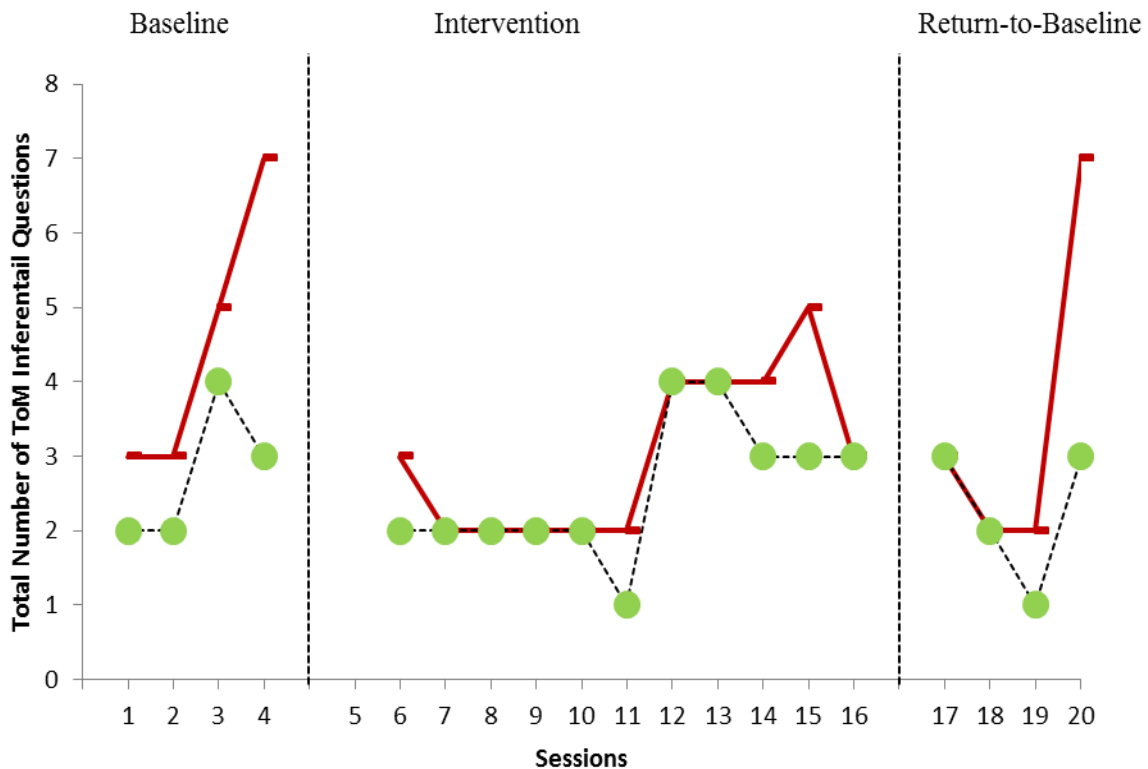


Figure 4: The number of Theory of Mind Questions asked each session (red bars) and the number of questions Ben answered correctly (Solid green circles) in successive sessions across the three experimental phases.

The results of the total number of ToM inferential questions asked every session and answered correctly by Ben are shown in Figure 4. During baseline the number of questions asked, and answered correctly indicate an accelerating trend, although Ben made a total of six errors. Ben began the intervention phase reading Level B passages, and continued this for the first three sessions when he moved to Level C. No ToM questions were asked during session five of the intervention phase. Ben immediately began to answer all the ToM questions correctly, and the trend of questions asked and answered correctly during this phase accelerates over time. The trend in the return-to-baseline phase is accelerating, with Ben answering all of the questions correctly in two sessions and making five errors.

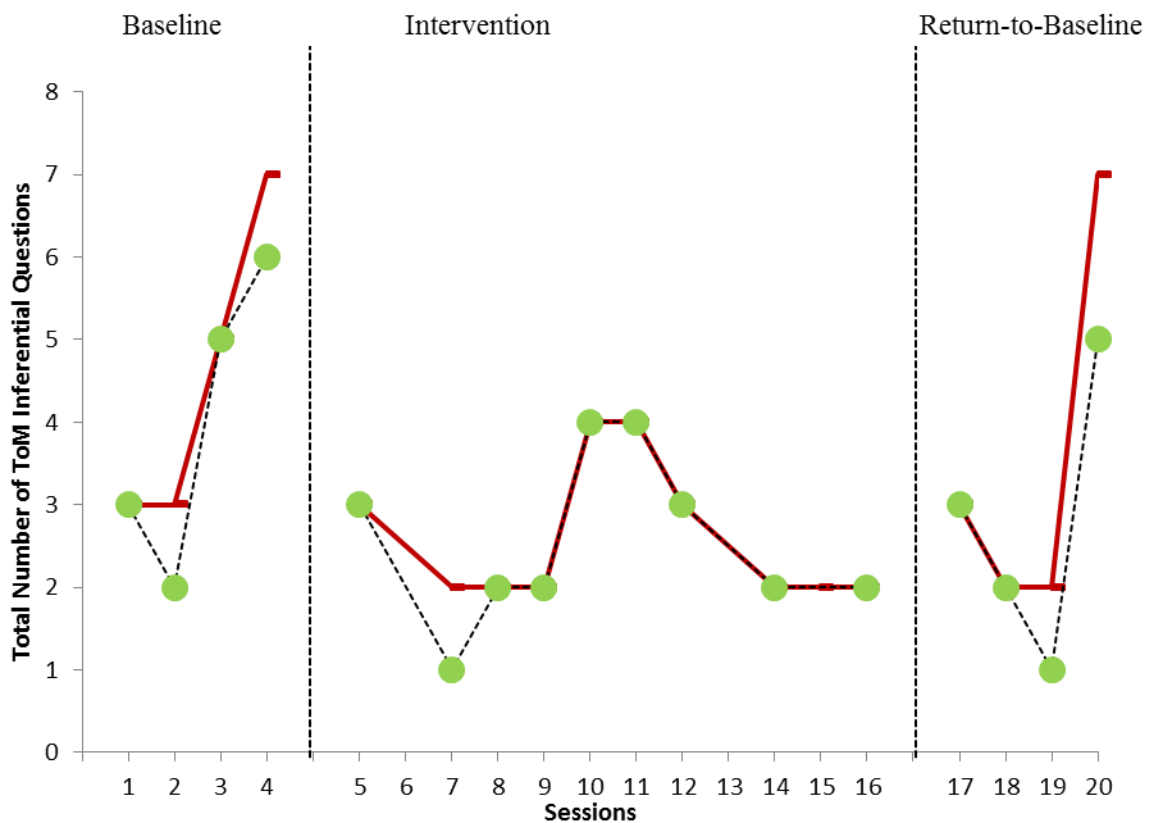


Figure 5: The number of Theory of Mind Questions asked each session (red bars) and the number of questions Jeremy answered correctly (Solid green circles) in successive sessions across the three experimental phases.

An accelerating trend in the baseline phase for both the number of questions asked, and the number of questions Jeremy answered correctly is shown in Figure 5. Two errors were made. Jeremy began reading passages at Level B for the first two sessions of the intervention phase, then moved to Level C for session seven and eight. Because Jeremy consistently continued to answer the questions correctly he then moved to Level D for the remainder of the study. Throughout the intervention phase the trend of questions answered correctly mirrors that of the number of questions asked and is relatively flat. The return-to-baseline phase shows an accelerating trend in the number of questions asked and answered correctly. Jeremy made three errors during this phase.

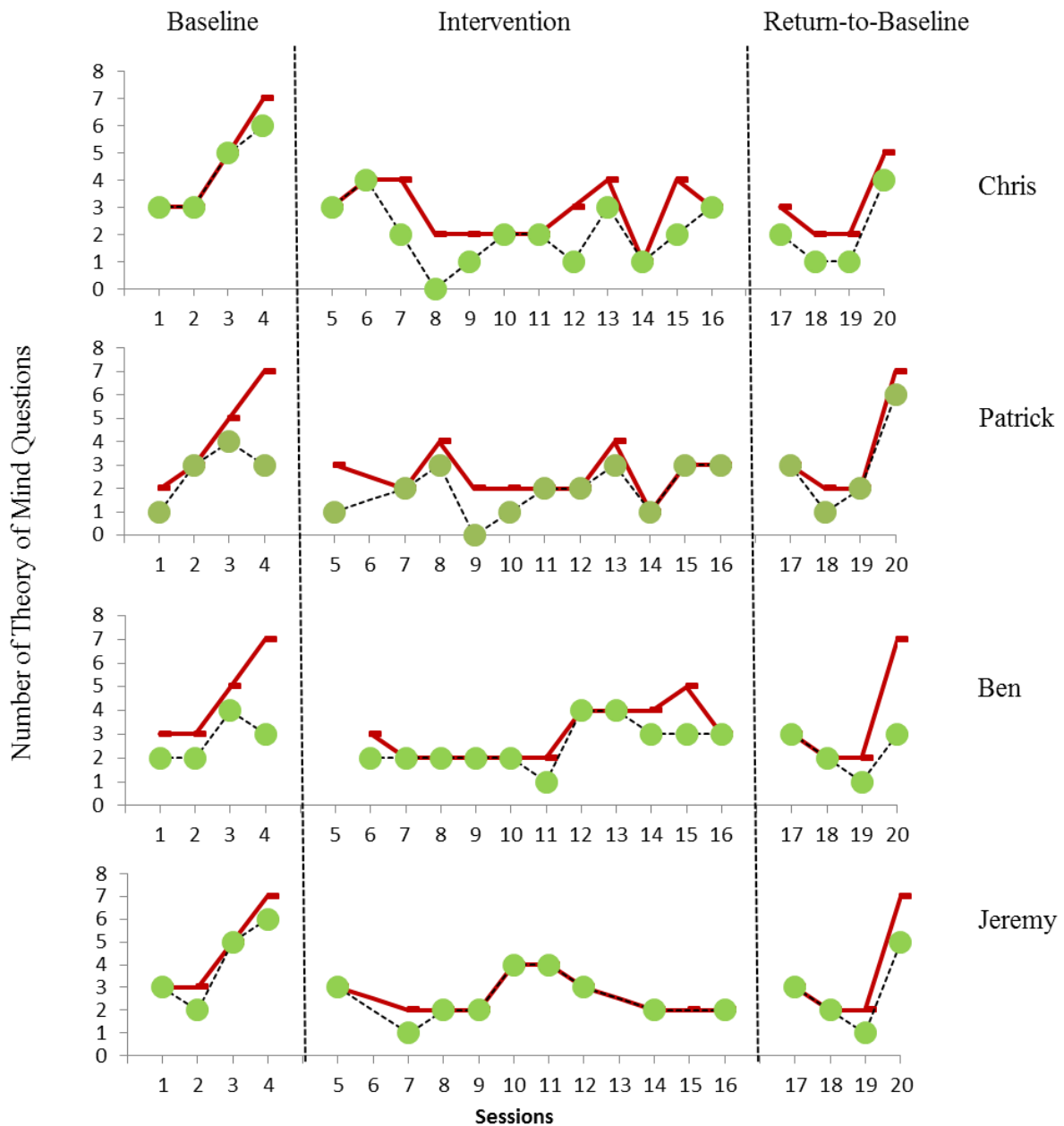


Figure 6: The number of Theory of Mind questions asked (red bars) each session, compared with the number of questions answered correctly by each participant (solid green circles) in successive sessions across three experimental phases.

Figure 6 shows the results of the total number of ToM questions asked compared to the number of questions answered correctly across all four participants. All four participants showed an accelerating trend in the baseline phase for both the number of questions asked and answered correctly. Both Chris and Jeremy made fewer errors throughout this phase. During the intervention phase, only Ben showed an accelerating trend in the number of

questions answered correctly compared to the number of questions asked. The other three participants showed flat trends. In the return-to-baseline phase three of the four participants showed an accelerating trend for both the number of questions asked and answered correctly. However, the number of questions that Ben answered correctly is flat in trend. All four participants also continued to make errors, although Patrick and Ben reduced the amount of errors they made during this phase.

Pre-Post Intervention Measures

Table 6

Pre and Post-Intervention Scores of the Progressive Achievement Test of Reading Comprehension for each Participant

Participant	Pre-Intervention	Post-Intervention
Chris	34.8	47.1
Patrick	20.9	32.4
Ben	25.1	33.6
Jeremy	33.6	36.7

The results of the PAT reading comprehension measure administered pre-and-post intervention are shown in Table 6. All four participants increased their scores from pre-to post-intervention. At pre-intervention Chris's scaled score for the PAT was 34.8 which indicated his reading comprehension was at a year 5 stanine, which is a typical level for his age. Post-intervention indicated a scaled score increase to 47.1, and his reading comprehension ability increased to a year 7 stanine which is well above the average ability for his peer group. Patrick's pre-intervention scaled score on the PAT reading comprehension test was 20.9 and his comprehension ability was at a year 3 stanine which was above average

for his age group. Post-intervention his scaled score increased to 32.4 and his comprehension ability was at a year 4 stanine which is well above average for his age group. Ben's PAT reading comprehension scaled score at baseline phase was 25.1 and his comprehension ability was that of a year 3 stanine which was above average for his age group. Post-intervention his scaled score increased to 33.6 and his comprehension ability was at a year 4 stanine level which is well above average for his age group. Jeremy's PAT scale score pre-intervention was 33.6 and his comprehension ability was at a year 3 stanine which is well below that of his peer group. Post-intervention Jeremy's scale score increased slightly to 36.7 and his comprehension ability increased to a year 4 stanine. However, this is still well below that of his peer group.

Table 7

Pre and Post-Intervention Scores of the Theory of Mind Strange Stories for each Participant

Participant	Pre-Intervention	Post-Intervention
Chris	5	11
Patrick	5	3
Ben	4	7
Jeremy	9	13

Theory of Mind understanding was measured pre- and post-intervention using the *Strange Stories*. As shown in Table 7, three out of the four participants increased their scores from pre-intervention to post-intervention. Chris scored 5 points during baseline out of a total of 16 possible points. At follow up he scored 11 points from 16. The ToM measure indicated that Patrick had limited understanding of ToM, scoring 5 points from a possible 16 points. Patrick's ToM score decreased at post-intervention to 3 points. Ben scored 4 points pre-

intervention, which increased to 7 points post-intervention. Pre-intervention Jeremy scored 9 points, and increased to 13 points post-intervention.

Chapter 5

Discussion

The aim of the current study was to investigate whether the possibility that teaching children with ASD to answer inferential questions using a cognitive strategy would improve their ToM understanding, inferential comprehension and reading comprehension skill. Three research questions were posed; Does teaching a strategy to answer inferential questions improve the participants' ability to answer inferential questions that require making a judgement about the thoughts, emotions, feelings, and behaviour of a character in a one or two sentence story?; Does teaching this strategy improve their reading comprehension?; Does teaching this strategy increase ToM understanding?

Summary of Results

Each participant's results will be discussed below; however, a major methodological limitation needs to be addressed first to help understand the outcomes of the study. While designing the study, it was decided that to show any changes in a repeated measures design, 10 questions per session would be the minimum amount needed to provide learning opportunities for the participants. It was also felt that it was necessary to ensure the participant understood the story; therefore factual questions were asked as well. Asking factual questions reduced the time available in the instructional session to ask more inferential questions. It was not possible to increase the 30 minute instructional time; firstly because of concerns about the participant's attention span and secondly because of the difficulty involved in removing the child from his regular classroom routine for longer periods of time. These complications reduced the number inferential questions to approximately five per session. Analysis after the study showed that ToM was not required to answer all of the inferential questions asked, which further limited the learning opportunities

provided to each participant. For purposes of this study, only the ToM questions were analysed and presented. The results for each participant are discussed below.

Jeremy's results indicate a ceiling effect, likely to be a result of the researcher not providing sufficient opportunities to answer ToM questions. Therefore, the number of questions which Jeremy could answer correctly was limited by the number of questions asked and the trend during the intervention phase is not meaningful in this case. His performance indicates he answered most of the questions correctly during baseline. This may be attributed to a limitation in the way the baseline phase was constructed. The baseline procedures were not consistent across sessions, as the level of difficulty of the reading passages changed each day, and this, taken together with the lack of sufficient numbers of questions, meant interpretation of the correct instructional level for the start of the intervention phase was not able to be made. However, due to the limitations mentioned above, the intervention was implemented as planned without adjusting for this.

Jeremy only made one error throughout the whole intervention phase, which indicates he only had one opportunity to learn from the feedback procedure incorporated in the teaching strategy, and this may have further limited his learning. Despite these limitations, Jeremy's skill at making accurate ToM inferences was maintained in the follow-up phase. In addition, his ToM improved (according to the *Strange Stories* post-test score) by four points. For three of the questions Jeremy scored the full two points where he had only scored one point in the pre-intervention test. For question six (see appendix 3) his answer in the pre-intervention test was "she actually wanted a rabbit" for which he scored zero points, but in the post-intervention test he answered "Her parents might get angry if she wanted something else." Indicating that he had understood the character's wish to spare her parents' feelings, not to be rude or insult her parents, and that her reaction was for her parents' benefit rather than just for her. Jeremy's reading comprehension score also improved slightly and he

increased one stanine to a higher year level of reading, but this was still two stanines below the expected comprehension level of his peer group. Thus, the repeated measured data may not accurately reflect Jeremy's learning due to the limitations of the measurement.

None of the studies of interventions for reading comprehension included in the literature review in chapter two measured whether the skills learnt during those interventions generalised to different tasks or situations. Many studies that aim to teach ToM by testing false-belief, state that although children with ASD learn the strategies well and can pass the false-belief tasks they are taught consistently, their skill in generalising these strategies to unlearnt tasks is limited (Begeer et al., 2011; Fisher & Happé, 2005; Ozonoff & Miller, 1995; Swettenham et al., 1996; Swettenham, 1996a; Williams et al., 2012). The findings from these studies previously referred to are in contrast to the results from the current study which found that teaching skills to improve reading comprehension can be generalised to other tasks, including one that involves the direct use of ToM.

Previously three studies have demonstrated that it is possible to teach children with ASD a specific skill and they can then use that skill in different situations or in different tests and improve their response in those tests. Feng et al. (2008) used a multimedia social skills training programme to teach ToM skills to an 11 year old boy. The intervention was intensive, and consisted of 40 minute sessions four times a week for 45 sessions. The skills that were taught progressed in complexity, and ToM and social skill attainment were measured throughout the intervention. A ToM test designed by the researchers was administered pre-and post-intervention and the participant's scores improved by 35.9% at the post-intervention test. Wellman et al. (2002a) used visual stimuli to teach the Sally-Anne false-belief task to seven male participants with ASD. This intervention also demonstrated moderate generalisation to different ToM tasks other than the Sally-Anne test, post intervention. This may have been due to the use of visual stimuli and explicit training of the

false-belief scenario which draws on the learning strengths of children with ASD. Paynter and Peterson (2013) also used visual stimuli to teach 24 children aged between 4-12 years, how cartoon bubbles can represent beliefs. The stages of the intervention mirrored ToM development, and participants generalised their skills learnt during the intervention to a researcher-developed ToM test post-intervention.

There may be other reasons that the scores of ToM and reading comprehension improved, including practice effects of reading the same eight *Strange Stories* in a short amount of time, and participants' willingness and comfort talking with the researcher. As the intervention progressed a relationship was built and participants may have trusted the researcher more and thus shared more information in their post-intervention answer.

Two participants showed improvement in answering ToM questions as a result of the intervention. Ben demonstrated an accelerating trend throughout the intervention phase, and he consistently answered most of the ToM questions correctly from session seven through to the end of the instructional sessions. This is in comparison with the baseline phase, which also showed an accelerating trend, but more errors were made especially as the reading content became harder. During the return-to-baseline phase, Ben continued to answer most questions correctly and reduced the number of errors he made.

From half way through the intervention phase Patrick answered all the questions correctly, except one in session 13. During the baseline phase and the first 6 sessions of the intervention phase his responses were highly variable and he often answered questions incorrectly. The baseline, although accelerating in trend, indicated that Patrick made a number of errors. During the return-to-baseline phase Patrick reduced the number of errors made and demonstrated a similar trend to that in baseline.

The success for these two participants is similar to that reported by Whalon and Hanline (2008) who taught three boys with ASD aged between 7 and 8 years to use a story-map to ask and respond to factual and inferential questions related to narrative stories. Although these participants were slightly older than Ben and Patrick, the level at which they were reading was similar. The participants in the Whalon and Hanline study were also given corrective feedback about their answers which is similar to the type of feedback used in the present study. All three participants increased the amount of comprehension questions they answered correctly during the intervention phase.

Both Ben and Patrick were reading at the same level at the beginning of the intervention as measured by the PAT which indicated that they were reading at a level above average for their age. Once the intervention was complete both participants improved their reading comprehension score on the PAT by one stanine. On the measurement of ToM only Ben increased his post-intervention score by three points and Patrick decreased his score by two points. The minimal improvement seen in Ben's ToM post-test score and no improvement in Patrick's score may have been due to the participants' age and ToM developmental level. It is also possible the content and vocabulary of the *Strange Stories* was too difficult for them despite their advanced reading ability.

The intervention showed very limited effects on Chris's ability to answer inferential questions requiring ToM. Chris continued to make errors throughout each phase of the intervention compared to baseline, which showed that he answered every question correctly except one in the fourth session. Chris continued to make mistakes during the return-to-baseline phase.

Possibility this result was caused by the intervention phase, when the strategy was taught, being too short and more sessions could have produced a better outcome. It may be that Ben and Patrick needed fewer sessions to learn the strategy, while Chris could have

benefited from more sessions. Chris's intervention phase consisted of 12 sessions. Using this number of sessions is supported by other studies such as Hua et al. (2012) who included between nine and 21 sessions in their intervention phase, and showed that the participants who had the longest learning time made the most gains. The intervention phase in the reading comprehension study by Whalon and Hanline (2008) included 26 to 31 sessions, and produced very good effects. One of the studies (Feng et al., 2008) that aimed to teach ToM skills to an 11 year old boy with ASD that resulted in good generalisation to other ToM tasks and an increase in ToM and social skills, consisted of 45 sessions. These studies may show that longer and intensive interventions could benefit children with ASD especially when learning complex cognitive skills such as ToM are involved.

Both a longer intervention phase and additional practice during each session might have benefited Chris. More opportunities to practice the use of the strategy could have been achieved if more ToM inferential questions had been asked each session. In the current study, Chris received fewer than three ToM questions in most instructional sessions, which severely limited the learning opportunities per session. One of the participants, Ben, in the study by Hua et al. (2012) barely increased his rate of answering inferential questions correctly following an intervention of 15 sessions, and this might be similar to any gains recorded for Chris. Both of these participants may have benefited from additional instruction.

Previous research indicates that children with ASD find it easier to answer factual questions rather than inferential questions (Cronin, 2014; El Zein et al., 2014; O'Connor & Klein, 2004). Despite this, only one study (Hua et al., 2012), reviewed in chapter two, differentiated between factual and inferential questions when measuring reading comprehension. Results from Hua and colleagues indicated that although participants were able to answer more inferential questions correctly post-intervention, the effects of the intervention on inferential comprehension was marginal. This may have been because the

intervention did not target inferential comprehension directly, and the feedback given to participants in response to their answers did not provide them with the skills needed to make complex inferences. The current study however, did differentiate between factual and inferential questions, and results show that regardless of reading level, factual questions were answered nearly always correctly by all four participants whereas inferential questions were answered correctly less often.

Results from studies that only measure responses to factual questions such as Stringfield et al. (2011) and Mucchetti (2013), or those that do not differentiate between factual and inferential questions (Whalon & Hanline, 2008) may not be measuring reading comprehension attainment adequately and results may not be truly representative of participants' skill levels (Cronin, 2014). Additionally, previous research has established that children with ASD have discrepancies in reading comprehension that differ from their intelligence, and many have word decoding skills superior to their comprehension skills (Tager-Flusberg, 2006). When studies only measure literal comprehension they are not measuring reading comprehension as a whole, and are only measuring a basic skill which children with ASD find easier than inferential reasoning, which requires a much greater depth of knowledge and cognitive ability (Brown et al., 2012; O'Connor & Klein, 2004; Woolley, 2011).

The results from this study show that while teaching a strategy to answer inferential questions may not have had a significant effect on all four participants' ability to answer ToM inferential questions, they were able to learn the strategy, and apply it to reading passages throughout the intervention phase. They were also able to apply the strategy in the return-to-baseline phase, even when they were no longer given feedback for their responses. After being taught the strategy participants were able to use this strategy to help them answer the questions relating to the ToM *Strange Stories* pre- and post-intervention. These results are

similar to findings by Paynter and Peterson (2013) and Swettenham et al. (1996). Both these studies taught participants direct ToM skills which included strategies such as thought-bubbles representing beliefs in people's heads (Paynter & Peterson, 2013), and the beliefs of other people being like photos in their heads (Swettenham et al., 1996). Both these studies showed highest calibre effects on ToM measures and also concluded that children with ASD can be taught to use and apply a simple cognitive strategy to help them understand ToM (Ozonoff & Miller, 1995).

Limitations and Strengths

The ABC design of this study builds on the AB design by adding a return-to-baseline phase where the instructional intervention is removed to determine whether the performance of participants is maintained in the absence of instruction (Gast & Ledford, 2014).

Confirmation of whether the intervention was responsible for any alterations in the target behaviour without the surrounding environment affecting the result can also be strengthened by replicating the experimental effect with other participants (Riley-Tillman & Burns, 2009). The implementation of a return-to-baseline phase in a typical ABA study cannot be used to evaluate academic skills, because once a skill has been taught, it is impossible to reverse these skills and return to a true pre-intervention baseline (Cooper et al., 2007). This can be minimised by using an ABC design.

One of this study's limitations was the lack of a consistent level of difficulty in the reading passages during the baseline phase. Ideally there should have been a pre-test to determine difficulty levels, and then this level should have been used throughout the study. It may have also been beneficial to have had longer baseline and return-to-baseline phases. This would have enabled greater assessment over a longer period of time of whether the intervention had any effect on answering ToM questions, although Gast and Ledford (2014)

state that collecting baseline data for three successive days should be sufficient if the baseline is consistent across each session.

Another limitation of this study was the variability in the content of the SRA reading passages. Many of the questions that were developed based on the content of these passages were unsatisfactory because they did not all require ToM to answer them. This caused a problem when analysing the questions and resulted in developing a coding system and several post-hoc attempts at coding the questions and answers as explained in chapter three. Not all the measures used to evaluate treatment effects were standardised or included in a manual. For example the *Strange Stories* are not a manualised ToM measure. However, to the researcher's knowledge no measure of ToM exists that has been standardised or has been included in a manual for practitioners to use.

The PAT, used to measure reading comprehension in the current study, is a norm-referenced, standardised and commonly used measure for reading comprehension used throughout schools in New Zealand. One strength of the current study is that the PAT was administered pre-and post-intervention to measure change in scores on a test of reading comprehension. Only one study (Hua et al., 2012) also administered a standardised measure of comprehension pre- and post- intervention. All the other studies (Mucchetti, 2013; Stringfield et al., 2011; Whalon & Hanline, 2008) that involved teaching reading comprehension to children with ASD only measured reading comprehension pre-intervention, thus limiting the conclusions that can be made regarding the effects of these previously mentioned interventions.

There are many limitations in the intervention itself, and one component which could have been improved was the way feedback was given when a participant made a mistake in a ToM answer. The experimental nature of this study is however, a strength, because to the best

of the researcher's knowledge, no study has previously reported linking inferential comprehension to potential changes in the ToM of children with ASD.

Implications and Areas for Future Research

The importance of understanding the reading comprehension ability of children with ASD has been highlighted in this study. Whilst the evidence is tentative, the current study found that children with ASD can be taught a strategy to help them answer inferential questions and that they not only find it more difficult to answer inferential questions when compared with factual questions, but they also find it harder to answer inferential questions that involve ToM. These findings could have implications in education for teachers and clinical implications for psychologists.

For teachers an understanding and awareness of the types of questions they ask children with ASD could be important, especially in situations involving assessment or asking questions in front of class peers. The findings from this study may have implications for the relevance of psychometrics and screening tools or assessment used by psychologists to make an ASD diagnosis. Practitioners need to be aware of the content in these assessments and the type of questions they ask the children while they are administering the assessment. For example, the commonly used Autism Diagnostic Observation Schedule (ADOS) is an assessment of play, communication and social interaction, for children, adolescents and adults that uses semi-structured questions to assess certain ASD diagnostic criteria. The ADOS consists of four modules that are designed for different developmental levels, cognitive abilities and language skills, seen in children with ASD, ranging from nonverbal to verbally-fluent. Module three is designed to be administered to children and adolescents who have fluent speech, such as those included in the current study. A large part of the assessment process is asking the child socio-emotional questions in relation to emotions, friends, loneliness, social difficulties and annoyance (Lord et al., 2000). It is therefore likely that the

questions practitioners ask contain references to ToM or require the ability to use ToM. If the administrator does not realise that it is more difficult for children with ASD to comprehend and answer these types of questions, it may cause the child to become frustrated and therefore the results may be biased.

Future research involving children with ASD needs to take into account whether the inferential questions used to measure comprehension require ToM to answer them. Specific aspects of comprehension impairment such as inferential understanding also need to be addressed and guided by theoretical frameworks of reading, such as The Simple View of Reading, and more specialised theoretical frameworks that relate to children with ASD such as ToM, Central Coherence and Executive Function. ToM research needs to include developmentally appropriate measures that test each stage of ToM, not just false-belief and the content of the resources used need to be assessed to make sure they are at the appropriate reading level for the participant.

Conclusion

This study contributes to research on the ToM and reading comprehension of children with ASD by providing an insight into how a theoretical framework such as ToM could be applied to understand academic difficulties. With regard to the types of questions children with ASD find harder to answer, the findings of the current study displayed a similar pattern to that seen in the reading comprehension literature. This study also indicated that children with ASD may benefit from being taught an explicit strategy to help them answer inferential questions, but requires more research to establish the possibility.

This study also increases the knowledge base with the finding that children with ASD have difficulty in answering inferential questions, especially inferential questions referencing mental states and requiring ToM. Children with ASD can learn explicit strategies quickly and learn to apply those strategies. Lastly, reading comprehension interventions for children with

ASD can be adapted from interventions used with typically developing children and those with learning difficulties and are suitable and effective in improving the reading comprehension and ToM problems that are so debilitating for children with ASD.

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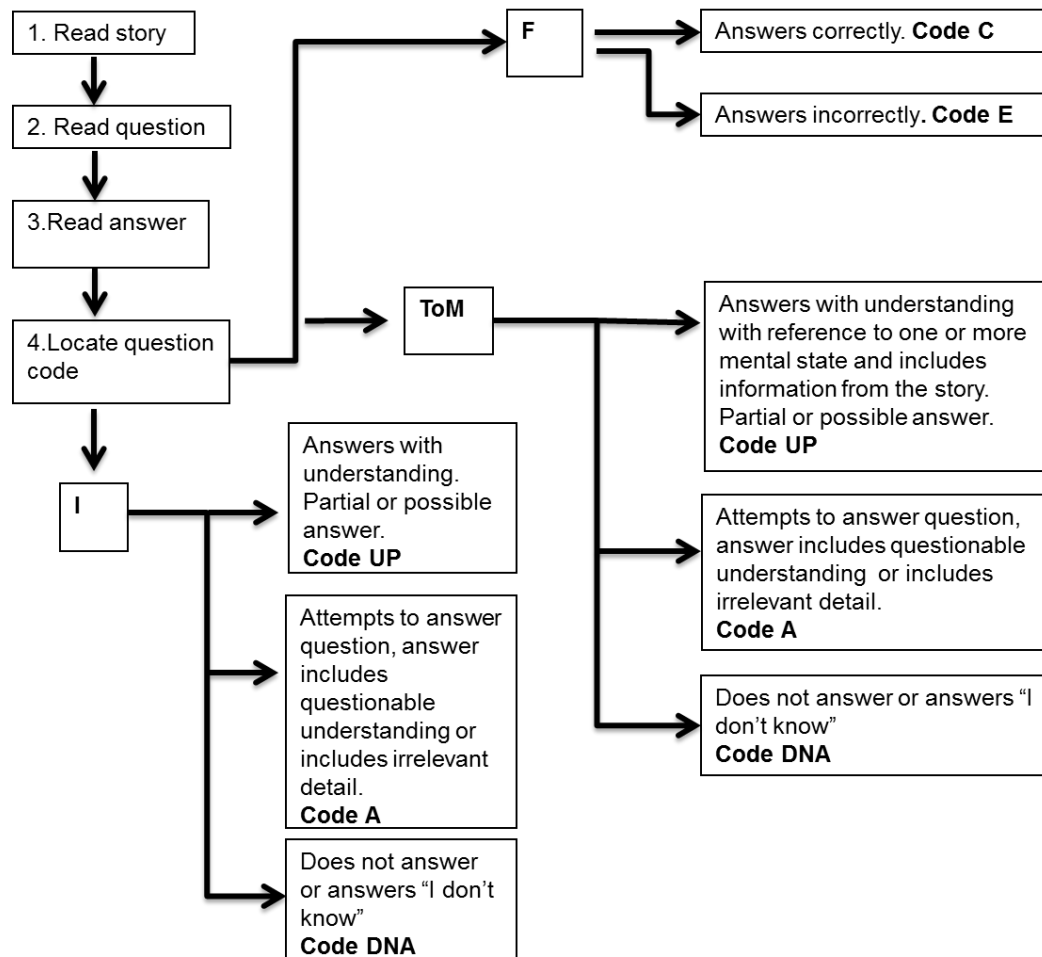
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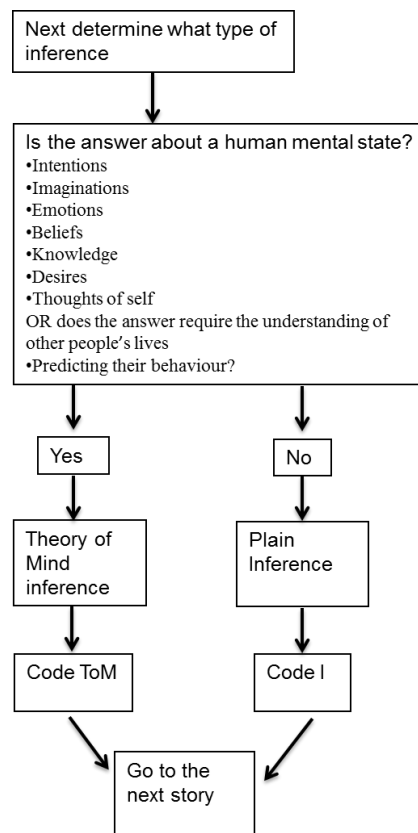
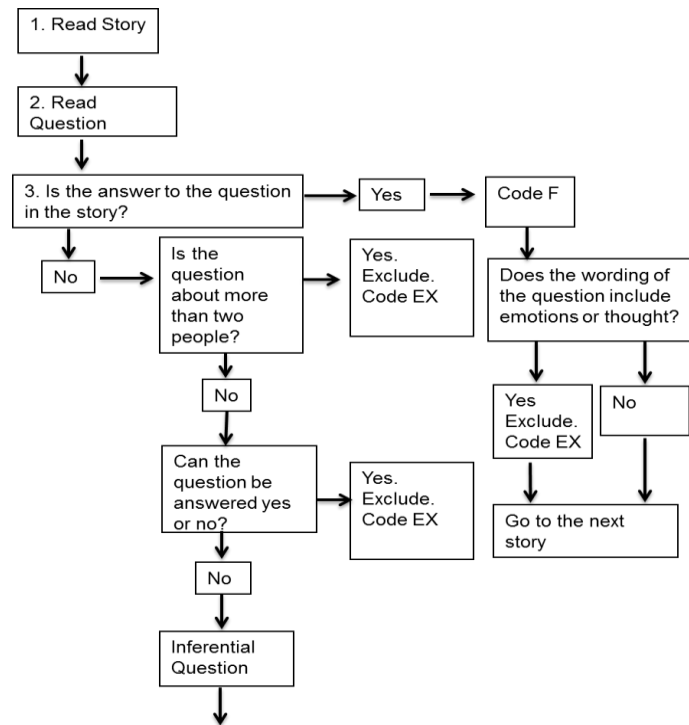
Appendix 1.

Flow chart for coding types of questions.



Appendix 2.

Flow chart for coding different types of inferential questions



Appendix 3.

Strange Stories

1. Simon is a big liar. Simon's brother Jim knows this, he knows that Simon never tells the truth! Yesterday Simon stole Jim's Ping-Pong bat, and Jim knows Simon has hidden it somewhere, though he can't find it. He is very cross. So he finds Simon and he says, "Where is my Ping-Pong bat? You must have hidden it either in the cupboard or under your bed, because I have looked everywhere else. Where is it, in the cupboard or under your bed?" Simon tells him the bat is under his bed.

Why will Jim look in the cupboard for the bat?

2. During the war, the Red army captures a member of the Blue army. They want him to tell them where his army's tanks are; they know they are either by the sea or in the mountains. They know that the prisoner will not want to tell them, he will want to save his army, and so he will certainly lie to them. The prisoner is very brave and very clever, he will not let them find his tanks. The tanks are really in the mountains. Now when the other side asks him where his tanks are he says, "They are in the mountains."

Why does the prisoner say that?

3. Brian is always hungry. Today at school it is his favourite meal- sausages and beans. He is a very greedy boy, and he would like to have more sausages than everyone else, even though his mother will have made him a lovely meal when he gets home! But everyone is allowed two sausages and no more. When it is Brian's turn to be served, he says, "Oh, please can I have four sausages, because I won't have any dinner when I get home!"

Why does Brian say this?

4. Jill wanted to buy a kitten, so she went to see Mrs Smith, who had lots of kittens she didn't want. Now Mrs Smith loved the kittens, and she wouldn't do anything to harm to them, though she can't keep them all herself. When Jill visited she wasn't sure she wanted one of Mrs Smith's kittens, since they were all males and she had wanted a female. But Mrs Smith said, "If no one buys the kittens I'll have to drown them!"

Why did Mrs Smith say that?

5. One day Aunt Jane came to visit Peter. Peter loves his aunt very much, but today she is wearing a new hat: a new hat which Peter thinks is very ugly indeed. Peter thinks his aunt looks silly in it, and much nicer in her old hat. But when Aunt Jane asks Peter, "How do you like my new hat?" Peter says, "Oh, it's very nice."

Why does he say that?

6. Helen waited all year for Christmas, because she knew at Christmas she could ask her parents for a rabbit. Helen wanted a rabbit more than anything in the world. At last Christmas Day arrived, and Helen ran to unwrap the big box her parents had given her. She felt sure it would contain a little rabbit in a cage. But when she opened it, with all the family standing around, she found her present was just a boring old set of encyclopaedias, which Helen did not want at all! Still, when Helen's parents asked her how she liked her Christmas present, she said, "It's lovely, thank you. It's just what I wanted."

Why did she say this?

7. Late one night Mrs Peabody was walking home. She doesn't like walking home alone in the dark because she is always afraid that someone will attack her and rob her. She really is a very nervous person! Suddenly, out of the shadows comes a man. He wants to ask Mrs Peabody what time it is, so he walks towards her. When Mrs Peabody sees the man

coming towards her, she starts to tremble and says, “Take my purse, just don’t hurt me please!”

Why did she say that?

8. A burglar who had just robbed a shop in making his getaway. As he is running home, a policeman sees him drop his glove. He doesn’t know the man is a burglar; he just wants to tell him he dropped his glove. But when the policeman shouts out to the burglar, “hey, you! Stop!” the burglar turns around and sees the policeman and gives himself up. He puts his hands up and admits that he did the break-in at the local shop.

Why did the burglar do that?

Appendix 4.

Information Forms

Sophie Worel-Dahl,
School of Health Sciences, College of Education
University of Canterbury
Private bag 4800
Christchurch 8140
Tel: +64 2102728917
sophie.worel-dahl@pg.canterbury.ac.nz



17/09/2013

Project title: A cognitive strategy to enhance reading comprehension and mental state attribution in children with Autism Spectrum Disorder

Information sheet for Child

Hello,

My name is Sophie Worel-Dahl and I am studying at the University of Canterbury. I want to do a project for university that looks at how people read stories and how much they understand what they read.

I have been told by your teacher that you might be able to help me with my project. To help me do my project, I would come and visit you at your school three times a week during term four. You would help me by reading some stories and answering some questions about the stories. The stories will be short, and not too hard. It does not matter if you don't like to read, or if you find reading hard, because I might be able to help you. I will help you by giving you some feedback, and some prompts while you are reading. I can also show you what to do before you read the stories.

All your answers to the questions you give me will be written down by myself, so I can look at them afterwards. This is called analysing the data. At the end of the project, I will give you and your parent/s a copy of your data that I have collected.

If at any point, you do not feel like reading, or being part of the project, that is fine too.

If you have any questions you can contact me on 02102728917 or sophie.worel-dahl@pg.canterbury.ac.nz or my supervisor, Kathleen Liberty, on 364 2545 or kathleen.liberty@canterbury.ac.nz.

If you any complaints, you can contact the Chair of the University of Canterbury Educational Research Human Ethics Committee.

This project has received ethical approval from the University of Canterbury Educational Research Human Ethics Committee. 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).

Thank you for taking the time to read this letter.

Kind Regards,

Sophie Worel-Dahl.

Sophie Worel-Dahl,
School of Health Sciences, College of Education
University of Canterbury
Private bag 4800
Christchurch 8140
Tel: +64 2102728917
sophie.worel-dahl@pg.canterbury.ac.nz



17/09/2013

A cognitive strategy to enhance reading comprehension and mental state attribution in children with Autism Spectrum Disorder

Information Sheet for Parent/Caregiver

My name is Sophie Worel-Dahl and I am completing a Master thesis in Child and Family Psychology. The aim of my thesis is to assess whether teaching children with Autism Spectrum Disorders a strategy to answer why and how questions, could enhance their reading comprehension and understanding of people's emotions. I currently work part time as a residential youth worker with youth who have a wide range of emotional, psychological and learning difficulties.

Your child's teacher has sent this letter home because I would like to invite your child to participate in this study. If you are interested in having your child participate please read and explain the contents of this information sheet and the consent form with your child.

If you agree to your child taking part they will be asked each session to read out loud, short stories at their appropriate reading level and answer comprehension questions after each story. The study will be conducted in three weekly 30 minute sessions during term four, in the back of the classroom or another location designated to me by the teacher or principal.

I will send you a short report at the end of each week about what your child has been working on. A summary of results of the project will be offered at the conclusion of the study.

If at any point your child expresses that he/she does not want to participate in an activity then he/she will be returned to the classroom. If your child wishes to withdraw from the study entirely, all information collected relating to your child will be erased.

Any data that is collected and used in publications and presentations will be coded with pseudonyms to maintain anonymity. We recognise that because participants will be withdrawn into a quiet area in the classroom, or taken right out, non-participating children will be aware their classmate is involved in a project. However, they will not be told participants are taking part in the project. All data will be kept private through storage on a secure computer or in a locked cabinet and will be destroyed after five years.

If you require further information you can contact the researcher, Sophie Worel-Dahl on 02102728917 or sophie.worel-dahl@pg.canterbury.ac.nz or her supervisor, Kathleen Liberty, on 364 2545 or kathleen.liberty@canterbury.ac.nz.

If you have any complaints, you can contact the Chair of the University of Canterbury Educational Research Human Ethics Committee.

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Sophie Worel-Dahl,
School of Health Sciences, College of Education
University of Canterbury
Private bag 4800
Christchurch 8140
Tel: +64 2102728917
sophie.worel-dahl@pg.canterbury.ac.nz



17/09/2013

A cognitive strategy to enhance reading comprehension and mental state attribution in children with Autism Spectrum Disorder

Information Sheet for Teachers, Principal and Board of Trustees

My name is Sophie Worel-Dahl and I am completing a Masters thesis in Child and Family Psychology. The aim of my thesis is to assess whether teaching a strategy to children with Autism Spectrum Disorders to answer inferential and factual questions could enhance their reading comprehension and mental state understanding.

I would like to invite children enrolled at your school to participate in my study. Participation will involve doing some tests on reading comprehension and mental state understanding, reading short stories (100-150 words) every session, and answering six factual and inferential questions after each story. Each participant will be taught to locate answers to the questions in the text using feedback and prompts from the researcher. The study will be conducted three times per week for seven weeks and sessions will be no longer than 30 minutes.

To complete this study I need at least five students to take part, who have a diagnosis of Autism Spectrum Disorder and who could benefit from reading comprehension instruction.

Potential candidates need to be older than six years of age, and have a reading level of year three or higher.

If you agree to nominate a student I will supply you with information and consent forms which the teacher can send home with the nominated child or follow other school procedures for parent contact, such as email or telephone. Consent must be obtained from the parent for the child's participation. Brief reports on the child's progress will be given to the child and teacher after each session.

Participation in this study is entirely voluntary and the principal, teacher or BOT, as well as the parent and child, maintain the right to withdraw at any stage without penalty.

You will receive a summary of this study. All data will be stored on a secure server or in a locked cabinet at the University of Canterbury and will be destroyed after five years. Prior to publishing or presenting any results all data collected will be coded with pseudonyms to maintain anonymity. Coded data will only be accessible by me and my supervisors prior to submission.

If you require further information please contact the researcher, Sophie Worel-Dahl on 02102728917 or sophie.worel-dahl@pg.canterbury.ac.nz, or her supervisor, Kathleen Liberty, on 364 2545 or kathleen.liberty@canterbury.ac.nz.

If you have any complaints, please contact the Chair of the University of Canterbury Educational Research Human Ethics Committee. This project has received ethical approval from the University of Canterbury Educational Research Human Ethics Committee.

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Appendix 5.

Consent Forms

Sophie Worel-Dahl,
School of Health Sciences, College of Education
University of Canterbury
Private bag 4800
Christchurch 8140
Tel: +64 2102728917
sophie.worel-dahl@pg.canterbury.ac.nz



17/09/2013

Project title: A cognitive strategy to enhance reading comprehension and mental state attribution in children with Autism Spectrum Disorder

Consent Form for Child

Please read this consent form. By ticking the boxes and writing your name at the end you are agreeing to help me with this project. Your parent/caregiver also has to give their consent for you to take part.

1. I am willing to take part in the project.

☐ Yes ☐ No

2. I understand what I will have to do.

☐ Yes ☐ No

3. Please write your name here _____

Please give this form to your parents so that they can put it in the supplied envelope with their own consent form to give to your teacher.

If you need further information you can contact the researcher, Sophie Worel-Dahl or her supervisor, Kathleen Liberty via the provided contact details. If you have any complaints, you can contact the Chair of the University of Canterbury Educational Research Human Ethics Committee.

Sophie Worel-Dahl,
School of Health Sciences, College of Education
University of Canterbury
Private bag 4800
Christchurch 8140
Tel: +64 2102728917
sophie.worel-dahl@pg.canterbury.ac.nz



17/09/2013

A cognitive strategy to enhance reading comprehension and mental state attribution in children with Autism Spectrum Disorder

Consent Form for Parents/Caregivers

I have been given a full explanation of this project and have been given an opportunity to ask questions. I understand what will be required of my child if I agree for him/her to take part in this project.

I understand that my child's participation is voluntary and that I may withdraw at any stage without penalty. Furthermore, upon withdrawal from the study, any data regarding my child will be removed and destroyed.

I understand that data from this study will be published in a thesis and could be published in an academic journal or presented at a conference. I understand that any information or opinions I or my child provides, will be kept confidential to the researcher and will not identify him/her.

I understand that all data collected for this study will be kept in locked and secure facilities at the University of Canterbury and will be destroyed after five years.

I understand that I will receive brief daily reports during the study which will be sent home with my child. I understand I will be given a summary of the results of the project at the conclusion of the study.

Below is a short questionnaire containing personal questions about your child. It would be greatly appreciated if you could fill it in and send it back to school to your child's teacher in the enclosed envelope. All details will be kept strictly confidential.

Please answer each of the questions in the space provided.

1. Please indicate if your child is a boy or girl by ticking the appropriate box.

☐ Boy ☐ Girl

2. What is your child's age? ____ / ____
Years/Months

3. What is your child's ethnicity?

☐ NZ European ☐ Maori ☐ Pacific ☐ European ☐ Asian ☐ Other

4. When were you told your child has an Autism Spectrum Disorder? ____ / ____ / ____
Year / Month / Day

5. Has your child been diagnosed with another co-occurring disorder or disability? (For example, hyperactivity, anxiety, hearing impairment).

☐ Yes

Please indicate below which co-occurring diagnosis or disability

☐ No

6. Does your child like to read?

☐ Yes

☐ No

7. Does she/he have any special interests and hobbies that you would like to let us know about?

I understand that if I require further information I can contact the researcher, Sophie Worel-Dahl or her supervisor, Kathleen Liberty via the provided contact details. If I have any complaints, I can contact the Chair of the University of Canterbury Educational Research Human Ethics Committee. By signing below I am declaring that I have read and explained the information sheet to my child and that they and I agree that they can take part in this study.

Your name (please print): _____

Your child's name (please print): _____

Your signature: _____ Date: _____

Please return this form to your child's teacher by the [insert date].

Thank you for taking the time to read and fill in this form.

Sophie Worel-Dahl,
School of Health Sciences, College of Education
University of Canterbury
Private bag 4800
Christchurch 8140
Tel: +64 2102728917
sophie.worel-dahl@pg.canterbury.ac.nz



17/09/2013

A cognitive strategy to enhance reading comprehension and mental state attribution
in children with Autism Spectrum Disorder

Consent Form for Principals, Teachers, and Board of Trustees

We have been given a full explanation of this project and have been given an opportunity to ask questions.

We understand what will be required of us if we agree for our school to take part in this project.

We understand that our participation, and that of our students, is voluntary and that we may withdraw at any stage without penalty. We also understand that if this occurs all information pertaining to the school, its staff and student will be removed from the study and destroyed.

We understand that any information or opinions we provide will be kept confidential to the researcher and will not identify us.

We understand that all data collected for this study will be kept in locked and secure facilities at the University of Canterbury and will be destroyed after five years.

We understand that we will receive a report on the findings of this study.

We understand that if we require further information we can contact the researcher, Sophie Worel-Dahl or her supervisor, Kathleen Liberty. If we have any complaints, we can contact the Chair of the University of Canterbury Educational Research Human Ethics Committee.

By signing below we are declaring that we have read and understand the statements above and agree to fulfil our role to allow the completion of this study. If we have provided our E-mail address we would like to receive a summary of the findings.

Board of Trustees (please print): _____

Signature: _____ Date: _____

Principal name (please print): _____

Signature: _____ Date: _____

Teacher name (please print): _____

Signature: _____ Date: _____

Appendix 6.

Human Ethics Confirmation



HUMAN ETHICS COMMITTEE

Secretary, Lynda Griffioen
Email: human-ethics@canterbury.ac.nz

Ref: 2013/52/ERHEC

11 September 2013

Sophie Worel-Dahl
School of Health Sciences
UNIVERSITY OF CANTERBURY

Dear Sophie

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 "A cognitive study to enhance reading comprehension and mental state attribution in children with autism spectrum disorders" 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 9 and 11 September 2013.

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

A handwritten signature in black ink, appearing to read 'N Surtees'.

Nicola Surtees
Chair
Educational Research Human Ethics Committee

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

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