The Effects of Picture and Word Presentations on Recognition and Memory Accuracy in Autism Spectrum Disorder

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A thesis submitted

in fulfillment of the requirement

for the Degree

of

Masters of Arts in Psychology

at the

University of Canterbury

by

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University of Canterbury

2011

Acknowledgements

I would like to thank my family, my parents and grandparents, for all their support, guidance and for putting up with me throughout writing this thesis. To my mum, who helped me come up with the central idea for this study, who listened while I vented, and inspired me to keep at it no matter how tough things got; to my dad who (despite the constant jokes about university) was there for me when I needed him, who supported me and gave me the alternative option that I needed to keep me going I love you both and thank you so much. To my little sister Mikayla who helped me set up the materials and ensure that they worked for someone her age – thank you.

A huge thank you goes out to Mr G Panting, the kids and the parents of the Lake Rotoiti School's senior class who acted as my guinea pigs by taking part in my pilot study, which set me on track for my main study.

To all the principals, teachers, parents and especially the kids and university students who took part in this study I would like to say a huge thank you as without you I would have been completely lost and this study would never have been able to happen.

I would like to thank my supervisors, Ewald Neumann and Paul Russell, for being there to answer all my questions (even the really silly ones) and for helping me through the trials and tribulations of my thesis. Furthermore, for pushing me to produce the best piece of research and literary work I could manage. Also to the people at the University Learning Skills Centre thank you for all your guidance and help throughout the writing of this thesis.

To my amazing friends who helped throughout this entire process; Mel and Matt who let me crash at their place whenever I needed to be in Christchurch, Mel for acting as one of my many proofreaders, Lisa for being such a brilliant distraction whenever I needed one and Sin who gave me the opportunity to study every quiet Sunday at work. Also to my bosses and workmates at 5 Points whose support and understanding really helped me through these last few months.

To everyone I have missed, and I don't doubt there are many, thank you for everything you've done to help make this study possible; it means the world to me.

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The purpose of the present study was to investigate the false memory rates for word and picture Deese-Roediger-McDermott (DRM) lists in children, adolescents and adults with autism spectrum disorder (ASD). Deese (1959), Roediger and McDermott (1995) developed the DRM paradigm as a method for testing the effects of semantic intrusion on the creation of false recollections. This method is used in the current thesis to test false memory in participants with Autism Spectrum Disorder (ASD), a disorder characterised by social, language and behavioural deficits. False memory studies of adults with this disorder have had conflicting results and found ASD participants have lower or similar false memory rates to controls. Experiment 1 compared false memory rates in 11 children, 11 adolescents and 5 adults with ASD to 15 children, 11 adolescents and 7 adult controls. ASD participants had higher false critical lure rates and lower studied item recognition rates than controls regardless of age. Adolescents had higher false and studied memory than children while adults had higher studied but lower false recognition rates than the younger groups. Due to the use of short DRM lists the adult participants recognised the fewest critical lures. In Experiment 2 there were 6 ASD children and 9 ASD adolescents compared with 6 control children and 9 control adolescents who were all tested both individually and in collaborative trios. Collaboration was beneficial to ASD adolescents and control children and adolescents by reducing false recognition and increasing studied item recognition. Collaboration was more beneficial for ASD adolescents and control children in the correct rejection of critical lures and for control adolescents in the recognition of studied items possibly due to decision making techniques. Critical lure recognition did not vary between collaborative trios and individuals and studied item recognition was decreased by collaboration in the ASD children. The observed decision making techniques employed revealed a clear pattern in social development and suggest ASD adolescents, but not ASD children, would benefit from group work. Overall the findings of this study, when taken into context with previous DRM studies, suggest that ASD participants have a delay in their social development and in the development of their association networks.

Chapter One

Introduction

It is a common misconception that memory is always accurate, when nothing could be further from the truth. It is very common for false memories to occur, from something as simple as remembering a yield (give way) sign when it was actually a stop sign, to someone identifying the wrong man as their rapist in a criminal proceeding (Loftus, 1997; Payne, Neuschatz, Lampinen & Lynn, 1997). In the last few decades there has been a flood of false memory research and one of the most common methods used is the Deese (1959), Roediger and McDermott (1995) (DRM) task. The DRM task uses semantically associated word lists to create false memories of non-presented critical lure words. For example '*apple, vegetable, citrus, ripe, salad, cocktail…*' tends to create the false recollection of the critical lure "***fruit***". The DRM task has been used to examine the false memory effect in numerous groups including children where it has been found that false memory rates are lower for children. It has also been used with different stimuli such as lists presented aurally and visually, or in pictures.

False memories could result from several different processes. A number of theories have been put forward to explain false memories including source misattribution theory, association activation theory and the distinctiveness heuristic, all of which will be discussed in much more detail later. A recent interesting area of DRM research is the effect of collaboration; working in groups of two or more. Collaborative studies can provide a better understanding of the effect other people can have on someone's memory. This is important as collaboration studies closely parallel the real world and have implications for the justice system.

The most important facet of the current investigation involves false memory in people with autism spectrum disorder (ASD). ASD is a predominantly social developmental disorder which affects approximately 50,000 New Zealanders (Autism New Zealand, 2005). Studies using the DRM task in adults with ASD have resulted in conflicting findings, with ASD adults having fewer (Beversdorf, Smith, Crucian, Anderson et al, 2000) or similar (Bowler, Gardiner, Grice, Saavalainen, 2000) critical lure intrusions in relation to controls. Studies have not been conducted with ASD children or in collaborative groups and will be further examined throughout the course of the current investigation.

This chapter will first give an overview of false memories before examining the DRM. It will then cover specific DRM studies examining age differences and studies involving adults with ASD. Subsequently it will put forward three of the most relevant theories explaining false memory effects in the DRM and lastly it will cover studies into collaboration in the DRM task.

1.1 False Memory

We all like to think our memories are infallible: "*I **know** it happened… I remember it as if it were only yesterday*". Unfortunately memory is not like a video tape, with everything accurately recorded ready to be played back at will. Memory can be changed and misled by imagination, perception, corroboration by other people, and misleading information. This is why people attending the same event can have such differing accounts of what happened. Of course something as simple as having a false memory about a toy you thought you had, or a fall off your bike that you could swear happened (but never did) is not going to hurt anyone. Still, if false memories such as these can take place it stands to reason that they can also occur with more serious events, such as those involving crimes, or repressed memories of childhood abuse. Take for example the Washington Sniper case of 2002 where two snipers killed ten people in Washington D.C. During

one of the early attacks an eyewitness reported seeing a white van at the scene, a detail later published by the media. Eyewitnesses at subsequent attacks also reported seeing a white van. These reports are now believed to be a result of false memory caused by the media's original suggestion of the importance of the white van. The snipers were later found to be executing their attacks from a blue car (Loftus, 2003). This example also demonstrates the impact that other people and the media can have on someone's false memory and the way in which they can trigger or create false memories.

False recollection in eyewitnesses (as with the general population) can result from misinformation, suggestion, and leading questions. Understanding the effects of these factors is very important for the criminal justice system. The growing understanding of false memory has led to significant changes within criminal law proceedings and with regard to police procedures. Some of the changes which have occurred include the increased use of DNA testing and convictions being made based predominantly on physical evidence with less emphasis being placed on eyewitness testimonies. Driving these changes were the many cases where people were wrongfully convicted as a result of erroneous eyewitness testimony. It has been estimated that 7,500 people who were arrested in the United States for serious crimes in 1999 were wrongfully convicted (Huff, 2002; cited in Loftus, 2003). This rate is believed to be much lower in other countries, such as New Zealand and Australia, although wrongful conviction is still a global problem (Huff, 2002; cited in Loftus, 2003).

A prominent example of erroneous eyewitness testimony is that of Ronald Cotton who was convicted of rape in 1986 (Loftus, 2003). The victim, 22 year old college student Jennifer Thompson, took the stand and named Cotton as her rapist. However, DNA testing later cleared Cotton of the charges and Bobby Poole pleaded guilty to Thompson's rape. In this case DNA

testing was not available until 11 years after Cotton's conviction based on Thompson's testimony, which was the key evidence in the case against Cotton. The biggest problem with eyewitness testimony is that, despite being a false memory, the witness can be entirely certain of their account of the events, and it is very difficult to discern a false memory from a true one. Unfortunately, wrongful convictions resulting from eyewitness testimony are a continuing problem despite the development of DNA testing and evidentiary procedures. This dilemma clearly demonstrates the need for a deeper understanding of false memories and the development of ways to discern false memories from true memories.

Another driving force behind false memory research comes from recognition of vividly imagined 'repressed' memories which can result from suggestion from the therapist. A case that really highlights this is that of Beth Rutherford who undertook therapy in 1992 (Loftus, 1997; Loftus, 2003). With the help of her therapist Rutherford developed memories of her clergyman father raping her and twice forcing her to abort her resulting pregnancies with a coat hanger. Later medical examination revealed that Rutherford was still a virgin and had never been pregnant, proving these memories were in fact false and resulted from suggestions made in her therapy sessions. Regrettably the damage had already been done as her father had been forced to resign his post in light of the allegations.

There are numerous cases where false memories have had a lasting negative effect, on both those who experienced them and the people who the memories related to. It is the hope that false memory research can eventually uncover a way in which false memories will be more discernible from true memories. This research has real implications to assist in uncovering techniques for therapists, law enforcement personnel, lawyers, and other professionals to reduce the likelihood of

creating false memories in patients and witnesses (as seen in the Ronald Cotton case, cited in Loftus, 2003).

1.2 The Deese-Roediger-McDermott (DRM) Paradigm

For quite some time it was believed that false recollection only occurred in paradigms employing materials 'rich in meaning' such as sentences, passages of writing or complex scenes viewed with slides or video tapes; in other words, depictions of natural occurrences found in everyday life. The majority of studies using list learning paradigms (lists of words memorised and then recalled with or without cues), while showing association and resulting in some level of false recognition, created inconsistent results when replicated (such as Underwood, 1965; cited in Roediger & McDermott, 1995). In fact, many list learning paradigms revealed small or non-existent false memory intrusions. Recognition tasks tended to result in greater false memory effects and recall tasks rarely resulted in any false memory intrusions.

Deese (1959) addressed these issues by developing word lists based on associative strength to non-presented critical lures. Deese created these word lists by giving participants 36 lists containing some of the Minnesota norms of the Kent-Rosanoff word-association lists and asking them to write down the first word they associated with each item (free association task). From this information, and a recall task carried out prior to the free association task, Deese (1959) was able to get an indication of which word lists had the strongest likelihood of resulting in a false memory. From the free association task Deese created word lists each consisting of 12 words which he presented to participants. A false memory was defined as a participant falsely recalling a non-presented critical lure (strong semantic associate). Deese found that the lists which started from the word with the strongest association to the critical lure down to the word with the weakest association, or vice versa, had the greatest chance of eliciting a false memory of the non-presented critical lure.

1.2.1 Word lists.

Since Deese's (1959) work several false memory studies have been carried out using list learning paradigms. A study of particular importance is that of Roediger and McDermott (1995). Roediger and McDermott presented participants with 16 of their 24 word lists modelled on Deese's (1959) lists, each containing 15 words (see Figure 1). Some of the participants completed a recall task where 55 percent of the time they recalled non-presented critical lures. The rest completed a recognition task where these participants falsely recognised 53 percent of the critical lures. Critical lure recollection was at approximately the same level as studied item recollection and much higher than recollection of any other non-presented (novel) words. It is interesting to note that participants who completed a recognition task immediately after a recall task, falsely recognised 72 percent of the critical lures. The paradigm that Roediger and McDermott created, by building on Deese's original work, has become known as the Deese-Roediger-McDermott (DRM) paradigm (or task) and is a widely used method of false memory testing.

Anger	Black	Bread	Chair	Cold	Doctor	Foot	Fruit
mad	white	butter	table	hot	nurse	shoe	apple
fear	dark	food	sit	snow	sick	hand	vegetable
hate	cat	eat	legs	warm	lawyer	toe	orange
rage	charred	sandwich	seat	winter	medicine	kick	kiwi
temper	night	rye	couch	ice	health	sandals	citrus
fury	funeral	jam	desk	wet	hospital	soccer	ripe
ire	color	milk	recliner	frigid	dentist	yard	pear
wrath	grief	flour	sofa	chilly	physician	walk	banana
happy	blue	jelly	wood	heat	ill	ankle	berry
fight	death	dough	cushion	weather	patient	arm	cherry
hatred	ink	crust	swivel	freeze	office	boot	basket
mean	bottom	slice	stool	air	stethoscope	inch	juice
calm	coal	wine	sitting	shiver	surgeon	sock	salad
emotion	brown	loaf	rocking	Arctic	clinic	smell	bowl
enrage	gray	toast	bench	frost	cure	mouth	cocktail

Figure 1: Example of eight of the 24 critical lures and corresponding DRM lists used by Roediger & McDermott (1995).

Following the recall or recognition task Roediger and McDermott (1995) had participants state whether words they had identified as list items were ones they judged as 'remember' or 'know' had been studied. In this instance 'remember' refers to items participants can remember with such clarity that they even recall the experience of the items' presentation (Payne, Elie, Blackwell & Neuschatz, 1996). In contrast, 'know' refers to items which participants are certain were studied

but cannot mentally relive experiencing (Tulving, 1985; cited in Payne et al, 1996; Roediger & McDermott, 1995). Using this technique to measure confidence Roediger and McDermott (1995) found that participants labelled critical lures as items they 'remember' more than as items they 'know' which indicates high confidence in their false recollection. Furthermore, participants demonstrated as much confidence in their false critical lure recollection as their true studied item recollection. Roediger and McDermott's (1995) findings suggest participants hold critical lure recollection with a great deal of confidence (see also Payne et al, 1996; Payne, Neuschatz, Lampinen & Lynn, 1997; Read, 1996 for confirmation of these results).

Some of these studies have found participants to be so confident in their false memories that they can go as far as to identify the source of the non-presented words (critical lures). For example, Payne et al. (1996) presented lists to participants on videotape with two separate speakers reading alternate words. Participants were required to indicate whether they recollected each word and then which speaker had said the words they had remembered. Even after subjects were informed that this task was particularly difficult and not to guess, participants still indicated 87% of the time which of the two speakers had said the non-presented critical lures. Some of these participants were so sure that the non-presented critical lures had been presented that even after being shown the video tape a second time they still believed the critical lures were in the study lists. Other studies have found participants to be so sure of their false recollections of the critical lures that they can even recall specific details such as the position of the critical lures in the studied lists and whether they were presented visually or aurally (for a review, see Payne et al, 1997). The confirmation of participant confidence across a number of studies strongly suggests that false memories can be held with as much confidence as memories for actual events. This has important connotations for eyewitness testimony and how much stock should be placed on a person's

insistence that the event they remember is accurate, as well as the certainty with which they assert this (Payne et al, 1996).

There are a number of factors which influence false memory rates using word lists: list length, the strength of the associations between the critical lure and studied items, and the use of distractor tasks and warnings. Shortened studied list length has been found to reduce the rate of false memories produced by adult participants. Roediger and McDermott (1995) demonstrated this by carrying out two separate experiments, both showing clear false memory effects, but using different length word lists; either with 12 or 15 words. The 12 word lists resulted in 40 percent recall of the non-presented critical lures which, when compared with the 55 percent recall of critical lures in the 15 word lists, shows a direct relation between list size and false memory. This finding was replicated by Surgue and Hayne (2006) who compared false memory rates for lists containing seven words to lists containing 14 words. They also concluded that shorter word lists significantly reduce false memory rates in adults.

One factor which has regularly been found to have a significant impact on false memory rates (critical lure recollection) in the DRM task is backward associative strength (BAS). This refers to the collective probability that each item in a study list will immediately elicit the critical lure during a free association task (Brainerd & Reyna, 2005). Roediger and McDermott (1995) suggested that BAS is the best predictor of whether a DRM list will result in the desired semantic intrusion (critical lure recollection). This has been further supported by Gallo and Roediger (2002) who found false memory rates were lower for lists with low BAS. Roediger, Watson, McDermott & Gallo (2001) examined factors that influence false recall in the DRM task using multiple regression and similarly found that BAS is the greatest predictor of false memory when other factors (e.g., word length, the number of associations between items) are considered. It is also

interesting to note that associative strength only affects false memory rates. True memory does not appear to change by varying the mean BAS of the study lists (Howe, Wimmer & Blease, 2009).

Another factor found to increase false memory rates is the use of an unrelated distractor task (such as a simple math task or reciting the alphabet) carried out between list presentation and testing. In a study conducted by Payne et al. (1996) participants had higher critical lure recollection than studied item recollection after they completed a simple math task prior to testing. Recall or recollection tasks that occur after delay periods of varying lengths reveal no change in critical lure recollection and decreased studied item recognition. This was the case regardless of whether the retention (delay) period was for one hour (Payne et al, 1996), one week or three weeks (Toglia, Neuschatz & Goodwin, 1999). Blair, Lenton & Hastie (2002) have also demonstrated that false memories can be strong after long retention periods. They found false memories were more stable than studied items when participants were retested after two weeks.

Giving participants warnings regarding the chances of semantic intrusions occurring during testing can affect false memory rates (McDermott & Roediger, 1998). Neuschatz, Payne & Lampinen (1997; cited in Payne et al, 1997) studied the effects of warning participants about the use of associated words in the studied lists. Before list presentation some of the participants were told that the lists contained semantically associated words and to be careful they did not mistakenly recollect related, but non-presented, words. A second group were given the same warning after list presentation but before testing and the control group received no warnings. This study found that warnings did not affect critical lure recall. In contrast, Gallo, Roberts and Seamon (1997) found warning participants reduced critical lure recollection rates but did not eliminate them.

Word lists can also be used with phonological and categorical associations, in a similar manner to the DRM task. Due to the high level of association between phonological associates they tend to

produce a very high percentage of false recollections (critical lure intrusions). Phonological association refers to words that sound similar, so for the critical lure "***king***" studied items would include words such as '*ring*', '*sing*', and '*thing*'. Categorical word lists are made up of words that fit into the same taxonomic category, so the DRM list for "***fruit***" would now include words like '*apple*', '*pear*', '*strawberry*', and '*banana*', rather than words like '*cocktail*', '*salad*', and '*bowl*', which are the semantic associates of "***fruit***". The key distinction between DRM and categorical lists is that categorical lists only use one level of association – taxonomic category, whereas a DRM list uses several levels of association including taxonomic category, situational association, antonyms, and functional associations. Studies comparing false and true memory rates for categorical and DRM lists have shown that categorical lists facilitate true memory more than DRM lists (Howe, 2006). Dewhurst, Bould, Knott and Thorley (2009) found that DRM lists resulted in higher false recollection than categorical lists but they attributed this to the DRM lists having higher BAS. There is no notable difference in false memory rates for the two list types when BAS is controlled for (Howe, 2006) and this finding holds true for both children and adults (Howe, 2006; Howe, Wimmer & Blease, 2009).

It has been suggested that false memories resulting from word lists could not have any implications in real world contexts such as the eyewitness misinformation effect (Steffens & Mecklenbraucker, 2007). This is not necessarily the case, as word list studies demonstrate how simple it is for false memories to occur and in particular how strong participants' confidence in their recollection of the misinformation can be. If false memories for critical lures can be held with as much confidence as is reported by DRM studies then it stands to reason that false memories for real world events would be held with a similar degree of confidence. Eyewitnesses who take the stand and appear confident in their recollections sway juries to a greater extent than witnesses with low confidence. As false memories in the DRM task can be held with so much conviction it is no surprise that there

have been found several people who have been misled by erroneous information yet still believe their false memory is correct despite being presented with proof that it is not. Indeed, Thompson was still as sure about her original identification of Cotton as her rapist in 1986 even after he was exonerated 11 years later as a result of DNA evidence and the true perpetrator plead guilty (Loftus, 2003).

1.2.2 Picture lists.

The DRM paradigm can also be carried out using simple geometric shapes, black and white drawings, colour pictures and photographs. Very few studies have directly compared the difference in false memory levels for pictures and words within subjects but a clear difference has come through in the studies conducted for each type of stimuli alone. A study conducted by Israel and Schacter (1997) found that adults had lower critical lure recognition with picture lists than word lists. Furthermore, Ghetti, Qin and Goodman (2002) compared memory accuracy for lists presented orally (words) or both orally and visually (words and pictures) for five and seven year old children as well as university undergraduates. They found that false recall and recognition was reduced by picture encoding for all age groups and, regardless of presentation type (words only or words and pictures) there were no differences between children and adults for critical lure recognition.

1.2.3 Summary

DRM list findings have been successfully replicated in numerous studies and the false memories (critical lure intrusions) created were generally held with high confidence. False memories (critical lure intrusions) and veridical memories (studied item recollection) are affected by the associative strength of the lists; the stronger the association between the list words and the critical lure the greater the likelihood the critical lure and list items will be recollected. Associative strength is more important than the type of associations within the list – semantic, categorical, or phonological. DRM lists typically use semantic association but categorical association has also

been used. These two list types do not result in differences in critical lure intrusion rates. However, categorical DRM lists result in higher rates of veridical memory (studied item recollection) than found in semantic DRM lists. Another important factor which affects false memory rates in DRM tasks is the length of the study list. Roediger and McDermott (1995) found this when they compared their 12 item word lists to 15 item word lists wherein the shorter lists resulted in fewer critical lure intrusions (false memories).

1.3 Age Differences in the DRM

It is not unusual for psychological research to centre predominantly on normally developed adults: especially in studies testing new paradigms or ideas. There are many reasons for this, such as ease of gaining participation, better control of confounding factors, and fewer ethically based issues to take into consideration than there are for children or people with disabilities. Initially the Deese-Roediger-McDermott (DRM) task was carried out in the same manner; however, in more recent years the DRM task has been applied to false memory studies focussed on children as well as other populations.

Studies of false memory rates in children are important as they give insight into memory development. In the case of the DRM task, studies of children indicate the manner in which semantic associations most likely develop as people age. DRM research has established that age is a key influencing factor on false memory levels. Children have fewer false critical lure recollections than adults on DRM word lists, and this appears to be the case regardless of whether the lists used are child or adult-normed (Anastasi & Rhodes, 2008; Caneiro, Albuquerque, Fernandez & Esteves, 2007). Caneiro et al. (2007) found that using age appropriate DRM lists increased the number of false memories in children, however false memory rates still increased further with age. This trend is supported by several studies finding that young children are the least

affected by memory intrusions such as those created by the DRM task (Caneiro et al, 2007; Brainerd, Reyna & Forrest, 2002). It is important to note that children's false memories are affected by backward associative strength (BAS) in the same manner as adults' false memories. The BAS of the list is the most important predictor of the false memory rate, whereas list type (categorical or DRM) only affects the level of true memory (Howe, Wimmer & Blease, 2009). However, regardless of whether the lists are categorical or DRM, false and true memory is lower in children than adults (Howe, 2006).

Howe, Wimmer and Blease (2009) found that true memories also increase with age and that automaticity is the greatest difference between children's and adults' false memory rates. Automaticity refers to the speed of association activation or the inability to prevent a semantic intrusion, and has been demonstrated in a number of studies where it has been found that children, when warned about the possibility of semantic intrusion, can suppress the critical lure intrusions (false memories) whereas adults cannot (Kimball & Bjork, 2002; Howe, 2005; McDermott & Roediger, 2008). This age difference helps give a better understanding of the manner in which some memory processes develop, and further support for some of the theories on how false memories work, for example association activation. The finding that critical lure intrusion (false memory) increases as people age is consistent with the idea that association networks become more inter-related and widespread with age and may result in an increase in the speed and automaticity with which older children and (even more so) adults can access their knowledge base (Howe et al, 2009).

One study which has found a pattern of results that directly conflicts with the accepted developmental pattern of false memory is that of Carlin et al. (2008). They studied false memory for pictures and compared three groups of participants: intellectually disabled adults with a mental age of six years, chronological age-matched controls (adults) and mental age-matched controls (six

year old children). Focussing just on the findings within the two control groups, Carlin et al. (2008) found a reversed developmental pattern: the children had higher false memory rates than the adults. Carlin et al. (2008) postulated that this reversed pattern was due to their use of picture stimuli rather than word stimuli as was commonly used in earlier DRM studies comparing adults and children. This suggests that the distinctiveness of pictures works in favour of adults by reducing their critical lure recollection, but increases or does not affect critical lure intrusions in children. Ghetti et al. (2002) also found that picture stimuli changed the developmental pattern. In their study critical lure recollection was similar for children and adults although the five year old children had slightly higher false recollection than the adult participants. Ghetti et al. (2002) and Carlin et al.'s (2008) pattern of results could also be explained by their use of shorter lists (seven and eight items respectively), which have been shown to equalise the difference in false memory levels between children and adolescents (Surgue & Hayne, 2006).

In summary, there is a very consistent trend in age differences within DRM research, regardless of whether the lists used were designed for adults or children. The older participants (adults or older children) consistently have higher false memory (critical lure intrusions) and veridical memory (studied item recollection) than children. It has been suggested that the core reason for this age-related trend is that children have less interconnected association networks. This means that the presentation of related items will result in slower and less automatic activation of the associated critical lure in younger children than in older children and, more so, adults. Despite this difference both children and adults are affected in the same way by the associative strength of the word lists; when backward associative strength (BAS) is high false memory rates increase for both age groups; and when BAS is low false memory rates decrease for both children and adults. Ghetti et al. (2002) and Carlin et al. (2008) found that this age-related trend reverses when picture lists are used instead of the typical word lists. However, this most likely relates more to their uses of short

DRM lists as this factor has been shown to result in the disappearance or reversal of the typical age-related trend in critical lure recollection on the DRM (Surgue & Hayne, 2006).

1.4 Autism Spectrum Disorder (ASD)

Autism Spectrum Disorder (ASD) is relatively new to the clinical community having only been a recognised disorder since the early 1990s (despite first being documented in the 1940s by Leo Kanner (1943; cited in Schreibman, 2007) and Hans Asperger (1944; cited in Schreibman, 2007)). However, it has since become a relatively commonly diagnosed disorder affecting approximately 1 in every 100 people worldwide, with an estimated 40,000 cases in New Zealand alone (Autism New Zealand, 2005).

ASD is characterised by social, language, and behaviour deficits, which vary in severity and can be presented with any number of cognitive, motor, and sensory deficits (illustrated in Figure 2). It is quite common for ASD to present alongside other disorders including attention deficit hyperactivity disorder (ADHD), dyspraxia, or learning disabilities.

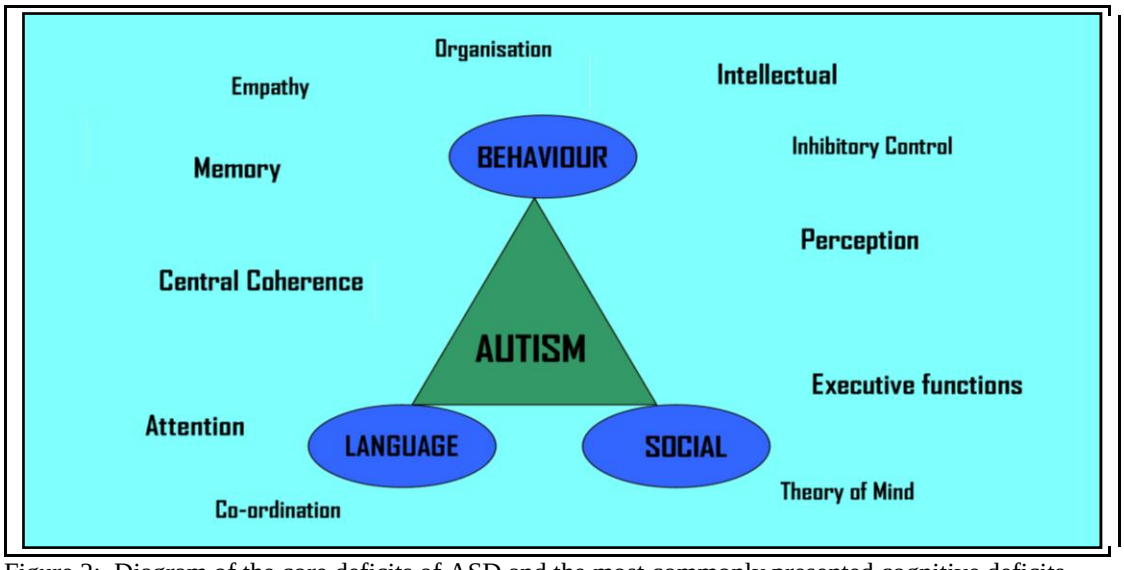

Figure 2: Diagram of the core deficits of ASD and the most commonly presented cognitive deficits.

1.4.1 The social side to ASD.

Ever since autism was first documented, it has been noted that the hallmark feature is the deficit in social behaviour and understanding. This is seen by their lack of interest in social interactions and their limited ability, or inability, to understand and appreciate the thoughts and feelings of other people. Some of the social understanding difficulties commonly seen in autistic individuals relate to theory of mind, empathy, understanding social cues and appropriate social behaviours or conversations.

Theory of mind is defined in the Oxford Dictionary of Psychology (Colman, 2006, pg. 760) as "people's intuitive understanding of their own and other people's minds or mental states, including beliefs and thoughts". It is widely accepted that individuals with ASD have limited or no theory of mind. This deficit has been demonstrated through the use of "false belief" tasks such as the "Sally/Anne" task (Wimmer and Perner, 1983; cited in Schreibman, 2007). The "Sally/Anne" task uses two dolls: Sally and Anne. The first doll, Sally, is shown putting a marble in a basket and then leaving the room. The other doll, Anne, plays with the marble and then puts it in a box before Sally returns to the room. After seeing the scenario, the clinician asks the child, 'Where will Sally look for the marble?' A typically developing child from about four years old will correctly state that Sally will look in the basket. This answer displays an intact theory of mind as the child clearly demonstrates an understanding of the difference between his/her knowledge and someone's false belief. Children on the autism spectrum fail this task, believing that Sally will look in the box where they know the marble will be. Some high functioning autistic individuals have been found to fail the 'false belief' task when they are young but pass once they get older, suggesting a delayed development of their theory of mind rather than a complete lack of theory of mind development.

Individuals on the autism spectrum also have difficulty reading and understanding facial expressions which can result in the lack of reciprocity found when interacting with someone with autism. Furthermore, the majority of autistic individuals, particularly those who are low functioning, are unable to comprehend the viewpoints of other people. Through programmes such as Applied Behaviour Analysis, some individuals with autism can be taught basic social cues and rules. Higher functioning autistic individuals (such as those diagnosed with Asperger's Syndrome) can gradually learn social rules and build a reserve of social experiences to assist them in their social interactions, but will generally always appear clumsy in their socialising (Attwood, 2008). Once these rules have been learned, they can become as immoveable as the autistic individuals' routine and a violation of one of these rules, no matter how small, can create a serious issue. These social deficits suggest that people with autism, particularly young children, would struggle with group work.

1.4.2 ASD and the DRM

The Deese-Roediger-McDermott (DRM) task has been widely used, not only to study people who have developed on a normal trajectory, but also people who deviate from the norm. This is largely due to the DRM task being one of the more user friendly methods of false memory testing, and may help deepen the understanding of memory processes in different disorders. Such is the case for ASD which has become a focus of many recent DRM studies. These studies have almost exclusively focussed on adults, and predominantly those who are higher functioning due to the language requirements of the DRM task. Nevertheless, there is a great deal of inconsistency in the current findings relating to false memory rates resulting from DRM studies with ASD participants. Beversdorf et al. (2000) compared studied item and critical lure recognition in high functioning adults with autism to age-matched controls. The participants with autism could more reliably distinguish critical lures from studied items than controls. However, there were no significant differences in studied item recognition between the two groups. Beversdorf et al. (2000) postulated

that the ASD participants had lower false recognition due to people on the autism spectrum having weak central coherence. Weak central coherence refers to an inability to understand context and a tendency to focus on the parts of the picture rather than the whole picture (Carter, 2000; Attwood, 2008; Schreibman, 2007). As a result of weak central coherence the high functioning autistic adults would likely have less widely interconnected word association networks (Beversdorf et al, 2000; Beversdorf, Narayanan, Hillier & Hughes, 2007). This would decrease the activation of critical lures during list presentation and therefore reduce the likelihood of those critical lures being recollected. The idea that people on the autism spectrum have less interconnected association networks is further supported by their poor performance in recalling semantically associated words (Bowler, Gaigg & Gardiner, 2008).

Bowler et al. (2000) found a similar pattern of results to Beversdorf et al. (2000) in studied item recognition. However, their study revealed no significant differences in false recognition of the critical lures between adults with Asperger's Syndrome and controls. Furthermore, when participants completed a recall task they found participants with Asperger's Syndrome recalled a similar number of critical lures to control participants but significantly fewer studied items. These findings conflict with the idea that individuals on the autism spectrum are less susceptible to memory illusions due to weak central coherence. Instead, the finding of lower studied item recall tracks with the idea that ASD individuals do not use semantic relatedness to support recall (Bowler, Matthews & Gardiner, 1997; cited in Bowler et al, 2000); however this does not explain the similar patterns in critical lure recall. Bowler et al. (2000) suggested that the ASD participants, though aware of the semantic relatedness of the word lists, were unable to use this to improve their recall or to reduce the intrusion of non-presented related words.

Bowler et al. (2000) also assessed differences in confidence for recognised words by asking participants to label recollected items as being a ‘remember’ (very confident) or ‘know’ (moderately confident) item and to then justify that decision. They found that ASD participants were less confident in their judgements of studied items than controls, reporting more items as ‘know’ than ‘remember’ items. There were no significant differences between the two groups for confidence in critical lure judgements. It is interesting to note that the key difference between the lists used by Beversdorf et al. (2000) and Bowler et al. (2000) is the length of the word lists used. Beversdorf et al. (2000) used lists derived from Roediger and McDermott (1995) which contained 12 words whereas Bowler et al. (2000) lists were only nine words in length. This difference may help explain the differences seen in false recognition rates between the two studies; however, this conjecture would require further exploration.

1.4.3 Summary

Autism Spectrum Disorder (ASD) is a developmental disorder which varies greatly between individuals and is characterised by a predominant disorder in social understanding. DRM studies comparing people on the autism spectrum to age-matched controls have focussed exclusively on adults and have had inconsistent findings in critical lure intrusion (false memory) rates. Beversdorf et al. (2000) found that ASD adults had lower false recollection than controls whereas Bowler et al. (2000) found no significant differences between ASD and control participants. Bowler et al. (2000) also found that ASD participants had lower confidence in their false critical lure recollections than controls. Studied item recognition was not significantly different between ASD and age-matched controls in either study. It has been suggested that weak central coherence (less interconnected association networks due to a lack of understanding of semantic associations) are the reason ASD participants have lower false recollection rates than age-matched controls. This theory does not account for the differing findings of these two studies. However, the differing length of the study lists used in these two studies may help explain the difference in recorded false

memory rates. Bowler et al. (2000) used shorter lists (nine words) than Beversdorf et al. (2000) (12 words), a factor which is known to affect children in the same manner as it appears to affect adults with ASD. Shorter lists appear to remove the differences found between ASD and control groups while longer lists result in controls recollecting more non-presented (false) critical lures than ASD participants. Nonetheless, this conjecture requires further exploration.

1.5 Theories on False Memories and How They Occur

A wide range of theories have been put forward to explain false memories resulting from word lists and the ways in which they present themselves. Some particularly pertinent theories that have come through in the literature are source misattribution theory, association activation theory, and the distinctiveness heuristic. These theories have a clear underlying tone of the importance of association in the creation of false memories in the Deese-Roediger-McDermott (DRM) paradigm.

1.5.1 Source misattribution theory.

Source misattribution theory proposes that false memories result from the failure to correctly monitor the source of the information from which a memory is produced (Brainerd & Reyna, 2005). Misattributing the origin or source of a memory is quite common. Occasions where you have wondered *"did it really happen or did I just dream it happened?"* are an excellent example of source misattribution. Failures in source monitoring are also common in the eyewitness suggestibility paradigm as eyewitnesses get confused between the event and post-event information (Brainerd & Reyna, 2005; Loftus, 1997). Another way in which source misattribution occurs in eyewitness testimony and repressed memories is through confusion between the event and subsequent related suggestions or imagined events. For example, witnesses of the Washington Sniper attacks who later heard, through the media, that the snipers were driving a white van and then reported seeing a white van at every scene despite the snipers driving a blue car (Loftus, 2003). Loftus (2003 pg. 231) put forward the idea that a vital reason witnesses can be wrong, "is

that they pick up information from other sources; they combine bits of memory from different experiences".

Source misattribution theory has mainly been used to explain repressed memories and erroneous eyewitness testimonies. However this theory can also be applied to word list paradigms such as the Deese-Roediger-McDermott (DRM) paradigm. Source misattribution occurs in the DRM paradigm because the non-presented critical lure comes to mind during the encoding of the study list making it hard to discern from the studied items during testing. In these instances the sources which become confused during recollection are the internal source (the critical lure triggered by the semantic associations in the word list) and the external source (the studied items from the word list). Johnson, Foley & Leach (1988) examined source memory in adults who were presented word lists read out by an experimenter and instructed to imagine other words spoken in the experimenter's voice or in their own voice. They found that participants had greater difficulty discerning whether a word had been heard or imagined when they had imagined the words in the experimenter's voice (similar sources) than when they had imagined the words in their own voice (dissimilar sources). This finding has also been noted in subsequent studies giving additional support to the source misattribution theory (for a review, see Lindsay, Johnson, Kwon, 1991).

Studies looking at source memory in children have found similar results with children having poorer source memory when the sources are perceptual and/or semantically similar than when they are dissimilar. Foley, Johnson & Raye (1983) found that six year old children had more trouble discerning between words they had spoken with those they had imagined saying than adults (similar sources). However, when discriminating between two readers or between words spoken by someone else and imagined in their own voice children performed at the same level as adults (dissimilar sources). Foley, Durso Wilder and Friedman (1991) also found that children have

greater difficulty correctly identifying a source when both sources are highly similar. In their study children between the ages of six and nine years performed actions and then imagined performing other actions. These children had greater difficulty identifying whether the action had been performed or imagined than adults.

People on the autism spectrum are known to have greater difficulty with source monitoring than controls. This is the case for children, adolescents and adults, and has been demonstrated in a number of studies examining source memory. Bennetto, Pennington & Rogers (1996) presented children and adolescents with high functioning autism with two separate word lists and each list was followed by a recall task. Bennetto et al. (1996) defined errors in source memory as intrusion of an item from the first list into the recall of the second list. In this study the ASD participants made nearly eight times as many errors in source memory (intrusions) as the age-matched controls. A later study carried out by Farrant, Blades & Boucher (1998) found no difference in source monitoring between children with ASD and controls. In this study children listened to tape-recorded lists with each word being repeated by either the experimenter or the participant. The experimenter was given a blue block to hold and the participant was given a red block to hold; which were used to support recall of the list items and sources. Following list item recall participants were asked to identify the source of each of the items recalled by indicating whether the word had been repeated by the person holding the red block or the person holding the blue block. There are two key differences between these studies. The participants in the Farrant et al. (1998) study were younger than those used in the Bennetto et al. (1996) study, and recall of the source was supported in the Farrant et al. (1998) study, but not in the Bennetto et al. (1996) study.

Bowler, Gardiner & Berthollier (2004) conducted a study to test whether the differences between these two studies (Bennetto et al. (1996) and Farrant et al. (1998)) was due to the difference in

support given to the recall of source. To do this they had adults with Asperger's disorder (a high functioning autism spectrum disorder) carry out one of four actions for each word list item during presentation (encoding). These actions were either thinking of a word that was close in meaning to the presented word, thinking of something that could be done with that item, thinking of a word that rhymed with the presented word, or thinking of a word that was longer than the presented word. Participants then completed a recognition task in which they indicated which items they recognised. This task was followed by a 10 minute break and a second recognition task. During the second recognition task participants were asked to indicate the action performed during list presentation for each item that they had recognised. Support for source was manipulated with participants either receiving a list of the four actions to choose from or were expected to recall the action without any prompt as to what those actions were. The Asperger's participants who received support in their recollection of the actions performed at a comparable level to the controls. However, those Asperger's participants who did not receive support in their recollection of the actions had greater difficulty in correctly identifying the action (source) associated with each word than controls. This indicates that people with Asperger's Syndrome have difficulty with source monitoring when no support is given for correct recollection of the memory's source.

In summary, source misattribution theory postulates that false memories in the DRM occur due to the participant getting confused by two different sources – the 'internal' source and the 'external source. The 'internal' or imagined source (the critical lure) is falsely recollected as an 'external' or real source (studied item) resulting in a false memory. This effect is greater when the two sources are highly similar (e.g., in the same voice) than when the two sources are dissimilar (e.g., words and pictures). This requirement of similarity between sources could also account for the reason picture lists result in fewer critical lure intrusions (false memories) than words as pictures are perceptually more different from one another than words are. Source similarity has been found to

affect children and adults in the same manner. In the case of people with ASD (regardless of age) source misattribution more readily occurs when the correct recollection of a source is not supported.

1.5.2 Association activation theory.

Association activation theory (AAT) is based on the idea of association networks in the brain which are automatically activated when a single part of the network is stimulated. For instance, when you think of '*knife*' you will automatically activate '*fork.*' The same applies to the associative pairs '*bread and butter*', '*shoe and sock*', and '*cat and dog*'. Association networks are made up of words or concepts that are commonly found together like those listed above, or words that share the same taxonomic category such as names of fruit, animals or countries. Words can be associated through several different means, for example taxonomic categories (e.g., furniture and bed), situational association (e.g., knife and fork), functional associations (e.g., eat and fork), and antonyms (e.g., day and night) (Howe et al, 2009). The Deese-Roediger-McDermott (DRM) paradigm utilises these different levels of association to create the lists that trigger critical lure recollection. To demonstrate how a DRM list acts as a trigger to an association network and results in critical lure intrusion Beversdorf et al. (2007) created a map of the DRM list for '***needle***' (refer Figure 3). This map only shows the list items and the non-presented critical lure showing that all of the items are inter-connected and relate to the critical lure '***needle***'. Other words would also receive activation however they would not be as strongly activated and were excluded from Beversdorf et al.'s (2007) network map to ensure a more clear-cut picture.

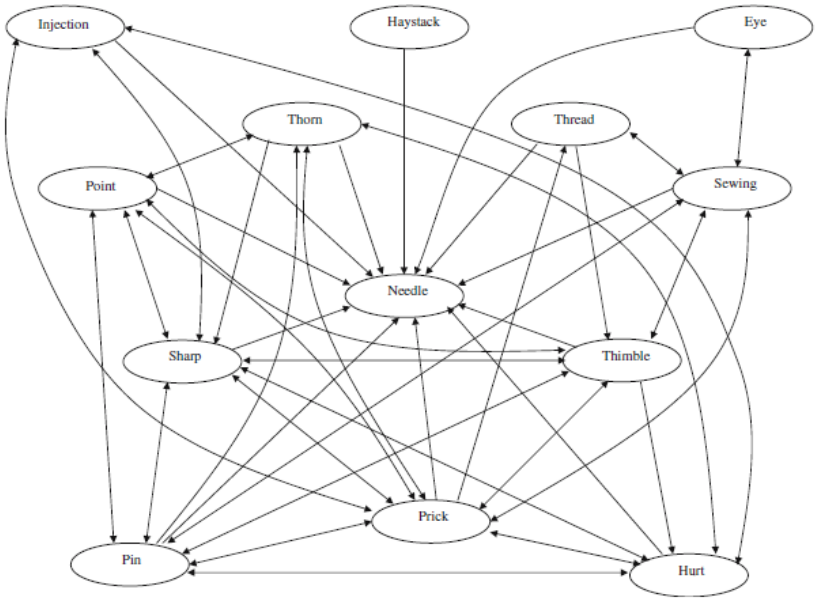

Figure 3: Diagram of the association network for the critical lure 'needle' as designed by Beversdorf et al (2007).

The strength and spread of the association network and the likelihood of a critical lure being recollected after the DRM list's presentation is directly affected by backward associative strength (BAS). This strength can be tested by giving a large number of people a list of the critical lures and asking them to list the first words that the critical lures bring to mind. The words which were recorded most frequently have the strongest associative strength and those recorded the least have the weakest associative strength (Deese, 1959). BAS can be used to determine the order of the words presented to participants undertaking a DRM task, by moving the words from the word with the strongest association to the critical lure through to the word with the weakest association. BAS is the strongest predictor of the effectiveness of a DRM list at eliciting a critical lure for both children and adults, which further supports association activation theory (AAT).

Critical lure intrusion (false memory) increases as people age and this correlates with the idea that association networks become more widespread and interconnected with age and experience. It has been suggested that as a result of association networks becoming more interconnected with age and an increased knowledge base the activation of these networks become more automatic.

Increased automaticity of association activation in adults appears to be the reason children are more able than adults to reduce critical lure recollection after being warned of the risk of semantic intrusions (Kimball & Bjork, 2002; Howe, 2005; McDermott & Roediger, 2008). Automaticity is potentially a greater problem with longer word lists than shorter word lists, which may help explain why children and adults have similar false memory rates for shorter DRM lists whereas children have fewer critical lure intrusions than adults for longer DRM lists (Surgue & Hayne, 2006; Metzger, Warren, Shelton, Price, Reed & Williams, 2008).

Association activation theory has also been used to explain the lower false recognition rates seen in adults with ASD compared to age-matched controls. It has been suggested that due to weak central coherence people on the autism spectrum have weak associative activation networks and therefore are less susceptible to memory illusions. This only appears to be the case with longer DRM lists as there are no clear differences between ASD and control participants for shorter DRM lists (Beversdorf et al, 2000; Bowler et al, 2000). Some theorists have combined both source misattribution theory and association activation theory to explain how the DRM task results in such false memory rates. This combined theory (association monitoring theory) postulates that false memories occur as a result of the activation of the critical lure during list presentation creating an ‘internal source’. During recollection the ‘internal source’ is incorrectly judged as the original source of the memory rather than as a non-presented critical lure.

To review, association networks in the brain are activated whenever a word is read or heard, and that activation increases when more related words are presented, as occurs in the DRM. This activation spreads beyond the presented related words to non-presented related words (such as the critical lure) and if the activation is strong enough it can result in the non-presented critical lure being falsely recollected as a presented item (constituting a false memory). Children have less

interconnected association networks due to age, and fewer life experiences, meaning the activation of critical lures during DRM tasks is weaker than it would be for older children and adults. This means children are more able to suppress critical lure intrusions and therefore have fewer false recollections than adults. A similar process occurs with ASD adults who are believed to have weakly connected association networks due to a lack of understanding of semantic association and context (weak central coherence). Automaticity of the activation of critical lures appears to be a greater problem with long DRM study lists as the differences observed between children and adults (and ASD adults and age-matched controls) disappear when short DRM study lists are utilised.

1.5.3 Distinctiveness heuristic.

Source misattribution theory and association activation theory both explain how false memories might be created in word lists. However, they do not explain why false memory rates are lower with picture lists than word lists. Schacter, Israel and Racine (1999) suggested that this difference (between picture and word false memory rates) was due to more available distinctive cues during encoding. This means participants would search their memories more thoroughly during retrieval and therefore recall the more distinctive pictures with greater accuracy than the less distinctive words. The more vigorous search would result in fewer memory errors for the distinctive items (pictures) than for words. Schacter et al. (1999) called this the distinctiveness heuristic, an idea that has been supported by numerous studies indicating that distinctive items result in fewer memory errors (false memories) than indistinct items (Carlin et al, 2008; Smith & Hunt, 1998; Israel & Schacter, 1997).

Israel & Schacter (1997) compared false memory rates for word lists presented alone with word lists presented simultaneously with pictures. Similarly to Schacter et al. (1999), Israel & Schacter found that false memory was lower in the picture and word list condition than in the word list

condition. Smith & Hunt (1998) found similar results when comparing visual (more distinctive) and aural (less distinctive) studied lists. In this study false memory rates were higher in the aural condition than the visual condition, which is in keeping with the findings of Israel & Schacter (1997) and Schacter et al. (1999). Gallo, McDermott, Percer & Roediger (2001) took these studies one step further by also looking at the effects of distinctiveness on the individual (within-subjects) by comparing individual false memory differences between words (audio) and pictures (visual). They found that the pattern of results that occurs between-subjects similarly occurs within-subjects giving further credence to the distinctiveness heuristic. In other words individuals who have carried out both an audio and visual DRM task have higher false recollections of critical lures from lists they heard than critical lures from picture lists.

Arndt & Reder (2003) also examined the distinctiveness heuristic. However, instead of comparing picture stimuli with word stimuli they manipulated the distinctive features of the written word. They did this by changing the fonts used for study list items in three separate conditions. Their study list contained six different themes each made up of 12 related words. The three conditions they used were 1) a different font for each of the 72 words (most distinctive), 2) a different font for each of the six themes (least distinctive), and 3) fonts randomly distributed across themes. False memory rates were the highest when font was associated with a certain theme (least distinctive) and lowest when a font unique to a particular word (most distinctive). This study suggests that it is not only pictures which create the necessary amount of distinctiveness to decrease false memory rates and further supports the distinctiveness heuristic. Another study that supports this idea was conducted by Dodson and Schacter (2001), who compared false memory rates for word lists participants had heard to those they had spoken. This study found that false memory rates were lower for the lists the participant had spoken (more distinctive event) than the lists they had heard

(less distinctive event). Studies have also shown that the distinctiveness heuristic applies to children in a similar manner to adults (for a review, see Howe, 2008).

To summarise, the distinctiveness heuristic applies to pictures and other distinctive materials used in the DRM. It postulates that when list items are more distinctive from one another (despite being semantically related) they are less likely to result in false critical lure intrusions. Furthermore, more distinctive items are more likely to be recollected which results in high studied item recognition (veridical memory) rates for these types of stimuli. This pattern has not been examined in ASD, however distinctive items have been suggested to result in a reversed developmental pattern for control children and adults, with children recollecting more false picture critical lures than adults (see Carlin et al, 2008 and Ghetti et al, 2002 for a review).

1.5.4 Summary

While the distinctiveness heuristic predominantly explains the differences between word and picture lists and not how false memories occur, both source misattribution theory and association activation theory cover the findings reviewed in the current chapter more adequately. Source misattribution occurs when participants misattribute a critical lure as a study item, something which commonly occurs when the two sources are highly similar. This theory also explains the difference in word and picture lists as picture list items are less similar to one another than word list items. Association activation theory also explains the majority of the findings reviewed in this chapter; it postulates that lists of associated items result in the automatic activation of the critical lure, which is subsequently recollected as a studied item. Theorists have also combined these two theories to make the association monitoring theory which suggests that the critical lure is automatically activated and this results in an ‘internal’ source which is later confused with the ‘external’ source (studied items), creating a false memory. This combined theory adequately explains all of the points presented in this chapter.

1.6 The Collaborative Effect – Working Together on the DRM

A further extension of the DRM paradigm looks at false memory effects in group situations (collaboration) and how working together influences false memory levels in individuals. This sort of research helps gain a better understanding of how groups work together in an intellectual task, and the impact of social groups on false memory. Understanding the collaborative effect is particularly important in relation to memory distortion in eyewitnesses and to understanding the effect the mass media can have on people's memory, as a number of crimes occur with more than one witness and are subsequently publicised by the media.

1.6.1 The group dynamic.

To understand how collaboration has an impact, it is important to first understand the group dynamic – the ways in which a group can interact and work together. There are several ways a group of people can work together to make decisions: 'follow a leader', 'majority-rule', and 'evidence-based discussion'. Essentially, 'follow a leader' occurs when the group conforms to the opinion or response of the clear leader of that group. This sort of dynamic is seen in monarchies, dictatorships, and peer groups (where children and adolescents will go by what the most popular child decides should happen at playtime, such as what to play and who to play with).

Majority rule is the type of decision-making seen in a democracy, such as when people vote for a political party or leader. It occurs when a decision is made based on the opinion or decision of the larger part (majority) of the group. This type of decision-making is greatly affected by group size and without a clear consensus can fall apart in groups with an even number of people, as these groups can reach a 50/50 split whereas odd-numbered groups cannot. When 'majority-rule' does not work, or reaches a stalemate, then 'evidence-based discussion' can be the best option for breaking a 50/50 split. 'Evidence-based discussion' involves group members putting forward clear, concise arguments as to why their opinion is the one the group should follow. In the case of the

DRM task, such arguments may involve three strategies: placing the word in context with other list words, naming the taxonomic category that the word was part of within the studied lists, or recounting an autobiographical memory of hearing the word in question. The 'evidence-based discussion' method of decision-making is commonly used by juries, committees, and interview panels, to name a few.

The group dynamic can be affected by factors other than group size, such as the types of people involved and the diversity in the group. For example, a group with several children and an adult may be more likely to make decisions based on the opinion of the adult who could be considered the clear leader due to age difference. This use of 'follow the leader' decision-making may also be applied when members of a group are known to have social deficits (such as autism) in order to minimise the strain of the social situation. On the other hand, people who are well matched in age and status are less likely to use this style of decision-making and more likely to require 'majority-rule' and 'evidence-based discussion'.

1.6.2 Studies into collaboration.

Deese-Roediger-McDermott (DRM) studies of false recollection in collaborative groups have focussed on adults and have shown that collaborative groups recollect more studied items than individuals (Maki, Weigold & Arelland, 2008; Clark, Hori, Putnam & Martin, 2000). Maki et al. (2008) had participants complete a recall task individually and then a second recall task as part of a collaborative duo, trio, or quartet. They also found that studied item recollection increased as a result of participants working collaboratively. Previous studies have suggested that an increase in studied item recollection in collaborative groups (in comparison to their individual scores) occurs when individuals complete two recall tasks in succession (Payne et al, 1996). Maki et al. (2008) controlled for this by completing a second experiment where individuals and collaborative trios and quartets completed two recall tasks in succession. There were no significant changes in

individual or collaborative recollection for critical lures or studied items between the second and first tasks. The collaborative groups still had higher studied item recollection than the individuals. These results suggest that Maki et al.'s (2008) findings in their first experiment were a result of participants working collaboratively and not due to the participants having already completed a recall task. In both experiments carried out by Maki et al. (2008) there were no significant differences in critical lure recall between collaborative groups and individuals.

Clark et al. (2000) suggested some of the findings that collaboration results in higher studied item recollection than working alone may result solely from pooled resources rather than social interaction (collaboration). In other words studied item recognition will generally increase when a group of people work together regardless of whether there is discussion (collaboration) or not. They compared individual performance to subsequent collaborative performance in groups of three adult participants (collaborative trios). Collaborative trios were instructed to make unanimous decisions to ensure that discussion (collaboration) was carried out. The individuals' scores were placed in groups of three and treated in three separate ways to make up comparison groups for the collaborative trios. Firstly Clark et al. (2000) created a 'nominal' group by averaging the responses of the individuals (to get an estimate of how the group should perform if they pooled their resources), secondly they recorded the scores of the participant who had the most accurate responses (lowest critical lure recognition and highest studied item recognition) to represent 'follow the leader' decision making. The last comparison group was made up from the responses that were the same for at least two of the three participants and represented the 'majority-rule' group. Clark et al. (2000) found that studied item recognition was higher and critical lure recognition (false memory) was lower in the collaborative trios and 'majority-rule' groups than in the 'nominal' groups and for individuals. These findings suggest that collaboration is beneficial to memory accuracy. It was also found that the benefits from working collaboratively varied

depending on the decision-making techniques used. Working collaboratively (using 'evidence-based discussion') resulted in a greater increase in studied item recognition and a smaller decrease in critical lure recognition than 'majority-rule' discussion. 'Follow the leader' was the least effective manner of decision-making as there were no significant differences found in critical lure recognition and lower studied item recognitions in this condition than in the nominal groups.

Thorley and Dewhurst (2009) examined collaborative DRM performance in groups of two, three and four. They also found that studied item recognition was higher in the collaborative groups and increased with group size. However, they found critical lure recognition to be higher in collaborative groups than nominal groups. They attributed this increase to an increased probability of group members recalling critical lures with bigger groups. In other words, the more people in a group the greater the chance one member will recollect a critical lure and therefore convince the other group members that it was a studied item. They also noted that there were no differences in novel item recognition between the collaborative groups and the equivalent sized nominal groups. The main difference between Clark et al. (2000) and Thorley & Dewhurst's (2009) study is the manner in which they created their nominal groups. Clark et al. (2000) had individuals complete a recognition task and then work in a group to complete a second recognition task. They then averaged the individual recognition responses given by the members of the collaborative groups to make up the nominal group (within-subjects design). However, Thorley and Dewhurst (2009) had different individuals to make up the nominal groups from those they used to make up the collaborative groups (between-subjects design). Also while both studies required collaborative groups to make unanimous decisions on each item only Thorley and Dewhurst (2009) instructed their participants to deliberate before making a decision. This coupled with their finding of higher studied item recognition in collaborative groups (by comparison to nominal groups) supports the conjecture that evidence-based discussion results in benefits for studied item recognition.

1.6.3 Real world collaboration.

Investigating the collaborative effects of list learning on false memory is important because of its parallel with real world events where false memories typically arise. Understanding how collaboration works on the list-learning level could help professionals understand those same effects in real world events and give rise to new ways of working around the effect working together can have on group members' individual accounts. One example is crimes where several people are witnesses, such as a bank robbery. Discussing the events within this group will affect individual accounts of what occurred and would probably increase the amount of misinformation recalled by the group of witnesses. Collaborative remembering also occurs at home when people recount events from their childhood to younger siblings; in consequence, these younger siblings may remember events that they 'experienced' despite being too young to have been involved or not having been born at the time of the event. Furthermore, collaboration occurs in board rooms, committees, political meetings, interview panels and juries. The mass media are also known to have an impact on false memory, particularly in relation to eyewitnesses and sometimes to juries, as facts presented by the media can 'contaminate' these groups with misleading information before (and during) criminal proceedings.

1.6.4 Summary

Collaboration or working together is a social task which has different effects depending on the group decision-making dynamic – 'follow the leader', 'majority-rule', or 'evidence-based discussion'. 'Follow the leader' refers to decisions made based on what the strongest member of the group says, whereas 'majority-rule' requires the decisions of the larger part (majority) of the group and 'evidence-based discussion' is the result of discussion within the group. In the DRM paradigm, collaboration studies have been carried out with adults and have resulted in varying findings. Thorley and Dewhurst (2009) found that both false and veridical memory rates increased as a result of collaboration. Maki et al. (2008) found collaboration resulted in no change in critical

lure intrusions (false memories) from working individually to working in a group. They also demonstrated that within-subjects collaboration studies like this are valid as the increase in studied item recollection in the collaborative groups was not affected by participants completing the same task twice. On the other hand, Clark et al. (2000) found that collaboration decreased false memory rates and increased veridical memories in collaborative trios. The degree of this benefit varied depending on the group dynamic. 'Majority-rule' trios resulted in the greatest decrease in false critical lure recollection whereas 'evidence-based discussion' resulted in the greatest increase in studied item recollection (veridical memory). However, 'follow the leader' decision making resulted in no change to critical lure recognition and a slight decrease in studied item recognition from nominal groups and individual participants.

1.7 Overall Summary

Memories for events that have not actually occurred (false memories) are prevalent in society and play a role in eyewitness testimonies, wrongful convictions and repressed memories. As a result, false memories have drawn a great deal of interest in the psychology community. Deese (1959), Roediger and McDermott (1995) developed a method of testing false memories (the DRM task) using lists of words semantically associated to a non-presented critical lure. If the critical lure is recollected after the lists are presented then it constitutes a false memory. Roediger and McDermott (1995) found that participants recalled 55 percent of the non-presented critical lures or recognised 53 percent of the critical lures. False memory rates are higher for longer lists than shorter lists and for those lists with higher associative strength to the critical lure (Roediger & McDermott, 1995; Surgue & Hayne, 2006; Surgue, Strange & Hayne, 2009; Metzger et al, 2008; Brainerd & Wright, 2005).

The DRM paradigm has been successfully replicated in a variety of false memory studies using both word and picture items within a range of populations. Picture DRM lists elicit fewer false memories and more veridical memories than word DRM lists. DRM studies have also shown that children have lower false memory rates and are more able to avoid semantic intrusions (critical lure recollections) than adults in word lists (Kimball & Bjork, 2002; Howe, 2005; McDermott & Roediger, 2008). However, this difference disappears when short word lists are used rather than the standard DRM lists of 15 words (Surgue & Hayne, 2006; Surgue et al, 2009; Metzger et al, 2008). Carlin et al. (2008) and Ghetti et al. (2002) have suggested that the developmental pattern reverses with picture DRM lists, however this may be due to their use of short lists.

The DRM has also become popular for studying false memory in people with disorders such as Autism Spectrum Disorder (ASD), a disorder with the hallmark feature of deficits in social understanding and behaviour (Attwood, 2008; Schreibman, 2007). Autistic individuals are believed to lack an understanding of context which is a result of weak central coherence (Kamio & Toichi, 2007; Beversdorf et al, 2000; Bowler et al, 2000). DRM studies have almost exclusively focussed on autistic adults and have had varying results with some recognition tasks revealing lower false memory rates than controls (Beversdorf et al, 2000) and others revealing similar false memory rates (Bowler et al, 2000). Lower false memory rates have been explained as resulting from the lack of understanding of context (weak central coherence) seen in individuals with ASD. The differences between the false memory rates reported in these ASD studies may be explained by the length of word lists used, which appear to have a similar effect to that seen in children (developmental) studies. It has also been found that people with ASD are less confident in their false recollections than controls (Bowler et al, 2000).

The three main theories that have been put forward to explain false memories in the DRM task (source misattribution theory, association activation theory and the distinctiveness heuristic) all draw from the same core concept: semantic association. Source misattribution theory states that the DRM lists automatically activate the critical lures, creating two 'sources': an 'internal source' (activated critical lure) and the 'external source' (word list). False memories occur when the participant recollects an internal source as an 'external source'. Association activation theory suggests that false memories are created from the automatic activation of the critical lure associated to the presented word lists, and as these lures cannot be successfully inhibited, they are recollected as studied words. The third theory, the distinctiveness heuristic, posits that stimuli that are more distinctive result in fewer false memories and more veridical memories as each list item is more distinguishable from other stimuli. This theory explains the differences found between picture and word false memory rates.

False memory can be affected by people working in collaboration with at least one other person. This effect is extremely pertinent to real world applications and is greatly affected by the group's dynamic, size, members, and diversity. DRM task decisions based on the consensus of the majority ('majority-rule') result in a greater reduction of false memories and a smaller increase in veridical memories than decisions made from 'evidence-based discussion', whereas 'follow the leader' decision-making does not result in any benefits (Clark et al, 2000; Clark et al, 2006). DRM task collaboration studies give insight into the social effects of false memory, but have only been studied with adults. It would be worthwhile applying a collaborative DRM task with children, to see how the group dynamic develops, and with people who have known social deficits such as ASD.

Chapter Two

Current Research

The current research combines the methods and ideas from three DRM studies (Beversdorf et al, 2000, Carlin et al, 2008, and Thorley & Dewhurst, 2009) to answer a three part question on false memory in Autism Spectrum Disorder (ASD). It investigates word and picture false recognition to answer questions regarding age differences, confidence ratings, and collaboration effects.

2.1 The Big Question

The current study specifically examines the question, 'What can word and picture DRM tasks tell us about false memory development in Autism Spectrum Disorder?' This question has been touched on, in part, by previous studies, but has not been adequately examined. The current study will not be able to give a complete picture of every facet of this question, but aims to shed more light on false memory in ASD. Because of the broad spectrum this question covers I have focussed on three key areas that have shown promise in the earlier review of DRM studies – age differences, confidence ratings, and collaboration.

2.1.1 Age differences.

The first, and possibly most important, component in this study looks directly at age differences in the ASD and control participants. Studies have found that neurotypical children have lower false memory rates than adults, except when using short lists (Surgue & Hayne, 2006) or pictures (Carlin et al, 2008; Ghetti et al, 2002). The current thesis examines differences in word and picture false memory levels as well as veridical memory levels in autistic and control participants in different age groups (8-12 year old children, 13-15 year old adolescents, and adults). The main aim of this component is to examine whether the established age difference for short study lists (higher

false memory rates for children than adults) is the same for the ASD participants as it is for the control participants, thereby giving a developmental perspective of false memory in ASD.

As this thesis utilises short study lists I hypothesise that adults and adolescents will have fewer false memories than children for both ASD and control participants. For this hypothesis to be supported I would expect the adult participants to have the lowest critical lure intrusion rate and children to have the highest critical lure intrusion rate. Adolescent participants' critical lure intrusion rates would be expected to fit in between these two age groups. This pattern is anticipated to occur in both the ASD and control participants and would corroborate the findings of Ghetti et al. (2002), Carlin et al. (2008), and Surgue & Hayne (2006).

2.1.2 Confidence ratings.

Something that has emerged in the literature on false memory in autism spectrum disorder (ASD) is the lower confidence this group has for their false judgements on critical lure items in DRM tasks in comparison with controls (Bowler et al, 2000). This makes up the second component being considered in the current study and is examined using a four point system ('Yes', 'I think so', 'I don't think so', and 'No') such as that used by Beversdorf et al. (2000). I am attempting to replicate this finding and uncover whether it also extends to pictures and varies with the participants' age. Although confidence ratings have been studied with ASD participants before, it appears that they have not been applied to picture false memory testing in people on the autism spectrum.

I hypothesise that participants with ASD will recognise fewer critical lures and be less confident in their false recognition than age-matched control participants. This would be verified by the ASD participants (of all ages) having lower critical lure recognition rates than age matched controls, as was seen in Beversdorf et al. (2000). To demonstrate lower confidence in their false critical lure

recognition ASD participants would respond with a higher percentage of 'I think so' responses than 'yes' responses in comparison to controls. This pattern would reflect that seen in Bowler et al. (2000) who found ASD participants labelled recollected items as one's they "know" (less confidence) were studied than as one's they "remember" (more confidence) were studied. On the other hand, if ASD participants in the current thesis respond to critical lures with a higher percentage of 'yes' responses and fewer 'I think so' responses than controls then the current investigation would conflict with Bowler et al.'s findings and suggest that ASD participants respond to critical lures with more confidence than control participants.

2.1.3 Collaboration.

The final component of this study, and the basis of Experiment 2, is the effect of collaboration on children and adolescents between the ages of eight and 15 on the autism spectrum as well as age-matched controls. The current thesis will look at the effects of collaboration on an individual level, comparing pre-collaboration individual scores with collaborative trio scores. It will also make between-subjects comparisons between autistic and control children. This should give an idea of the effects of collaborative remembering on autistic and control children, and hopefully a more exact measure of the collaborative effect. There have been no studies into collaboration effects in autism or children. Gaining some understanding of such effects in a group with known social deficits and in children will help give further insight into ASD and how the ability to work successfully with others develops with age. As ASD is a predominantly social disorder it would be expected that collaboration would be more detrimental to ASD participants than controls.

Based on this assumption I hypothesise that collaboration will decrease total veridical recognition and increase false critical lure recognition in participants with ASD, compared with controls. If this hypothesis is supported it will corroborate the findings of Thorley and Dewhurst (2009) who demonstrated lower veridical studied item recognition and higher false critical lure recognition in

collaborating neurotypical adults than individual neurotypical adults. This is the pattern that will need to be revealed in the current investigation for control participants (and to a greater extent the ASD participants) for this hypothesis to be supported. However, if critical lure recognition decreases or studied item recognition increases as a result of working collaboratively, in either the ASD or control participants then the hypothesis would not be supported.

2.2. Hypotheses

To summarise there were three major hypotheses being pursued in the present study. Each one was developed based on the findings of earlier research and pertains to the three key areas of interest in this study – age differences, confidence ratings, and collaboration. The first hypothesis was that adults and adolescents will have fewer false memories than children for both ASD and control participants. The second hypothesis postulated that the ASD participants will recognise fewer critical lures and be less confident in their false recognition than age-matched control participants. The last hypothesis focussed on collaboration and hypothesised that collaboration will decrease total veridical recognition and increase false critical lure recognition in ASD participants compared with controls.

Chapter Three

Method

3.1 Pilot Study

A pilot study was conducted to ensure the efficacy of the lists and methods being used in the experiment proper. It was designed to test for the methods allowing for the optimal (most appropriate) level of critical lure and studied item recognition. Eighteen children aged between eight and 13 were tested both individually and as collaborative trios. Each set of three DRM lists (eight items per list) consisted of 24 words or pictures and three non-presented critical lures. Half of the participants were presented with each set (three lists) followed by the corresponding recognition task, one at a time, until the two word sets and the two picture sets had been presented. This means these participants completed four short presentations and recognition tasks – two words and two pictures (four recognition tasks). The other half of the participants were presented with six lists at a time followed by the corresponding recognition task for both words and pictures. This means these participants completed two long presentations and two recognition tasks – one word and one picture (two recognition tasks).

3.1.1 Results.

The short presentations with four recognition tasks, particularly for the picture lists and in the collaborative trios, resulted in a ceiling effect of high accuracy (nearly perfect studied item recognition coupled with very low false critical lure recognition). The long presentations with two recognition tasks resulted in false recognition rates similar to those found in Roediger and McDermott's (1995) study where 55 percent of the word critical lures were falsely recognised. Moreover, the two recognition tasks took less time for participants to complete and appeared to hold the participants' attention better than the four recognition tasks. Based on these findings it was decided that the experiment proper would employ the long presentations with two recognition tasks to ensure more appropriate critical lure recognition levels.

3.2 Experiment Proper

The materials and methods used during the pilot study were applied to create the experiment proper which makes up the core component of the current investigation and examines the three hypotheses outlined in chapter two.

3.2.1. Participants

Participants were 22 children and adolescents with autism spectrum disorder (ASD) aged between eight and 15 years of age, and 26 age-matched controls. Participants were recruited from primary, intermediate and secondary schools, and through an advertisement in the Autism New Zealand newsletters (refer Appendix 1), in Nelson, Christchurch, Dunedin and Wellington. School principals were approached via letters (refer Appendix 2) and informed consent was received, also via letters, from both the children taking part (refer Appendix 3) and their parent/legal guardian (refer Appendix 4). Each child received a $5 United Video rental voucher for their participation.

There were also five adults with ASD and seven controls recruited from the University of Canterbury who gave their informed consent (refer Appendix 5) and participated in a designated room on their campus. These participants received a $10 Pak N Save voucher following their participation in the study.

3.2.2. Materials

The four blocks of picture stimuli used by Carlin et al (2008) were adapted to suit New Zealand children for use in the picture task of this study (refer Appendix 6) and were transferred to their word equivalents for use in the word task (refer Appendix 7). Each set contained three lists of semantically related items and each list consisted of eight studied items relating to a critical lure. For example, *keys, seatbelt, bus, truck, bicycle, motorcycle, plane* and *train* all relate to the critical lure ‘car’. Participants were presented with either set one and two of both the picture and word stimuli, or set three and four of both the picture and word stimuli.

3.2.2.1. Word memory task.

The author recorded herself saying each word one at a time creating separate files for each word. All 48 words were put into a Microsoft PowerPoint presentation in the order shown in Appendix 7. The words were timed at one word every four seconds with the entire two set (six lists) presentation taking approximately four minutes. There were two 48 word presentations created – one using sets 1 and 2 and the other using sets 3 and 4.

3.2.2.2. Picture memory task.

The pictures used were the picture equivalents of the inter-related lists used in the word task. The pictures were found using www.clipart.com and http://images.google.co.nz on the internet. All 48 pictures were put into a Microsoft PowerPoint presentation in the order shown in Appendix 6. The pictures were timed so each picture was on screen for four seconds with the entire two set (six lists) presentation taking approximately four minutes. There were two picture presentations created; each containing 48 pictures – one using sets 1 and 2 and the other using sets 3 and 4.

3.2.2.3. Recognition tasks.

The word recognition task was read out to participants by the author and consisted of 60 items made up of five studied items from each of the six lists, the six corresponding critical lures, and 24 unrelated novel items (refer Appendix 8). Each item in the recognition task was ordered randomly and read out as a question: 'Did you hear… (Car)?' Participants circled their responses on a recognition task sheet (refer Appendix 9) which contained four response options: 'Yes' (4), 'I think so' (3), 'I don't think so' (2) and 'No' (1). These options were used to gauge the participants' confidence in their responses to each item.

The picture recognition task was also read out by the researcher and consisted of 60 items made up of five studied items from each of the six lists, the six corresponding critical lures, and 24 novel items (refer Appendix 10). Each item in the recognition task was ordered randomly and read out as

a question: ‘Did you see… (Apple)? The participants completed the same response sheet (refer Appendix 9) as was used in the word recognition task.

3.2.3. Procedure

Before testing was undertaken, approval to conduct the study was obtained from the University of Canterbury Human Ethics Committee (refer Appendix 12). Additionally, children could only take part with signed consent from their parents/legal guardians (refer Appendix 4) and their own signed consent (refer Appendix 3). University students also had to give their informed consent before the study commenced (refer Appendix 5).

Participants were randomly assigned to be presented with either the word presentation (six lists) first or the picture presentation (six lists) first. They were also randomly assigned to either sets one and two of both the picture and word presentations or sets three and four of the two presentations (see Table 1).

Table 1: The possible list/presentation order participants were randomly assigned to within their schools.

SET ONE AND TWO	Picture	Word
	Word	Picture
SET THREE AND FOUR	Picture	Word
	Word	Picture

3.2.3.1. Experiment 1 – age differences.

Participants sat in front of a computer monitor and, in silence, watched their first two sets (six lists) of stimuli. This took approximately four minutes. Immediately following the first presentation participants were given the corresponding recognition task. The author read out each item of the recognition task as a question “Did you see/hear…(Car)?” and the participants would circle their response as a ‘yes’, ‘I think so’, ‘I don’t think so’, or ‘no’. Participants were instructed to respond with a ‘yes’ if they were certain that the item was in the presentation and an ‘I think so’ if they

believed the item was in the presentation but were not certain. Similarly a ‘no’ response was given if they were sure the item was not presented and ‘I don’t think so’ if they believed the item was not presented but were not certain. Once this task had been completed participants watched the second presentation and completed the corresponding recognition task in the same manner. The second presentation was of the remaining form of stimuli. For example, if the first presentation was pictures then the second presentation would be words.

3.2.3.2. Experiment 2 – collaboration.

Children and adolescents between ages of eight and 15 were randomly placed in groups of three within their schools. The three participants sat in front of a computer monitor and, in silence, watched the first two sets (six lists) of stimuli. Immediately after the presentation was completed participants were given the recognition task to complete individually in silence. The recognition task was carried out by the author reading out each item as a question “Did you hear/see… (apple)?” and the participants would circle their response as a “Yes”, “I think so”, “I don’t think so”, or “No”. Once the individual recognition task was completed their response sheets were collected by the author and the participants were instructed to complete the same recognition task as a trio. They were told to make the decisions on how to respond to each item together but were not instructed on how to resolve any conflicts. The group recognition task was conducted in the same manner as the individual recognition task using the same items. This means that the participants in the collaborative trios watched or heard the presentation once before completing the exact same recognition task twice in succession. Once the group recognition task was completed the second presentation and the corresponding recognition task was completed in the same way. If the first presentation was words then the second presentation was pictures or vice versa.

Following completion of the experiment children were given a $5 United Video rental voucher and adults received a $10 Pak N Save voucher. Once all of the data had been collected, debriefing

sheets (refer Appendix 13) were sent to the schools which had been involved in the study to be given to the participants' parents/legal guardians. Adult participants received their debriefing forms via email.

Chapter Four

Results and Discussion

All data was converted to a percentage of the participants' total responses for each item type before being analysed. For each participant indications of 'Yes' and 'I think so' (confidence ratings of 3 and 4) were added together as an indicator of an affirmative response to a studied item, critical lure or novel item.

4.1 Experiment 1

Experiment 1 looked exclusively at differences between the ASD and control participants in relation to their individual responses only. This was carried out by comparing 11 children, 11 adolescents and 5 adults with ASD[1] to 15 children, 11 adolescents and 7 adult controls. For the age differences data only the percentage of affirmative responses (indications of 'yes' and 'I think so' added together) to novel items were subtracted from the percentage of affirmative responses to critical lures and studied items to control for "yes" bias (Carlin et al, 2008). As a result of "yes" bias removal seven of the participants were then excluded from analysis of the "yes" bias corrected data due to their extreme "yes" bias and the finding that removal of "yes" bias resulted in a reduction in studied item recognition to zero or a negative number. The participants excluded were three ASD children, two ASD adolescents and two control children. Means and standard deviations (SD) for the age differences data before and after "yes" bias removal are shown in Table 2. Based on the "yes" bias formula used the novel item affirmative responses constitute the "yes" bias, meaning that "yes" bias analyses can only be carried out with the critical lures and studied items. The data was analysed both before and after "yes" bias was removed.

[1] It was very difficult to find schools and parents with ASD children and adolescents willing to take part in the current study. This was also the case for the adult participants (both ASD and control) which resulted in the low participant numbers. This will be further discussed in the limitations section of Chapter 5.

Table 2: Table of Means and St Dev. for ASD and control participants in their age groups for word and picture critical lures, studied items and novel items as well as the "yes" bias corrected () critical lures and studied items.

WORDS

	Critical Lure		Studied Item		Novel Item	
Group	*Mean %*	*St Dev.*	*Mean %*	*St Dev.*	*Mean %*	*St Dev.*
ASD						
8-12yr old	41 (15.6)	± 29.1 (15)	71.6 (55.5)	± 13.8 (20.9)	24.8	± 27.7
13-15yr old	80.2 (51.6)	± 19.5 (21.3)	77.9 (40.8)	± 11.3 (19.2)	45.1	± 28.3
18yr old +	33.6 (29.6)	± 28.6 (30.9)	82 (78)	± 12.8 (13.6)	4	± 2.8
CONTROL						
8-12yr old	41.3 (19.9)	± 30.7 (27)	79.3 (55.1)	± 12.8 (18.4)	27.7	± 19.2
13-15yr old	43.1 (19.2)	± 32.6 (12)	76.7 (51.6)	± 14.5 (30.9)	25.1	± 26.4
18yr old +	19.1 (11.6)	± 11.3 (10.7)	77.6 (68.1)	± 17.7 (14.7)	9.4	± 7.2

PICTURES

	Critical Lure		Studied Item		Novel Item	
	Mean %	*St Dev.*	*Mean %*	*St Dev.*	*Mean %*	*St Dev.*
Group						
ASD	41 (27.8)	± 26.1 (18.7)	90.7 (87.3)	± 12.3 (18.4)	19.3	± 33.7
8-12yr old	44 (26)	± 32.6 (25.1)	79.4 (70.3)	± 13.4 (7.2)	14.6	± 14.9
13-15yr old	16.8 (12.6)	± 11.7 (7.2)	93.4 (89.2)	± 5.2 (11.1)	4.2	± 7.4
18yr old +						
CONTROL						
8-12yr old	35.6 (26.2)	± 28 (22.3)	85.8 (79)	± 7.6 (15.5)	8.3	± 12.8
13-15yr old	27.3 (18.5)	± 31.8 (26.7)	89.4 (79.9)	± 21.7 (23)	9.6	± 13.9
18yr old +	16.7 (12)	± 19.2 (12.8)	75.6 (68.4)	± 15.1 (16.9)	7.1	± 10.7

4.1.1 Age differences.

A 2x3x2 repeated measures ANOVA was carried out on the mean affirmative responses to critical lures, studied items, and novel items as well as "yes" bias corrected critical lures and studied items. The between-subjects factors were age group (8-12 year old children versus 13 -15 year old adolescents versus adults) and group (ASD versus controls), and the within-subjects factor was list type (words versus pictures).

Critical lures

As the critical lures constitute the occurrence of a false memory they were analysed first. The between-subjects factor of age group was significant, $F(2,54) = 5.68$, $p<0.05$ and a Fishers LSD post-hoc test found that the adolescent participants had significantly higher critical lure recognition than the children and adults ($p<0.05$). There were no significant differences between the children and adults however children had slightly higher critical lure recognition. This pattern was generalised over the ASD and control participants suggesting both groups followed this age-related trend. The second between-subjects factor, group (ASD versus controls), did not quite reach significance, $F(1,54) = 3.74$, $p=0.058$. ASD participants had higher false critical lure recognition than controls however this was not statistically significant. There was a significant difference in the within-subjects factor of list type (words versus pictures), $F(1,54) = 13.80$, $p<0.05$. Critical lure recognition was higher for word lists than picture lists which supports the distinctiveness heuristic as the more distinctive items resulted in lower false critical lure recollection. The only significant interaction was between age group and list type, $F(2,54) = 6.83$, $p<0.05$. Fishers LSD post-hoc tests found that only the adolescents recognised significantly more word critical lures than picture critical lures ($p<0.05$). Picture and word critical lure recognition followed the same age-related trend. However, the difference between adolescents and both children and adults was only significant for the word critical lures.

Novel item affirmative responses were subtracted from the critical lure affirmative responses to remove any "yes" bias for each participant. When "yes" bias corrected data was compared in a 2 (group) x 3 (age) x 2 (list type) ANOVA there were no significant differences, however the patterns of critical lure results were the same as those seen before "yes" bias was removed (Refer Figure 4). This suggests that the differences in critical lure recognition between age groups were not due to "yes" bias. This was further supported by the finding that participants, regardless of age

or group, recognised significantly more critical lures than unrelated novel items ($F(1,54) = 59.73$, $p<0.05$).This also suggests that the relatedness of the critical lures to the studied items played a significant role in critical lure recognition for both the ASD and control participants.

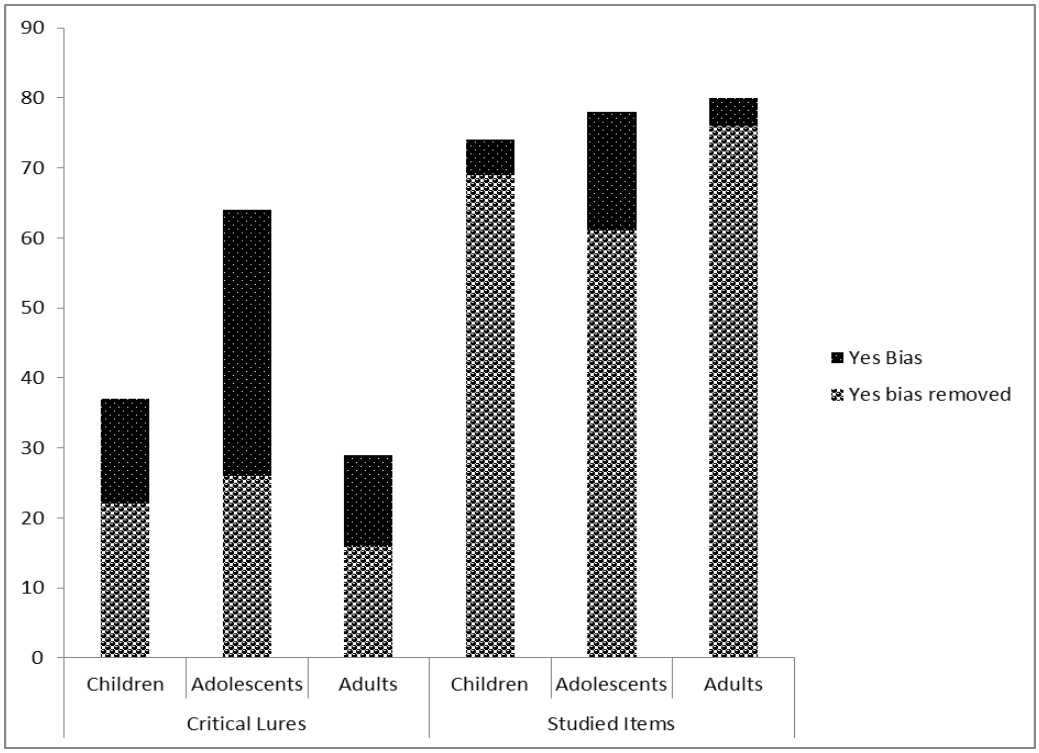

Figure 4: Graph of age differences in false recognition for words and pictures (both with and without yes bias) averaged over the ASD and control participants

Studied items

For the studied items only the within-subjects factor of list type (words versus pictures) was significant, $F(1,54) = 13.43$, $p<0.05$. Studied item recognition was lower for word lists than picture lists. This is consistent with the idea that distinctive items increase studied item recognition. As there were no significant differences found for the between-subjects factor group (ASD versus controls) it can be assumed that the two groups were closely matched for this type of task. Studied item recognition was slightly higher with age in both groups and for word and picture study lists; however, this trend was not significant. When "yes" bias was removed from the studied item data by subtracting novel item affirmative responses from studied item affirmative responses the within-subjects factor list type (word versus picture) was significant, $F(1,47) = 71.48$, $p<0.05$ as

was the interaction between age and list type, $F(2,47) = 7.91$, $p<0.05$. The pattern of results found once "yes" bias was removed was very similar to that seen in the original studied item analysis, except studied item recognition for all groups was lower and the adolescent participants' recognised fewer studied items than the other two age groups (Refer figure 4). This suggests that adolescents had a higher tendency to express "yes" bias than children or adults.

Novel items

Novel item recognition was significant for the between-subjects factor age group, $F(2,54) = 3.08$, $p<0.05$ and the within-subjects factor list type (words versus pictures), $F(1,54) = 19.58$, $p<0.05$. A Fishers LSD post hoc test revealed the same pattern of results as was seen in the critical lure analysis – adolescents had the highest novel item recognition and adults had the lowest novel item recognition. The interaction between list type and age was also significant, $F(2,54) = 8.19$, $p<0.05$ as was the three way interaction between list type, age group and group (ASD versus control), $F(2,54) = 6.46$, $p<0.05$. Fisher LSD post hoc tests on the two way interaction revealed that children and adolescents had significantly higher word recognition than picture recognition for novel items. When a Fishers LSD post hoc test was carried out on the three way interaction it was revealed that only the control children and the ASD and control adolescents had significantly higher word recognition than picture recognition for novel items.

Summary of age difference results

The age-related trends found in the current study partially support the first hypothesis being tested in this thesis – 'adults and adolescents will have fewer false memories than children for both ASD and control participants'. This was the case for the adults when compared with the children as adults had fewer false critical lure intrusions (false memories) than children. However the finding that adolescents have higher false critical lure recognition than the other age groups is inconsistent

with this hypothesis. The adult and children comparisons are consistent with the findings of Surgue & Hayne (2006) and Ghetti et al. (2002), as my findings reflect their age-related pattern for short study lists (which were utilised in the current thesis).

4.1.2 Confidence ratings.

A 2x3x2 repeated measures ANOVA was carried out on the mean affirmative responses to critical lures and studied items[2]. The between-subjects factors were age group (8-12 year old children versus 13 -15 year old adolescents versus adults) and group (ASD versus controls), and the within-subjects factor was confidence rating ('I think so' (3) versus 'Yes' (4)). Before analysing the 'yes' and 'I think so' responses they were calculated as a percentage of the total affirmative responses (combined 'yes' and 'I think so' responses). This method of analysis reflects the manner in which Bowler et al. (2000) analysed their confidence data where participants were asked to state their confidence for items they had claimed to recognise. Means and standard deviations (SD) for the 'yes' (high confidence) responses are shown in Table 3.

Table 3: Table of Means and St Dev. (SD) for 'Yes' responses (indications of high confidence) in ASD and control participants, in their age groups, for word and picture critical lures and studied items.

	WORDS				**PICTURES**			
	Critical Lure		Studied Item		Critical Lure		Studied Item	
Group	*Mean %*	*SD*	*Mean %*	*SD*	*Mean %*	*SD*	*Mean %*	*SD*
ASD								
8-12yr old	92.4	± 17.4	91.4	± 15.3	57.5	± 47.3	98.7	± 3.1
13-15yr old	84.9	± 16.9	85.9	± 13.3	82.3	± 31.7	95.1	± 11.4
18yr old +	66	± 42.2	94.8	± 4.1	80	± 44.7	98	± 3.1
CONTROL								
8-12yr old	53.5	±41.2	92.1	± 10.3	71.1	± 45.2	95.5	± 7.7
13-15yr old	63.7	± 37.3	88.5	± 14.6	41.4	± 42.7	91.6	± 15.5
18yr old +	57.1	± 53.5	95.3	± 6.7	38	± 48.7	94.6	± 6.4

[2] Novel items were not included as there were no statistically significant differences and novel item confidence analysis did not relate to the aims of the experiment.

Critical lures

The between-subjects factor, group (ASD versus control), was significant for both word ($F(1,54) = 4.45$, $p<0.05$) and picture ($F(1,54) = 5.28$, $p<0.05$) critical lures. In both cases the ASD individuals had a greater difference between 'Yes' and 'I think so' responses for critical lures. This demonstrates that the ASD participants had higher confidence in their false recognition than controls. The within-subjects factor, confidence rating ('Yes' versus 'I think so') was also significant for both words ($F(1,54) = 35.98$, $p<0.05$) and pictures ($F(1,54) = 24.76$, $p<0.05$). This analysis indicated that participants were confident in their affirmative responses to critical lures. There were no significant interactions for the word critical lures however, the three way interaction between group, age group and confidence rating was significant for the picture critical lures, $F(2,54) = 3.53$, $p<0.05$. A Fishers LSD post hoc test revealed that the ASD adolescents were more confident in their picture critical lure recognition than age-matched controls and that the ASD children were less confident than the ASD adolescents and the ASD adults.

When word and picture critical lures were compared for differences in confidence ratings using a 2 (group) x3 (age group) x2 (list type) x2 (confidence rating) ANOVA the same within-subjects and between-subjects factors were found to be significant. More importantly the four way interaction between group (ASD versus control), age group, list type (word versus picture), and confidence rating ('Yes' versus 'I think so') was significant, $F(2,54) = 5.50$, $p<0.05$. When this analysis was graphed all groups indicated lower confidence in picture critical lures than word critical lures except the ASD adults and control children (refer Figure 5). A Fishers LSD post hoc test revealed that only the ASD children had significantly different confidence ratings for words and pictures with higher confidence in words than pictures.

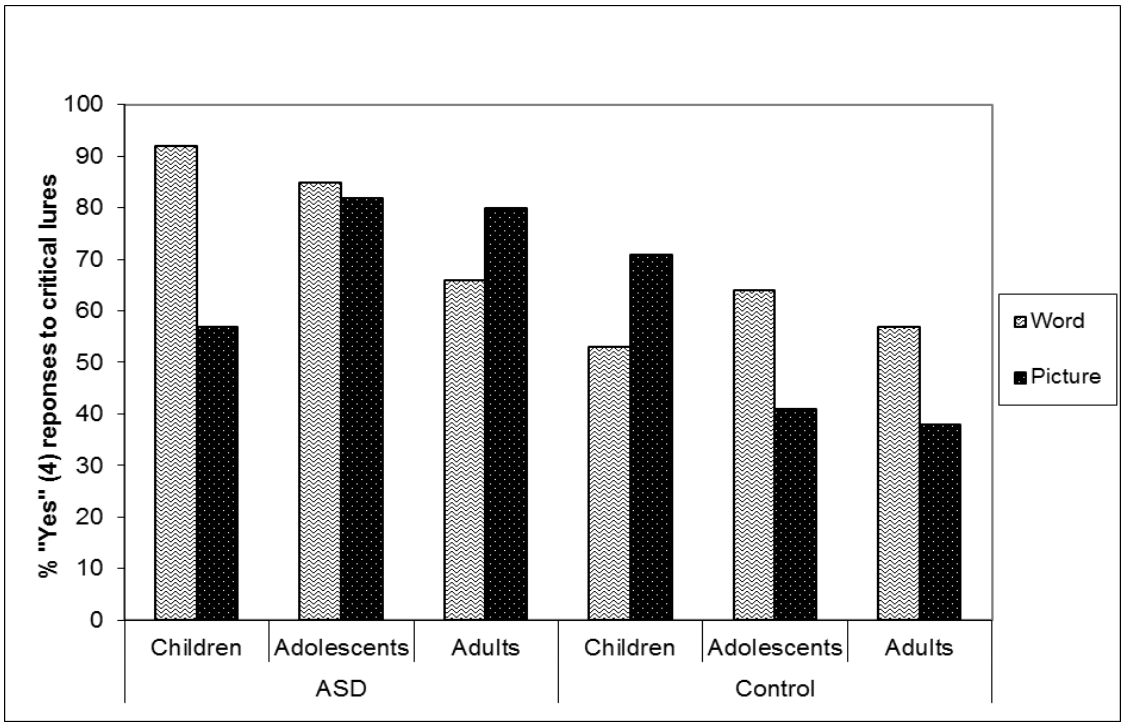

Figure 5: Graph comparing mean "Yes" confidence ratings (highest confidence) for word and picture critical lures between ASD and control children, adolescents, and adults.

Studied items

The within-subjects factor, confidence rating ('Yes' versus 'I think so'), was significant for both word ($F(1,54) = 582.62$, $p<0.05$) and picture ($F(1,54) = 1204.5$, $p<0.05$) studied items with 'Yes' responses being significantly higher than 'I think so' responses. This means that all participants demonstrated very high confidence in their studied item recognition. There were no significant differences found between age groups or ASD and control participants. Furthermore, the level of confidence was very similar for both word and picture stimuli.

Summary of confidence ratings results

The confidence ratings results have the opposite trend from that predicted in the second hypothesis and the trend found by Bowler et al. (2000). This is due to the ASD participants in the current study demonstrating higher confidence in their critical lure recognition than control participants, and this was consistent for all age groups. The second hypothesis also predicted that the ASD participants would recognise fewer critical lures (based on previous studies) which was also

unsupported by the current study, where ASD participants consistently demonstrated higher critical lure recognition. The finding that ASD participants had higher critical lure recognition and higher confidence than controls suggests that weak central coherence (the poor use of association networks) was not at play here. When all three DRM studies of ASD individuals are taken together (Beversdorf et al. (2000), Bowler et al. (2000), and the current study) it appears that the pattern of differences between ASD and control participants varies as a result of varied study list length in the same manner as studies comparing control children and adults (e.g., Surgue & Hayne, 2006; Ghetti et al, 2002).

4.2 Experiment 2

Experiment 2 takes a step beyond the first experiment to look at how the same lists affect false memory in collaborative trios by comparing 6 ASD children and 9 ASD adolescents[3] with 6 control children and 9 control adolescents.

A 2x2x2 repeated measures ANOVA was carried out on the mean affirmative responses to critical lures, studied items, and novel items. The between-subjects factors were age group (8-12 year old children versus 13 -15 year old adolescents) and group (ASD versus controls), and the within-subjects factor was collaboration (individual response versus collaborative trio response). When confidence ratings were examined for collaborative effects there were no significant differences found for any group, meaning confidence did not increase or decrease as a result of working collaboratively. As a result confidence ratings will not be discussed in relation to collaboration.

[3] Finding schools where at least 3 students were on the autism spectrum and were willing to take part was nearly impossible despite the high incidence rate of this disorder. This will be further discussed in the limitations section of Chapter 5.

Critical lures

There were no significant findings for picture critical lures; however the data trends were very similar to those found with the word critical lures. As a result, only the word critical lures will be discussed. The between-subjects factor, age, was significant $F(1, 26) = 42.20$, $p<0.05$, with adolescents demonstrating a greater difference between their individual and collaborative critical lure recognition rates than children. The within-subjects factor, collaboration, was also significant $F(1,26) = 4.54$, $p<0.05$. False critical lure recognition was lower in the collaborative groups than the individuals (refer Figure 6). The only significant interaction found was for the two between-subjects factors, group and age group $F(1,26) = 7.08$, $p<0.05$. A Fishers LSD post hoc test found that the ASD adolescents had a greater difference between their individual and collaborative critical lure rates than the other three groups. There were no other significant differences found. It appears that ASD adolescents experienced the greatest decrease in their critical lure recognition rates when working collaboratively. The control adolescents demonstrated a greater decrease in false critical lure recognition than the ASD and control children. Novel item recognition also decreased as a result of working collaboratively.

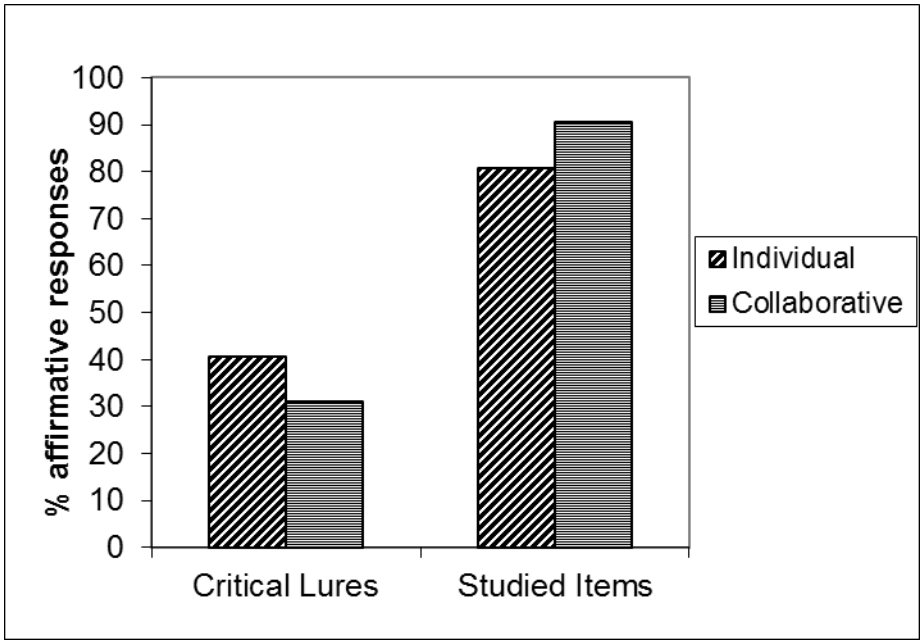

Figure 6: Graph showing the combined ASD and control individual versus collaborative trio results for false critical lure and correct studied item recognition for the word lists.

Studied items

For the word studied items only the within-subjects factor, collaboration, was significant $F(1,26) = 7.37$, $p<0.05$, with higher studied item recognition for the collaborative groups than individuals. The between-subjects factor, age, was significant for the picture studied items, $F(1,26) = 5.78$, $p<0.05$, with the children demonstrating a greater difference between their individual and collaborative recognition rates than the adolescents. The within-subjects factor, collaboration, was also significant in the picture studied items, $F(1,26) = 11.00$, $p<0.05$, with the same pattern as was found in the word studied items (higher studied item recognition in the collaborative trios than individuals). The only significant interaction was between group (ASD versus control) and age group, $F(1,26) = 7.80$, $p<0.05$. A Fishers LSD post-hoc test revealed that children had a greater difference between their collaborative and individual recognition rates than adolescents, and that the ASD adolescents had a smaller difference between collaborative and individual recognition than was found in the control adolescents.

Benefits of collaboration

A 2x2x2x2 repeated measures ANOVA was also carried out comparing the 'yes' and 'no' responses for individuals with the collaborative trios. The between-subjects factors were group (ASD versus control) and age group (children versus adolescents) and the within-subjects factors were collaboration (individual versus collaborative trio) and response ('yes' versus 'no'). Benefits to critical lure recognition were calculated by subtracting the mean collaborative 'yes' response from the individual 'yes' response. Similarly the benefits to studied item recognition were measured by subtracting the mean individual 'yes' response from the collaborative 'yes' response. This analysis was carried out to break down the benefits (decrease in critical lure recognition and increase in studied item recognition) to see whether the pattern of benefits reflect the decision-making techniques the participants were observed using and the findings of Clark et al. (2000).

This analysis revealed the same trends as the other analyses of the collaborative data with the ASD participants demonstrating a greater decrease in critical lure recognition than controls and controls demonstrating a greater increase in studied item recognition than ASD participants. However, the four-way interaction revealed further details into these trends for each group and age group. I found that both the word and picture items had the same pattern of results, however the benefits were slighter for the picture items as only the four way interaction for word critical lures was significant, $F(1,26) = 5.05$, $p<0.05$. When the benefits were calculated for both the word and picture critical lures and studied items it was found that critical lure recognition decreased in all groups except the ASD children, who demonstrated no differences in false critical lure recognition (refer Table 4 and Figure 7). Furthermore, the ASD children's studied item recognition decreased as a result of working collaboratively whereas the other groups all benefitted from collaboration with an increase in their studied item recognition (refer Table 4 and Figure 7).

Table 4: Mean % 'Yes' responses for ASD and control individuals and collaborative trios, and the difference between the means (decrease in critical lure recognition and increase in studied item recognition).

		Critical Lures (CLs)			**Studied Items (SIs)**		
		Individual	Collab.	Diff.	Individual	Collab.	Diff.
ASD	Children	17	17	0	65	52	-13
	Adolescents	72	50	22	68	70	2
CONTROL	Children	39	17	22	83	93	10
	Adolescents	35	28	7	66	74	8

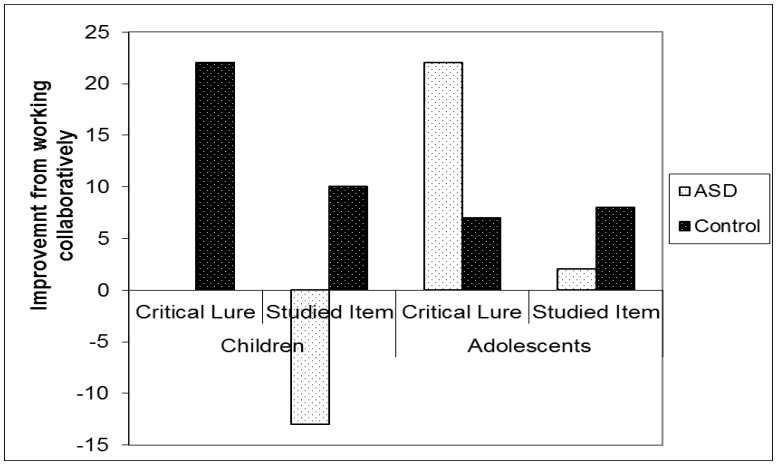

Figure 7: Graph showing a breakdown of the benefits of collaboration in the correct rejection of word critical lures and recognition of studied words for ASD and control children and adolescents.

Summary of collaboration results

The collaboration results supported the third hypothesis – 'that collaboration will decrease total veridical recognition and increase false critical lure recognition in ASD participants compared with controls' – in the children only. The ASD children showed a decrease in their studied item recognition as a result of working collaboratively and no change from their individual to their collaborative critical lure recognition. This decrease in studied item recognition suggests that group work on this type of task may be detrimental to people with ASD in this age group (under 12 years old). However, this was not the case for the older ASD participants who demonstrated clear benefits from working collaboratively, particularly with their critical lure recognition. The control children and adolescents both demonstrated clear benefits from working in collaborative trios.

The ASD children were observed to employ 'follow the leader' decision-making, while the ASD adolescents and control children utilised 'majority-rule', and the control adolescents made decisions using 'evidence-based discussion'. These observations coupled with the pattern of benefits found for each group in the current thesis are consistent with the results of Clark et al.'s (2000) nominal (estimated) groups applying the same techniques. What is particularly important here is that the findings for these decision-making styles that Clark et al. (2000) put forward were based on performance estimated from individual scores (except the 'evidence-based discussion' group which was based on actual collaborative performance), whereas the findings of the current thesis are a result of observed group decision-making. This means the findings of the current thesis solidify the ideas and results put forward by Clark et al. (2000).

Chapter Five

General Discussion

To summarise, the most important findings of the current thesis were that participants with autism spectrum disorder (ASD), regardless of age, had higher critical lure recognition (false memory) rates and confidence in their false recognition than age-matched controls. Also, studied item recognition was not significantly different between groups but did increase slightly with age for both the ASD and control participants suggesting the two groups were well matched for this type of task. Furthermore, critical lure recognition was found to be highest in the adolescent participants and lowest in the adult participants for both ASD and control groups. It is important to note that when "yes" bias was removed the trends in critical lure recognition remained the same despite these differences no longer being significant. Picture lists resulted in higher studied item recognition and lower critical lure recognition than word lists. Nonetheless, the age and group patterns were very similar for both list types. Finally, collaboration was beneficial to all groups except the ASD children. This benefit was demonstrated by an increase in studied item recognition coupled with a decrease in critical lure recognition. ASD adolescents demonstrated a greater decrease in critical lure recognition than control adolescents as a result of collaboration. However, there was a greater increase in studied item recognition for the control adolescents due to collaboration than for the ASD adolescents. Control children demonstrated similar benefits to the ASD adolescents however their decrease in critical lure recognition was slightly lower and their increase in studied item recognition was slightly higher than the ASD adolescents. In the case of the ASD children, studied item recognition decreased as a result of collaboration and there were no significant changes in their critical lure recognition. This group was the only group where collaboration appeared to negatively impact their performance on the DRM tasks.

5.1 Tying it All Together

The main aim of the current thesis was to address the question, "what can word and picture DRM tasks tell us about false memory development in autism spectrum disorder (ASD)?" This was carried out by addressing three hypotheses, the first of which explored age differences in both autistic and control individuals. The age-related pattern found in this thesis partially supported the first hypothesis, "adults and adolescents would have fewer false memories than children for both ASD and control participants", in the finding that adults had lower false critical lure recognition than children in both groups. This hypothesis was based on studies that have used short DRM lists similar to the lists I used, rather than the typical developmental pattern (false memory rates increasing with age). However, the adolescent participants had higher false critical lure recognition than both children and adults which does not support this hypothesis. There are no studies which have placed adolescents' performance on short DRM lists into context with children and/or adults. It may be that short lists do not affect adolescents in the same manner as they do adults and therefore do not change the standard developmental pattern for adolescents. They also demonstrated the highest level of "yes" bias. Focussing on the age-related trend for the children and adult participants I have found it to be consistent with Surgue & Hayne (2006) and Ghetti et al. (2002), who demonstrated a similar difference between children and adults' false memory rates when short study lists (such as mine) were used. The trend was also consistent with Carlin et al.'s (2008) study, where the lists were derived from. These consistencies give further evidence towards the effects of short word lists on false critical lure recognition in children and adults. It also suggests that the deviation from the standard age-related trend (adults demonstrating higher critical lure recognition than children) experienced by Carlin et al. (2008) was not a result of distinctiveness as they had postulated (based on their exclusive use of picture lists), but was due to their use of short study lists. This is likely the case as the same pattern was found in both the word and picture lists used in the current study.

Studied item recognition increased slightly with age but was not significantly different between any groups for words or pictures. However, when "yes" bias was removed the adolescents' studied item recognition dropped below the children's and adults' studied item recognition rates. This, coupled with the adolescents having the greatest decrease in critical lure recognition when "yes" bias was controlled for, suggests both ASD and control adolescents have a greater propensity to give an affirmative response in the recognition task. For all participants word critical lure recognition was higher than picture critical lure recognition and word studied item recognition was lower than picture studied item recognition. This is consistent with the distinctiveness heuristic as the picture items were more distinctive than the word items and were expected to increase overall accuracy. "Yes" bias did not differ between ASD and control participants meaning it is safe to say this was not the cause of any differences between the two groups.

The second hypothesis examined differences in confidence ratings and proposed that ASD participants would have lower critical lure recognition and lower confidence in their critical lure and studied item recognition than age-matched controls. I found the opposite of these predictions with ASD participants, regardless of age, demonstrating both higher false critical lure recognition and higher confidence in their critical lure recognition. There were no differences found between the two groups for studied item confidence ratings. These findings are inconsistent with the confidence ratings findings of Bowler et al. (2000), who found ASD participants were less confident in their studied item and critical lure recognition than control participants. The confidence ratings may differ due to the manner in which high confidence and low confidence in affirmative responses was defined. In Bowler et al. (2000) very strict definitions were given for the high confidence ('remember') responses. Participants could only indicate a 'remember' response if they had a physical recollection of the item, for instance a 'remember' response for a picture of a

dress would have to involve a fine detail such as the colour of the dress. In the current thesis participants were simply told to indicate ‘yes’ (high confidence) if they were certain that the item had been presented and ‘I think so’ if they believed the item had been presented but they were unsure. There was no expectation of a physical recollection for ‘yes’ responses. As these two studies are the only ones which have analysed confidence ratings of ASD participants on the DRM (in this manner) there is no way of knowing the cause of this inconsistency without further research.

The findings of the current thesis were also inconsistent with the false memory rates found by Bowler et al. (2000) and Beversdorf et al. (2000). Beversdorf et al. (2000) found ASD participants had lower critical lure recognition rates than controls whereas Bowler et al. (2000) found that ASD and control participants had similar critical lure rates. The finding that all three of the DRM studies with ASD participants (Bowler et al, 2000; Beversdorf et al, 2000; and the current thesis) are inconsistent suggests an underlying, fundamental difference in the methodology. The significant difference between the three studies is the length of the study lists used. In Beversdorf et al. (2000) participants were presented with lists of 12 words and ASD adults were found to have significantly lower critical lure recognition than age-matched controls. Bowler et al. (2000) used word lists containing nine items each and found their ASD adults had similar false memory rates to age-matched controls. The current study utilised lists containing eight items and found that children, adolescents and adults with ASD had higher false memory rates than age-matched controls. It appears that as shorter study lists are used the gap between ASD and control participants’ critical lure recognition closes. The manner in which list length affects critical lure recognition in ASD participants is the same as that evidenced in age-related (developmental) DRM studies. In these DRM studies shorter lists result in children having lower false critical lure recognition than adults, while in longer lists they have very similar and sometimes higher critical lure recognition rates.

Both Bowler et al. (2000) and Beversdorf et al. (2000) postulated that the ASD participants have weak central coherence (poor understanding of context) which would mean they would be poorly equipped to utilise the semantic associations of the list words to increase their recollection of the studied items, and would make the automatic activation of critical lures unlikely. However, the results of the current thesis suggest that participants with ASD do not have difficulty with utilising the associations between the critical lures and the study words or between the study words themselves to aid their recognition. This is supported by the fact that "yes" bias did not differ between the two groups and controlling for it did not change the original trends seen in the data. Considering the age-related trend for differing study list lengths is very similar to the trend that is appearing for participants of all ages with ASD, it can be assumed that ASD critical lure recognition rates are not a result of weak central coherence. A simpler explanation is that this trend is a result of a delay in the development of their association networks, which results in them performing in the same manner as control children on DRM tasks. This developmental delay theory appears to explain the findings of all three studies (Beversdorf et al, 2000; Bowler et al, 2000; and the current thesis) but requires further exploration.

The findings of Experiment 1 strongly support the association activation theory, as all participants recognised high levels of the non-presented, strongly associated, critical lure items; and this finding was not a result of "yes" bias for either the ASD or control participants. However, this theory postulates that children and adults should have similar rates of critical lure recognition as a result of shorter lists, and based on my developmental delay theory this should also be the case for the ASD participants. Both the children and ASD participants demonstrated higher critical lure recognition than the adults and controls respectively suggesting there was more at play than just association activation. It is based on this that I believe the association monitoring theory best fits my findings. This theory states that the critical lures are activated by studied item presentation but

are only recognised if source misattribution also occurs. Source misattribution is most likely to occur when the two sources are similar or they are unsupported by further aids to recollection. While the critical lures did not meet the requirement of similarity (as the studied items were presented in the authors voice and the critical lures were likely experienced in the participants voice), there was no support given to assist participants in correctly attributing the critical lures as non-presented items. This would have been a particular issue for the ASD participants who have been found to have greater difficulty with unsupported source attribution. This is highlighted by the finding that the difference between ASD and control false memory rates was larger than the difference between children and adults. Association monitoring theory also explains the differences in word and picture recognition, as picture items share fewer similarities to one another (are more distinctive) than word items, meaning any picture critical lures activated are less likely to be incorrectly attributed as a study item. This difference can also be explained by the distinctiveness heuristic.

The third, and final, hypothesis examined the effects of collaboration on children and adolescents with ASD compared with age-matched controls. I hypothesised that ASD participants would have a decrease in their veridical memory rates as well as an increase in their false memory rates as a result of working in collaborative trios. This hypothesis was made on the basis that the predominant characterisation of ASD is as a social disorder. Prior to the current study there had been no DRM collaboration studies carried out within this group. This hypothesis was supported by the ASD children only, as for them working in a collaborative group resulted in a decrease in studied item recognition and no significant change in critical lure recognition. However, for the ASD adolescents clear benefits were found as a result of working in a collaborative trio, as their critical lure recognition was lower and their studied item recognition was higher in the

collaborative trios than for individuals. Both the control children and control adolescents demonstrated these same benefits from working collaboratively over working individually.

Presuming that decision-making techniques become increasingly complex with age then there were clear developmental patterns found in the observed decision-making techniques of both the control and ASD participants. In the control groups children predominantly used the 'majority-rule' technique, whereas control adolescents primarily utilised 'evidence-based discussion'. The ASD adolescents used 'majority-rule' almost exclusively whereas the ASD children used a 'follow-the-leader' style of decision-making, where the person recording the group's responses appeared to record their own responses with little consideration of the other group members. The 'follow the leader' style of decision-making is only as good as the person who is taking the lead, so if they have less accurate responses than the expected group's results, collaboration will be detrimental to recognition accuracy.

When these observed decision-making techniques are coupled with the patterns of benefits demonstrated by each group, further support is given to the results and theories of Clark et al (2000) who suggested that different styles of decision making will result in different degrees of collaborative benefits. Most importantly, that 'majority-rule' results in a greater benefit to false memory reduction and a smaller benefit to studied item recognition than 'evidence-based discussion'. This explains the differences found in the groups used in this study and clearly supports Clark et al.'s (2000) findings. Their theories were based on estimated performance using individual scores for the 'follow the leader' and majority-rule' manipulations and actual performance for the 'evidence-based discussion', whereas, the current thesis used observed decision-making techniques giving a solid tie between the patterns of results and the style of decision-making applied. The findings of Experiment 2 also support my working hypothesis that

ASD participants' performance on DRM tasks is a result of developmental delay as here in this social DRM task they were also one step behind age-matched controls developmentally. Furthermore, these findings imply that, to some extent, ASD performance in social group situations result from a delay in the development of their social skills rather than a complete lack of skills. Moreover, ASD adolescents may benefit from group work, such as that required in the DRM collaboration task, whereas ASD children most likely will not.

5.2 Limitations

The main limitations of this study revolved around the small sample size and the participants themselves. The small sample size was due to difficulties recruiting participants as the study focussed predominantly on ASD and control children and adolescents under the age of 15. Furthermore, participants were found through schools so potential participation had to be signed off by the schools as well as the parents, and the participants themselves. Very few schools had more than one or two students with ASD making participation in the collaborative trios difficult, as the study was held in school hours at the schools that agreed to participate. Many of the schools contacted did not reply and several of those who agreed to take part could not get a response from parents or the parents would refuse to consent to their child's participation. As a result of this, recruitment was extended from Nelson and Christchurch to include Wellington, Blenheim and Dunedin. Adult participants were recruited from the University of Canterbury, as it was the only tertiary institution in those cities that was willing to send out an email advertising the study. Many of the university students who agreed to take part in the study then did not attend the pre-organised session making it impossible to have adult collaborative trios. No further participants responded to the advertisements placed in the Autism New Zealand newsletters in these cities either.

As it was so difficult to get the desired sample size for this study there could be very few restrictions put on the criteria for the participants being recruited. To this end, the only restrictions were the age of participants (between eight and 15 for children and over 18 for adults), that ASD participants had an official diagnosis, and that the ASD participants had average or better English language skills. As far as the control group went the only restriction was that they had no diagnosed disorders. This study gives a very trans-diagnostic sample of people on the autism spectrum as there were no restrictions placed on the exact ASD diagnosis of the individuals; meaning participants may have had a diagnosis of autism, pervasive developmental disorder, autism spectrum disorder or Asperger's disorder. Moreover, there were no exclusion criteria set for potential co-morbidity with other disorders such as attention deficit/hyperactivity disorder (ADHD) and dyspraxia. Additionally, no controlling measure for intelligence was carried out as the researcher was unqualified to conduct the type of neuropsychological assessment required to measure intelligence. Even if such a measure had been conducted it would have been of little use except as a potential confounding variable for data analysis, and would have placed further restriction on time and a very difficult recruitment process.

As far as experiment design goes the clearest limitation was the lists used, which were derived from Carlin et al (2008) and were chosen for their ability to elicit false memories in children and to be represented by pictures. While these lists successfully elicited false memories in the participants taking part in the current study, they had not been used with ASD participants before. Furthermore, the pattern of age differences and comparison between autism spectrum disorder (ASD) and control participants found were the opposite of the trends documented in false memory literature. The age differences found in the current thesis, where adults had lower false memory rates than children, is the same pattern found by Carlin et al.'s (2008) study. Carlin et al. (2008) explained their age-related pattern as a result of their use of pictures rather than words. They suggested that

distinctiveness has a greater impact on adults than children which is why (in this case) adults have lower false recognition than children. It is more likely a result of the length of the study lists as we found this age-related pattern with both the word and picture lists ruling out Carlin et al.'s distinctiveness explanation. Short study lists have been found to result in this age-related trend (Surgue & Hayne, 2006) and as my lists consist of eight words or pictures each, whereas the standard DRM lists are 15 words in length, it can be assumed that this was the case in Carlin et al. (2008) and the current thesis.

As these lists were adapted to suit New Zealand children, backward associative strength (BAS) of these lists is unknown and most likely varies widely among the 12 lists. In an attempt to control the effects of varying BAS on critical lure (false memory) in studied item recognition all 12 lists were presented as word and picture presentations in a counter-balanced fashion. This means that where one participant was presented with the first half of the lists as words and the remaining half as pictures another participant was presented with the first half of the lists as pictures and the remaining half as words. This manipulation was randomly assigned to participants and means that any differences observed between word and picture recognition was likely not due to the BAS of the lists.

Another potential limitation of the current thesis is that participants were required to complete two relatively similar recognition tasks individually, and in the case of the collaborative trio members two recognition tasks in succession both regarding the same items. To help control any effects on this, the individual level participants were randomly assigned to a presentation order; either words and then pictures or pictures and then words. The collaborative groups presentation order was also randomised however the collaboration study required the participants to complete the recognition task twice in succession for each presentation (word and picture). As a result there was no way to

control for the effect of completing two recognition tasks in succession. However, Maki et al. (2008) and Clark et al (2000) found that getting collaborative participants to complete a recognition task individually and then the same task collaboratively (as I did here) does not affect false or veridical memory rates. Due to this finding it is likely that using a repeated recognition task for each presentation in the collaborative trios has not had a significant impact on the findings of the current thesis.

5.3 Directions for Future Research

There are a number of directions that can be taken for future studies using the current thesis as a building block. Firstly, this entire study could be redone using recall tasks in place of the recognition tasks used here. Also, the theories used to explain the pattern of results found in the current thesis could be tested by comparing false memory rates of people with Attention Deficit/Hyperactivity Disorder (ADHD) with controls and ASD participants, and directly testing context use, inhibitory control and attention as controlling measures. These theories and findings could also be tested by using lists which vary in length, using eight, 12 and/or 15 words, or using a larger more homogeneous group of ASD participants to try and uncover whether the developmental delay theory relates directly to ASD or resulted from a co-morbid disorder.

An important area that needs to be re-examined in a future study is confidence ratings in ASD individuals. A comparison between confidence ratings using definitive definitions for 'Yes' (remember) and 'I think so' (know) responses and undefined 'Yes' and 'I think so' responses would be required as this comparison is the main difference between the way confidence was measured in Bowler et al.'s (2000) study and the current thesis. A study looking at the effects of these two methods would hopefully explain the differing results of these two studies, or else disprove the efficacy of one of the studies' findings.

The key area which can be built on is collaboration, which shows clear potential from the current study. It would be interesting to learn if the benefits found here can be replicated in future studies, whether the increased benefit resulting from participant age extends to adults, and whether these patterns of results hold for larger or smaller groups. What effects different ratios of controls and ASD members would have on collaborative false memory would be a worthwhile topic for additional research. This would give a clearer indication of how autistic individuals of all ages make group decisions, how they are affected by non-autistic individuals, and hopefully give further support for the developmental delay theory and the findings of the current study and those of Clark et al. (2000).

5.4 Concluding Remarks

To conclude, this study gives deeper insight into the memory mechanisms and the drive for central coherence in autism spectrum disorder (ASD). The findings of this thesis suggest that ASD individuals are quite capable of using semantic associations to aid recognition. This places the theory of weak central coherence, in relation to the DRM paradigm, in question. When taken into context with other DRM studies of ASD this thesis has suggested that the difference between the findings of Beversdorf et al. (2000) and Bowler et al. (2000) are not due to weak central coherence but are a result of the length of the study lists. This was demonstrated by the finding that Beversdorf et al. (2000) used the longest study lists (12 words) and found ASD participants had lower false memory rates than controls, while Bowler et al. (2000) and the current thesis used shorter study lists (9 and 8 words respectively) with an equivalent (or higher) number of false memories for ASD and control participants. The finding that list length impacts on false memory rates in ASD participants in a very similar manner to control children (when compared to adults) suggests a delay in the development of the association networks. When longer lists are used ASD adults, like control children, have lower critical lure intrusion (false memories) rates than control

adults (Beversdorf et al, 2000). However, when shorter lists are used there are no significant differences found between ASD adults and age-matched controls (Bowler et al, 2000). This finding forms the basis for my developmental delay theory which postulates that ASD participants' performance on DRM recognition tasks is a result of the delayed development of their association networks rather than a lack of use or understanding of associations, as is suggested by weak central coherence theory.

Additionally, this study has shed some light on the manner in which autistic individuals make collaborative decisions and how these methods change and develop with age, giving some insight into the social development of ASD and control individuals. The collaboration findings of this study also support my developmental delay hypothesis. It appears that decision-making methods become more complex with age, shifting from 'follow the leader' to 'majority-rule' to 'evidence-based discussion'. In the control groups the children were observed employing 'majority-rule' decision-making with limited use of 'evidence-based discussion', while the adolescents used 'evidence-based discussion'. On the other hand the ASD children made decisions using the 'follow the leader' technique and the ASD adolescents employed 'majority-rule'. Looking at the developmental progression of decision-making techniques it can be postulated that the ASD participants were developmentally one step behind the control groups, supporting the developmental delay hypothesis. This improvement in the style of decision-making, with age, for ASD participants implies their social skills will develop. Furthermore, while group work and therapy may be of little benefit (or even detrimental) to ASD children it could be very beneficial to adolescents with ASD.

This thesis strongly supports the findings of Clark et al. (2000) who put forward an idea that different decision-making methods resulted in different types of collaborative benefit. They found

that ‘follow the leader’ decision-making resulted in no change in false memory rates and lower studied item recollection than nominal (estimated) groups, whereas both ‘majority-rule’ and ‘evidence-based discussion’ resulted in benefits. The ‘majority-rule’ groups had lower critical lure (false memory) recognition than the ‘evidence-based discussion’ groups and the ‘evidence-based discussion’ groups had higher studied item recognition than the ‘majority-rule’ groups. Clark et al.’s (2000) ‘follow the leader’ and ‘majority-rule’ groups were created based on estimates of how the trios would perform if they were to use these decision-making methods based on their individual scores and the ‘evidence-based discussion’ comparison was made based on their actual collaborative scores. The current thesis confirmed the findings of Clark et al. (2000) using observed group performance, cementing their ideas on decision-making effects.

Overall, the current study has made significant strides in answering the question, “What can word and picture DRM tasks tell us about false memory development in ASD”. The most important finding being that DRM performance in ASD participants is affected by study list length in a manner that reflects control children (when compared to control adults). Furthermore, that performance on collaborative DRM tasks is affected by decision-making techniques which appear to be developmentally one step behind controls in the ASD participants. These findings support the hypothesis that ASD performance on DRM tasks is due to a delayed development of their association networks (coupled with delayed social development in the case of collaboration studies), not a lack of understanding or use of context (and consequently the semantic associations of the DRM) as was postulated by Beversdorf et al. (2000) and Bowler et al. (2000) in accordance with weak central coherence theory.

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Appendices

Appendix 1: Autism New Zealand Advertisement

PARTICIPANTS NEEDED FOR A UNIVERSITY STUDY

A researcher completing her Master's thesis in Psychology
at the University of Canterbury needs participants to participate
in a study looking at associative memory in children with
Autism Spectrum Disorder (including Asperger's
Syndrome and Autism).
Participants are required to be between 8 and 12 years old
and have proficient English and verbal skills.
The study will be carried out in the child's school with
their principal's permission.
Participants will receive a $5 United Video rental voucher.
This study has been reviewed and approved by the
University of Canterbury's Human Ethics Committee.

**If you are interested in participating or would like further
Information please phone Megan Borlase on (03) 521 1847
or email mab188@student.canterbury.ac.nz**

Appendix 2: Letter to School Principals

College of Arts

Department of Psychology

Megan Borlase
Department of Psychology
University of Canterbury
Private Bag 4800
Christchurch
03 521 1847

The Principal
[Name of School]
[School Address]
[Christchurch/Nelson/Wellington/Dunedin]
[Date]

Dear *[Principal's Name]*,

My name is Megan Borlase and I am carrying out a Master of Arts degree in Psychology at the University of Canterbury. I am interested in conducting research with 8 – 12 year old children with Autism Spectrum Disorder, as well as age matched children who are developing on a normal trajectory, in the Christchurch/Nelson/Wellington/Dunedin area. I would very much appreciate the opportunity to work with 8 – 12 year old children in your school.

My research entitled '*The effects of visual and verbal presentations on recall and memory accuracy in Autism Spectrum Disorder during middle childhood'* is exploring the accuracy of memory of visual and verbal stimuli in children with Autism Spectrum Disorder. If successful this research could give insight into the role of semantic association in memory processes in Autism Spectrum Disorder. Furthermore it may shed light on new techniques to aid learning for children with Autism Spectrum Disorder, particularly in secondary and tertiary educational settings. I am also interested in memory accuracy from a forensic psychology standpoint particularly in relation to eyewitness testimony due to the percentage of intellectually disabled persons and children who are victimized in some way each year.

The study involves students studying a series of words and pictures and completing a recognition task followed by a naming task. Some of the children in both the control and the Autism Spectrum Disorder group will be working in groups of four whereas the rest of the participants will work individually. This is to test the effect of working collaboratively on memory recall and accuracy. This study should take no more than 45 minutes but participants will be given an hour slot just in case and to give the researcher preparation time between participants. There is no foreseen harm to the participants and the research will be conducted in school hours (ending at

5pm at the latest for students who have been indicated as willing to stay until this time). Students are to be tested in an empty room using a computer program specially designed for this study.

With your approval, the participants will be given a $5 United Video rental voucher as a reward for their participation in this study. This research project has been reviewed and approved by the University of Canterbury Human Ethics Committee. I have developed a parental information and consent form which you are welcome to read through at your request.

If you would like to discuss this study further please feel free to contact me on 03 521 1847 or email mab188@student.canterbury.ac.nz. You are also welcome to contact me with any queries or concerns, or alternatively you can contact either of my supervisors – Dr Ewald Neumann on 03 364 2987 ext 7955 or Mr Paul Russell on 03 364 2987 ext 6170 with concerns or queries.

I would very much appreciate and enjoy the opportunity to work with you and the students of your school.

Yours Faithfully,

Megan Borlase Dr Ewald Neumann (Supervisor) Mr Paul Russell (Co-supervisor)

Appendix 3: Children's Information Sheet and Consent Form

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

You are invited to take part in a University study

What is the study about?
We want to know if it is easier for children between 8 and 12 years old to remember things they see or that they hear. We are also interested in knowing whether there are any differences in memory between children who have Autism Spectrum Disorder and those children who do not have it. This is important because it will help us learn more about how memory works and maybe find some new ways to help children remember more things.

What will I have to do in the study?
In this study you will be asked to look at some pictures and hear lists of words and then you will be asked questions about what you saw and heard. You may be working with 3 other children or by yourself for this part. After you have looked at the pictures and been asked some questions you will be asked to look at a list of pictures and tell the researcher what each picture is of. The study should take no more than 45 minutes. The tasks will be done in an empty room at your school with someone from the university. It is important to remember that there are no 'right' or 'wrong' answers all we want is for you to do your best.

Are there good and bad things about the study?
There are no bad things about this study. You will be able to have a few quick breaks during the session and will be able to have a drink bottle with you if you like. Also at the end of the session you will get a United Video rental voucher to thank you for taking part in this study.

Who will know how I did in the study?
No one else besides me and my two supervisors will know how you did. All of the information is kept safely locked up at the university.

Can I decide if I want to be in the study?
Yes. No one can make you be in the study. If you decide that you don't want to do it then that is OK and no one will be upset or disappointed. Also if you say yes but then change you mind later then that will be OK as well.
You will have the chance to ask questions at your school before the study. Also you parents or caregivers have been given some information about this study so you can ask them to explain it to you or explain anything you don't understand.
If you would like to do the study please write you name and sign on the lines below. Then bring this form and the form signed by your parents or guardians back to school to give to your teacher.

Your Name: _____
Signature: _____
Date: _____

Appendix 4: Parents' Information Sheet and Consent Form

College of Arts

Department of Psychology

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Dear Parents/Guardians,

My name is Megan Borlase and I am carrying out a Master of Arts degree in Psychology at the University of Canterbury, investigating visual and verbal associative memory. This study aims to help expand our understanding of Autism Spectrum Disorder by studying the use of semantic association in visual and verbal memory. The findings from this study may shed light on new techniques that can be used to assist learning in children with Autism Spectrum Disorder. This may be particularly useful in the future with secondary and tertiary education when tests and examinations play a greater role. A letter will be sent out at the completion of the study containing further information on the research aims.

My research project will involve making comparisons between children aged 8 – 12 years who have been diagnosed with Autism Spectrum Disorders to an age, gender and education level matched control group of children developing on a normal trajectory. All participants will be required to have proficient or better English and verbal skills.

The study will be carried out in an empty classroom at their school and each child will complete the study individually with only the researcher in the room. Children will be shown a series of pictures and words and then given a memory test followed by a short naming task. This should take no more than 45 minutes. Some of the children with Autism Spectrum Disorder and some of the control group will work in groups of four whereas the rest of the participants will be tested individually. This is to see if children with Autism Spectrum Disorder have an increased recall when working collaboratively or alone. There is no foreseen harm to the participants and the research will be conducted in school hours. Your child will be offered a $5 United Video rental voucher at the completion of the experiment. If at any time your child becomes distressed or uncomfortable they will be given a break and then asked if they would like to continue. If not then they will be able to go back to their classroom with the opportunity to reschedule or to withdraw from the study completely.

If you have any queries or concerns about the project please do not hesitate to contact either myself (03) 521 1847 or email me at mab188@student.canterbury.ac.nz), or one of my supervisors - Dr Ewald Neumann on 364 2987 ext 7955, or Mr Paul Russell on 364 2987 ext 6170. The results from the experiment will be held in the strictest confidence and only my supervisors and I will have access to them. If published, the students' information will remain confidential and anonymous.

Participation in the study is entirely voluntary and if your child wishes to withdraw from the study at anytime he or she may do so. Any information relating to him/her will also be withdrawn at that time.

This research project has been reviewed and approved by the University of Canterbury Human Ethics Committee.

Please complete the following form and return it to your child's teacher with the child's consent form. Thank you.

I have read and understand the description of the above named study. I consent to the publication of the results with the understanding that my child's anonymity will be preserved. I also understand that, if unhappy with this decision, (before the publication of the experiment) I can withdraw from the study at any stage and all information relating to my child's participation and results will be destroyed.

I agree to allow my child _____ to participate in the study described above. I have informed my child about what is involved in taking part in the study and was present when he/she gave their written consent.

Name: (please print) _____

Relationship to Child: _____

Signed: _____

Date: _____

PLEASE PRINT:

Child's Name: _____ □ Male/ □ Female

Child's Date of Birth: _____

Child's Class: _____

Has your child received any diagnosis of clinical conditions? If so please list these below, indicating the nature and date of the diagnosis and who made that diagnosis (e.g., a GP, a psychologist).

Diagnosis Date of Diagnosis Diagnosis administered by (e.g. GP)?

1.
2.
3.

My child has competent or better English and verbal skills: □ Yes □ No

My child could have their sessions after school (finishing by 5pm at the latest): □ Yes □ No

My child would be best to have sessions during the: □ AM □ PM □ either

Thank you for your time. A note will be sent out with your child's session times. If there are any times when you do not want your child to have a session or times which you feel would be most suitable please indicate this below and we will do our best to accommodate this.

Appendix 5: University Students' Information Sheet and Consent Form

College of Arts

Department of Psychology

My name is Megan Borlase and I am carrying out a Master of Arts degree in Psychology at the University of Canterbury, investigating visual and verbal associative memory. This study aims to help expand our understanding of Autism Spectrum Disorder by studying the use of semantic association in visual and verbal memory. The findings from this study may shed light on new techniques that can be used to assist learning in children and adults with Autism Spectrum Disorder. This may be particularly useful within secondary and tertiary education settings where tests and examinations play a greater role. A letter will be sent out at the completion of the study containing further information on the research aims.

My research project will involve making comparisons between children and adults who have been diagnosed with Autism Spectrum Disorders to an age, gender and education level matched control group developing on a normal trajectory. All participants will be required to have proficient or better English and verbal skills.

The study will be carried out in an empty room in the psychology department building and each participant will complete the study individually with only the researcher in the room. You will be shown a series of pictures and words and then given a memory test followed by a short naming task. This should take no more than 45 minutes. Some of the participants with Autism Spectrum Disorder and some of the control group will work in groups of three whereas the rest of the participants will be tested individually. This is to see if people with Autism Spectrum Disorder have an increased recall when working collaboratively or alone. There is no foreseen harm to the participants and the research will be conducted in school hours. You will be offered a $10 Supermarket voucher at the completion of the experiment. If at any time you become distressed or uncomfortable you will be given a break and then asked if you would like to continue. If not then you will be able to leave with the opportunity to reschedule or to withdraw from the study completely.

If you have any queries or concerns about the project please do not hesitate to contact either myself (03 5211847 (home), 0272533685 (text or call) or email me at mab188@student.canterbury.ac.nz), or one of my supervisors - Dr Ewald Neumann on 364 2987 ext 7955, or Mr Paul Russell on 364 2987 ext 6170. The results from the experiment will be held in the strictest confidence and only my supervisors and I will have access to them. If published, the students' information will remain confidential and anonymous.

Participation in the study is entirely voluntary and if you wish to withdraw from the study at anytime you may do so. Any information relating to you will also be withdrawn at that time.

This research project has been reviewed and approved by the University of Canterbury Human Ethics Committee.

Please complete the following form. Thank you.

I have read and understand the description of the above named study. I consent to the publication of the results with the understanding that my anonymity will be preserved.
I also understand that, if unhappy with this decision, (before the publication of the experiment) I can withdraw from the study at any stage and all information relating to my participation and results will be destroyed.

I, _____ agree to participate in the study described above. I have read about what is involved in taking part in the study and understand what I am consenting to.

Name: (please print) _____ □ Male/ □ Female

Age: □ 18–25 □ 26–30 □ 31–45 □ 45+

Major: _____

Signed: _____

Date: _____

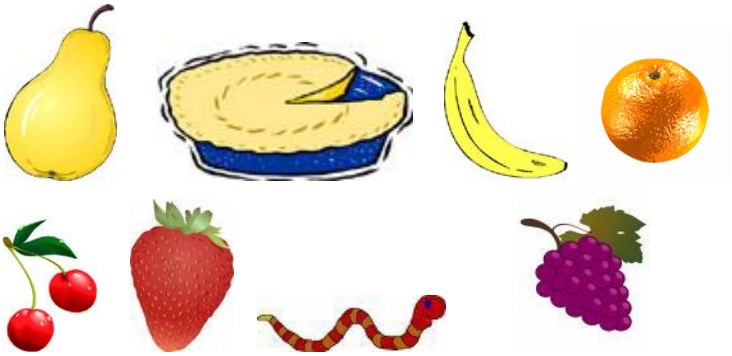
Have you received any diagnosis of clinical conditions? If so please list these below, indicating the nature and date of the diagnosis and who made that diagnosis (e.g., a GP, a psychologist).
Diagnosis Date of Diagnosis Diagnosis administered by (e.g. GP)?
1.
2.
3.

I have competent or better English and verbal skills: □ Yes □ No

Appendix 6: Stimuli List for Picture DRM Task

SET ONE

LIST 1



LIST 2

LIST 3

SET TWO:

LIST 1

LIST 2

LIST 3

SET THREE:

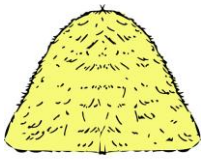
LIST 1








LIST 2





LIST 3





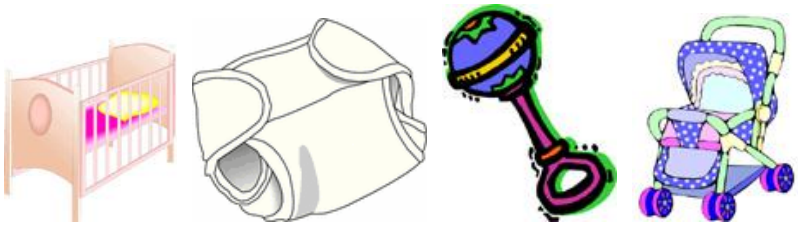



SET FOUR:

LIST 1

LIST 2

LIST 3



Appendix 7: Stimuli List for Word DRM Task

WORD SET

SET ONE:

List One:

Critical	Associates
Car	Keys
	Seatbelt
	Truck
	Bus
	Bicycle
	Motorcycle
	Plane
	Train

List Two:

Critical	Associates
Needle	Thread
	Haystack
	Pin
	Hedgehog
	Cactus
	Thistle
	Sewing Machine
	Wool

List Three:

Critical	Associates
Rain	Umbrella
	Cloud
	Gumboots
	Puddle
	Rainbow
	Sun
	Lightning
	Jacket

NOVEL:

Cat
Dog
Mouse
Tiger
Lion

Letter
Envelope
Stamp
Mailbox
Mailman

Salad
Lettuce
Cucumber
Tomato
Mushroom

SET TWO:

List One:

Critical	Associates
Hammer	Nail
	Builder
	Saw
	Wrench
	Screwdriver
	Axe
	Tape measure
	Screw

List Two:

Critical	Associates
Horse	Saddle
	Paddock
	Unicorn
	Bridle
	Pig
	Zebra
	Sheep
	Cow

List Three:

Critical	Associates
Baby	Crib
	Diaper
	Rattle
	Stroller
	Teddy bear
	Blocks
	Car seat
	Bottle

NOVEL:

King
Throne
Queen
Crown
Castle

Guitar
Piano
Violin
Saxophone
Drums

Moon
Astronaut
Stars
Earth
Telescope

SET THREE:

List One:

Critical	Associates
Apple	Pear
	Pie
	Banana
	Orange
	Cherries
	Strawberry
	Worm
	Grapes

List Two:

Critical	Associates
Fish	Rod
	Mermaid
	Hook
	Whale
	Dolphin
	Shark
	Octopus
	Crab

List Three:

Critical	Associates
Santa	Elves
	Reindeer
	Present
	Christmas Tree
	Ornament
	Angel
	Stocking
	Christmas Cracker

NOVEL:

Pencil
Pen
Eraser
Paper
Crayon

Chair
Table
Stool
Desk
Bench

Bed
Blanket
Slippers
Pajamas
Pillows

SET FOUR:

List One:

Critical	Associates
Mickey Mouse	Minnie Mouse
	Pluto
	Donald Duck
	Goofy
	Pooh Bear
	Disney Castle
	Tinkerbell
	Cinderella

List Two:

Critical	Associates
T-Shirt	Shorts
	Button
	Jeans
	Vest
	Sweater
	Skirt
	Tie
	Dress

List Three:

Critical	Associates
Fire	Dragon
	Log
	Matches
	Fireman
	Fireplace
	Chimney
	Fire engine
	Rocket

NOVEL:

Fork
Spoon
Knife
Plate
Napkin

Eyes
Ear
Glasses
Mascara
Owl

Foot
Sock
Heel
Sneaker
Jandals

Appendix 8: Word Recognition Task

Did you hear…

Paddock	**Hammer**	*Throne*	*Saxophone*	Teddy Bear	*Lettuce*
Cucumber	Stroller	Zebra	Plane	Bottle	Saddle
Seatbelt	*Mailman*	**Baby**	Axe	Bicycle	*Stars*
Telescope	Haystack	Tape Measure	Train	*Tomato*	*Dog*
Hedgehog	Pig	Cloud	Keys	*Violin*	Nail
Gumboots	Screw	Thread	*Mailbox*	*Stamp*	Puddle
Blocks	Wrench	*Astronaut*	*Earth*	Thistle	Diaper
Queen	*Piano*	Sun	*Envelope*	**Horse**	Cactus
Umbrella	*Mushroom*	**Needle**	*Lion*	*Mouse*	*Drums*
Crown	**Rain**	Sheep	*Castle*	**Car**	*Tiger*

KEY:

BOLD = Critical Lures
NORMAL = Studied Items
ITALIC = Novel Items

Appendix 9: Participants' Recognition Task Sheet

RECOGNITION TASK

Circle your answer to each question asked by the researcher below:

1. 4 3 2 1
   YES I THINK SO I DON'T THINK SO NO

2. 4 3 2 1
   YES I THINK SO I DON'T THINK SO NO

3. 4 3 2 1
   YES I THINK SO I DON'T THINK SO NO

4. 4 3 2 1
   YES I THINK SO I DON'T THINK SO NO

5. 4 3 2 1
   YES I THINK SO I DON'T THINK SO NO

6. 4 3 2 1
   YES I THINK SO I DON'T THINK SO NO

7. 4 3 2 1
   YES I THINK SO I DON'T THINK SO NO

8. 4 3 2 1
   YES I THINK SO I DON'T THINK SO NO

9. 4 3 2 1
   YES I THINK SO I DON'T THINK SO NO

10. 4 3 2 1
    YES I THINK SO I DON'T THINK SO NO

11. 4 3 2 1
    YES I THINK SO I DON'T THINK SO NO

12. 4 3 2 1
    YES I THINK SO I DON'T THINK SO NO

13. 4 3 2 1
    YES I THINK SO I DON'T THINK SO NO

14. 4 3 2 1
    YES I THINK SO I DON'T THINK SO NO

15. 4 3 2 1
    YES I THINK SO I DON'T THINK SO NO

16. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

17. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

18. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

19. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

20. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

21. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

22. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

23. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

24. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

25. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

26. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

27. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

28. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

29. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

30. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

31. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

32. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

33. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

34. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

35. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

36. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

37. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

38. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

39. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

40. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

41. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

42. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

43. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

44. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

45. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

46. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

47. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

48. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

49. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

50. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

51. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

52. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

53. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

54. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

55. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

56. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

57. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

58. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

59. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

60. 4 3 2 1
YES I THINK SO I DON'T THINK SO NO

Appendix 10: Picture Recognition Task

Did you see….?

Dragon	*Spoon*	Cracker	Tie	Shark	*Glasses*
Santa	Cinderella	Stocking	*Slippers*	*Knife*	Jeans
Pie	Fireplace	*Jandals*	*Pillows*	*Sneakers*	*Plates*
Pyjamas	Dolphin	*High Heel*	Present	**Fire**	*Pen*
Strawberry	*Blanket*	Pooh Bear	Dress	*Owl*	Angel
Paper	Mermaid	Orange	Donald Duck	Rocket	**Mickey**
Stool	*Sock*	Chimney	Reindeer	Worm	Goofy
Rod	*Bench*	**T-Shirt**	*Napkin*	*Mascara*	Fire man
Fish	Cherries	Sweater	*Eraser*	*Crayon*	Button
Desk	**Apple**	Crab	*Table*	Pluto	

KEY:

BOLD = Critical Lures
NORMAL = Studied Items
ITALIC = Novel Items

Appendix 11: Human Ethics Committee Approval

Human Ethics Committee
Secretary
Tel: +64 3 364 2241, Fax: +64 3 364 2856, Email: human-ethics@canterbury.ac.nz

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Ref: HEC 2009/28

15 April 2009

Megan Borlase
Department of Psychology
UNIVERSITY OF CANTERBURY

Dear Megan

The Human Ethics Committee advises that your research proposal "The effects of visual and verbal presentations on recall and memory accuracy in Autism Spectrum Disorder during middle childhood" has been considered and approved.

Please note that this approval is subject to the incorporation of the amendments you have provided in your email of 8 April 2009.

Best wishes for your project.

Yours sincerely

Dr Michael Grimshaw
Chair, Human Ethics Committee

Appendix 12: Debriefing Form

College of Arts

Department of Psychology

Dear Parents/Guardians,

Thank you for allowing your child to participate in a study on visual and verbal associative memory and the accuracy of memory recall. The main aim of this study was to find out if the type of stimuli (visual or verbal) and working collaboratively had any effect on memory accuracy. Your child was presented with a study list of words or pictures which were associated with a critical word that was not presented in the study list. For example your child was presented with words like "umbrella", "sun" and "rainbow" which are all related to the critical word "rain". What we were measuring was whether your child recalled "rain" as being on the study list and how sure they were that "rain" was in the list. The recall of this word is what we call a 'false memory' or a memory of an event (the word being on the study list) that never actually occurred.

We were interested in learning three key things – 1) whether memory was more accurate in the visual or verbal conditions, 2) whether working in a group had any effect on the accuracy of children with Autism Spectrum Disorder's recall and 3) whether the children with Autism Spectrum Disorder had more or less accurate memories than the control group. There are a number of reasons for studying false memories, which are mostly to test the accuracy of memory and the susceptibility different populations have to misinformation. This is particularly important in relation to eyewitness testimony and other related areas. Also using the methods we did gives us some insight into the mechanisms used by children to remember different words, particularly the use of semantic association.

Your child's participation in the study has been greatly appreciated and thanks again for assisting in this study. If you would like to withdraw from the study, or have any concerns or queries, please contact myself on 03 521 1847 (or by emailing mab188@student.canterbury.ac.nz) or my supervisors – Dr Ewald Neumann on 03 364 2987 ext 6964 or Mr Paul Russell on 03 364 2987 ext 6170. If you choose to withdraw from the study then all information pertaining to your child's participation will be destroyed.

Sincerely,

Megan Borlase
Department of Psychology
University of Canterbury
Phone 521 1847

Dr Ewald Neumann (Supervisor)
Department of Psychology
University of Canterbury
Phone 346 2987 ext 6964

Mr Paul Russell (Co-supervisor)
Department of Psychology
University of Canterbury
Phone 364 2987 ext 6170