Cognitive Neuroscience of False Memory: The role of gist memory

Katarina Jane Bellamy

PhD Psychology
University of Edinburgh 20010

Acknowledgements

As with all Ph.Ds there are many people behind the scenes whose help proved invaluable. My thanks to both Sharon and Sergio for their advice, time and also for their support through some very difficult times. Also to Mum and Ashley who came through with ‘parent-aid’. To Eddie Dubourg for revealing the mysteries of ePrime and helping devise the program for the DRM paradigm. Special thanks go to our amnesia patient DA who returned again and again and again! And to the staff, family and patients of Fundación Integrar in Columbia, specifically Clara Lucia Avila who collected the data and answered innumerable questions; and to Professor Domingo Garcia-Villamisar and the patients, staff of the Asociación Nuevo Horizonte, Madrid. Also to Dr Jon Stone and the patients from the Memory Clinic at the Western General Hospital, Edinburgh. Finally, a BIG acknowledgement should be made to the wonderful Mario Parra-Rodriguez who acted as courier, interpreter, instructor and counsellor for myself, and the researchers in Columbia.

For Gervais Bellamy

Abstract

This thesis explores the role of gist memory and gist representation in the formation of false recognition, specifically in the Deese, Roediger and McDermott Paradigm. We found that normal individuals displayed a range of susceptibility to false recognition and true recognition and this was related to their scores on both the Autism Spectrum Quotient and the Toronto-Alexithymia Scale. More 'male-brained' participants exhibited less susceptibility to false recognition but also less veridical recognition. The reverse was true for more 'female-brained' participants. The idea of false recognition and gist memory lying along a continuum was further emphasised by work on individuals with Autism Spectrum Disorder. We found they were less susceptible to false recognition but also produced less veridical recognition. We also found differences in performance between two groups of autism individuals who also differed in age. The results of further manipulations using both picture and word paradigms suggested that gist memory could be improved in younger individuals with autism. We also examined a patient group with Functional Memory Disorder using the DRM paradigm and a confabulation task and found them less able to produce true recognition in the DRM compared with a control group. Their memory impairments could not be attributed to depression since none were clinically depressed, so we suggested that they represent the tale end of impairment to gist memory. We also explored gist memory in a patient with dense anterograde amnesia who showed reduced true recognition and a tendency to reduced false recognition, but through manipulation of the stimuli using word and pictorial material she could perform like controls due to improved item-specific discrimination. A new face recognition paradigm was also tested in which she showed a tendency towards increased false recognition in comparison with controls.

Finally, we suggest the use of the DRM paradigm as a test for memory malingering since we found participants could not replicate the performance of amnesia patients without a cost in their response latencies. This is discussed through the case study of GC a man suspected of exaggerating his memory symptoms.

Contents

Chapter Four: False recognition in Adolescents and Adults with Autism Spectrum Disorder

Chapter Five: False Recognition and Gist Memory in Patients with Functional Memory Disorder

Chapter Six: DA – A Case Study of Amnesia and False Memory Recognition

Chapter Seven: GC – A Case investigating the use of the DRM paradigm as a test for Memory Malingering

Chapter One: Introduction to False Memory Research

> *Memory is strange - part movie, part dream. You can never know if what you remember is the essential thing or something else entirely, a grace note. Of my father here's what I have: it's late at night, and from a darkened hallway I see a man in a plaid bathrobe yelling at my mother, who's standing before him in a long, pink nightgown, her hands clasped in front of her chest. I watch for a long time, but they don't see me, and though the man is yelling, the memory is soundless.*

Anne Packer, *The Dive From Clausen's Pier*, 2002, p.28.

1.1 Introduction

Hollywood film producers would like us to believe that memory is neatly packaged on videotape to be recalled accurately at a moment's notice, or by expedient prompting. But as the opening quote from *Clausen's Pier* demonstrates, memory is not so convenient or accurate. In this, the heroine of the story struggles to recall images of her father before he left when she was still a young child. The writer, Anne Packer, grasped the observation that memory often lacks detail; some images seem to be indelible, others changeable, and important sensory information, in this case sound, is missing. However, despite this, the heroine is able to comprehend that the man is shouting due to the overall gist of events. But as a child, did she recognize these signs as that of an argument, or was it only later in life when her knowledge of human behaviour incorporated adult conduct?

The questions regarding the elusive nature of recall are unanswered in the book, but the passage above demonstrates how thinking about memory and its influence on our lives does not remain the preserve of philosophers and scientists. Why do we recall certain events with such clarity, others only with prompting and some with uncertainty? Do we *remember* an event, or do we *know* that it happened? These are questions that are explored by people from all walks of life: poets, writers, artists, scientists and musicians.

In the opening chapter of *Memory Distortion*, Daniel Schacter draws attention to the classic film *Rashomon,* by director Akira Kurosawa (Schacter, 1995). The film revolves around the philosophical question, what is the truth? Set in ancient Japan it portrays the rape of a woman and the subsequent murder of her Samuraihusband from the viewpoint of four different witnesses. Each witness is convinced their version of events is the truth, but the versions are conflicting, exonerating the witness and implicating one of the other three in the crime. The viewer is left with the question which version of the event is true? Can we believe any of the testimonies, or are all the witnesses lying to exonerate themselves from the crime?

Memories are constructs, subject to individual interpretation; a conundrum observed by Elizabeth Loftus who notes that, "memory is not always the same thing as the truth" (Loftus & Ketcham*,* 1991, p.xiv*)*. She argues that, "Humans hold fiercely to the belief that our memories are preserved intact, our thoughts are essentially imperishable, and our impressions are never really forgotten" (*Ibid*, p.16). Yet, research into memory demonstrates this is simply not the case. Perhaps we hold on to this belief because our memories are so personal. They form the very foundation of our learning experiences and beliefs, our loves and our losses. Indeed, the belief that memory is accurate and unchangeable is the basis for accepting eye witness testimony in courtrooms today, something Loftus demonstrates is fraught with problems in her book *Witness for the Defense* (Loftus & Ketcham, 1991). In this, Loftus examines several miscarriages of justice that were brought about as a direct result of the misguided belief that eyewitness testimony, which by its nature is reliant on human memory, is infallible. It is perhaps not surprising in the light of such evidence, that the need to explain how and why false memories occur has become of such interest to researchers.

1.2 The Origins of False Recognition and False Memory Research

In 1932 social psychologist, Sir Frederic Charles Bartlett, wrote a book called *Remembering: A Study in Experimental and Social Psychology*. It is a collection of experimental results that explore Bartlett's fascination with human memory, and more importantly, his observations of the inaccuracy of memory. Bartlett noticed early on that memory is a dialogue between perception and recall. On presentation of a scene to later recall, the observer perceives only a minority of the details and later fills in any gaps by using their knowledge of similar situations, something he later referred to as 'schematic modes' (Bartlett, 1932, p.304). Commenting on the recall performance of his subjects, Bartlett noted, "He may do this without being in the least aware that he is either supplementing or falsifying the data of perception" (*Ibid.* p.14).

Bartlett's work was different to his predecessors in that he entered into a discourse of what is actually meant by the terms remembering, perceiving and imaging. He was also aware of the artificiality of laboratory experiments, and desired more naturalistic settings in which to observe memory performance. Bartlett held the view that memory was a reconstructive process that was continually renegotiated throughout an individual's lifetime and experiences: "Life is a continuous play of adaptation between changing responses and environment" (Bartlett, 1932, p.16).

Perhaps most importantly, Bartlett rejected the idea that the majority of memory recall was accurate, a belief that tends to persist even to this day. In a survey conducted by Elizabeth and Geoffrey Loftus, 169 individuals were asked to read two statements and say which one they thought related to their own belief about human memory (Loftus & Loftus, 1980). Of the 169 subjects, 75 had formal graduate training in psychology; the remainder came from a variety of backgrounds. In essence the statements were either, A) that memory is permanent and even 'lost' memories can be recovered by using special techniques (e.g. hypnosis) or; B) memories can be forgotten and, once lost, cannot be recovered by special techniques. The responses demonstrated the persistent belief, even amongst those with psychology training, that memory is permanent with 84% of psychologists and 69% of non-psychologists selecting statement A.

One of Bartlett's experiments involved the recall of a story called *The War of the Ghosts*, a traditional Native American folktale. Subjects read the story twice and were then later asked to recall the story after intervals of fifteen minutes up to several years. The story itself to any non-Native American is rather unusual, and Bartlett observed several interesting phenomena that occurred during the recall phase of the experiment. The first was perhaps not surprising: after a few hours' subjects recalled the story in an abbreviated form and this shortening process persisted throughout the subsequent repetitions. Subjects also changed details of the story in order to make it more salient to their own cultural framework; for example, the majority of the participants changed the title to '*Battle of the Ghosts*'. Bartlett also noticed that details that were hard to integrate into his subjects' cultural knowledge were simply omitted from the story. In other words, details that could be interpreted by an individual's active schema were more easily recalled than the items that could not. These latter schema-irrelevant items were either dropped or altered to fit the individual's rationale.

Another observation made by Bartlett on this experiment was that the word 'war' appeared four times in the original story, yet subjects often intruded words like 'battle' and 'enemy', which never appeared but were more congruent with his subjects' cultural reference and had stronger associative links. Bartlett noted that at the time of the experiment many of his subjects had had first hand experience of the First World War and so their experiences may have influenced their subsequent choice of words. Such observations led him to form his model of 'schematic modes' that describe memory encoding and decoding in terms of not only an individuals experiences, but also their cultural references. Bartlett made several conclusions regarding this experiment, the most salient to this thesis being, "It again appears that accuracy of reproduction, in a literal sense, is the rare exception and not the rule" (Bartlett, 1932, p.93). He also noted that for each individual once they had produced their final version of the story, even if it contained inaccuracies, it remained, "remarkably persistent, once the first version has been given" (*Ibid.*).

However, later attempts to replicate Bartlett's experiments by others did not produce such dramatic results or even failed to produce false memories entirely, so the experiment faded into the background (e.g. Gauld & Stephenson, 1967; Roediger, Wheeler & Rajarma, 1993). This may be because Bartlett's work focused on a naturalistic setting of false memories and use of cognitive theories to explain the results, while behavioural theory and stimulus-response research were the focus in psychology research. But subsequent attempts to replicate the work have missed the essence of Bartlett's aim: he was not trying to create false memories but rather explore why falsehoods in recall were clearly so persistent. He was trying to identify the cognitive processes that were entwined in this process. Regarding *The War of the Ghosts* experiment, Bartlett was aware that he had to set certain limitations on his methodology so as not to be overwhelmed by data. He commented, "Consequently, the results of the experiment as they are here described no doubt represent a section only of an incomplete process of transformation" (Bartlett, 1932, p.63).

Bartlett was not alone in his work on the inaccuracy of memory recall. Others, such as Alfred Binet (1900) and Stern (1910), examined the production of false memories in the light of subjects being asked misleading questions. Children were asked to view a particular event or a series of objects, and were subsequently asked questions about what they had seen. Some of these questions were designed to be misleading and therefore produce false memories. More recently the work of Elizabeth Loftus and her colleagues has provided some compelling evidence that false memories can be induced even in adults (Loftus et al., 1978; & Loftus 1991). In what is now known as the 'misinformation task', subjects were shown a sequence of events during a study phase, such as a car approaching a junction. In the next study phase of the same events they were given additional information, some of it, unbeknown to them, misleading; in this case the introduction of a 'Stop' sign on the road that was not present in the original sequence of events. Loftus and her colleagues found that during a final retrieval phase, subjects were more likely to recall the event, not as it had occurred, but in such a way that the misleading information, and hence the 'Stop' sign, was now incorporated into the memory of the original event.

An obvious conclusion of this work is that what is encoded into our memories is not always the same as what is decoded at a later date and that the processes of encoding and decoding are subject to falsehoods. Why should this occur? At the beginning of the twentieth century, the German biologist Richard Semon developed a theory of memory encoding and decoding. Although Semon is not well known today he formed a model of the memory and coined the term memory 'engram' which is widely used in describing memory processes by his later contemporaries. Semon hypothesized that there was a strong relationship between the encoding and decoding processes, which he called 'engraphy' and 'ecphory' respectively (see Semon 1904/1921; 1909/1923). He argued that at encoding, or engraphy, the brain had to use ecphory processes in order to encode new information with relevance to the individual's current circumstances and previous knowledge. Therefore, the newly formed memory engram was not a literal version of reality but rather an interpretation of events. This is not dissimilar to Bartlett's model, which also views memory recall as a reconstructive process. Indeed, the idea of memory recall being reconstructive and subject to change is now widely accepted.

Semon's theory means that false memory formation can occur quite easily at not only the encoding but also at the decoding stage. Even the consolidation of memory can be blighted by falsehoods. As we saw above, the work of Stern, Binet, and Loftus relied on misleading questions or information, and this may cause the person to focus on more relevant schema of the question in light of the current circumstances, rather than the actual recall of events as they occurred. If, as Semon and Bartlett theorized, a person uses past knowledge to interpret new events, using a leading question such as, "Can you describe the getaway car used by the bank-robbers?" implies that a car was already present at the scene, and therefore can mislead the memory into forming a description of a car, since this is relevant to our current cultural idea that bank-robbers tend to use a getaway vehicle.

However, the studies that use this type of methodology of presenting information and then subsequently asking misleading questions, or that use the misinformation task to generate false memories, lack a robust paradigm that can produce consistent, reliable results. Not everyone is lured by leading questions and misinformation; in fact most of the participants are adept at filtering out the misleading information (Loftus, 1991). Therefore, a paradigm was needed that would produce reliable results again and again and offer more in depth examinations of the underlying processes of false memory formation.

1.3 The DRM Paradigm

In 1959 James Deese ran an experiment to investigate the intrusion of previously unstudied words on selected word lists. Each subject saw 36 lists consisting of 12 words that were constructed from primary associates of a critical item. For example, the critical word *needle* produced the list: *thread, pin, eye, sewing, sharp, point, pricked, thimble, haystack, pain, hut,* and *injection*. Subjects were then given an immediate free recall. He found that, "the probability of a particular [critical] word occurring as an intrusion in immediate free recall of a list of words may be predicted from the tendency for the intruding word to occur as a response in free association to the items on the list. It is implicit that such association frequencies represented previously learned habits" (Deese, 1959, p.21). He posited the hypothesis that, "the probability of an intrusion in recall is proportional to the average association strength of that item in the context of the material being recalled" (*Ibid.*). He proposed the associative account of verbal intrusion in which words that could prime easily both forwards and backwards were more likely to be subject to subsequent false intrusions during recall. Underwood (1965) took up Deese's argument and formulated his 'implicit associative response' theory, which argued that presenting a word such as *hot* would automatically trigger the activation of the word *cold*, so that during the recall stage the word *cold* was highly likely to appear as an intrusion on the list even if it had never been presented.

Oddly, this tantalizing step into a paradigm that would produce reliable false recognition was forgotten until 1995 when Roediger and McDermott resurrected Deese's original experiment. They carried out two experiments; the first was a replication of Deese's and produced 40% false recall of the critical lures. In the second they expanded the test materials using twenty-four lists each consisting of fifteen words generated as associates from a critical lure. Roediger and McDermott examined both false recall and also whether the critical lures would be falsely recognized during a study phase, in which subjects were also asked to respond 'remember' or 'know' as to whether the words had been shown during the original study phase. In this study phase subjects were also shown non-studied words, which had no association to the previously studied word lists. In order for there to be no false recognition, subjects should reject the critical lures as often as they rejected the non-studied words. Roediger and McDermott (1995) found a high false recognition rate of 55% for the critical lures. Furthermore, subjects reported a strong confidence in remembering the critical lures as having appeared during the original lists. Roediger and McDermott argued that schematic processing was applicable to this form of false recognition since the word *needle* fitted with the overall schema of the studied items: *thread, pin eye, sewing* and so on.

1.4 False Memory or False Recognition?

False memory research has rapidly escalated in the last few years, partly as a result of the robustness of the Deese (1959), Roediger and McDermott (1995) (DRM) paradigm. However, Pezdek and Lam (2007) recently carried out an analysis of research which used the title 'false memories' and argued that the term should be used with caution, particularly when referring to studies which employ the DRM paradigm. This paradigm does not create false memories; it only elicits false recognition of previously unseen critical lures. In fact, out of the one hundred and ninety-eight articles that used the term 'false memory' in their title, Pezdek and Lam found that only twenty six (13.1%) used the term as it was originally intended; that is the creation of entirely new events or erroneous information about an event that later becomes implanted as memory in the brain. It is important to differentiate between the two in order to clarify what a research experiment is actually intending to investigate about memory and for what purposes.

In a later reply to their original paper Pezdek comments, “it is bad science to use the same term to refer to two different phenomena because it implies that the same cognitive or neuropsychological processes underlie both phenomena in a way that is theoretically meaningful. And, different cognitive processes appear to underlie the formation of memories for entirely new events and memories for changes in details of observed events” (Pezdek, 2007, p.29).

However, this assertion that the DRM paradigm and experiments designed to elicit false memories utilize different cognitive functions may not be true. For example, Eisen et al. (1999) found a positive correlation between false recognition errors in the DRM and errors in an experiment investigating the susceptibility of individuals to report on misleading information. Furthermore, Platt, Lacey, Iobst and Finkelman (1998) also found a positive correlation between false recognition errors in the DRM paradigm and errors in autobiographical memory. It should be noted, however, that Wilkinson and Hyman (1998) failed to find such a correlation when they examined false recognition errors in the DRM and autobiographical memories. This could, of course, simply be down to the different methodologies used by the various research teams to elicit false recognition and false memories. For example, Eisen et al. (1999) used the DRM for their false recognition task and then a misleading information task to elicit false memories, whereas Wilkinson and Hyman (1998) also used the DRM but then used a task designed to elicit false autobiographical memories whose methodology is not comparable to Eisen et al.'s misleading information task.

This thesis recognizes Pezdek and Lam's (2007) criticism and only applies the term 'false memories' in experiments that are specifically designed to elicit memories of previously unpresented information and reserves the term 'false recognition' when discussing the Deese, Roediger and McDermott paradigm.

1.5 Theories of false memory recognition and formation

1.5.1 Implicit Association and spreading activation theories

Roediger and McDermott (1995) touched upon Deese (1959) and Underwood's (1965) association theories, primarily Underwood's 'implicit association theory' which argues that people unconsciously generate the critical item in response to being presented with the closely associated word lists. But what is the cognitive mechanism that produces such implicit association? Roediger and McDermott (1995) also briefly touch upon Anderson's spreading activation theory (Anderson, 1983). In this Anderson proposes that units of memory processing are called cognitive units, which can be made up of several elements, for example short sentences, pairs of words or even single items (see Figure 1). So the word *cat* may trigger *dog*, which triggers *bone* which triggers *skeleton* and so on. As each new unit is formed its strength increases with practice along a spreading activation throughout the whole network. This leads to a considerable overlap in information, for at retrieval working memory gathers information from available sources, including long-term memory. This overlap is important as it may explain why subsequent recognition tests cause semantically similar items to be falsely recognized at the point of retrieval. If the network is activated strongly enough, such as by the presentation of an associated word list (e.g. dog, bone, skeleton), then presenting a critical lure (e.g. cat) at the recognition stage in the Deese, Roediger and

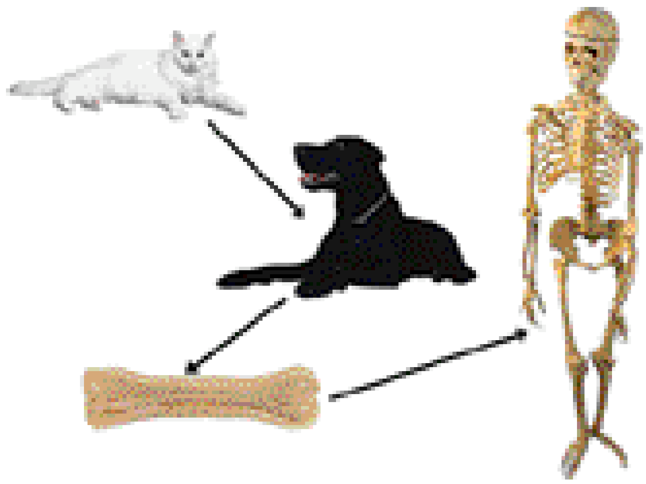


Figure 1: Example of Anderson's spreading activation theory

McDermott paradigm will prompt the network into mistaking the critical lure for one that appeared earlier.

1.5.2 Parallel-Distribution Models

McClelland's (1995) parallel distribution model works on the principle that, "memories are not stored as discrete traces but rather are superimposed on preexisting memories in a composite representation" (Schacter, 1995, p.19). In essence, the parallel distribution processing system is a huge network of interconnecting, but relatively simple, processing units. Forming a particular memory begins by activation of a series of these units, and encoding this memory relies on the strength of the activation between the various units. But since each learning event can be influenced by subsequent experiences and previous connections there is room for the formation of distortions, either by omission or addition of information (McClelland, 1995). In other words previous learning may exert an inhibitory, or in some cases excitatory, influence over the strength of the connection pathways and therefore lead to the formation of false memories.

A way of demonstrating how this 'propagation of activation' works is to use the scenario of trying to name an actor in a film. We have all had the experience of watching a film and finding ourselves unable to name a famous actor. We can often name the character in the film or describe the actor's features or what the character did, but the name remains elusive on the tip-of-our-tongues. Gradually, as the information builds up there is often enough activation of the system to finally propagate the name (usually several hours later when the conversation is long since over!).

In a similar manner false memory and false recognition occurs as the pathways are strongly excited or inhibited. In the case of excitatory connections a word such as *needle* may be activated when the word list *thread, pin eye, sewing* and so on, is presented causing *needle* to be falsely recognized during the recall stage. For false memories the situation is more complex as added information may form excitatory pathways that lead an individual to believe new, misleading information and therefore incorporate this into the memory trace. Or we may simply forget as the pathways are inhibited, therefore not forming strong enough connections between the various units, allowing new but erroneous information to be incorporated into the memory.

This model is harmonious with both Bartlett's schema-relevant theory and yet broad enough that it can also encompass the association models as well. Yet what all these models imply is that formation of such false memories remains unconscious and implicit which may not always be the case, as we shall see below.

1.5.3 Fuzzy Trace Theory

Reyna and Brainerd's (Reyna, 1995) fuzzy-trace theory (FTT) of memory hypothesizes that at encoding subjects develop both a verbatim memory trace and a 'gist' memory trace. Verbatim traces are described as the 'memory of form', that is memory of contextual details and surface features; whilst gist traces are the 'memory of meaning', that is the memories created from the overall themes or associations of the presented stimuli. Although similar to Tulving's (1981) model of episodic and semantic memory, the FTT model does not view the two processes as dichotomous, rather verbatim and gist traces are seen as opposite ends of a continuum that interact. A key concept of the FTT model is that since gist traces are the accumulation of the associations of verbatim traces, they are more robust than the verbatim memory. In essence, the FTT model predicts that for experiments that use misleading information or questions to create false memories, the false memories will remain robust because they are harmonious with the gist trace of the overall theme of the stimulus. However, the other side of the FTT hypothesis is that verbatim traces are more vulnerable to degradation since they lack the accumulation of traces found in gist memory. Hence, false recognitions are more prevalent than true recognitions, which is consistent with Bartlett's observation that accurate memory recall was, "the rare exception and not the rule" (Bartlett, 1932, p.93). The persistence of false memories in light of the fuzzy-trace theory has been further supported by the work of Brainerd, Reyna and Brandse (1995) in children, and by Payne, Elie, Blackwell and Neuschatz (1996) in adults. It may also explain why Bartlett found his subjects adhered to their inaccurate recall of *The War of the Ghosts*.

When the fuzzy-trace theory is applied to the DRM paradigm it predicts that participants will recall the studied items by utilizing both verbatim and gist traces. However, the critical lures are falsely recognized as a result of the durability of gist traces due to a strong sense of familiarity to the original word lists (Barnhardt et al. 2006). The strength of this activation can be so strong that during the study phase, that is when studying the word list *sharp, prick, point* etc., the subjects may automatically come up with the critical lure *needle* before it has even been presented. Hence, during the subsequent recognition phase, on seeing the critical lure *needle* subjects are prompted by their gist memory to falsely recognize this word as having been presented on the original study list.

Brainerd and Reyna (1998) were also among the first to develop the subject of gist representation as one of the processes that underlie false memory formation. The influence of this theory is widespread in that it incorporates many of the ideas of previous models. What exactly is 'gist' memory? We know that verbatim memory is the ability to recall specific details of an event, for example: the man was wearing a suit, there was map of Britain behind him, and he was pointing to cloud and snow symbols on the map and numbers. Gist memory is the ability to see the broader picture and make semantic and generic links between the information being presented in order to give us a general 'feel' of the event, for example: the man was giving the weather forecast on television.

The advantage of gist representation is that it can incorporate theories such as schema-relevant information and yet still be congruent with theories such as McClelland's parallel distribution model. When applied to the Deese, Roediger and McDermott paradigm we can argue that a strong gist representation of a studied word list will mean the critical lure will often be falsely recognized due to the fact that it fits the general gist of the previously studied list, or in other words it is strongly associated. A non-presented word does not fit and so can be quickly rejected.

When applied to false memory formation we can use our weatherman example to argue that congruent information, even if it is misleading, will be accepted into the gist representation. We could use a leading question such as "Where on the map was the sunshine symbol?" even if one was not present, as this is harmonious with most subjects' general gist knowledge about what we can expect to see on a weather forecast map.

1.5.4 Source Monitoring Errors

Perhaps the commonest memory error we make is that of remembering the precise where and when an event happened. Most of us have experienced the family squabble when individuals cannot agree on the specifics of a past family occasion. Each person is convinced his or her version of events, such as who was present or what day it was, is the truth. The failure to correctly attribute a memory to its original trigger is called a source monitoring error. Source monitoring theory was first proposed by Johnson, Hashtroudi and Lindsay (1993), and describes memory errors as a result of participants failing to determine accurately the source of activation associated with the stimuli.

Source monitoring errors apply to a large percentage of the memory errors we all make, but it was Clancy et al. (2002) who suggested that the DRM paradigm may also show this type of error, in that subjects simply forget the where and when of learning the critical lure and so falsely recognize it as having being studied on the original list. The same argument applies to the false recognition of non-studied words, and the incorrect rejections of any studied words.

However, one area where source monitoring theory excels is in the investigation of ‘flashbulb’ memories. For example, most people will be able to relate the story of when and where they were when they heard the news of Princess Diana’s death. Most of us can recall in vivid detail the moment we heard the news, what we were doing and whom we were with. Brown and Kulick (1977) argued that such events were ‘frozen’ into the memory, which suggested that they were not susceptible to false memory intrusion. Further research has lent credence to this idea that flashbulb memories retain a high degree of veracity (Conway et al., 1994). But are they really that accurate?

A number of researchers have challenged the hypothesis that flashbulb memories are accurate. Sadly, world events have provided ample opportunities for this phenomenon to be examined, most recently with the terrorist attack on September 11th, 2001. Talarico and Rubin (2003) questioned university students on their memories not only of the attack, but also for a recent, everyday event that preceded the attack. Subjects completed questionnaires about the events on 12th September 2001 and for their everyday event. They were then divided into three groups and called back to answer questionnaires at 1 week-, 6 week- or 32 week-intervals respectively after the event. This methodology ensured that concerns regarding forced rehearsals of the memory would not interfere with the question of veracity. Talarico and Rubin found that contrary to previous assumptions regarding the accuracy of flashbulb memories, they were just as susceptible to inaccuracies as everyday memories. What contrasted flashbulb memories from everyday memories was the *confidence* with which subjects reported them. This complimented the work of Christianson (1989) who also noted the inaccuracy of flashbulb memories but noted such confidence was also tied to the emotional weight of the events.

In a similar vein, Neisser and Harsch (1992) examined the subsequent recall of the Challenger disaster in 1986, which demonstrated the high incidence of source monitoring errors. People were asked after the event to recall the details of the disaster, and then again at periods of weeks, months and years. The details of when or where a person was at the time of the disaster often changed dramatically, also bringing into question the whole concept that ‘flashbulb’ memories were fixed and unchangeable, instead of being just as vulnerable to source monitoring errors as everyday memories.

Chapter Two: False Memory Research in Healthy and Clinical Populations.

2.1 Introduction

Traditionally, cognitive neuroscience has focused on damage to specific regions of the brain in order to hypothesise which regions were responsible for particular cognitive functions. In the case of false memory recognition and formation it is the *normal* healthy brain that provides these 'damaged' memories. As we saw in *Chapter One* accuracy of memory recall is the exception, false memories occur quite readily in healthy individuals. However, just as we can turn to damaged cognition in order to understand healthy memory processes, so too can we uncover information about the formation of false memories in healthy individuals by examining clinical and patient populations.

2.2 Healthy Populations: Children and Older Adults

All the world's a stage,
And all the men and women merely players.
They have their exits and their entrances,
And one man in his time plays many parts,
His acts being seven ages. At first the infant,
Mewling and puking in the nurse's arms.
Then the whining schoolboy with his satchel
And shining morning face, creeping like snail
Unwillingly to school…
…The sixth age shifts
Into the lean and slippered pantaloon,
With spectacles on nose and pouch on side,
His youthful hose, well saved, a world too wide
For his shrunk shank, and his big manly voice,
Turning again toward childish treble, pipes
And whistles in his sound. Last scene of all,
That ends this strange, eventful history,
Is second childishness and mere oblivion,
Sans teeth, sans eyes, sans taste, sans everything.

Extract of Jaques' Speech in *As You Like It*,
Act 2, Scene 7.
William Shakespeare

William Shakespeare regarded the process of ageing and development as a cycle that returned man to his original, child-like first age resulting in ‘oblivion’ to his degenerated circumstances. The fascination with the process of ageing and the loss of mental faculties was not lost on this English playwright and he returned to the theme frequently in both plays and poetry.

The interest in the polar extremes of the human development continuum is also a frequent source of false memory research. By examining the deficits of both polar groups we can enlarge our understanding of the development of human memory. Such research has further important implications in the legal sphere when investigating the reliability of eyewitness testimony.

Memory development is progressive, and if we take Bartlett’s (1932) schemata model it is subject to significant change as an individual builds on their social and cultural knowledge. In harmony with this, Ornstein and Haden state that, “developmental changes in prior knowledge about events that are being experienced, in the strength and organization of underlying representations in memory, and in fundamental information processing skills can all influence what can be remembered and reported” (Ornstein & Haden, 2002, p. 30).

2.2.1 Children

Children do not have the same scope of schematic or language information to draw from as adults. For example, when relating a story that was heard previously children will report it as a sequence of events as opposed to adults who are more likely to relate the overall gist, or theme of the story (Wells, 1986). One linguistic phenomenon is joke telling, which is a skill that requires the teller to manage material in order to preserve the sequence, motives and hence the punch line. It also involves understanding the concept of misleading information, and beyond the one-liner jokes produced in early childhood, from the ages of eight to twelve years of age there is often an explosion of quite sophisticated joke telling in children as their language skills develop (Bancroft, 1985). This occurs at about the same age as when a child begins to move away from the narration of a story as a sequence of events to the more adult performance of relating the theme or gist, a developmental process that will continue into adulthood (Wells, 1986), The implications that gist may not be fully developed until adulthood predicts that very young children in particular will be less susceptible to false recognition of the critical lures in the DRM paradigm. They will be unable to build the gist representation of the studied words (e.g. *nap, doze, bed, night* etc.) and so will not respond 'Yes' and produce false recognition to the critical lures (e.g. *sleep*). This failure to form gist representation also predicts that they will produce less true recall to the studied words. Consistent with this hypothesis is the work of Brainerd, Reyna and Forrest (2002) who examined the performance of three age groups (five-year olds, eleven-year olds and college undergraduates) in the DRM. For true recall of studied words adults produced more correct responses than eleven-year olds, and the eleven-year olds produced more than the five-year olds. The pattern for false recognition was similar with adults producing more false recognition than eleven-year olds, and eleven-year olds producing more than the five-year olds. However, this did not mean that children were less susceptible to false recognition overall since both age groups produced far more intrusions to the non-studied words than adults. The argument posited for this pattern of recognition is that gist in children is underdeveloped, meaning they cannot maintain the thematic gist of the studied words and so do not respond to the critical lures. However, the false recognition to the non-studied words is explained in terms of an inability to make informed diagnostic processes based on the underdeveloped gist (*Ibid.*).

The idea that gist is underdeveloped in children is supported by the earlier work of Felzen and Ansifeld (1970) who discovered that third-graders were less likely than sixth-graders to produce false recognition to critical lures that were semantically related to previously studied words. There is also evidence that the developmental processes in children influence false recognition of particular types of words. Dewhurst and Robinson (2004) found that when comparing false recognition to words that were phonologically or semantically related, five-year olds produced more false recognition to the phonological words than semantic words compared with eleven-year olds. In fact in the eleven-year olds the opposite pattern was found with more false recognition to the semantic words, again supporting the theory that gist is underdeveloped in young children since semantic relationships rely on the gist process. This finding is also in harmony with linguists' observations of story telling patterns in children who gradually revert from the recitation of the sequence of events, to the adult recitation of gist and themes that require semantic processing (Wells, 1986).

In experiments designed to elicit false memories in children and examine their suggestibility, Saywitz and Lyon (2002) note that several factors will influence a child's performance:

> 1. Children's recall is deficient. "Memory begins with understanding an event as it is being experienced…as children's basic knowledge and understanding of events being remembered changes as a result of instruction or experience, their memories may shift in the direction of the newer understanding" (Ornstein & Haden, 1996, pp. 30 – 31).
>
> 2. Young children trust adult's knowledge. This information coupled with other factors such as the motivation of the individual, can result in children being more susceptible to suggestibility when questioned by adults as opposed to their peers (e.g. Ceci, Ross & Toglia, 1987; Kwock & Winer, 1986).
>
> 3. Young children find it difficult to identify the sources of their beliefs. Several studies have shown dramatic age differences in children's source monitoring abilities. Children have underdeveloped skills in this area and so are unable to always correctly attribute information to its source, the danger being that misinformation can be easily incorporated into a child's memory (for review see Saywitz & Lyon, 2002).

This susceptibility to suggestion leads to the hypothesis that in experiments designed to elicit false memories children will be just as likely as adults to form illusory memories. Indeed, this does seem to be the case, with children also subsequently holding firm to their belief in the new, but false, memory (for review see Loftus, Feldman & Dashiell, 1995). This supports the findings that children have underdeveloped source monitoring abilities. Similarly, Ackil and Zaragoza (1998) examined age differences in a paradigm that involved participants studying a video of a series of events and subsequently answering questions. Some questions were true, that is they were about events that had actually occurred in the video, others were leading questions about events that had not occurred. They found that first-, third-, and fourth- graders were more likely to produce confabulations to leading questions than adults.

Such findings in the Deese, Roediger and McDermott (DRM) paradigms in comparison with experiments designed to elicit false memories by suggestibility could be used by supporters of Pezdek and Lam's (2007) argument that the cognitive processes underlying the two paradigms are different. However, it should be noted that in both cases it is the underdevelopment of *different* cognitive processes that produce the two conflicting results. That is, reduced false recognition in the DRM paradigm in children is a result of the underdevelopment of gist processing; whereas the increased susceptibility to false memory formation in experiments employing suggestibility and leading question paradigms is a result of the underdevelopment of source monitoring.

2.2.2 Older Adults

As humans age, there are physiological changes in the brain, specifically cerebral blood flow to the anterior regions (Gur, et al., 1987) and a loss of neural tissue (Raz et al., 1993). The prefrontal cortex of a healthy brain is involved in the encoding and retrieval of information as well as the temporal organization of memory (specifically the dorsolateral prefrontal regions), and so is vital for source monitoring processes (for review Gazzaniga, Ivry & Mangun, 2002, Ch. 12, pp. 511 – 521). However, in ageing there is a decline in memory performance for tasks that rely on the frontal regions, with episodic memory and source monitoring being among the most vulnerable to decay (for review see Grady & Craik, 2000). The physiological evidence of a decrease in the volume of the frontal lobes due to atrophy has driven the main hypothesis for those interested in false memory research to argue that as source monitoring decreases as people age, then older adults will demonstrate increased susceptibility to false recognition in the DRM paradigm *and* an increase in suggestibility and hence false memory formation in misinformation tasks and confabulation paradigms.

Examining the formation of false memories, Dodson and Krueger (2006) used an eyewitness suggestibility paradigm in which participants viewed a video of a police chase and subsequently answered questions, some of which were misleading. The two participant groups were divided between the ages of seventeen to twenty-three years of age, or sixty to seventy-nine years of age. Dodson and Krueger found that older adults were more likely to commit suggestibility errors to the misleading questions than the younger adults, especially if they were confident of their response. The younger adults only showed an increase in susceptibility errors to misleading question when they were uncertain of the correctness of their response.

Daniel Schacter and his colleagues have also found a similar pattern of increased susceptibility to false memory recognition in older adults in the Deese, Roediger and McDermott paradigm (DRM). Kensinger and Schacter (1999) investigated age differences by examining whether older and younger adults could suppress false recognition of the critical lures if they were given multiple study-trial phases. After one trial of a standard DRM paradigm, older adults produced significantly more false recognition to the critical lures. They decided to examine whether repeated study phases and trials would help the older adults suppress false recognition. They found that after five study-trial phases both young and older adults' veridical recognition to the studied words increased, as did their correct rejection of the non-studied words. However, only the younger adults showed a significant decrease in their false recognition to the critical lures, and this was confirmed by examining the corrected false recognition rates, (that is subtracting the false alarm responses to the non-studied words from the false alarms to the critical lures) with only young adults showing the decreases in false recognition across the trials. They then used signal detection theory to examine whether these results were due to changes in sensitivity to the stimuli or response bias (for example, older adults might be more bias to making 'old' responses). Kensinger and Schacter (1999) note that because of the different assumptions underlying signal detection analysis and corrected recognition analysis (see Snodgrass & Corwin, 1988), signal detection analysis does not provide additional information to the corrected recognition analysis but rather provides a different perspective on the results. Age differences were only found in the signal detection data for gist memory; specifically older adults were unable to reduce the influence of gist memory. Kensinger and Schacter (1999) applied the Fuzzy-Trace Theory (FTT) to these age related findings in the DRM paradigm, suggesting that older adults relied more on gist trace processing than younger adults in order to compensate for age-related decrements in verbatim traces.

Schacter and his colleagues have also used the DRM paradigm to look at false recognition of pictorial stimuli as opposed to words. In a paradigm that used categorically related pictures (e.g., boats, cats, shoes and teddy bears), Koutstaal and Schacter (1997) found that younger and older adults had comparable results for true recognition of studied items. However, older adults produced higher false recognition to both the critical lures and non-studied items compared with younger adults, a finding that was important since Koutstaal and Schacter (1997) argued that pictures should reduce source monitoring errors and hence suppress false recognition. However, if source monitoring processes are vulnerable in older adults due to the physiological changes in the frontal lobe, then their decision as to whether an item is new or old will rely on general conceptual or gist information. This finding was also supported by the signal detection data, which showed that for gist-specific memory older adults showed heightened sensitivity to gist. On a final note, Koutstaal and Schacter (1997) note that older adults may also fail to encode the 'distinctive' properties of pictorial stimuli.

Subsequently, Schacter, Israel and Racine (1998) carried out an experiment to examine what Schacter describes as the 'distinctiveness heuristic' theory: "a mode of responding based on participants' metamemorial awareness that true recognition of studied items should include recollection of distinctive details" (*Ibid,* p.3). In turn, this awareness of the distinct features of pictures should suppress false recognition to the critical lures, since although similar a participant will remember not seeing them previously. Following Koutstaal and Schacter's (1997) findings, Schacter, Israel and Racine (1999) argued that older adults were unable to use the *distinctiveness heuristic* in order to suppress their false recognition to critical lures in a pictorial DRM paradigm. They hypothesized that if they could manipulate the experimental conditions in order to remove the younger participants' reliance on the distinctive features of the picture stimuli, then false recognition suppression would be eliminated in both older *and* younger adults. They produced a within subject design in which all participants saw a pictorial version of the lists and a word version. Schacter et al. (1999) argued that the word version would suppress the distinctiveness of the pictorial stimuli as participants would rely on list-specific information rather than distinctive information during the recognition phase. Their results supported the hypothesis and false recognition to the critical lures was increased in both age groups. Additionally, older adults maintained increased false recognition and decreased true recognition in comparison to the younger age group.

Earlier, Bartlett, Strater and Fulton (1991) examined age differences in face recognition by using a paradigm in which participants had to study two lists of faces with a one-week interval between the two study phases. They then underwent a recognition phase in which they saw 24 faces from week one, 24 faces from week two and 24 new faces that had not been studied. They had to make 'last week', 'today' or 'new' judgements for each face. Older adults produced more false recognition to the new faces compared with younger adults. Furthermore, in a second experiment participants had to study 48 non-famous faces. One-week later in a recognition phase they saw these faces again along with 48 famous faces. Participants were asked to rate each face they saw as 'definitely famous', 'possibly famous' or 'non-famous'. They were also reminded that a face studied the previous week was to be judged as non-famous. Older adults produced more false fame judgments to the non-famous faces than the younger adults. Taking into account the results of both experiments, Bartlett et al. (1991) argued that older adults relied more on familiarity judgments in recognition than their younger counterparts. However, in light of Schacter, Israel and Racine's (1998) findings we could also argue that Bartlett et al.'s (1991) work could be attributed to a failure in older adults to use the *distinctiveness heuristic* of facial recognition in order to suppress both false recognition and false fame judgments.

2.3 Amnesia

What happens to false memory formation in those individuals who have damage to the areas of the brain commonly thought to be responsible for memory formation, such as the medial temporal lobes (MTL) and related diencepahlic structures, or the frontal lobes? There is little research involving examining amnesia patients' formation of false memories using suggestibility type paradigms, but researchers have relied on the Deese, Roediger and McDermott paradigm in order to explore false recall and recognition in amnesia patients.

2.3.1 Medial temporal lobe amnesia & Korsakoff's Syndrome

The medial temporal lobe (MTL) consists of the hippocampus, subiculum, dentate gyrus and surrounding neocortical regions. It is well established that damage to the MTL region, for example as a result of encephalitis or lesions due to epilepsy, can result in amnesia. The case study of a patient known as HM, who had a procedure to remove his temporal lobe bilaterally in order to ease his epilepsy in the 1950s, revealed how important these regions are to memory. Subsequent to the operation, HM demonstrated impaired memory in that he could no longer learn new information (anterograde amnesia); he had difficulty with his autobiographical memory and retaining new semantic information (review Gazzaniga, Ivry & Mangun, 2002, Ch. 8, pp. 301 – 302).

Korsakoff's Syndrome is a memory impairment caused by thiamine deficiency in the brain that is the result of nutritional depletion and alcohol is one cause (and by far the most common) of this. It often presents after an episode of Wernicke's encephalopathy but can also have a more insidious onset (for review see Kopelman, Thomson, Guerrini & Marshall, 2009). The symptoms include anterograde and retrograde amnesia, and in some cases confabulation of memories. Episodic memory is severely damaged in Korsakoff's syndrome while implicit memory remains intact. The neuropathology of Korsakoff's syndrome implicates damage to the thalamic and mamillary bodies, general cortical atrophy, loss of neurones from the superior frontal cortex and a decrease in cerebral blood flow to the frontal and parietal regions (Kopelman, et al., 2009, Harper & Kril, 1987). This suggests that patients with Korsakoff's may differ in their memory performance from other amnesia patients who have aetiologies involving the MTL region, as we shall see below.

Daniel Schacter and his colleagues have led the research into false recall and recognition in amnesia populations. Schacter, Verfaellie and Pradere (1996) took twelve amnesia patients with mixed aetiologies and exposed them to the Deese, Roediger and McDermott paradigm (DRM). Six patients had Korsakoff's syndrome, 5 had medial temporal lobe damage and 1 had thalamic damage. The amnesia patients produced fewer correct hits to previously studied words, and had more false alarms to the non-studied words compared to the controls. However, they also made fewer false alarms to the critical lures than the controls; in other words, amnesia patients showed an apparent reduced false recognition.

This reduced false recognition was a result of Schacter and colleagues' analysis methods which used corrected false recognition rates. On first observation, the false recognition rates for the amnesia patients were comparable to the control groups. However, when taking into account the amnesia groups response bias to say 'yes' even to non-studied words, the corrected false recognition rates (i.e. the false alarm rate to critical lures, minus the false alarm rate to non-studied words) were considerably reduced in comparison to controls. Schacter, Verfaellie and Koutstaal (2002) defend this analysis method by arguing, "Because such a tendency could inflate estimates of false recognition to related theme words, it is important to use corrected false-recognition measures (or signal detection analyses) that take into account such a response bias" (Schacter, et al., 2002, p.117).

To account for this pattern of reduced false recognition, Schacter et al. (2002) argued that the results showed a deficit in amnesia patients in both conceptual and perceptual gist representation. In healthy individuals strong links are formed between the items on each of the word lists creating, and maintaining, a good gist representation. During the recognition phase controls can easily identify previously studied words, but this strong gist representation means they are more susceptible to identifying the critical lures words as having been on the original list, given that it fits with the overall gist of a previously studied list. However, a non-studied word does not fit with the gist of the studied word lists, and so the control can easily reject this. In contrast, Schacter et al. (*Ibid.*) argued the impaired gist representation of the amnesia group does not allow them to form these strong links whilst studying the word lists so they find it harder to identify the studied words. Since they lack this robust gist formation they are not as susceptible to accepting the critical lures as readily as the control group. Furthermore, this damaged gist representation leaves them unable to distinguish the non-studied words from previously studied words so producing a bias response to say ‘old’ to these items.

With this in mind Schacter, Verfaellie & Pradere (1996) hypothesized that it should be possible to manipulate levels of false recognition in both control and amnesia groups by manipulating the conditions so they are more or less conducive to eliciting false recognition. Schacter, Verfaellie, Anes and Racine, (1998) tested this theory by using repeated study and testing of the word lists prior to the recognition phase in the DRM paradigm. Furthermore, they examined the performance differences between Korsakoff’s patients and patients with amnesia (the latter had MTL damage as a result of either anoxia or encephalitis). They argued that Korsakoff’s patients, due to the damage to the frontal lobes, should show a greater impairment to source monitoring processes than the amnesia patients. They also hypothesized that repeated study of the word lists would enable the normal control groups to increase their veridical and explicit memory and therefore decrease their false recognition to the critical lures. In contrast the amnesia patients would not be able to increase their veridical recollection as a result of their poor item-specific memory, but would show an increase in false recognition as a result of their inability to suppress gist based themes as the increasing trials improved their gist representation. Their findings supported the first hypothesis in that controls were able to use the repeated study phases to increase veridical recall and hence reduce false recognition. However, according to Schacter et al. (1998) the increased false recognition in the patient group was only found in the Korsakoff’s patients; the other amnesia patients showed a flat or fluctuating pattern across the trials. Schacter et al. (1998) argued that the frontal lobe damage in Korsakoff patients may contribute to their inability to suppress their increasing sensitivity to gist traces as the number of study trials increases; this is similar to the over-reliance on gist traces seen in ageing populations. In contrast, the other amnesia patients showed no sign of this increase in gist sensitivity and so they had a flat, fluctuating pattern across an increase of trials. It is difficult to draw any firm conclusions from this work given the small and divided patient population. However, of note from this work is the finding that the amnesia patients without Korsakoff's syndrome did not seem able to improve either their gist or veridical memory cues across trials.

To further support the gist theory for false recognition, Schacter had to rule out other theories such as Underwood's 'implicit associative response'. As we saw in *Chapter One* this model argues that a subject will implicitly generate the word 'hot' when shown the word 'cold' thereby causing the word 'hot' to be falsely recognized a later stage. The only way to exclude this theory is to use items that a subject cannot implicitly create. In order to explore this, Koutstaal, Schacter, Verfaellie, Brenner and Jackson (1999) developed a Deese, Roediger and McDermott-type paradigm that used novel, computer-generated, abstract patterns. Each pattern was a complex shape formed from a prototype, the prototype subsequently acted as the critical lure. Once again, Koutstaal et al. (1999) found reduced false recognition amongst the amnesia patient group compared with the control group (the amnesia group were of mixed aetiologies; anoxia, encephalitis, thalamic infarct and Korsakoff's syndrome). The findings supported the argument that reduced false recognition in the patient group could be attributed to degraded gist representation rather than to poor memory and failure to implicitly respond with the prototype shape, since this had never been seen before and it was highly unlikely that either patients or controls could generate this item during the study phase.

However, this paradigm only examined perceptual memory processes. In order to examine whether semantic and conceptual gist processes are implicated in false recognition, Koutstaal, Verfaellie and Schacter (2001) used the categorized picture DRM paradigm using the same stimuli as Koutstaal and Schacter (1997). The authors argued that any false recognition to the critical lures would be a result of gist representation, either semantic or conceptual but not as a result of implicit response.

Once again, Koutstaal et al. (2001) found impaired false recognition among the amnesia patient groups in comparison with the controls. Later, Schacter et al. (2002) concluded the results from these experiments, "further confirm that amnesic patients show reduced false recognition under conditions where memory for gist, rather than source confusions regarding individual items, is the primary determinant of illusory memory" as well as strengthening the claim that gist representation in normal individuals is one of the main drives of false recognition in the DRM paradigm (Schacter et al., 2002, p.122). Furthermore, they draw out a key point regarding this work that, "under conditions that favor the development of strong gist representations, and that work against using explicit recollection to suppress such representations, amnesic patients show reduced false recognition compared to healthy controls" (*Ibid*., p.123).

Taking this one step further, Verfaellie, Schacter and Cook (2002) used Brainerd and Reyna's (1998) 'meaning recognition' paradigm whereby participants are asked not to make 'old-new' decisions on words but rather to say if the words appearing during the recognition phase are related in meaning to any of the words in the study phase. Participants endorse far more theme words in the meaning condition in comparison with the 'old-new' condition. According to their theory, the meaning condition relies entirely on gist memory for responses. By using this paradigm Verfaellie et al. (2002) could distinguish between the two alternative theories of gist memory in amnesia in order to explain their lower rates of false recognition: either gist memory itself is impaired or access to gist is impaired. If the former hypothesis was correct, and gist memory itself is damaged then the reduction in false recognition for amnesia patients (in comparison with controls) should be as pronounced in the meaning condition as it is in the standard condition. Conversely, if amnesia patients can still encode and store gist memory but are unable to access this during retrieval, then the lower rates of false recognition, compared with controls, in the meaning condition should be reduced, if not eliminated.

Verfaellie et al. (2002) took sixteen amnesia patients of mixed aetiologies (Korsakoff's syndrome, encephalitis, anoxia, bithalamic stroke) and seventeen control participants and tested them on a paradigm that consisted of 32 lists of 16 words. Each list was composed of 15 words with one critical lure, similar to the DRM paradigm. In contrast to the DRM, during the recognition phase for the meaning condition participants are asked to respond 'old' if they recognized an item as being related to *any* of the studied word lists and 'new' if they did not think the word was related to any of the themes presented in the study lists. The standard condition just asked for an 'old-new' response as to whether the word had appeared on the original lists, similar to the DRM paradigm.

Verfaellie et al. (2002) found the amnesia patients endorsed fewer critical lures in the meaning condition than controls thereby exhibiting impaired false recognition. This failure to eliminate the reduction in false recognition in amnesia patients in comparison with controls supported their first hypothesis. The authors concluded that in patients with amnesia there is an inability to encode, store, or maintain a strong gist representation.

The conclusion regarding damaged gist memory in amnesia patients is not without its criticisms; however the converging evidence suggests that this pattern of reduced false recognition in amnesia patients is repeatable across trials. Gallo (2006, p. 207) offers an alternative, arguing that interpreting these results using gist representation is at odds with the associative activation account. This would suggest that impaired priming of the critical lures during the study phase could indicate that it is reduced associative activation that is at fault in amnesia patients.

2.3.2 Frontal Lobe Damage

As discussed earlier, the frontal regions of the brain are important for memory processes such as episodic memory and source monitoring. Investigating patients with damage to these regions provides added understanding regarding these cognitive processes since frontal lobe damage patients should be more susceptible to false recognition and recall.

To investigate this, Melo, Winocur and Moscovitch (1999) used a patient group with mixed aetiologies with medial temporal lobe damage (MTL), medial temporal lobe *and* frontal lobe damage, or with frontal lobe damage (the patient demographics are shown in Figure 2). The group with only frontal lobe damage had no amnesia. The results for the recognition trial showed that patients with MTL *and* frontal lobe damage had a pattern of true and false recognition consistent with that seen in the above studies

Patient	Sex	Age	Edu[a]	Hand	Aetiology	Lesion Location
MTL/D Amnesics						
DA	M	45	17	RH	Herpes encephalitis	Bilateral medial temporal lobe
CC	M	60	20+	RH	Astrocytoma/hydrocephalus	3rd ventricle; diencephalon
PT	F	52	14	RH	Right temporal lobe artery malformation	Right temporal lobe
JF	F	53	16	RH	Seizures, specific aetiology unknown	Bilateral medial temporal lobe
Mean		53	16.7			
FL Amnesics						
KC	M	45	15	RH	Traumatic brain injury	Bilateral medial temporal lobe, right frontoparietal, right occipital
FE	F	60	15	LH	ACommA aneurysm clipped	Left orbitofrontal and dorsolateral frontal
RC	M	61	10	RH	Cerebral vascular accident	Bilateral orbitofrontal including ventromedial frontal
GE	M	59	10	RH	Occlusion of intracerebral artery	Bilateral frontal including ventromedial and anterior regions
Mean		56	12.5			
FL Nonamnesics						
CB	F	29	12	RH	Epilepsy/resection frontal corticectomy	Right dorsolateral frontal
DW	M	59	13	RH	Cystic meningioma—dural base	Right frontal convexity at level of lateral sphenoid ridge
PK	F	35	16	LH	Traumatic brain injury	Right frontal
ED	F	65	7	RH	ACommA aneurysm clipped	Right frontal from A1 to A2, large left-frontobasal lesions
DS	M	60	16	RH	ACommA aneurysm clipped	Right inferior medial frontal
SP	M	35	16	RH	Brain tumour	Right frontal
Mean		47	13.3			

[a] Years of education.

Figure 2: Patient demographics from Melo, Winocur & Moscovitch (1999)

in amnesia patients with MTL damage. That is, they had reduced false recognition compared with controls and produced more false recognition to the non-studied words. However, the frontal lobe patients without amnesia showed considerably higher false recognition to the critical lures compared with either controls or the MTL and frontal lobe population. Melo et al. (1999) argued the results demonstrated that the impairment in monitoring processes in the frontal lobe patients made them more vulnerable to false recognition.

Budson et al. (2005) also explored false recognition in frontal lobe patients this time using Schacter's *distinctiveness heuristic* model (Schacter et al., 1997). Budson et al. (2005) wanted to see if patients with frontal lobe damage could use the distinctive features of a picture in order to reduce their false recognition (patient demographics for frontal lesions can be found in *Appendix H*). However, the results showed that the frontal lobe patients could not reduce their false recognition in the picture paradigm indicating they could not use the *distinctiveness heuristic*. The authors therefore suggest that the distinctiveness heuristic is a metacognitive strategy that is reliant upon the frontal lobes, and so accessible in healthy controls.

In a case study of patient BG who had right frontal lobe damage, Curran, Schacter, Norma and Galluccio (1997) explored his performance over a variety of false recognition tasks and stimuli (including words and pseudowords, words and T-junction counting, pseudowords and pronunciation ratings, words and liking ratings). All participants had to explain the basis of their remember judgement for each word. There was no difference in false or veridical recognition across all conditions for the controls. They found that only in the 'word and liking' condition, which required semantic encoding, could BG suppress his false recognition and perform as well as a control. In other conditions BG produced considerably higher false alarms compared with controls. The authors reasoned that the semantic encoding condition was 'more conducive to specific recollection, and many studied items triggered relatively specific recollections of the encoding episode' (Curran et al., p.1045, 1997). BG could utilise specific information about the items, thereby reducing his false response bias that was based on general familiarity features in previous conditions. This over-reliance on general features to produce high rates of false alarms is similar to the pattern of false recognition we saw in older populations in the DRM paradigm. However, in those cases, high false alarms to the critical lures were attributed to the over-reliance on gist-based features in ageing populations due to an inability to access verbatim traces (e.g. Kensinger & Schacter, 1999).

The implication that increased false recognition in frontal lobe damage may be due to over-reliance on gist traces is not mentioned in the above research. Instead the higher rates of false recognition found in frontal lobe patients, compared with controls, is usually attributed to impairments in monitoring processes, yet either theory seems equally valid and Schacter and his colleagues do attribute this in later work (e.g. Kensinger & Schacter, 1999).

2.4 Alzheimer's Disease

Patients with Alzheimer's Disease are interesting due to their marked deficits in episodic memory. We have already seen above in research on older adults and patients with frontal lobe damage, that deficits in episodic memory lead to interesting patterns of false recognition in the DRM paradigm, specifically an increased susceptibility to false recognition of critical lures.

David Balota and Andrew Budson have led the research in false memory formation in dementia populations. Balota et al. (1999) explored false recall and recognition in five populations: young adults (aged 17 to 33 years); healthy older adults (aged 60 to 79 years); healthy 'old-old' adults (aged 80 to 96 years); older adults with very mild dementia (aged 66 to 91 years); and finally older adults with mild dementia (aged 56 to 90 years). Both dementia groups had a mild form of Alzheimer's Disease. Using corrected true recognition (studied word hits minus non-studied word false alarms) and corrected false recognition (critical lures minus non-studied word false alarms) analysis, they found that as false recognition increased as a function of age, true recognition decreased. In contrast Alzheimer-type patients showed a decrease in both corrected true and false recognition.

In a similar manner to Kensigner and Schacter (1999), Budson et al. (2000) explored false recognition in Alzheimer patients after single and multiple exposure(s) to the word lists in the study phase in order to see if multiple exposure could enhance item-specific memory and thereby reduce false recognition to the critical lures. After a single exposure to the word lists (that is the participants studied six word lists of fifteen words once before the recognition phase), patients with Alzheimer's disease showed a reduction in corrected false recognition. Budson et al. (2000) argued that Alzhemier patients have not only degraded source monitoring processes but also problems with their gist specific memory so that it is difficult for them to filter out the non-studied words but at the same time means they do not have the same gist memory for the studied words and hence also produce reduced true recognition.

When patients and controls were given multiple exposure to the studied word lists before the recognition phase, controls were able to suppress their false recognition to the critical lures. However, compared with the younger adults, patients with Alzheimer's Disease actually *increased* their false recognition to the critical, non-studied words. Budson et al. (2000) argued that by giving Alzheimer patients multiple trials allows them to build up their gist memory for the studied words, thereby increasing their false recognition as their episodic memory and source monitoring processes are still vulnerable. In contrast the multiple exposures allowed controls to build on their item-specific memory and so reduce false recognition to the critical lures. All groups showed an increase in corrected true recognition to the studied words after multiple study trials.

To investigate if reduced false recognition in Alzheimer patients is due to problems with processing information in semantic memory, Budson, Desikan, Daffner and Schacter (2001) used a DRM paradigm that used categories of novel, computer-generated abstract shapes. They argued that in this paradigm, due to the nature of the stimuli, participants would not be able to use any previously acquired semantic information. Using corrected true and false recognition rates, Budson et al. (2001) found Alzheimer patients produced reduced false recognition and true recognition compared with controls. They argued the pattern of findings in Alzheimer patients in DRM-type paradigms cannot be solely attributed to just deficits in long-term semantic memory, but instead highlight poorly developed and maintained gist information since gist encompasses both semantic information and perceptual information.

Watson et al. (2001) used a paradigm to explore false recognition in phonological, semantically related and hybrid word lists in controls and people with Alzheimer's disease. For the semantically related word lists, they found controls produced more true recognition than patients. However, both groups showed comparable false recognition to the critical lures. However it should be noted they did not use the corrected false recognition analysis used by Budson et al. (2000) and so did not take into account the high false recognition rates to the non-studied words produced by the patient group. This highlights a problem in any research that different analytical methods can produce what appear to be on the surface, conflicting results between research groups. Furthermore, when using patient groups there is the added complication that within a group, patients will be in varying stages of the disease.

2.5 Autism and Asperger's Syndrome

Autism and Asperger's are defined as developmental disorders resulting in abnormal communication skills, impairment in social interaction, and repetitive behaviours. Asperger's is often described as 'high-functioning' autism in that individuals often present with normal language and intellectual capabilities (for review see Fay, 1988). There is also evidence that individuals with autism spectrum disorders have some difficulties with episodic memories. For example, when using Tulvings (1981) remember-know paradigm adults with Asperger's syndrome produce less 'remember' responses and more 'know' responses than matched controls suggesting they lack the recollective experiences and rely more on the familiarity of the 'know' response (Gardiner, Bowler & Grice, 2003).

There is a paucity of research surrounding investigating false memories and false recognition in the Autism and Asperger populations. This seems surprising given that their developmental deficits should provide interesting insight into how their memories function, in particular within adult autism populations since the majority of research has focused on children's populations (Bowler et al., 2000). At the time of writing there have only been two studies investigating false recall and recognition in the Deese, Roediger and McDermott paradigm and these have produced conflicting results. The first by Beversdorf and colleagues (2000) investigated a population of eight individuals with Autism Spectrum Disorders (ASD) and sixteen age-matched adults. They found that the ASD group had better true recognition to the studied items than the control group, but they *also* produced less false recognition to the critical, non-studied words than the control group. However, the ASD group produced more false responses to the non-studied, unrelated words than the controls. The finding of greater true recognition was attributed to the high memory capacities often found in ASD populations. The reduced false recognition to critical words was attributed to a restriction in the semantic-associative networks, an idea not dissimilar to the underdeveloped gist representation model we saw in children which would also explain the higher false recognition to the non-studied, unrelated words.

The second study by Bowler et al. (2000), involved ten participants with Asperger's syndrome. They found no differences in false recognition between the

Asperger's individuals or controls. However, in experiment two in which they monitored *remember* versus *know* responses in the recognition phase, individuals with Asperger's made more *know* judgments to true recognition of the studied words.

The obvious difference here is the patient populations for the two research studies (Asperger's and Autism individuals), which one could argue suggest not conflicting results, but rather different findings for different patient groups. This will be discussed further in *Chapter Four*.

2.6 Depression and Anxiety

There is a wide acceptance amongst researchers that cognition and emotion are interrelated (for overview see Mineka & Nugent, 1995). Beck's (1967; 1976) model of depression and anxiety is useful within the context of this thesis as it employs Bartlett's (1932) schema model. Mineka and Nugent (1995) provide a succinct definition of schemata describing them as "organized representations of prior knowledge which guide the current process of information". Beck describes individuals with depression and anxiety as being in a state of over-stimulation of specific schemata relevant to their disorder. Hence, for people with depression this would mean replaying negative schemata so that there is a bias for focusing on, and therefore remembering, more negatively charged information. In the case of anxiety, there is a focus on the danger schemata meaning individuals will focus on and retain more information relevant to threatening stimuli (Beck, 1967).

Within the field of false memory research there have been surprisingly few studies investigating the phenomena amongst people with depressive and anxiety disorders. Instead, there has been a tendency to explore memories in relation to the mood of the event or stimulus. For example, Dewhurst and Parry (2000) found that negative stimuli tended to be recalled in greater vividness and detail than neutral or positive stimuli. Furthermore, Bless and Schwarz (1999) found that positive stimuli were frequently recalled only with feelings of familiarity and a general gist of the information. Yet few studies have attempted to explore the relationship between individuals with depression and susceptibility to false memories.

The DRM paradigm provides a reliable platform to examine depression, anxiety and false recognition. For example, Zoellner et al. (2000) investigated individuals with post-traumatic stress disorder (PTSD), traumatized individuals without PTSD and controls who were rated according to the Beck Depression Inventory (Beck et al., 1996) and the State-Trait Anxiety Inventory (Spielberger et al.,1970). They found that both traumatised groups, with or without PTSD, produced more false recall to the critical, non-studied words than the control group. This was only related to the State-Trait Anxiety measures, no relationship was found for the Beck Depression Inventory (BDI). However, it should be noted that the group with post-traumatic stress disorder were all on medication to address their depression (selective serotonin uptake inhibitors and/or benzodiazepines), and this may have influenced why no relationship was found between false recall and the results for the BDI since benzodiazepines can cause short-term memory loss (e.g. Desai et al., 1983).

Clancy et al. (2002) found a positive correlation between false recall and recognition to critical, non-studied words and depression as measured on the Beck Depression Inventory (BDI). However, this study examined individuals who either believed aliens had abducted them, or who reported 'recovered' memories of an alien abduction and so the results are discussed, perhaps unsurprisingly, in terms of an individual's susceptibility to hypnotic suggestibility and schizotypic features. It should be noted that in an earlier study Clancy et al. (2000) failed to find such a relationship between BDI scores and false recognition in women who reported sexual abuse in childhood, although the group who reported recalling 'repressed' memories did show a greater susceptibility to false recognition of the critical, non-studied words.

In a similar study investigating women reporting childhood sexual abuse, Bremner et al. (2000) found that women who had been abused and suffered from post-traumatic stress disorder (PTSD) were more likely to falsely recognize the critical, non-studied words than either women who had been abused but had no symptoms of PTSD, and controls. However, no correlations were found between false recognition and other clinical psychological measures.

Moritz, Gläscher and Brassen (2005) found that patients with depression, as measured by the Hamilton Depression Rating Scale, recalled fewer studied words than controls. However, within this finding they discovered that people with depression did recall more emotionally charged words, but fewer neutral words, compared to the controls. In addition, although overall false recognition rates did not differ between the groups, individuals with depression did falsely recognize more emotionally charged critical, non-studied words more than controls. This supports previous research showing individuals with depression demonstrate a response bias to negatively charged stimuli (e.g. Bower, 1981; Segal et al., 1995). It should be noted that Moritz et al. (2005) departed from the DRM paradigm in that they only used four lists of twelve words. The original paradigm employed 24 lists of 15 words. This departure would have a significant effect on the number of data points for the analysis.

Peiffer and Trull (2000) also employed the DRM paradigm in order to look at individual differences that might predict suggestibility and false recall production in women. They found that women who were more suggestible, as rated by the Gudjonsson Suggestibility Scale, and acquiescent were more susceptible to false recall. This would support the findings of Clancy et al. (2000; 2002).

However, Gallo (2006, pp. 165 – 166) advocates caution when interpreting the results from such studies since they use subjects from special populations (i.e. childhood abuse or alien abduction). There may also be other factors, such as medication or experimental procedure that could affect results. For example, Watts, Morris and MacLeod (1987) found that patients with depression, measured by the Levine-Pilowsky Depression Questionnaire, produced more false recognition to the critical, non-studied words compared to controls but *only* in the condition where participants had to vocalize words on presentation. In the silent condition there no difference between the two groups for false recognition.

Despite the criticisms the research does show the usefulness of the Deese, Roediger and McDermott paradigm for investigating individual differences in false recall and recognition. In a later chapter of this thesis Gallo’s (2006) comments are taken into consideration when examining depression and anxiety traits in a group of clinical patients and controls.

2.7 Imaging studies and false memories

Researchers have often employed a variety of brain imaging techniques to determine if someone is telling the truth or lying, since identifying conditions such as spontaneous confabulation can often reveal underlying medical conditions such as Korsakoff's Syndrome (for review see Hirstein, 2005). However, in the case of determining whether a healthy individual is producing false memories or not, the picture becomes somewhat more confusing since we do not go out of our way to lie to ourselves. As we have seen, false memories are incorporated into our schemata as easily as true memories; they're not intentional lies. Nevertheless, this has not stopped intrepid researchers exploring possible means to determine the difference in brain activity between false and true memories.

Gonsalves and Paller (2000) produced an experiment investigating event-related brain potentials (ERPs) that implicated, perhaps unsurprisingly, visual imagery in the process of forming false memories. During a study phase participants' ERP responses were monitored as they looked at a series of words. Participants were instructed to visualize a picture of each word. For half the words, a picture was subsequently presented, and for the other half they were not and were shown a blank slide instead (see Figure 3).

During the recognition phase, participants heard a word being read out with 2.5-second intervals allowing them to respond. For each word they had to say 'Yes' if they thought it had been studied along with its picture, and 'No' if they thought it had not. Non-studied words were also included in the recognition phase to act as control items.

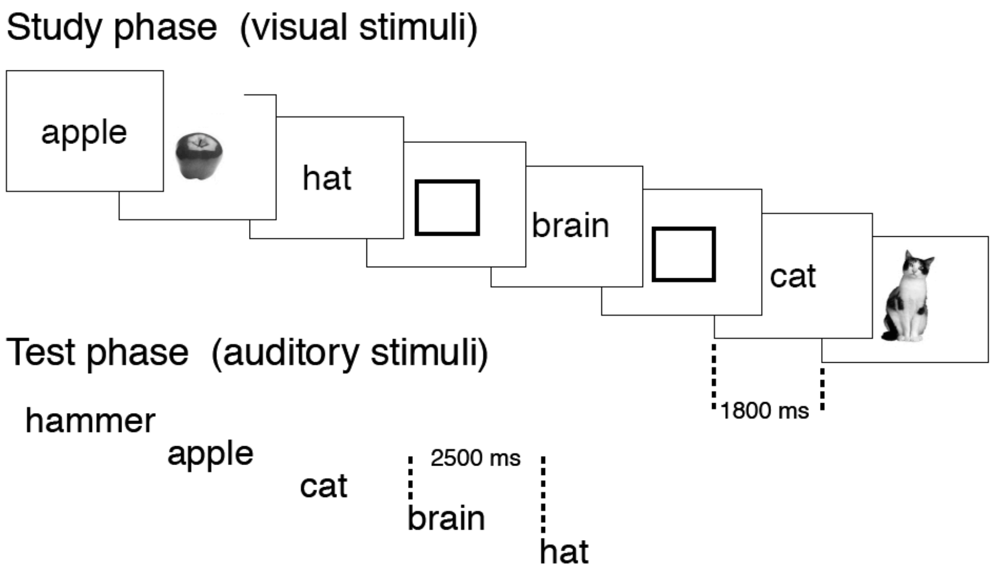


Figure 3: From Gonsalves & Paller 2000

Gonsalves and Paller (2000) found that participants produced around 30% false memories. That is they incorrectly said 'Yes' to words as having being presented with pictures when in fact they had been presented with a blank slide. When examining the event-related potential (ERP) data for the study phase, Gonsalves and Paller discovered that posterior ERPs were more positive for a studied word if it was subsequently falsely recalled as having been presented with a picture. For the recognition phase, ERPs were more positive for true than false memories. In both cases Gonsalves and Paller suggest that the posterior ERP responses correlated with activity in the occipital lobe region of the brain.

Cabeza et al. (2001) used a DRM paradigm to examine false recognition using functional Magnetic Resonance Imaging (fMRI). Their results implicated the medial temporal lobe region of the brain, in particular the parahippocampal gyrus, which showed more activity for 'True' than 'False' words. The parahippocampal gyrus is thought to be important for sensory information processing (see Bear et al., 2001, Ch.23, p.756). Cabeza et al. (2001) argued that this response for 'True' items indicates the recovery of perceptual information, something not available for the 'False' items. They also found dissociation in the prefrontal cortex region (PFC); the bilateral dorsolateral PFC was more activated for the True and False words than for

New items, that is the non-studied unrelated words, which they suggests reflects monitoring processes for the retrieved information. In contrast, the left ventrolateral PFC showed more activation for ‘New’ items as opposed to the ‘True’ or ‘False’ items, which they suggest is due to semantic processing since the ‘New’ items do not fit with the semantic gist of the studied word lists.

Fabiani, Stadler and Wessels (2000) looked at lateralized brain potentials to true and false recognition. Using the DRM paradigm, participants studied lists of words that were randomly presented to either the left or right visual field, Event-related potentials were measured during the recognition phase with the studied, critical or non-studied words being presented centrally. Fabiani et al. found lateralized activity for the studied words that was absent for the critical, non-studied words. In other words, false memories did not produce a sensory signature.

As Schacter and Slotnick (2004) note, the implications of imaging studies suggest that there is more activation for true items in regions of the brain that are associated with sensory and perceptual for details, than for false items. Taking the hypothesis that true recognition is associated with greater sensory reactivation compared with false recognition, they tested subjects on the DRM paradigm using abstract shapes (see Koutstaal et al, 1999). The main finding was greater activation for true recognition as opposed to false recognition in the regions of the brain responsible for early visual processing.

2.8 Conclusion

One had a lovely face,
And two or three had charm,
But charm and face were in
vain
Because the mountain grass
Cannot but keep the form
Where the mountain hare has lain.

Memory, W. B. Yeats

The poet Yeats recognized the fragility of the human memory and its susceptibility to change in relationship to an individual’s circumstances. Just as grass can no longer keep its form once flattened by a hare, memory changes form as our experiences and concepts add to our general schematic representations.

In these two introductory chapters we have seen how the inaccuracies of the human memory can aid us in understanding its underlying functions. A common theme throughout the research is that gist memory is an underlying cognitive function that aids us in constructing schematic representations, but misleads us into forming false memories. However, there will always be unanswered questions regarding memory. This thesis sets out to fill some of those gaps in our knowledge, such as the relationship between depression and false memories; a further exploration into individual differences and a study investigating the performance of autistic individual's in the DRM paradigm. Furthermore, it also examines the flexibility of the DRM paradigm and looks at whether it can be used in clinical settings to explore functional memory weakness and whether or not it can differentiate between those with genuine memory problems and those who are malingering. Underlying this work is the theme of gist representation and Bartlett's schematic representation; how can we use these two concepts to interpret our findings?

Chapter Three: Individual Differences and Susceptibility to False Recognition in the DRM Paradigm

> *Even if several people experience "the same" event, they will interpret it differently depending on their prior experiences. Each person perceives an event with different backgrounds and proclivities. Each of us has had different experiences and likewise different attitudes, knowledge, dispositions, and biases.*
>
> Roediger and Gallo (2002, *pp. 4 – 5*).

3.1 Introduction

The knowledge that each person encodes and subsequently interprets an event into their memory in a unique fashion opens the door to the question, are there specific individual differences that can affect a person's susceptibility to false recognition and hence the formation of false memories? Do these differences suggest a person who is more susceptible to false memory intrusions is therefore a less reliable witness, an important consideration when interpreting eyewitness testimony in criminal cases? Or, conversely, are there adverse aspects to being less susceptible to false recognition?

Individual differences and false recognition in the Deese (1959), Roediger and McDermott (1995) paradigm (DRM) have been explored in clinical populations (e.g. depression, ageing) to investigate personality differences. For example, Clancy et al. (2002) found a positive correlation between depression and susceptibility to false recognition of critical lures in the DRM paradigm; Zoellner et al. (2000) found a positive correlation between anxiety and false recognition; and finally, Koutstaal and Schacter (1997) investigated age-related differences in the DRM paradigm suggesting that older adults were more susceptible to false recognition due to their over-reliance on gist information. However, as useful as these clinical findings are they encompass populations of people who may not be considered 'reliable witnesses' in a courtroom. For example, the population studied in Clancy et al. (2002) consisted of individuals who believed they had been abducted by aliens, or who thought they had undergone such an experience and subsequently suppressed it. They were more susceptible to false recognition but also produced less veridical recollection of the studied words. Perhaps more controversial is Zoellner et al.'s (2000) study which investigated women who were suffering post-traumatic stress disorder after being victims of violent crime, including sexual assault. Their findings indicated that women who experienced more anxiety were more susceptible to false recall and recognition, but their veridical recall for studied items was not significantly different from the control group. Zoellner et al. (2000) are careful to point out such findings should not be interpreted to mean that traumatised individuals are more likely to form false memories of the traumatic event, but the failure to highlight the consistent veridical recall in the trauma group does leave such research open to misinterpretation. However, the majority of those who do provide eyewitness testimony in legal cases are not from specific clinical populations, and mounting research into false memories has demonstrated that no one, it would seem, is immune to the vagaries of their own memories. Are there fundamental individual differences that lead some people to produce more false recognition than others in the DRM paradigm?

Before exploring this further it is important to clarify one issue regarding the DRM paradigm: that the results cannot be attributed to an individual's specific circumstances at the time of testing. For example, if Clancy et al. (2002) found a positive correlation between depression and susceptibility to false recognition then a normal individual who might feel particularly upset on the day of testing would be more susceptible to false recognition than they would be, for example, a week or two later. Blair, Lenton and Hastie (2002) investigated this argument by testing individuals in two sessions separated by two weeks. Participants saw the same materials and undertook exactly the same procedure for both sessions. Blair et al. (2002) found an individual's susceptibility to falsely recognizing a particular critical lure in week one was an accurate predictor of their susceptibility to falsely recognize the same critical lure in week two. Furthermore, across all subjects there was a positive correlation for false recognition between week one and week two ($r = 0.76$). To ensure this was not due to response bias (that is a bias to saying 'yes' all of the time be they critical lures, studied words or non-studied words) the levels of false recognition were corrected by subtracting the incorrect responses for the unrelated non-studied words. The same relationship was found after they corrected for true false recognition indicating that an individual's susceptibility to false recognition remained stable across time.

Researchers have also examined whether there would be significant differences in response to gender stereotypes in the materials used in the DRM paradigm. Lenton, Blair and Hastie (2001) examined the possibility that gender stereotyping of the word lists may also influence false recognition. Participants were divided into two groups. The first group was assigned to the stereotypical ‘male’ word lists, such as *lawyer* and *soldier*; the second was assigned to the ‘female’ word list, for example *nurse* and *secretary*. Both groups also studied neutral words lists. Lenton et al. (2001) found that individuals who had studied either male or female stereotypes were subsequently more likely to falsely recognize the related gender role for the critical lures. Furthermore, the researchers questioned participants after the experiments and found the majority were unaware of the gender stereotyping of the word lists and from this concluded that their responses to the critical lures was a result of *implicit association* to the themes of the studied words, rather than the use of any strategic processing by the participants. However, this could also be interpreted in the light of gist processing since the ability to categorise words into themes would require good gist, suggesting those individuals who did produce more false alarms to the gender stereotyped lures had better gist memory.

Incorporating both sex differences and gender stereotypes in the words lists, Baust and Ferraro (2004) argued that men would produce more false recognition to stereotypical male lists and women to the female lists. The results did not support their hypothesis and no sex difference was found, although they did replicate Lenton et al.’s (2001) finding that gender stereotyping of the word lists was a significant factor in false recognition.

This leads to the next question: if there are individual differences to susceptibility to false recognition and false memories, where do these differences lie within a normal population? Given the above findings of a relationship between gender stereotype and susceptibility to false recognition a logical choice of research has been sex differences. However, studies have found no relationship between sex and susceptibility to false recognition (e.g. Clancy et al., 2002; Seamon et al., 2002; Baust & Ferraro, 2004). One argument for the failure to find sex differences in these studies is the use of small population samples (Voyer, 1996), and this is something that will be discussed below. Another area of discrepancy is the variation in the number of word lists used by researchers. For example, Baust and Ferraro (2004) only used five word lists, which would have considerably reduced the number of data points for each individual. In contrast, the original Roediger and McDermott (1995) paradigm used twenty-four lists of fifteen words each associated with a single critical lure. In the light of work such as Stadler, Roediger and McDermott (1999) if there are individual differences in false recognition to particular critical lures then it would seem imprudent to use limited numbers of words lists as this does not accurately reflect the wide variety of vocabulary and stimuli which each individual encounters every day and are, therefore, likely to produce false recognition to.

Although other individual traits and differences have been explored they often find correlations between only one aspect of the DRM paradigm, such as a relationship with false recognition of the critical lures but no correlations for the studied words. For example, Peiffer and Trull (2000) examined suggestibility and self-esteem in young adult women and found a positive correlation between suggestibility and false recall but did not recount the relationship between self-esteem and veridical recall of the studied words, presumably because the latter was not significant. In another study Watson, Bunting, Poole and Conway (2005) divided their participants into two groups: those with high working memory span, and those with low working memory spans. Participants with high spans had better veridical recall for the studied list words than the low span group. However, there was no significant difference in false recall of the critical lures except in the warning condition phase, when participants were warned prior to the recall phase to avoid false recollection of the critical lures. Here, the difference between the two groups in veridical recall remained the same as in the first experiment, but this time participants with a high working memory span were more able to suppress false recall to the critical lures than their low span counterparts. The findings were discussed in terms of superior episodic memory for the high working span group, hence the higher rates of veridical recall for the studied words, but also allowing them to suppress false recognition in the warning condition.

The aim of this study was to investigate whether there is a reliable indicator of susceptibility to false recognition in the DRM paradigm within a normal population. Very few research studies investigating individual differences have engaged with the concept of gist memory as a driving force behind false recognition even though a number of findings could be interpreted in this light (e.g. Stadler et al. 1999). Nor have they engaged with the idea that gist memory is a developmental process that can affect false recognition as suggested by ageing studies such as Koutstaal and Schacter (1997). However, Lövdén (2003) did investigate the increase in false memory with ageing but discussed the findings in terms of changes in episodic memory and processing speeds as opposed to the increasing reliance on gist memory with age. Any reliable method of investigating individual differences would need to show good correlations for both true and false recognition, since good gist representation should be reflected in both high rates of correct hits to studied words as well as increased susceptibility to false recognition of the critical lures. In light of the above research work what methods can we use to investigate individual differences?

3.1.1 Second digit to fourth digit ratio (2D:4D) and hemispheric laterality

In a meta-analysis of research work, Daniel Voyer (1996) criticised a large number of studies investigating sex differences and hemispheric laterality (often measured by presenting stimuli to the left and right visual fields, or audio stimuli using dichotic listening, see Springer & Deutsch, 1981) citing small population samples, specifically when applied to studies that also explored hemispheric differences in the brain. Since laterality effects were often minimal to begin with, adding sex differences to the data often produced conflicting results. However, DRM studies investigating sex differences have yielded no significant results. In part, this may be due to the small sample populations, for example, Clancy et al. (2002) had only eighteen male and fifteen female participants and these were spread over three different clinical groups. Or, the failure to find sex differences could be a result of limited materials, for example, Baust and Ferraro (2004) only used five word lists limiting the number of data points. To ensure there is a robust experimental design any procedure should incorporate both a large participant sample and preferably the full twenty-four word lists to maximize the data.

However, an alternative way of examining sex differences is by viewing males and females as opposite ends of a continuum and to find another measurement to rate a person's 'physical' sex. One such rating is the second digit to fourth digit ratio. The second digit to fourth digit ratio (2D:4D) is a sexually dimorphic trait under the control of the Homeobox gene, which also controls the differentiation of the testes and ovaries (Peichel et al., 1997). Male 2D:4D ratio is lower than female 2D:4D ratio, that is males have relatively longer fourth fingers in relation to their second fingers compared with females. Furthermore, there is evidence that the 2D:4D ratio is determined by the fourteenth week of pregnancy (Manning et al., 1998) so that adult 2D:4D ratio and hormone levels may be determined by prenatal 2D:4D ratio and hormone levels. Hence high prenatal testosterone and low oestrogen, favoured by a male foetus, will be indicated by a low 2D:4D ratio. Conversely, low prenatal testosterone and high oestrogen will be indicated by a high 2D:4D ratio and hence will favour a female foetus. Manning et al. (2001) argue that if low 2D:4D ratio is an indication of high prenatal testosterone, then this may in turn be an indicator of more 'male' developmental traits such as autism.

Taking into consideration that 2D:4D ratio may indicate more 'male' traits, and the work of Beversdorf et al. (2000) which found individuals with autism showed reduced false recognition in the DRM paradigm, we can hypothesise that there should be a positive correlation between 2D:4D ratio and false recognition of the critical lures *and* hits to the studied words. That is, individuals expressing more 'female' 2D:4D ratios will be more susceptible to false recognition but will also produce higher true recognition to studied words. Individuals expressing more 'male' 2D:4D ratios will be less susceptible to false recognition. Furthermore, Bellamy & Shillcock (2007) examined hemispheric asymmetry and found the right hemisphere was more susceptible to false recognition and *post hoc* tests indicated this lay with the female participants. Therefore, we can also hypothesise that if 2D:4D ratio does drive false recognition in the DRM paradigm then this will be especially significant in the right hemisphere in individuals with more 'female' 2D:4D ratios.

However, there is a note of caution cited by Springer and Deutsch (1981) regarding sex differences and laterality. Similar to Voyer (1996) they argue that although the majority of experiments in this field often cite females as being less 'lateralized' than males, there are a number of studies that do not show sex differences (and many go unpublished for this reason) since a variety of methodologies may mask individual variability. Furthermore, it is unusual to find a study reporting greater lateralization in females as opposed to males, so our results may show no differences between male and female based on 2D:4D ratio. Another point to bear in mind is that 2D:4D ratio only reflects levels of testosterone at a specific moment in pregnancy, not the entire embryonic period, and so there may be no differences in group comparisons. With this in mind we wanted to find a way to investigate individual differences to false recognition (excluding laterality) using an alternative measure of sex differences.

3.1.2 Autism Spectrum Quotient and Toronto Alexithymia Scale

Daniel Voyer (1996) also suggested that researchers tend to equate biological sex differences with individual differences, but the two may not be related. This leads to the idea that an alternative way of exploring sex differences might be to view the concept of male and female cognition as opposing ends of a continuum not governed by outward biological differences.

In 1997 Baron-Cohen and Hammer introduced the 'extreme male-brain theory of autism'. This theory was postulated from the observation that autism is strongly sex-dependent with a male to female ratio of 4:1. In essence, the theory argues that autism is an expression of one end of the sex continuum resulting in predominantly 'male-brained' characteristics. The next expression of 'male-brain' characteristics is Asperger's Syndrome, which has all the related characteristics of autism but without the cognitive, and language delay that is a marked feature of autism. This is also strongly sex dependent with a male to female ratio of 9:1. Baron-Cohen & Hammer (1997) argue that autism and Asperger's lie on a continuum of social-communication disability with more 'female-brains' lying at the opposing end. Normal individuals can, therefore, express autistic characteristics that would fall along this continuum. With this in mind Baron-Cohen et al. (2001) developed the Autism-Spectrum Quotient (AQ) designed to examine autism characteristics within a normal population. It is made up of fifty questions divided into five different areas of assessment: social skills, attention switching, imagination, communication, and attention to detail. A copy of the self-assessment questionnaire can be found in *Appendix B*. Although the AQ is not designed to be a diagnostic tool, by assessing the questionnaire over a large population, including Asperger's Syndrome and individuals with high-functioning autism as well as controls, Baron-Cohen et al. (2001) argued a useful cut-off point of a score of thirty-two or over in a normal individual on the AQ *may* indicate Asperger's Syndrome.

One facet of autistic individuals is an inability to communicate or express their emotions, or to interpret those of other people (Baron-Cohen & Hammer, 1997). Where there is reporting of feelings it is often related to bodily sensation rather than a specific emotion. This difficulty in expressing emotion and describing feelings was first described by Sifnéos (1973), who coined the term Alexithymia. Alexithymia is a personality trait and similar to the Autism Spectrum Quotient in that the degree to which an individual expresses these traits falls along a continuum. Bagby, Taylor and Parker (1994) developed the twenty-item Toronto Alexithymia self-assessment scale (TAS-20). Since then the questionnaire has been adjusted and tested for its validity until it reached the format most widely used as shown in *Appendix B* (Parker et al., 2003; Taylor et al., 2003). The higher the score on the TAS-20 the more Alexithymic traits a person expresses with a score of 61 considered a diagnosis of Alexithymia.

Berthoz and Hill (2005) examined the reliability of the TAS-20 for assessing emotion regulation in autism. Adults with autism spectrum disorder and controls completed the TAS-20 questionnaire and the Bermond-Vost Alexithymia questionnaire (BVAQ-B), which was recently developed as an alternative to the TAS-20. Berthoz and Hill found strong test-retest reliability for the TAS-20 scale that was able to discriminate between the autism group and controls whereas the BVAQ-B did not show the same discrimination. The ability of the TAS-20 scale to discriminate between those with autism and controls suggests that in a correlation with the Autism Spectrum Quotient (AQ) we should find a positive relationship, that is the higher an individual's AQ score (more autistic traits) the higher their TAS-20 (more Alexithymic traits).

3.2 Experiment 1: Laterality and 2D:4D ratio and susceptibility to false recognition in the DRM paradigm.

This experiment examines if there is a sex difference in susceptibility to false recognition. Given the failure of previous work to find any sex differences based solely on outward biological features we have chosen second to fourth digit ratio (2D:4D) in order to determine sex difference along a continuum. Bellamy and Shillcock's (2007) work indicated in *post hoc* testing that if there was a difference it lay with females, specifically with the right hemisphere being more susceptible to false recognition. That is when stimuli are presented to the left visual field – right hemisphere (lvf-RH) there is higher false recognition to the critical lures in comparison with the right visual field – left hemisphere (rvf-LH). If this is true, then we hypothesise that in a large study sex difference, as measured by 2D:4D ratio, will reveal more 'female' 2D:4D ratio individuals (that is a high second to fourth digit ratio) will be more susceptible to false recognition of the critical lures and that this should be more pronounced in the lvf-RH.

3.2.1 Participants

One hundred participants (50 male, 50 female) between the ages of 18 and twenty-five years old were recruited via the University of Edinburgh's careers website. All the participants were students of the University. All were native speakers of English and were dominant right-handed as tested using the Edinburgh Handedness Scale (Oldfield, 1971). All had normal or corrected to normal vision with no reading difficulties. The age range was restricted in order to keep the sample as homogenous as possible taking into account Voyer's (1996) criticisms for investigating sex differences. They were paid £6 for their participation.

3.2.2 Method and Materials

Subjects sat in front of a computer screen. They were told they were taking part in a study to investigate memory. The experiment was divided into two sections. In part one of the experiment participants were instructed via the computer screen to study the twenty-four lists of fifteen words and answer the maths questions in between each word list. The word lists are in *Appendix A* and are the same as those used by Bellamy & Shillock (2007). Although similar to the Roediger and McDermott (1995) word lists, the word lists used here were previously pre-tested amongst native English speakers since the Roediger and McDermott (1995) word lists were more appropriate for American-English speakers (e.g. the word *sweet* was associated with the word *candy*, which would not be true for native English speakers). The mathematical questions between each word list acted as a distracter task and prevented rehearsal of the word lists. The word lists and order of presentation of words within the lists were presented randomly. The words were presented at 1-second durations with an interval of 500 *ms* between each word. Once all twenty-four word lists had been studied the subjects were instructed to take a break. During this time their second to fourth digit ratio was measured. This was carried out by photocopying each hand and then measuring the distance from the tip of the relevant fingers down to the first basal crease using calibrated Vernier calipers (Manning et al., 2001). Subjects then returned to the computer where they were instructed to carry on with the second part of the experiment, which was the recognition phase. Participants saw 96 words consisting of 48 words from the studied words lists, 24 critical lures (from which each word list was derived, see *Appendix A*), and 24 non-studied words that had no relation to either the studied words or critical lures. Investigation of hemispheric bias was achieved during the recognition phase by presenting half the words to either to the left or right visual field. Participants were instructed to stare at the central fixation cross and to avoid unnecessary head movement during the recognition trial. The words were presented randomly either 3cm horizontally to the left or the right of the cross for a duration of 120 *ms* to avoid any re-fixation. Participants were instructed to press ‘Yes’ on the computer keyboard if they thought the word had appeared on the original studied lists, or ‘No’ if they thought the word was new. The ‘d’ and ‘k’ keys were used for the ‘Yes’ and ‘No’ responses and these were counterbalanced across participants. The experiment lasted approximately one hour and participants were paid £6 for their time.

3.2.3 Design

This was a mixed design with Visual Field (lvf or rvf) and Type of Word (critical lure, studied or non-studied) as the within-participant factors, and sex (male or female) as a between participants factor. Response accuracy was the dependent measure. Digit ratio was correlated with critical word incorrect, studied word correct and non-studied word incorrect. We also used the two-high threshold theory to examine corrected true and false recognition rates (Snodgrass & Corwin, 1988).

3.2.4 Results

The descriptive statistics for the experiment are shown in Table 1.

Table 1: Descriptive Statistics for Experiment 1

	Male N = 50		Female N = 50		Total N = 100	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Age	20.6	1.77	20.3	1.36	20.4 (18 – 25)	1.58
Digit Ratio	0.96	0.03	0.97	0.03	0.96 (.9 – 1.03)	0.03
Edinburgh Handedness	9.53	0.54	9.70	0.40	0.96 (8.5 – 10)	0.48
Left-Visual Field (RH)	**Mean %**	**SD**	**Mean %**	**SD**	**Mean %**	**SD**
Critical Lure Incorrect (24 Items)	62.0	18.14	61.49	18.2	61.75 (0 – 100)	18.03
Studied Word Correct (48 Items)	64.58	14.46	67.66	12.84	66.12 (37.5 – 100)	16.69
Non-studied Word Incorrect (24 Items)	10.99	12.53	6.99	11.46	8.99 (0 – 58.3)	12.11
Right-Visual Field (LH)	**Mean %**	**SD**	**Mean %**	**SD**	**Mean %**	**SD**
Critical Lure Incorrect (24 Items)	60.66	20.27	57.50	22.63	59.08 (8.3 – 100)	21.42
Studied Word Correct (48 Items)	67.00	13.85	67.50	16.54	67.25 (20.83 – 95.83)	15.18
Non-studied Word Incorrect (24 Items)	16.83	14.23	11.99	14.50	14.41 (0 – 58.33)	14.50

A repeated measures mixed ANOVA was carried out with Word Type (critical, studied and non-studied) and Visual Field (left visual field, right visual field) as the two within subject factors and participant response as the dependent variable. Sex difference (i.e. male or female) was the between group factor. There was a significant effect overall for Visual Field and Word Type, F (2, 196) = 499.9, $p <$ 0.001. *Post hoc* paired samples t-tests revealed this significance lay with the non-studied words (t (1,99) = -3.83, $p < 0.001$); that is the rvf-LH produced more incorrect responses (14.4%) compared with the lvf-RH (8.99%) to the non-studied words. There was a significant main effect of Word Type, F (2, 99) = 279.171, $p < .001$. *Post hoc* analyses revealed that participants were significantly more likely to false recognize the critical lures compared with the non-studied words for both the lvf-RH and rvf-LH (t (1,99) = 24.7, $p < 0.001$ and t (1,99) = 19.28, $p < 0.001$ respectively. There were no significant differences between the visual fields for either critical lures or studied words (see Figure 4). There was no significant interaction between Word Type, Visual Field and Sex, F (2, 196) = 0.98, *ns*.

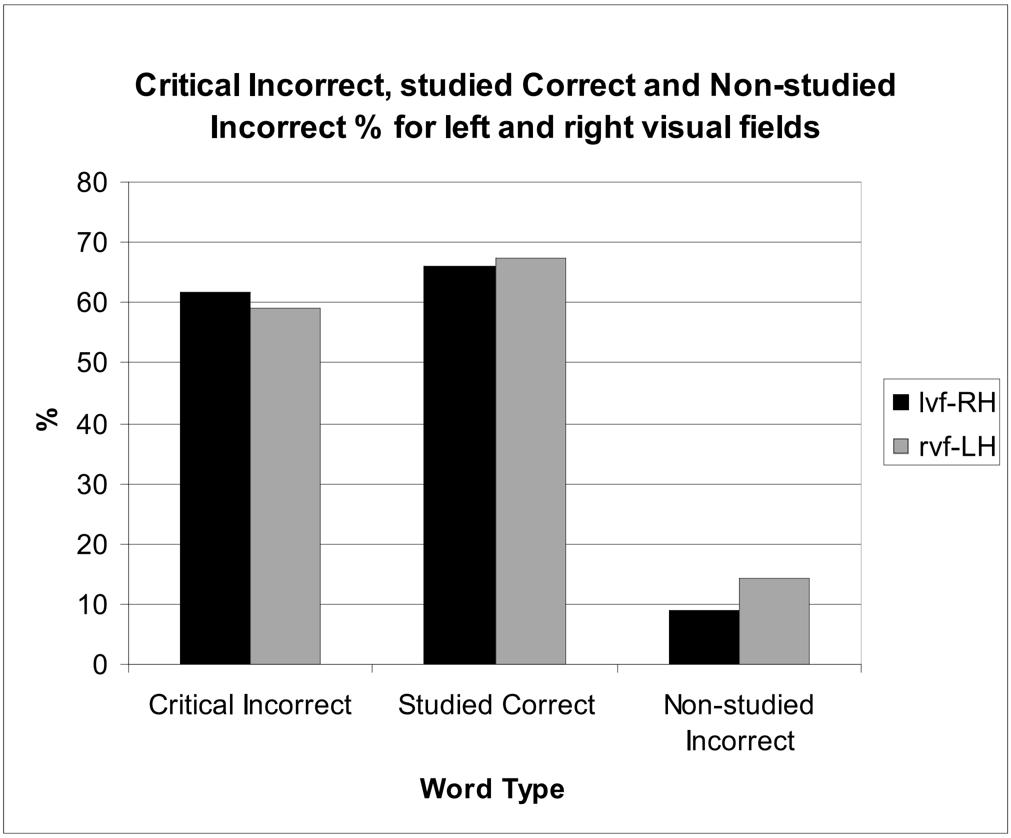


Figure 4: Experiment 1, Critical Lures Incorrect, Studied words Correct and Non-studied words Incorrect for left and right visual fields.

Because we are interested in the relationship between digit-ratio, laterality and recognition, one-tailed Pearson's correlations were undertaken between critical lure incorrect, studied word correct, non-studied word incorrect and digit-ratio. No significant correlations were found between digit ratio and any of the word types.

In accordance with Snodgrass and Corwin's (1988) recommendations regarding signal-detection theory in memory recognition we used the two-high-threshold theory to examine corrected true and false recognition rates (this method of analysis is also advocated by Kensinger & Schacter, 1999). In order to obtain corrected true and false recognition rates the incorrect rates for the non-studied words are subtracted from both the critical lures incorrect and studied words correct. These can be seen in Figure 5.

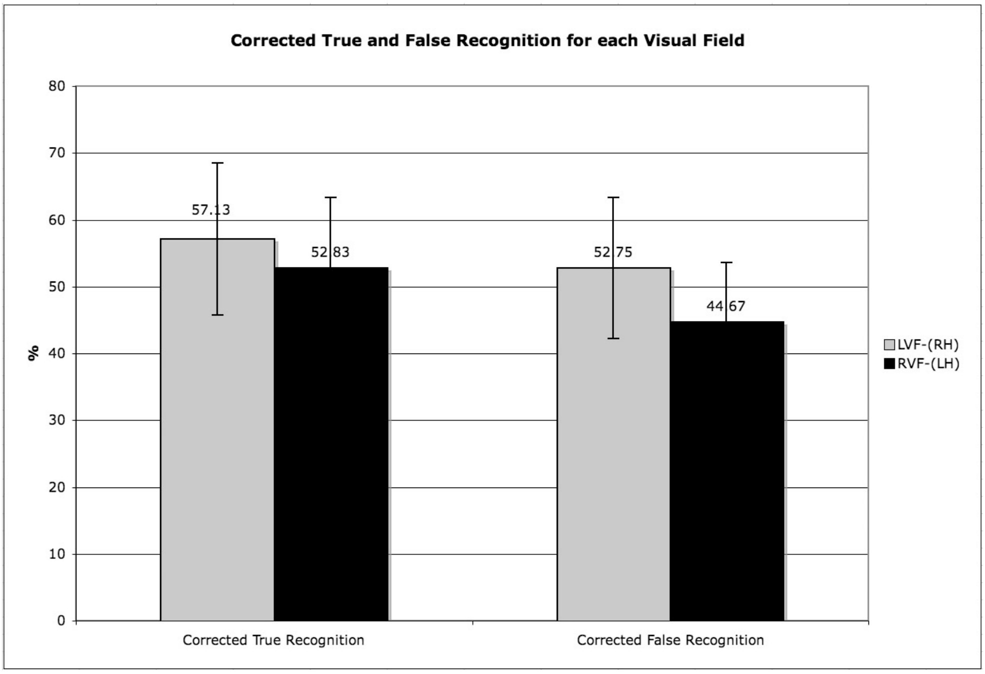


Figure 5: Corrected True and False Recognition rates for each visual field

A repeated measures ANOVA with Word Type and Visual Field as the main subject factors and Sex as the between group factor was carried out. There was a significant main effect for Word Type, F (1,98) = 13.28, $p < 0.001$. There was also a significant effect for visual field, F (1,98) = 14.62, $p < 0.001$; that is there were higher rates of corrected true and false recognition in the lvf-RH compared with the rvf-LH. There was no significant effect for Sex, F (1,98) = 1.89, p = *n.s.* There were no significant correlations found for digit ratio and correct true and false recognition rates for each visual field.

To ensure the difference did not lie at the opposing ends of the continuum of digit ratio, the top twelve and bottom twelve scores for second digit to fourth digit ratio (2D:4D) were selected (see Figure 6).

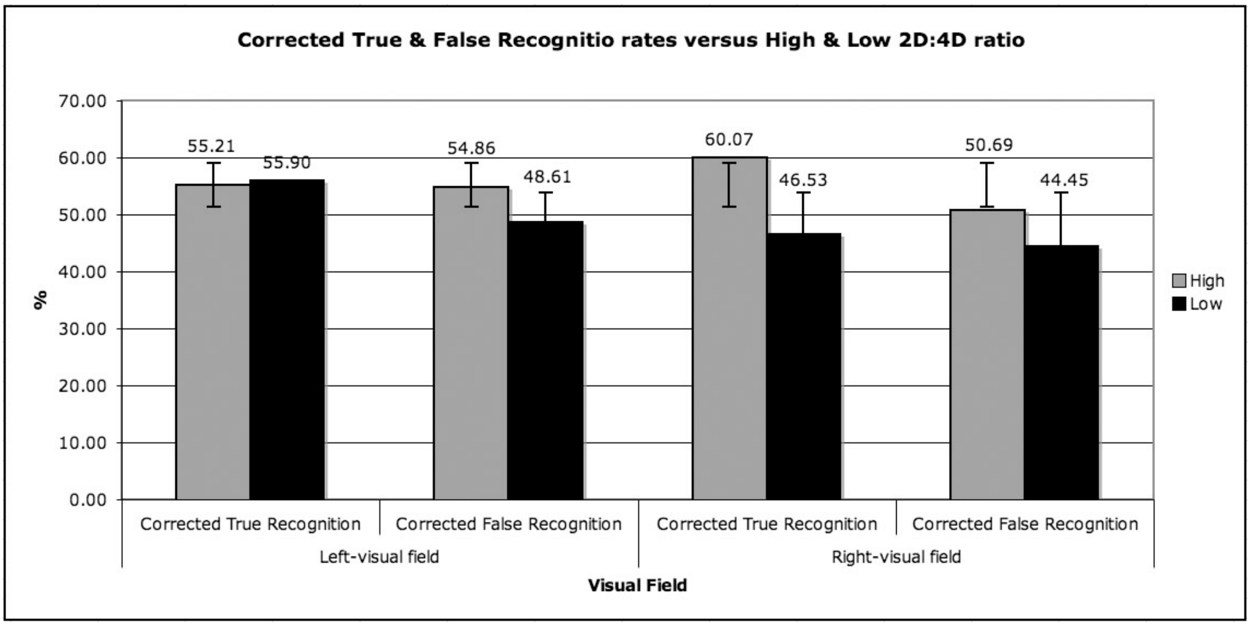


Figure 6: Corrected true and false recognition rates for low and high 2D:4D ratio

A mixed ANOVA, with Visual Field (left and right) and corrected true/false recognition (Word Type) as the within subject factors and Digit Ratio category as the between group factor (e.g. High or Low 2D:4D) was carried out. There was no interaction between Visual Field, Word Type or Digit Ratio $F\ (1, 22) = 1.976$, $p =$ *n.s.* and the between group analysis of subjects with either high or low 2D:4D ratios was also not significant, $F\ (2, 22) = 1.236$, $p =$ *n.s.*

3.2.5 Discussion

Laterality effects were only present for non-studied words. However, this is an important finding since our argument states that gist memory is the driving factor behind false recognition, so it should also improve the discrimination of the non-studied and studied words since good gist allows maintenance of large amounts of related information in memory while at the same time enables the rejection of items that do not fit the gist, i.e. the non-studied words. Our findings indicate that that the lvf-RH was better at rejecting the non-studied words and so had lower rates of incorrect responses compared with the rvf-LH. This suggests that the lvf-RH has better gist discrimination than the rvf-LH for non-studied words.

These effects were further supported by the laterality differences found for corrected true and false recognition, indicating a right hemisphere bias for corrected false recognition, which is consistent with the work of Ito (2001) and Bellamy and Shillcock (2007). That is, the lvf-RH produced more false recognition of the critical lures compared with the rvf-LH indicating that while gist memory may aid in the correct rejection of the non-studied words it makes the lvf-RH more vulnerable to accepting the critical lures as they fit the overall gist of the previously studied words. The lvf-RH also had higher corrected true recognition rates indicating a better signal detection for the studied words in the right hemisphere compared with the left.

The failure to find significant laterality effects for critical lures and studied words in the initial analysis is puzzling since the increase in population sample should have magnified the laterality effect. However, one suggestion is that if false recognition of the critical lure is dependent on gist memory, and gist memory is itself a developmental function, then the effects of laterality may be reduced in a population that was restricted by age in order to magnify any sex differences (e.g. Bellamy and Shillcock used a population ranging from 21 to 32 years of age). Our decision to use a narrow age band was based on Voyer's (1996) recommendation that population samples should be as homogenous as possible. However, this homogeneity may itself obscure laterality effects that would be seen in a broader population, particularly if they relate to developmental traits that increase with age. This current study used a population between 18 and 25 years old and as Koutstaal and Schacter (1997) found, with increasing age comes increasing reliance on gist traces rather than the veridical traces as episodic memory declines. This argument suggests that for younger populations there is more reliance on the veridical traces, although this does not make them entirely immune to the effects of the gist traces hence producing false recognition.

This experiment also investigated whether 2D:4D ratio and laterality influenced susceptibility to false recognition of the critical lures. The failure to find significant results for 2D:4D ratio using a large population and the full twenty-four word lists suggest that such differences are not an indicator of an individual's susceptibility to false recognition. This may be because, as mentioned in the introduction, 2D:4D ratio is only an indicator of testosterone levels at a specific point in embryonic development.

3.3 Experiment 2: Autism Spectrum Quotient (AQ) and the 20-item Toronto Alexithymia Scale (TAS-20) as predictors for susceptibility to false recognition in the DRM Paradigm.

Berthoz and Hill (2005) found a correlation between autism and the 20-item Toronto Alexithymia scale (TAS-20). From this we hypothesize that there will be a positive correlation between the Autism Spectrum Quotient (AQ) and the TAS-20 scale, that is the higher an individual's TAS-20 score, the higher there AQ scale indicating a more 'male' brain.

Furthermore, taking into account previous work involving individuals with high-functioning autism (e.g. Beversdorf et al., 2000) we hypothesize that the individuals with more 'male-brained' traits (i.e. high TAS-20 and AQ scores) will produce less corrected false recognition to the critical lures. This would be in harmony with what Beversdorf et al. (2000) reported that individuals with autism were less susceptible to false recognition of the critical lures. But Beversdorf et al. (2000) also found higher recognition to the studied words in individuals with autism compared with controls. However, it should be noted this difference was only significant in the 'YES' responses as opposed to the 'DEFINITELY' responses to studied words and was in a very small population sample of only 8 autism patients compared with 16 controls. They concluded that this was because individuals with autism have a much higher category memory for the studied words (although it should be noted that this finding had been in relation to categories of proper names in a case study of one autism patient, Mottron et al., 1996). Furthermore, Beversdorf et al. (2000) do not comment on the results for non-studied words in that autism patients produced more incorrect responses compared with controls. Therefore their conclusion that autism patients produce more veridical recognition to studied words may not be entirely accurate if their results had been corrected for true recognition by subtracting the incorrect responses of the non-studied words.

Our argument proposes an alternative theory to Beversdorf et al. (2000) regarding veridical recognition in that individuals with autistic traits and hence more 'male-brains' will have less true recognition to the studied words since they are unable to maintain as strong a gist memory for the categories of words, but at the same time this inability to form gist memory also makes them less susceptible to false recognition of the critical lures. In contrast, those with more 'female' brains should be more susceptible to false recognition but will also fair better on the veridical recognition of the studied words. There should, therefore, be a negative correlation between false recognition of critical lures and AQ/TAS-20 scores, and there should be a negative correlation for studied words and AQ/TAS-20 scores.

3.3.1 Participants

One hundred and fifty participants (55 male, 95 female) between the ages of eighteen and sixty-nine years old were recruited via the University of Edinburgh's careers website or via word of mouth by 2nd and 3rd year psychology students who carried out the experiment as part of their projects. All the participants were students of the University. All were native speakers of English, had no reading difficulties and normal or corrected to normal vision. Those recruited via the career's website were paid £6 for participating. All had a minimum of 13 years of education.

3.3.2 Method and Materials

The materials and method were identical to *Experiment 1*, except for the recognition phase words were presented in the centre of the screen for a duration of 500 *ms.* After the study phase participants were instructed to take a break and complete the questionnaires (see *Appendix B*) before moving on to the recognition phase. Questionnaires included the TAS-20 (Parker et al., 2003), the Autism Spectrum Quotient (AQ) (Baron-Cohen et al., 2001) and the Edinburgh Handedness Inventory (Oldfield, 1971). Once they completed the questionnaires they were told to move on to the recognition phase and focus on the central cross, which appeared for 500 *ms* between each word. Each word appeared for up to 500 *ms* and disappeared the moment the participant entered their response. Participants were instructed to press 'Yes' on the keyboard if they thought the word was present in the original studied lists and ‘No’ if it wasn’t. The ‘d’ and ‘k’ keys on the keyboard were used for the responses and were counterbalanced across participants.

3.3.3 Design

This was a mixed design with Word Type (critical lure, studied or non-studied) as the within-participant factors, and Sex (male or female) as a between participants factor. Response accuracy was the dependent measure. Results from the Autism Spectrum Quotient (AQ) and Toronto Alexithymia Scale (TAS-20) were correlated with each other and critical word incorrect, studied word correct and non-studied word incorrect. We also used the two-high threshold theory to examine corrected true and false recognition rates (Snodgrass & Corwin, 1988). Individual response bias was calculated using Snodgrass and Corwin’s (1988) formula for two-high threshold signal detection where response bias $b' = FA / [1 - (H - FA)]$, where FA = the total number of false alarms (that is critical lure incorrect and non-studied word incorrect) and H = total number of hits (that is studied words correct). A response bias of $b' = 0.5$ would indicate a neutral bias; a b' greater than 0.5 indicates more liberal responses (that is a greater tendency to say ‘yes’ to the stimuli); b' less than 0.5 indicates a more conservative response bias (a greater tendency to say ‘no’ to the stimuli).

3.3.4 Results

The descriptive statistics, including results for the Autism Spectrum Quotient (AQ) and the 20-item Toronto Alexithymia Scale (TAS-20) for *Experiment 2* are shown in Table 2.

Table 2: Descriptive Statistics for Experiment 2.

	Male N = 55		**Female N = 95**		**N = 150**	
	Mean	**SD**	**Mean**	**SD**	**Mean (ranges)**	**SD**
Age	23.95	9.57	26.02	10.73	25.26 (18 – 63)	10.33
Autism Spectrum Quotient	18.1	6.14	14.17	5.42	15.61 (4 – 37)	5.99
TAS-20	50.4	11.84	45.86	8.99	47.52 (27 – 81)	10.33
	Mean %	**SD**	**Mean %**	**SD**	**Mean % (ranges)**	**SD**
Critical Lure Incorrect (24 Items)	66.89	14.88	67.98	14.52	67.58 (33.3 – 95.8)	14.61
Studied Word Correct (48 Items)	71.02	12.42	71.29	13.22	71.19 (33.3 – 100)	12.89
Non-studied Word Incorrect (24 Items)	15.68	13.39	17.10	13.62	16.58 (0 – 58.3)	13.51
Corrected True Recognition	55.34	19.20	54.18	17.89	50.88 (-16.7 – 91.66)	18.78
Corrected False Recognition	51.21	19.81	50.88	18.78	50.99 (-4.16 – 95.83)	19.10

A repeated measures mixed ANOVA with Word Type as the within subject factor and Sex as the between subject factor found a significant main effect for Word Type, F (1,148) = 460.68, $p < 0.01$. Participants had a higher rate of false recognition to the critical lures than the non-studied words. Test of between-subject effects found no significance for Sex, F (2,148) = 0.645, *n.s.*

The scatter plot for AQ and TAS-20 indicated a positive linear relationship between the two variables (see Figure 7). The correlation for the two was significant, $r = 0.55$, $df = 148$, $p < 0.001$.

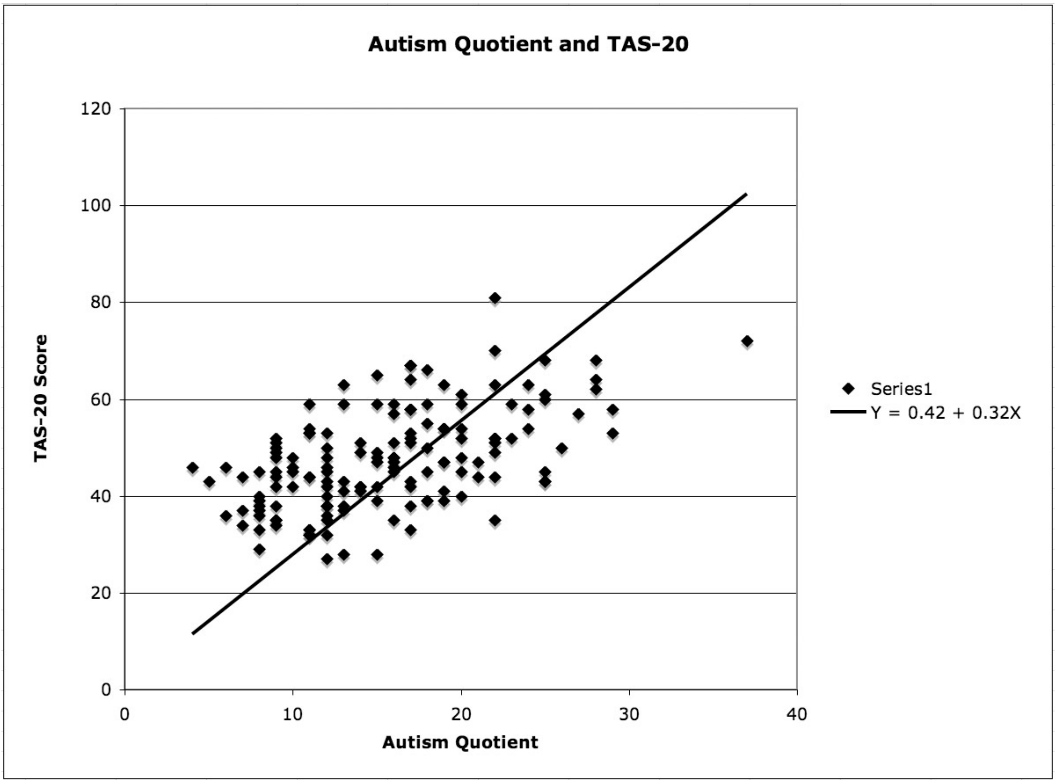


Figure 7: Scatter plot for AQ and TAS – 20

The higher the TAS-20 score, the higher an individual's AQ. Using regression analysis it is possible to predict a participant's AQ from their TAS-20 score. The equation is Y' = 0.428 + (0.320X) where X is an individual's AQ and Y' is the best prediction for their TAS-20 score.

In the next set of correlations (shown in Table 3) AQ and TAS-20 scores were correlated with critical lure incorrect (i.e. false recognition), studied word correct and non-studied word incorrect. There was no significant correlation for non-studied words and the AQ or TAS scores. There was a significant negative relationship for both AQ ($r = -0.24$, $df = 148$, $p < 0.001$) and TAS-20 scores ($r = -0.26$, $df = 148$, $p < 0.001$) in relation to the critical lure incorrect. There was also a significant negative relationship for both AQ ($r = -0.15$, $df = 148$, $p < 0.05$) and TAS-20 scores ($r = -0.14$, $df = 148$, $p < 0.05$) for studied words correct. That is, individuals with higher AQ and TAS-20 scores were less susceptible to false recognition of the critical lures, but also produced less veridical recognition of the studied words.

Table 3: Correlations

	AQ Pearson's Correlation	Significance (1- tailed) *p*	TAS-20 Pearson's Correlation	Significance (1 – tailed) *p*
Critical Lure Incorrect	-0.24	< 0.01	-0.26	< 0.01
Studied Correct	-0.15	< 0.05	-0.14	< 0.05
Non-studied Incorrect	-0.042	n.s	0.12	n.s
Corrected True Recognition	-0.075	n.s	-0.17	< 0.05
Corrected False Recognition	-0.15	< 0.05	-0.25	< 0.01
Response Bias	-0.21	< 0.01	-0.084	n.s

To ensure there was no response bias effect, correlations were run for both corrected true and false recognition. A significant negative relationship for corrected false recognition was found for both AQ (r = -0.15, df = 148, p < 0.05) and TAS-20 (r = -0.25, df = 148, p < 0.001); that is the higher the individual's AQ and TAS-20 scores the lower their false recognition. There was no significant relationship for AQ and corrected true recognition, however the negative relationship for TAS-20 scores and true recognition persisted (r = -0.17, df = 148, p < 0.05); the higher a person's TAS-20 scores the lower their true recognition. A stepwise linear regression found that for true recognition TAS-20 scores explained 34% of the variance, F (1, 148) = 5.142, p < 0.05; AQ scores were not significant. For corrected false recognition stepwise regression found that TAS-20 scores explained 60% of the variance in corrected false recognition, F (1, 148) = 12.787, p < 0.01. AQ scores were entered second and accounted for a further 21% of the variance in false recognition F (2, 147) = 6.455, p < 0.01. Lower false recognition is, therefore, associated with high TAS-20 and AQ scores.

Individual response bias was calculated using Snodgrass and Corwin's (1988) formula for two-high threshold signal detection. A significant negative relationship was found for response bias and AQ scores (r = -0.21, df = 148, p < 0.001), that is the higher an individual's AQ the more conservative their response bias, which is reflected in the results for the correlations.

3.3.5 Discussion

The results supported the hypothesis that individuals with more ‘male’ brained characteristics (that is high AQ and TAS-20 scores), were less susceptible to false recognition but also less veridical recognition to the studied words. Conversely, ‘female’ brains (that is low AQ and TAS-20 scores) produced more veridical recognition but in turn were more susceptible to false recognition of the critical lures. Of further interest is the conservative response bias associated with higher AQ scores, suggesting a better discrimination between true and false recognition in more ‘male’ brains. The reduced false recognition is a finding that corresponds to the work of Beversdorf et al. (2000). However, in contrast to Beversdorf et al. (2000) we found that individuals with more ‘male-brain’ characteristics (i.e. high AQ and TAS-20 scores) produced lower recognition to the studied items. This supports our arguments that by relying more on episodic or literal information, as opposed to semantic or gist information, individuals with more ‘male-brained’ characteristics do not maintain the gist of the studied words and therefore produce less veridical recognition.

The results also found a positive correlation between Autism Spectrum Quotient (AQ) scores and the 20-item Toronto Alexithymia scale (TAS-20). That is, the higher an individual’s AQ score (more ‘male’ brained), the higher their TAS-20 scores (more Alexithymic traits). This corresponds with Berthoz and Hill’s (2005) findings that people with autism spectrum disorders expressed more Alexithymic traits in terms of poor verbalizing and expression of emotional states.

Since there were correlations for TAS-20/AQ and both false and true recognition the results indicate that both assessments are good indicators of an individual’s susceptibility to false recognition. Regression analysis suggests that the TAS-20 scale is the more reliable indicator but it should be noted that since this experiment was carried out the Autism-Spectrum Quotient questionnaire has undergone various modifications for a diversity of languages (e.g. Dutch: Hoekstra et al., 2008) and ages (e.g. adolescence, Baron-Cohen et al., 2006) and a later version may produce stronger results.

3.4 General Discussion

This chapter set out to find if there were indicators that would predict an individual's susceptibility to false recognition. Sex differences were ruled out as a factor in false recognition since both digit ratio and sex did not produce significant results, although individuals did show a right hemisphere bias for corrected false recognition. However, the results for the Autism-Spectrum Quotient and the 20-item Toronto Alexithymia scale did indicate individual: 'male' brains are less susceptible to false recognition but 'female' brains have better true recognition. This would suggest that 'female' brains rely more on gist details when encoding information into the memory, giving them wider access to veridical details but putting them more at risk of encoding misleading information. In contrasts the 'male' brain is good at discriminating between true and false recognition by relying more on episodic or literal memory. The cost of this, however, is a reduction in veridical memories. Why should this be so?

In the introduction we argued that an individual's susceptibility to false recognition might be an important consideration when considering the validity of eyewitness testimony. However, the results in the second experiment have shown that for the 'silver-lining' of reduced susceptibility to false recognition there is a 'cloud' of decreased veridical recognition. So while a more 'male' brained witness may be less susceptible to false recognition and perhaps misleading information, they may also retain less veridical details and vice versa for the 'female' brain. Schacter and Dodson (2001) also note this paradoxical nature of human memory arguing that the 'sins of the memory' produce either 'Vices or Virtues'. Memory errors are a side effect of a cognitive system that has adapted to allow humans to store vast quantities of information without having to encode every perceptual detail. It would be impossible, and highly impractical, if every time we woke up our brains started to notice every specific event of our day. Gist memory allows information to be bundled together in packages that can be accessed as and when required. Anderson and Schooler (1991) suggest a model of memory as being intrinsically reliant on the environment of the individual. Individuals encode only what they need to know and what is of relevance to their surroundings. Information within this framework that is familiar and frequently used does not require our specific attention. If we fit gist memory into this argument we can see how certain types of memory errors, such as those in the DRM paradigm occur. The critical lures are easily overlooked since they fit with the environment of the studied word list that the critical lure generated.

This argument is familiar and takes us full circle back to Bartlett's model of memory schemata in which each individual constructs a memory environment relative to their needs, knowledge and surroundings. It is, perhaps, no wonder that in the effort to be efficient our memories readily accept misleading information if it fits with the schemata we have acquired.

In addition, if poor gist memory is associated with more male brain features such as autistic traits and alexithymia, and if children exhibit lower gisting abilities (e.g. Wells, 1986,) then it suggests a strong developmental relationship for this particular process. This suggests that for individuals with autism gist memory is not as well formed and they rely on more veridical or literal information to make their memory decisions. If this is true then we should be able to see this developmental difference in gist memory quite early on in children with high-functioning autism compared to their age-matched peers. Wells (1986) noted that the ability to develop themes and gist begins around the ages of eight to twelve years of age and will continue to develop right through until adulthood. Furthermore, Brainerd, Reyna and Forrest (2002) noted an increasing pattern of false and true recognition in the DRM paradigm with increasing age, and Ackil and Zaragoza (1998) found children were more susceptible to forming false memories in the light of misleading questions. To explore this further in the next chapter we examine false recognition in children and young adults with high functioning autism in comparison with their age matched peers.

Chapter Four: False Recognition in Adolescents and Adults with Autism Spectrum Disorder

4.1 Introduction

The previous chapter examined how individual differences affect true and false recognition in the Deese, Roediger and McDermott (DRM) paradigm. *Experiment 2* showed those individuals with higher scores on the Autism Spectrum Quotient (Baron-Cohen et al., 2001) and the Toronto Alexithymia Scale (Parker et al., 2003) had reduced false and true recognition on the DRM. This suggests (along with research on populations of differing ages, see *Chapter Two*) that individuals with autism spectrum disorder (ASD) might show reduced false recognition in the DRM paradigm as result of poorly developed gist memory.

To date there have only been two investigations into false recognition in ASD populations. Beversdorf et al. (2000) carried out a study on high functioning autism using the DRM paradigm and found a reduction in false recognition in ASD individuals compared with controls. They also argued that people with autism faired better on the studied items due to better category memory but their results failed to take in to account the proportion of incorrect responses to the non-studied items.

Beversdorf and colleagues note "in ASD, the diminished degree of hippocampal neuronal arborization results in a reduction in the amount of associative information stored in neocortical areas" (Beversdorf et al., 2000, p. 8737). If the amount of associative information stored is reduced then gist representation in ASD individuals will also be poor (since gist, by its nature, relies on maintaining strong associative links). ASD individuals, therefore, will fail to maintain the associative links between the studied words and this in turn will reduce false recognition to the critical lures. However, it is likely that gist memory also enables individuals to distinguish between the studied and non-studied items. Hence reduced gist memory could result in ASD individuals producing higher rates of incorrect 'Yes' responses to the non-studied, unrelated items meaning that overall their corrected true recognition should be lower compared with controls, not higher as indicated by Beversdorf et al. (2000).

The second investigation into false recognition in autism individuals by Bowler et al. (2000) did not find a reduction in false recognition compared with controls. Why should there be this conflict? Bowler et al. (2000) used individuals with Asperger's, which although related to Autism has one notable difference in that Asperger's individuals do not have developmental delay of spoken language (although conversely they often present with dyslexia, for review see Ehlers & Gillberg, 1993). Comparing individuals with Asperger's Syndrome to individuals with high functioning autism may be the main cause for these conflicting results since individuals with Asperger's Syndrome could still have good gist memory for words due to more developed linguistic functions compared with ASD individuals. Secondly, they used different methods to analyse their data: Beversdorf et al. (2000) examined corrected false recognition Bowler et al. (2000) did not. Finally, they used different methods. Beversdorf et al. (*Ibid.*) used recognition; Bowler et al. (*Ibid.*) used free recall of the word lists.

Primarily, this research aims to further explore false recognition in individuals with ASD (Current definitions of ASD, Autism and Asperger's Syndrome can be found in *Appendix I*). The first hypothesis is that if gist memory is impaired in ASD individuals then they will produce lower levels of false recognition *and* lower corrected true recognition of the studied words compared with controls (*Experiment 3a*). Furthermore, the inability of autism individuals to maintain gist should be demonstrated by a negative response bias in the word condition, whereas controls should have a positive response bias.

The second aim of our research is to extend the DRM paradigm employing the Schacter et al.'s (1999) 'distinctiveness heuristic'. This states that when normal individuals study pictures as opposed to words in the DRM paradigm, false recognition is reduced due to the distinctiveness of the perceptual details which individuals can encode from pictures. This is lacking in words, where the semantic features are encoded as opposed to any individual distinct properties resulting in higher false recognition for the critical lures. Schacter and colleagues have examined various populations including individuals with Alzheimer's disease. For example, they found people with Alzheimer's could employ the distinctiveness heuristic to lower their false recognition, which had previously been found to be higher than that of normal individuals (Budson et al., 2000). This paradigm using pictures has yet to be extended to a clinical autism population.

The work of Whitehouse et al. (2006) suggests that people with ASD might have impairments in 'inner speech', or internal dialogue. So when seeing a picture of an object they do not name the object in their thoughts and so lack the capability of binding the name to the features of the object being displayed. This suggests that when given a set of pictorial stimuli in the study phase (*Experiment 3b*), people with autism will perform in a similar manner as they did in the word condition, unable to use the semantic features so that when presented with the critical lures they should show low false recognition, but they may also have difficulties distinguishing between the studied and non-studied, unrelated items, producing low corrected false recognition. In effect, the performance of ASD individuals in a picture-only condition should not, therefore, differ from the word-only condition. If they rely solely on perceptual features, as suggested by Whitehouse et al. (*Ibid.*), then the picture condition may produce increased recognition of the studied pictures (compared with the word-only condition) but will also mean they cannot use gist representation or the *distinctiveness heuristic* to suppress false recognition to the non-studied pictures. This predicts that Autism individuals should, therefore, in the picture-only condition show some increase in corrected true recognition due to a positive response bias (that is a tendency to respond 'Yes') compared with their performance in the word-only condition.

In contrast, normal individuals should be able to employ the 'distinctiveness heuristic' and suppress their false recognition whilst at the same time using the distinct features to increase corrected true recognition. Controls should also show a neutral response bias in the picture-only condition since there are fifty-percent available correct 'no' responses and fifty-percent correct 'yes' responses in the recognition phase.

If Whitehouse et al.'s (2006) 'inner speech' theory is correct, in *Experiment 3c* by giving individuals with autism both perceptual and gist details in the form of words *and* pictures, it is possible that encoding both types of information may *increase* their gist performance. Crucially, this will mean that they show increased false recognition to the critical lures and will have the tools to suppress false recognition to the non-studied items since these will not fit the gist of the studied categories. In contrast normal individuals should demonstrate an increase in false recognition compared with their performance in the picture only condition since the added semantic information from the words will to some extent override the perceptual details of the pictures.

We can summarise the hypotheses as follows:

Experiment 3a Words: ASD individuals will show reduced false recognition to the critical lures and reduced corrected true and false recognition to the studied items in comparison with controls. Additionally, if ASD individuals do have poor gist memory they will not be able to filter out the non-studied, unrelated items and so overall will produce lower corrected true and false recognition in comparison with controls.

Experiment 3b Pictures: ASD individuals will show low false recognition to the critical lures as found in the word condition, but some increase in corrected true recognition since the addition of perceptual features should improve their discrimination of the non-studied, unrelated items. Controls will be able to use the distinctiveness heuristic to suppress nearly all the false recognition to the critical lures and non-studied unrelated items hence showing an increase in corrected true recognition in comparison with their performance on the word-only condition.

Experiment 3c Words and *Pictures*: ASD should show an increase in corrected true and false recognition in comparison with their performance in *Experiments 3a* and *b*. Controls may show an increase in corrected false recognition since the gist representation of the words in this condition may override the perceptual details and hence result in higher false recognition to the critical lures. In this condition we argue that ASD individuals will be able to encode both semantic and perceptual details and hence their pattern of performance in *Experiment 3c* should be comparable to controls.

Note on Participants:

Due to the difficulty in recruiting individuals with ASD in the UK we accepted the help of Professor Domingo Garcia-Villamisar, who works as a clinician at the Asociación Nuevo Horizonte in Madrid. The Asociación is a residential care centre for adults with ASD based just outside of Madrid in Spain. Individuals stay at the centre for varying degrees of time depending on their current home status and the level of care required. They are taught day-to-day living skills, education, and occupational work in order to provide them with the ability to live as independently as possible outside of the Asociación. Participants were recruited directly by Professor Garcia-Villamisar who provides clinical psychological services for the residents.

Professor Garcia-Villamisar was provided with the program and materials required to run the DRM paradigms outlined below. However, there was a technical problem during the collection of the data, which resulted in a considerable delay in the production of the results from Madrid. Due to time constraints, a second Spanish-speaking centre was approached, this time in Bogota, Colombia.

The Fundación Integrar institute in Colombia works on a similar premise to The Asociación in Madrid, except that the attendees are children and young adults with various developmental difficulties including ASD. ASD individuals were recruited for the experiments by the clinicians Leidy Diana Castro Jaramillo, and Yaneth Milena Cuadros Pardo, both from the University of Antioquiaáá. The permission of the parents was attained in all cases. Clara Lucia Avila, a phonoaudiologist from the National University of Colombia, was trained to use the DRM programs and collected the data results. The Spanish word lists originally provided for work in Spain were subsequently altered (see *Appendix C*) to accommodate the linguistic variations between European Spanish and Colombian Spanish. All the data from both institutes was subsequently returned to this researcher and analysed in the UK.

4.2 Experiment 3a,b and c: False recognition in adolescents to young adults with autism spectrum disorder.

4.2.1 Patient and Control Data

Individuals with Autism were all recruited from the Fundación Integrar institute in Columbia. Controls were age matched and were recruited locally. Table 4 shows the demographic data for ASD individuals and the controls.

Table 4: Demographic data for participants.

Autism Individuals N=13				Controls N=12			
Subject No.	**Age**	**Sex**	**Years of School**	**Subject No.**	**Age**	**Sex**	**Years of School**
1	20	F	n/a	1	18	F	11
2	18	M	11	2	17	M	11
3	26	M	11	3	13	F	8
4	17	M	U	4	15	F	11
5	12	F	6	5	13	F	8
6	18	M	11	6	13	F	8
7	12	M	6	7	22	F	U
8	14	F	n/a	8	26	M	U
9	14	M	7	9	14	M	9
10	13	F	7	10	17	F	11
11	13	F	7	11	18	M	U
12	14	F	8	12	14	F	8
13	13	M	6				
	15.69		8.00		16.67		9.44
	4.03		2.16		4.01		1.51

Eighteen ASD individuals were recruited, but five were discounted from the study due to failure to complete the task or lost data. The clinical neuropsychology data for the ASD individuals and their I.D.E.A Autism spectrum scores can be found in Table 5.

Table 5: Clinical neurospychology data for autism individuals.

Subject No.	WISC III Total IQ	ICAP					IDEA				
		MS	SCS	PLS	SWC	GII	S	CL	A/F	S	Total
1	62	12	17	14.7	12	13	6	9	9	9	33
2	70	6.2	7.3	11.6	13.1	10	6	6	6	6	24
3	87	12	17	17	17	16.5	6	6	6	6	24
4	73	6.2	6.8	13.1	8.8	8.1	6	6	6	6	24
5	61	5.5	4.9	6.3	6.4	5.1	6	6	6	6	24
6	70	6.9	11.2	10.8	12.2	10.5	6	6	6	6	24
7	83	5.5	5.1	7	7.7	6.6	6	6	6	6	24
8	55	5.7	3.4	8.11	5.6	5.1	8	6	8	9	31
9	89	5.5	12.2	10.4	10.9	9.7	6	6	6	6	24
10	*	12	13.9	13.1	11.7	12.9	6	6	6	6	24
11	*	12	13.9	13.1	11.7	13.9	6	6	6	6	24
12	65	6.2	6.3	7	6.11	7.2	6	6	6	6	24
13	64	5	6.3	3.9	4.11	4.5	6	6	6	6	24

KEY

*	Patients commenced their intervention too young and at that time IQ was not measured. They both are high functioning, in 7 primary level, and do not have any requirement for special education.	
WISC III	Wechsler Intelligence Scale for Children, Third Edition (Spanish)	
ICAP	*ICAP Inventory for Client and Agency Planning (Bruininks et al, 1986)*	
	MS	Motor Skills
	SCS	Social & Communication Skills
	PLS	Personal Life Skills
	SWC	Skills Within the Community
	GII	General Independence Index
IDEA	Inventario de Espectro Autista (Rivière, 2002)	
	S	Social
	CL	Communication & Language
	A/F	Anticipation/Flexibility
	S	Symbolism
	Total	Total Autism Spectrum Score

4.2.2 Method and Materials

Three sets of materials were created (see *Appendix C*). The first were twelve Spanish word lists derived from Fernandez, Diez and Alonso (2006) word association norms. Because we subsequently wanted to convert these to picture lists we only used concrete nouns that could be easily depicted. These were then corrected for differences between European Spanish and Columbian Spanish (for example, the word car in European Spanish is *coche* but in Columbian Spanish it is *carro*). The second set of stimuli for *Experiment 3b* were picture representations of the same words, and the third set for *Experiment 3c* were words *and* pictures together. There are, therefore, three conditions: words, pictures, words *and* pictures. Each condition has a critical item (the bold word in the word list *Appendix C* indicates the critical item that is not presented during the study phase) and fifteen studied items.

The method for each condition was identical. Participants were told they were taking part in a memory experiment presented on a computer. Participants were instructed to study the word lists (or picture groups) in part one of the experiment. The stimuli were presented centrally on a computer screen for a duration of 1s per item. The 12 lists were presented randomly. In between each list participants carried out simple mathematical problems for 30 seconds, which acted as a distracter task. When all 12 lists had been studied participants moved on to the recognition phase. They saw 24 studied items (top two items from each list), the 12 critical lures, and 12 non-studied, unrelated items. They were instructed to respond 'Yes' or 'No' on the keyboard to indicate whether the item they saw was on the original lists or not. The 'd' and 'k' keys on the keyboard were used for the 'Yes' and No' responses and counterbalanced across participants. The participants returned to complete all three conditions of the experiment (words, pictures, words and pictures). The presentation of the three conditions was counterbalanced across all participants with an interval of at least two weeks between each condition. A native Colombian-Spanish speaker, Ms Clara Avila, conducted the experiment.

4.2.3 Design

There are two main independent variables for the within subject design: Stimuli Type (critical incorrect, studied correct and non-studied incorrect) and Condition (words, pictures, words and pictures). The between subject variable is Group (ASD or Control). These will be entered into a mixed ANOVA. The dependent variable is response (Yes/No). Using Snodgrass and Corwin's (1988) recommendations for signal detection in memory experiments we will examine Corrected False Recognition (critical incorrect minus the non-studied incorrect) and Corrected True Recognition (studied correct minus non-studied incorrect). We will also explore response bias (see *Chapter Three* for equation) and use *post-hoc* t-tests to explore the differences between the two groups and conditions.

4.2.4 Results

Table 6 shows the descriptive statistics for *Experiments 3a, b* and *c*. *Experiment 3a* was the word only condition, *Experiment 3b* is the picture only condition and *Experiment 3c* is the word and picture condition.

Table 6: Descriptive Statistics for Experiments 3a, b and c.

	Words (3a)		**Pictures (3b)**		**Words & Pictures (3c)**	
Stimuli	ASD *M%* (SD)	Controls *M%* (SD)	ASD *M%* (SD)	Controls *M%* (SD)	ASD *M%* (SD)	Controls *M%* (SD)
Critical Incorrect (12 Items)	39.62 (11.36)	61.83 (18.63)	38.92 (11.48)	20.75 (10.35)	32.07 (26.11)	24.25 (17.27)
Studied Correct (24 Items)	57.12 (14.76)	68.04 (11.98)	74.99 (17.09)	78.88 (10.60)	76.27 (12.99)	75.96 (10.97)
Non-studied Incorrect (12 Items)	33.78 (21.07)	19.41 (13.90)	23.77 (12.05)	6.17 (8.05)	10.25 (10.33)	6.17 (10.06)

The responses were subject to a 3 X 3 repeated measures ANOVA was carried out with Stimuli Type (critical incorrect, studied correct and non-studied incorrect) and Condition (words, pictures, words and pictures) as the two main factors. There was a significant main effect for Stimuli Type, F (2, 23) = 241.1, $p < 0.001$ and Condition F (2, 23) = 8.99, $p < 0.05$. Between group analysis showed a significant interaction between Group and Stimuli Type, F (2, 23) = 5.552, $p < 0.05$ and Group and Condition, F (2, 23) = 7.56, $p < 0.05$. Since the ANOVAs indicated significant differences between the three conditions (See Figure 8) in order to explore this in depth *post hoc* analyses using independent samples one-tailed t-tests were carried out. The results can be found in Table 7.

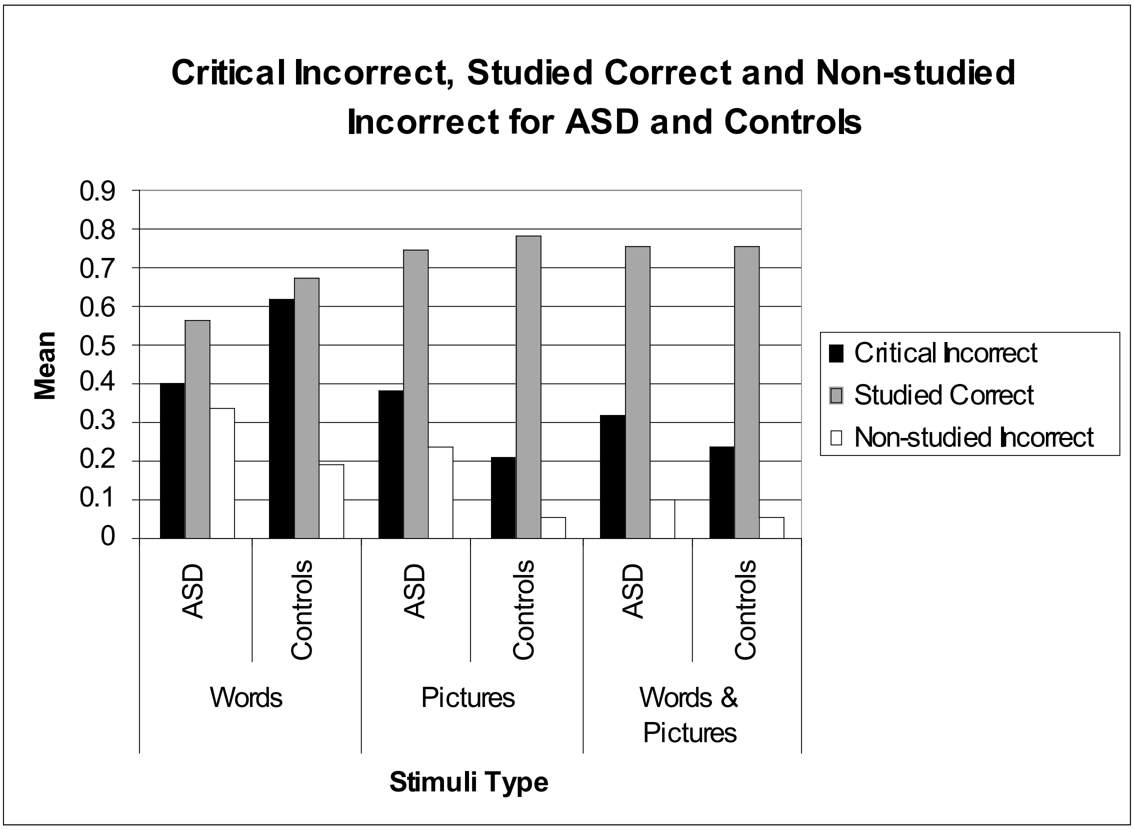


Figure 8: Critical incorrect, studied correct and non-studied incorrect for Experiments 3a,b and c.

Table 7: Post – Hoc Independent Samples t-Test: ASD v Controls

N=25	t	Sig. (2-tailed)
	Lower	Lower
Words Critical Incorrect	3.633	.001
Words Studied Correct	2.014	.056
Words Non-Studied Incorrect	-1.991	.059
Pictures Critical Incorrect	-4.145	.001
Pictures Studied Correct	.666	.512
Pictures Non-Studied Incorrect	-4.255	.001
Words & Pictures Critical Incorrect	-.875	.390
Words & Pictures Studied Correct	-.062	.951
Words & Pictures Non-Studied Incorrect	-.994	.330

The independent t-tests show that the critical words incorrect are significantly lower (t (24) = 3.63, $p < 0.001$) for ASD individuals (M = 0.4, SD = 0.11) compared with controls (M = 0.62, SD = 0.19). Furthermore, although the results for studied correct and non-studied incorrect just miss significance (p = 0.056 and p = 0.059 respectively), they indicate a trend for ASD individuals to produce less studied words correct and more non-studied words incorrect in comparison with controls. Independent t-tests for the picture only condition show ASD individuals (M = 0.39, SD = 0.11) have significantly higher critical lures incorrect (t (24) = -4.14, $p < 0.001$) in comparison with controls (M = 0.21, SD = 0.10). The means for ASD individuals (M = 0.24, SD = 0.12) for pictures non-studied incorrect are also significantly higher (t (24) = -4.25, $p < 0.001$) compared with controls (M = 0.06, SD = 0.08).

Finally, the t-tests show no significant differences for critical lures incorrect, studied items correct or non-studied items incorrect between ASD individuals and controls in the word *and* picture condition.

As we are also interested in the differing performances within the three conditions for ASD individuals we carried out paired-samples t-tests. The results can be found in Table 8.

Table 8: Paired samples t-tests for the three conditions for ASD and Controls

	Controls N = 12				ASD N= 13			
Pair	Mean	SD	t	Sig (2-tailed)	Mean	SD	t	Sig (2-tailed)
WCI - PCI	.41	.23	6.227	.001	.01	.12958	.193	.850
WCI - WPCI	.37	.22	6.032	.001	.07	.20015	1.358	.199
PCI - WPCI	-.03	.16	-.753	.467	.07	.27640	.893	.389
WSC - PSC	-.10	.15	-2.445	.033	-.18	.19972	-3.229	.007
WSC - WPSC	-.08	.16	-1.792	.101	-.19	.12424	-5.581	.001
PSC - WPSC	.03	.07	1.319	.214	-.01	.15482	-.314	.759
WNSI - PNSI	.13	.12	3.770	.003	.10	.24300	1.484	.164
WNSI - WPNSI	.13	.16	2.937	.014	.23	.18550	4.575	.001
PNSI - WPNSI	.00	.07	.000	1.000	.13	.13245	3.685	.003

WCI = Word critical incorrect
PCI = Picture critical incorrect
WPCI = Word & Picture critical incorrect
WSC = Word studied correct
PSC = Picture studied correct
WPSC = Word & Pictures studied correct
WNSI = Word non-studied incorrect
PNSI = Picture non-studied incorrect
WPNSI = Word & Picture non-studied incorrect

Paired samples t-tests indicated that between the three conditions (word, picture, word *and* picture) there were no significant differences for critical lures incorrect for the ASD individuals. Controls, however, showed significant differences for the critical lures incorrect between the word and picture condition ($p < 0.01$), the word and word *and* picture condition ($p < 0.01$), but not between the picture and word *and* picture condition.

The studied items correct paired samples t-tests showed significant increases for ASD individuals between the word and the picture condition ($p < 0.05$); the word and word *and* picture condition ($p < 0.01$); but no differences between the picture and word *and* picture condition. Finally, for the non-studied items incorrect controls showed a significant decrease between the word and picture condition ($p < 0.01$), and the word and word and picture condition ($p < 0.05$). The ASD individuals also showed significant decreases for non-studied items for the word and word *and* picture condition ($p < 0.01$), and the picture and word *and* picture condition ($p < 0.01$).

Signal Detection Analysis

Using Snodgrass and Corwin's (1988) recommendations for signal detection we explored corrected true and false recognition and response bias for ASD individuals and controls. The results are shown in Figure 9.

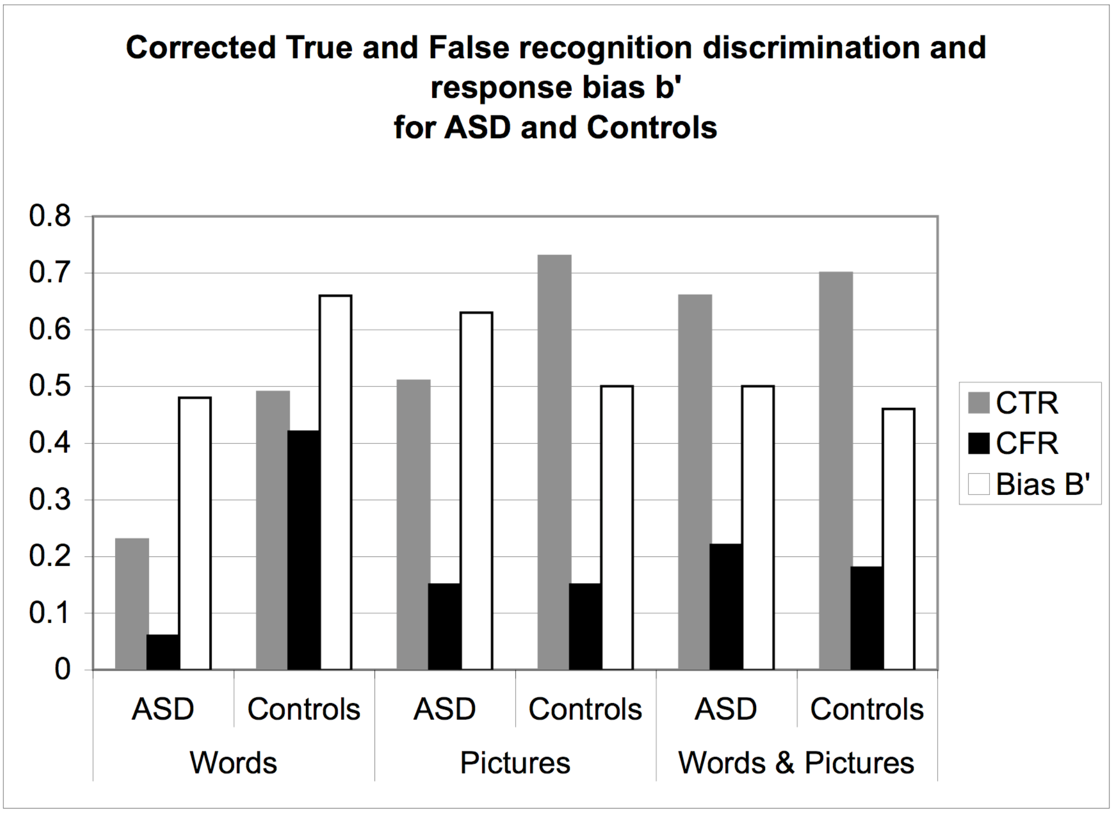


Figure 9: Corrected True (CTR) and Corrected False Recognition (CFR) and Response Bias for controls and ASD individuals.

Table 9 shows the descriptive statistics for corrected true and false recognition. A response Bias of 0.5 is a neutral score (that is equal 'Yes' and 'No'), more than 0.5 is a liberal response bias (tendency to say 'Yes' more) and less than 0.5 is a conservative response bias (tendency to say 'No' more frequently).

Table 9: Descriptive Statistics for Corrected True Recognition (CTR) and Corrected False Recognition (CFR) and Response Bias.

	Words		**Pictures**		**Words & Pictures**	
	ASD *M* (SD)	Controls *M* (SD)	ASD *M* (SD)	Controls *M* (SD)	ASD *M* (SD)	Controls *M* (SD)
CTR	0.23 (0.24)	0.49 (0.17)	0.51 (0.19)	0.73 (0.14)	0.66 (0.21)	0.70 (0.16)
CFR	0.06 (0.18)	0.42 (0.23)	0.15 (0.12)	0.15 (0.09)	0.22 (0.24)	0.18 (0.13)
Bias *b*'	0.48 (0.12)	0.66 (0.14)	0.63 (0.18)	0.50 (0.19)	0.50 (0.27)	0.46 (0.28)

The results were subjected to a 2 X 3 repeated measures ANOVA with Discrimination (Corrected True Recognition and Corrected False Recognition) and Condition (words, pictures, words and pictures) as the two main factors. There was a significant main effect for Condition F (2, 46) = 8.61, $p < 0.05$. Between group analysis showed a significant interaction between Group, Condition and Discrimination, F (2, 46) = 4.59, $p < 0.05$.

As above we then carried out independent samples t-tests this time for Corrected True Recognition, Corrected False Recognition and response Bias. The results can be seen in Table 10.

Table 10: Independent Samples t-tests for CTR, CFR and Response Bias.

N = 25	t	Sig. (2-tailed)
	Lower	Lower
Words Corrected True Recognition	-3.064	.006
Words Corrected False Recognition	-4.386	.001
Words Response Bias	-3.270	.003
Pictures Corrected True Recognition	-3.187	.004
Pictures Corrected False Recognition	.133	.895
Pictures Response Bias	1.861	.076
Words & Pictures Corrected True Recognition	-.513	.613
Words & Pictures Corrected False Recognitions	.482	.634
Words & Pictures Response Bias	.321	.751

For the word only condition there were significant differences in means for Corrected True Recognition ($p < 0.05$), Corrected False Recognition ($p < 0.001$) and Response Bias ($p < 0.05$). ASD individuals, therefore, produced less corrected true and false recognition than controls and also show a more liberal response bias; that is a tendency to say 'Yes'. In the Picture only condition there was a significant difference between the two groups for Corrected True Recognition ($p < 0.05$), that is, ASD individuals had less correct recognition of the studied pictures in comparison with controls. This is due to the fact that in this condition, as we saw above, ASD individuals still produced higher false recognition to the non-studied items than controls. There were no significant differences between ASD individuals and controls in the word *and* picture condition.

As above, because we are also interested in the differing performances within the three conditions for ASD individuals we carried out paired-samples t-tests. The results can be found in Table 11.

Table 11: Paired Samples t-test for Corrected True Recognition, Corrected False Recognition and response Bias (*b'*) for controls and patients

	Controls N = 12				ASD N = 12			
Pair	Mean	SD	t	Sig (2-tailed)	Mean	SD	t	Sig (2-tailed)
WCTR - PCTR	-.24	.14	-5.85	.001	-.28	.30	-3.38	.005
WCTR - WPCTR	-.21	.21	-3.52	.005	-.43	.22	-6.90	.001
PCTR - WPCTR	.03	.10	.96	.357	-.15	.17	-3.05	.010
WCFR - PCFR	.28	.28	3.45	.005	-.09	.23	-1.47	.166
WCFR - WPCFR	.24	.24	3.46	.005	-.16	.35	-1.64	.126
PCFR - WPCFR	.16	.24	2.29	.042	-.07	.24	-1.01	.332
WBias – Pbias	.20	.29	2.35	.039	-.15	.17	-3.18	.008
WBias - WPBias	.04	.24	.55	.595	-.010	.25	-.15	.886
PBias - WPBias	-.24	.14	-5.85	.001	.14	.29	1.74	.108

WCTR = Word Corrected True Recognition
PCTR = Picture Corrected True Recognition
WPCI = Word & Picture Corrected True Recognition
WCFR = Word Corrected False Recognition
PCFR = Picture Corrected False Recognition
WPCFR = Word & Pictures Corrected False Recognition
WBias = Word response Bias
PBias = Picture response Bias
WPBias = Word & Picture response Bias

There were no significant differences for the three conditions for ASD individuals and Corrected False Recognition. However, there was for Corrected True Recognition with a gradual increase across the three conditions and this was significant for words, pictures and words *and* pictures. There was a significant difference for ASD individuals in response bias between the word and picture condition ($p < 0.05$) as these individuals moved from a neutral response bias (*b'* = 0.48) to a more liberal bias (*b'* = 0.63).

In contrast, controls showed a significant difference between the word and picture condition and between the word and word *and* pictures condition for Corrected True Recognition ($p < 0.001$ and $p < 0.05$) respectively. Controls also showed a significant difference in performance between all three conditions for Corrected False Recognition ($p < 0.05$ for each paired sample). There was also a significant difference for response bias between the word and picture condition ($p <$

0.05) as they moved from a liberal response bias in the word condition (*b*' = 0.66) to a neutral response in the picture condition (*b'* = 0.5). There was also a significant difference for controls response bias between the picture condition and the word *and* pictures condition ($p < 0.001$) as they moved from a neutral response bias in the picture condition (*b'* = 0.5) to a more conservative response bias in the word *and* pictures condition (*b'* = 0.46).

4.2.5 Discussion

We began with several hypotheses regarding the performance of individuals with high-functioning autism spectrum disorder (ASD). The first stated that if Beversdorf et al. (2001) were correct in arguing the ASD individuals lacked the ability to form good associations between words then they would show lower false recognition to the critical lures. This was supported by our results, with the ASD group showing significantly lower false recognition to the critical lures compared with controls. However, we also extended this argument to say that if poor gist association was the cause for this difference then it would seem logical to argue that gist memory would also result in poor discrimination in ASD individuals; that is they would be unable to use gisting details to filter out incorrect false recognition to the non-studied words. They would, therefore, show significantly lower *corrected* true and false recognition compared with controls, coupled with a more positive response bias. Our results also supported this hypothesis. Corrected true recognition was indeed significantly lower in ASD individuals and they had a significantly more positive response bias in comparison with controls.

Secondly, for the picture only condition we argued that ASD individuals lacked what Whitehouse et al. (2006) call 'inner speech' and so would be unable to internally name the pictures as they appeared. The ASD individuals would, therefore, perform in a similar manner to the word-only condition with regards to false recognition to the critical lures. Again, results supported this hypothesis with ASD individuals showing no difference in performance for critical lures incorrect between the word and the picture condition.

We also stated that since ASD individuals were relying more on perceptual features, in the picture-only condition their performance on the studied items should also improve in comparison with the word-only condition. They should, therefore, have higher corrected true recognition compared with the word-only condition since they get more of the studied pictures correct. This pattern of performance was confirmed by paired samples t-tests for the two conditions, which was significant. We also argued that their corrected false recognition should show no change between the word and the picture condition due to the persistence in incorrectly saying 'Yes' to the non-studied items increase. The reason for this is an increase in response bias from the word condition to the picture condition and this was supported by the paired samples t-tests. In contrast, the control group were able to suppress their false recognition to the critical lures in the picture-only condition, and since they can use gist information they can easily discriminate between the non-studied items and studied items and hence produce almost no incorrect responses to the non-studied pictures.

Finally, we argued that by giving added information in the form of a word *and* picture condition we could help ASD individuals by providing additional semantic information and hence aid their gist representation. ASD individuals would increase their false recognition to the critical lures. The results supported this hypothesis for critical incorrect, studied correct, corrected true and false recognition and response bias in that the ASD individuals did not differ significantly from controls.

In conclusion, our results support the findings of Beversdorf et al. (2001) that individuals with high-functioning autism spectrum disorder produce less false recognition in the Deese, Roediger and McDermott paradigm. This may be due to an inability of ASD individuals to form good gist associations to the studied words. Furthermore, this lack of gist representation means that in a picture-only condition they still remain unable to discriminate between critical words and studied items and also studied items and non-studied items resulting in false recognition compared with controls. However, they can use some distinct features to increase their corrected true recognition. Finally, by providing them with added information we were able to get ASD individuals to perform like controls in a word *and* picture condition.

However, Beversdorf et al. (2000) used adults (Age M = 31.8) and our experiment used adolescents and young adults. If gist memory is a process which develops with age, then this may also be true with Autism population. The data from the Madrid ASD individuals in the next experiment may help us explore this possibility.

4.3 Experiment 4a, b and c: False recognition adults with autism spectrum disorder.

4.3.1 Patient and Control Data

Individuals with Autism were all recruited from the Asociación Nuevo Horizonte, Madrid from the clinic run by Professor Garcia-Villamisar. Controls were recruited locally in Madrid.

Table 12: Demographic data for participants.

Autism Individuals N=10 Subject No.	Age	Sex	Controls N=10 Subject No.	Age	Sex
1	30	M	1	27	M
2	30	M	2	45	F
3	30	F	3	30	M
4	30	F	4	24	F
5	33	M	5	29	F
6	20	M	6	28	M
7	20	M	7	36	M
8	32	M	8	28	F
9	38	M	9	27	F
10	33	M	10	31	M
M	29.60		*M*	30.50	
SD	5.62		SD	5.99	

Initially, eleven ASD individuals were recruited but one participant was dropped due to data loss.

4.3.2 Method and Materials

The methods and materials were identical to those used in *Experiments 3a, b* and *c*. The Spanish Word Lists can be found in the *Appendix C*. Professor Domingo Garcia-Villamisar, who is a native Spanish speaker, ran the experiments.

4.3.3 Design

The design was identical to *Experiments 3a, b* and *c*.

4.3.4 Results

Table 13 shows the descriptive statistics for *Experiments 4a, b* and *c*. *Experiment 4a* was the word only condition, *Experiment 4b* is the picture only condition and *Experiment 4c* is the word *and* picture condition.

Table 13: Descriptive Statistics for Experiments 4a, b and c.

	Words (4a)		**Pictures (4b)**		**Words & Pictures (4c)**	
Stimuli	ASD *M%* (SD)	Controls *M%* (SD)	ASD *M%* (SD)	Controls *M%* (SD)	ASD *M%* (SD)	Controls *M%* (SD)
Critical Incorrect (12 Items)	76.60 (21.95)	80.80 (12.52)	73.30 (27.33)	25.10 (13.27)	46.70 (22.89)	36.60 (11.86)
Studied Correct (24 Items)	89.65 (9.14)	88.00 (7.08)	85.32 (16.28)	85.75 (9.47)	81.35 (17.38)	89.30 (11.59)
Non-studied Incorrect (12 Items)	75.70 (20.36)	40.70 (10.77)	69.20 (32.25)	10.30 (10.36)	46.60 (33.20)	31.80 (19.98)

The responses were subject to a 3 X 3 repeated measures ANOVA was carried out with Stimuli Type (critical incorrect, studied correct and non-studied incorrect) and Condition (words, pictures, words and pictures) as the two main factors. There was a significant main effect for Stimuli Type, $F(2, 18) = 22.94$, $p < 0.01$ and Condition $F(2, 18) = 66.66$, $p < 0.01$. Between group analysis showed a significant interaction between Group and Stimuli Type, $F(2, 36) = 12.88$, $p < 0.01$, and Group and Condition, $F(2, 36) = 13.77$, $p < 0.01$. Since the ANOVAs indicated significant differences between the three conditions (See Figure 10) in order to explore this in depth between the two groups *post hoc* analyses using between group independent samples one-tailed t-tests were carried out. The results can be found in Table 14.

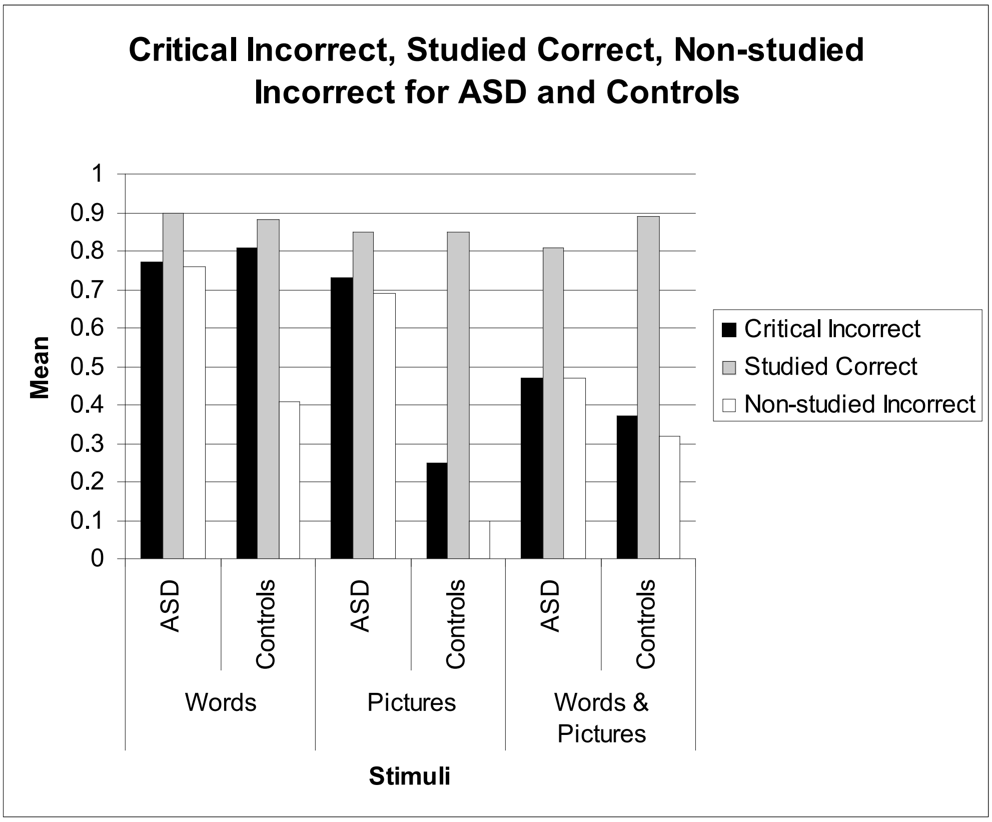


Figure 10: Critical Incorrect, studied correct and non-studied incorrect for Experiments 4a, b and c.

Table 14: Post – Hoc Independent Samples t-Tests: ASD v Controls

N= 20 (df = 18)	t	Sig. (2-tailed)
Words Critical Incorrect	-0.52	.606
Words Studied Correct	.438	.667
Words Non-Studied Incorrect	4.80	.001
Pictures Critical Incorrect	5.10	.001
Pictures Studied Correct	-0.03	.973
Pictures Non-Studied Incorrect	5.53	.001
Words & Pictures Critical Incorrect	1.24	.231
Words & Pictures Studied Correct	-1.21	.243
Words & Pictures Non-Studied Incorrect	1.21	.243

The independent t-tests show that the non-studied words incorrect are significantly lower (t (18) = 4.80, $p < 0.01$) for ASD individuals (M = 0.76, SD = 0.20) compared with controls (M = 0.41, SD = 0.11). There were no significant differences found for critical words incorrect or studied words correct. Independent t-tests for the picture only condition show ASD individuals (M = 0.73, SD = 0.27) have significantly higher critical lures incorrect (t (18) = 5.10, $p < 0.01$) in comparison with controls (M = 0.25, SD = 0.13). The means for ASD individuals (M = 0.69, SD = 0.32) for pictures non-studied incorrect are also significantly higher (t (18) = -4.25, $p < 0.01$) compared with controls (M = 0.10, SD = 0.10).

Finally, the t-tests showed no significant differences for critical lures incorrect, studied items correct or non-studied items incorrect between ASD individuals and controls in the word *and* picture condition.

As we are also interested in the differing performances within the three conditions for ASD individuals we carried out paired-samples t-tests. The results can be found in Table 15.

Table 15: Paired samples t-tests for the three conditions for ASD and controls.

	Controls N = 10				ASD N = 10			
Pair	Mean	SD	t	Sig (2-tailed)	Mean	SD	t	Sig (2-tailed)
WCI - PCI	.56	.15	11.76	.001	.03	.29	.356	.730
WCI - WPCI	.44	.15	8.88	.001	.29	.23	4.14	.003
PCI - WPCI	-.12	.22	-1.68	.126	.26	.33	2.53	.032
WSC - PSC	.03	.09	.897	.393	.04	.20	.707	.497
WSC - WPSC	-.01	.09	-.408	.693	.08	.19	1.33	.216
PSC - WPSC	-.04	.12	-.998	.344	.04	.08	1.45	.180
WNSI - PNSI	.31	.15	6.33	.001	.06	.22	.950	.367
WNSI - WPNSI	.09	.22	1.262	.239	.29	.34	2.71	.024
PNSI - WPNSI	-.21	.211	-3.257	.01	.22	.27	2.61	.028

WCI = Word critical incorrect
PCI = Picture critical incorrect
WPCI = Word & Picture critical incorrect
WSC = Word studied correct
PSC = Picture studied correct
WPSC = Word & Pictures studied correct
WNSI = Word non-studied incorrect
PNSI = Picture non-studied incorrect
WPNSI = Word & Picture non-studied incorrect

Paired samples t-tests for critical lures incorrect found a significant decrease between the word condition and the word *and* picture condition ($p < 0.01$) for ASD individuals. There was also a significant decrease for critical lures between the picture condition and the word *and* picture condition ($p < 0.05$). However, there was no difference found for critical lures incorrect between the word and picture conditions. In contrast, controls showed a significant decrease between the word and picture conditions for critical lures incorrect ($p < 0.01$); and a significant *increase* between the word and the word and picture conditions (p < 0.01).

However, there were no significant differences for the two groups for any of the studied correct conditions (words, pictures, words *and* pictures). Finally, for the non-studied items incorrect, controls showed a significant decrease between the word and picture condition ($p < 0.01$), but a significant increase between the picture and the word *and* picture condition (p <0.05). In contrast, the ASD individuals showed a significant decrease between the word and word *and* picture condition ($p < 0.05$), and also the picture and word *and* picture condition ($p < 0.05$).

Signal Detection Analysis

The results for signal detection (corrected true and false recognition and response bias) are shown in Figure 11.

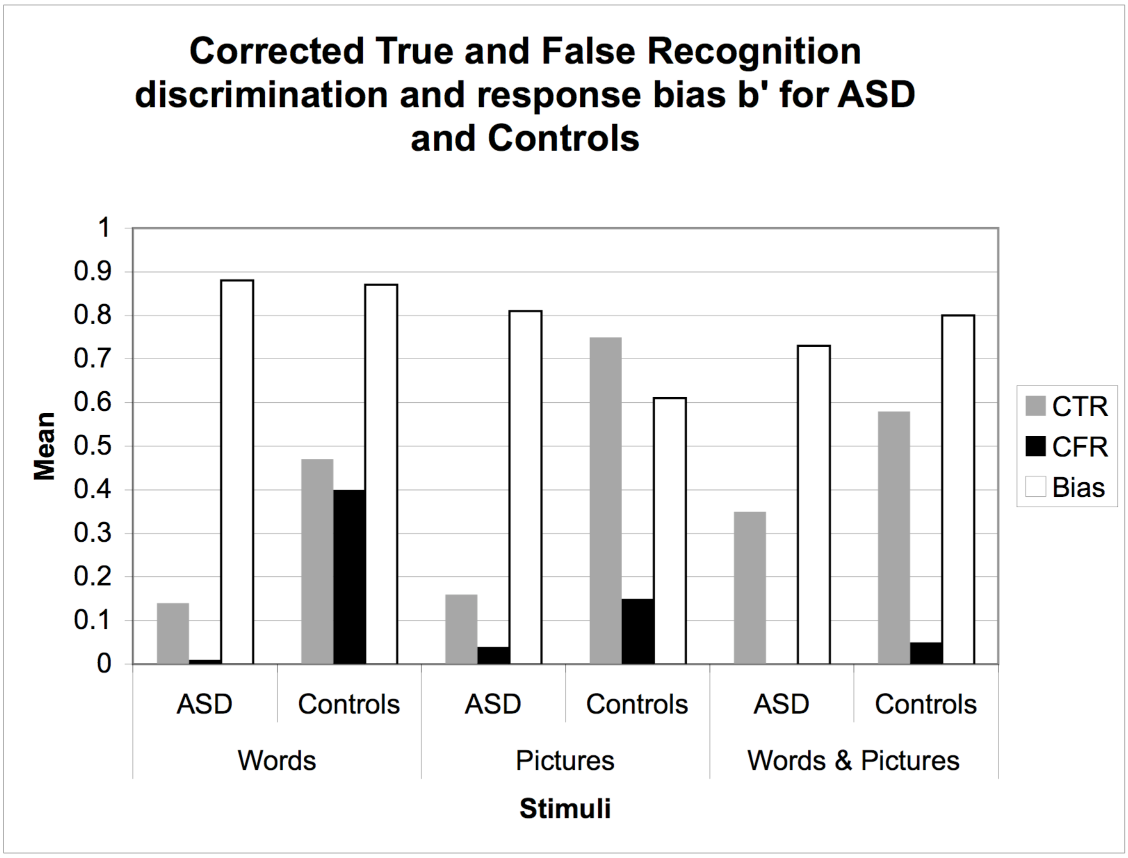


Figure 11: Corrected True (CTR) and Corrected False Recognition (CFR) and response bias for controls and ASD individuals.

Table 16 shows the descriptive statistics. A response Bias of 0.5 is a neutral score (that is equal 'yes' and 'no'), more than 0.5 is a liberal response bias (tendency to say 'yes' more) and less than 0.5 is a conservative response bias (tendency to say 'no' more).

Table 16: Descriptive Statistics for Corrected True Recognition (CTR), Corrected False Recognition (CFR) and Response Bias.

	Words (4a)		**Pictures (4b)**		**Words & Pictures (4c)**	
	ASD *M* (SD)	Controls *M* (SD)	ASD *M* (SD)	Controls *M* (SD)	ASD *M* (SD)	Controls *M* (SD)
CTR	0.14 (0.16)	0.47 (0.11)	0.16 (0.33)	0.75 (0.14)	0.35 (0.36)	0.58 (0.15)
CFR	0.01 (0.19)	0.40 (0.19)	0.04 (0.26)	0.15 (0.12)	0.00 (0.44)	0.05 (0.25)
Bias *b'*	0.88 (0.10)	0.87 (0.07)	0.81 (0.25)	0.61 (0.14)	0.73 (0.22)	0.80 (0.17)

The results were subjected to a 2 X 3 repeated measures ANOVA with Discrimination (Corrected True Recognition and Corrected False Recognition) and Condition (words, pictures, words and pictures) as the two main factors. There was no significant main effect for Condition F (2, 18) = .152, p < n.s. Between group analysis showed a significant interaction between Discrimination and Group, F (2, 36) = 12.48, $p < 0.01$; and also Group, Condition and Discrimination, F (2, 36) = 13.58, $p < 0.01$.

We again carried out independent samples t-tests for Corrected True Recognition, Corrected False Recognition and also included response Bias. The results can be seen in Table 17.

Table 17: Post – Hoc Independent Samples t-Tests for CTR, CFR and Response Bias

N = 20 (df = 18)	t	Sig. (2-tailed)
Words Corrected True Recognition	-5.502	.001
Words Corrected False Recognition	-4.591	.001
Words Response Bias	0.130	.898
Pictures Corrected True Recognition	-5.254	.001
Pictures Corrected False Recognition	-1.158	.262
Pictures Response Bias	2.168	.044
Words & Pictures Corrected True Recognition	-1.866	.078
Words & Pictures Corrected False Recognitions	-0.293	.773
Words & Pictures Response Bias	-0.765	.454

For the word only condition there were significant differences in means for Corrected True Recognition ($p < 0.01$), Corrected False Recognition ($p < 0.01$), but no significant difference for the Response Bias, with both groups producing liberal responses. ASD individuals, therefore, produced less corrected true and false recognition than controls as a result of poor discrimination of the non-studied incorrect words. In the Picture only condition there was a significant difference between the two groups for Corrected True Recognition ($p < 0.01$) and response bias ($p < 0.05$), that is ASD individuals had less correct recognition of the studied pictures in comparison with controls and maintain the liberal response bias. There are no significant differences between ASD individuals and controls in the word *and* picture only condition.

As above, because we were also interested in the differing performances within the three conditions for ASD individuals we carried out paired-samples t-tests. The results can be found in Table 18.

Table 18: Paired Samples t-test for Corrected True Recognition, Corrected False Recognition and response Bias (*b'*) for Controls and ASD.

	Controls N = 10				ASD N = 10			
Pair	Mean	SD	t	Sig (2-tailed)	Mean	SD	t	Sig (2-tailed)
WCTR - PCTR	-.28	.16	-5.42	.001	-.02	.21	-.312	.762
WCTR - WPCTR	-.10	.20	-1.59	.147	-.21	.32	-2.05	.071
PCTR - WPCTR	.18	.12	4.71	.001	-.18	.28	-2.11	.064
WCFR - PCFR	.255	.20	4.01	.003	-.03	.25	-.391	.705
WCFR - WPCFR	.35	.35	3.21	.011	.01	.43	.058	.955
PCFR - WPCFR	.09	.33	.933	.375	.04	.43	.293	.776
WBias – Pbias	.25	.13	6.11	.001	.06	.28	.686	.510
WBias - WPBias	.07	.14	1.65	.133	.14	.25	1.82	.101
PBias - WPBias	-.18	.21	-2.64	.027	.08	.20	1.29	.229

WCTR = Word Corrected True Recognition
PCTR = Picture Corrected True Recognition
WPCI = Word & Picture Corrected True Recognition
WCFR = Word Corrected False Recognition
PCFR = Picture Corrected False Recognition
WPCFR = Word & Pictures Corrected False Recognition
WBias = Word response Bias
PBias = Picture response Bias
WPBias = Word & Picture response Bias

There were no significant differences between the three conditions for ASD individuals for Corrected False Recognition, Corrected True Recognition and response Bias. However, there was a trend in the ASD results for a gradual increase in Corrected True Recognition across words, pictures and then words *and* pictures.

In contrast, controls showed a significant increase between the word and picture condition and a significant decrease between the picture and word *and* pictures condition for Corrected True Recognition ($p < 0.01$ and $p < 0.01$) respectively). Controls also showed a significant decrease in Corrected False Recognition between words and pictures, and between words and words *and* pictures ($p < 0.01$ and $p < 0.05$ respectively). There was also a significant difference for response bias between the word and picture condition ($p < 0.01$) as they moved from a liberal response bias in the word condition (*b*' = 0.87) to a more neutral response in the picture condition (*b'* = 0.61). There was also a significant difference for controls response bias between the picture condition and the word *and* pictures condition ($p < 0.05$) as they moved from a neutral response bias in the picture condition (*b'* = 0.61) to a more liberal response bias in the word *and* pictures condition (*b'* = 0.80).

4.3.5 Discussion

The first hypothesis stated that ASD individuals would show lower false recognition to the critical lures in the word only condition. This was not supported by our raw (uncorrected) results in Madrid by the independent samples t-test. However, the ASD individuals did still produce lower *corrected* true *and* false recognition in comparison with controls and these were significant as shown by our independent samples t-tests. This suggests that asdult ASD individuals still lack the necessary gist representation to filter out the non-studied words resulting in a liberal response bias and lower corrected true and false recognition. Hence we can still argue that their results support the hypothesis since they also have significantly lower corrected false recognition in comparison with controls.

Secondly, we argued for the picture only condition ASD individuals would perform in a similar manner to the word-only condition with regards to false recognition to the critical lures. Again, our results for Madrid supported this hypothesis with adult ASD individuals showing no difference in paired samples t-tests for false recognition to the critical lures between the word and picture condition.

We also hypothesised that ASD individuals should have higher corrected true recognition in the picture condition compared with the word-only condition since they were able to use more perceptual details to remember the items. This was not supported by paired samples t-tests for the two conditions. The Madrid ASD individuals produced more false recognition to the non-studied items. We will discuss this finding below. However, we also argued that their corrected false recognition should show no change between the word and the picture condition and this was supported by our results.

Finally, we argued in the word *and* picture condition we could help ASD individuals increase their gist memory by providing additional semantic and perceptual details. ASD individuals should show an increase in corrected true and false recognition in comparison to *Experiments 4a* and *b*. The results only partially supported this hypothesis with an increase in corrected true recognition but not corrected false recognition. However, their pattern of performance in the words and picture condition was comparable with controls with no significant differences except the more liberal response bias in the ASD group.

The results from Madrid support Beversdorf et al. (2001) findings in that corrected true and false recognition in a word condition were lower in adult ASD individuals than controls. They also support the argument that there is no difference in false recognition between the word and picture condition. Also, the ASD individuals could use the binding properties and performed like controls in the word *and* picture condition.

However, the picture condition differed from the Columbian results in that there was no increase in corrected true recognition for ASD individuals in comparison with their performance on the word condition. This is discussed below.

4.4 General Discussion

Our two experiments are consistent with the findings of Beversdorf et al. (2001) in that both ASD groups showed reduced corrected true and false recognition in a word DRM paradigm. We also argued their performances would not change with regards to false recognition of critical lures and therefore corrected false recognition in a picture paradigm since they lacked the ability to 'name' pictures and hence access semantic and gist details. The results also supported this. The descriptive statistics of the two groups are shown in Table 19.

Table 19: Descriptive statistics for Madrid v Columbia

		Words		Pictures		Words & Pictures	
		ASD *M*% (SD)	Controls *M*% (SD)	ASD *M*% (SD)	Controls *M*% (SD)	ASD *M*% (SD)	Controls *M*% (SD)
Critical Incorrect (12 Items)	**Columbia**	**39.62 (11.36)**	**61.83 (18.63)**	**38.92 (11.48)**	**20.75 (10.35)**	**32.07 (26.11)**	**24.25 (17.27)**
	Madrid	76.60 (21.95)	80.80 (12.52)	73.30 (27.33)	25.10 (13.27)	46.70 (22.89)	36.60 (11.86)
Studied Correct (24 Items)	**Columbia**	**57.12 (14.76)**	**68.04 (11.98)**	**74.99 (17.09)**	**78.88 (10.60)**	**76.27 (12.99)**	**75.96 (10.97)**
	Madrid	89.65 (9.14)	88.00 (7.08)	85.32 (16.28)	85.75 (9.47)	81.35 (17.38)	89.30 (11.59)
Non-studied Incorrect (12 Items)	**Columbia**	**33.78 (21.07)**	**19.41 (13.90)**	**23.77 (12.05)**	**6.17 (8.05)**	**10.25 (10.33)**	**6.17 (10.06)**
	Madrid	75.70 (20.36)	40.70 (10.77)	69.20 (32.25)	10.30 (10.36)	46.60 (33.20)	31.80 (19.98)

However, we stated that if relying on perceptual details of pictures ASD individuals should increase their performance on corrected true recognition, since in both cases response bias should increase. However, this was only true for the Columbian younger ASD group, the older Madrid group did not show an increase in corrected true recognition (Table 20) as a result of the persistence of high false recognition to the non-studied, unrelated pictures.

Table 20: Discrimination and Response Bias for Madrid and Columbia

		Words		Pictures		Words & Pictures	
		ASD *M (SD)*	Controls *M (SD)*	ASD *M (SD)*	Controls *M (SD)*	ASD *M (SD)*	Controls *M (SD)*
Corrected True Recognition	**Columbia**	**0.23 (0.24)**	**0.49 (0.17)**	**0.51 (0.19)**	**0.73 (0.14)**	**0.66 (0.21)**	**0.70 (0.16)**
	Madrid	0.14 (0.16)	0.47 (0.11)	0.16 (0.33)	0.75 (0.14)	0.35 (0.36)	0.58 (0.15)
Corrected False Recognition	**Columbia**	**0.06 (0.18)**	**0.42 (0.23)**	**0.15 (0.12)**	**0.15 (0.09)**	**0.22 (0.24)**	**0.18 (0.13)**
	Madrid	0.01 (0.19)	0.40 (0.19)	0.04 (0.26)	0.15 (0.12)	0.00 (0.44)	0.05 (0.25)
Response Bias	**Columbia**	**0.48 (0.12)**	**0.66 (0.14)**	**0.63 (0.18)**	**0.50 (0.19)**	**0.50 (0.27)**	**0.46 (0.28)**
	Madrid	0.88 (0.10)	0.87 (0.07)	0.81 (0.25)	0.61 (0.14)	0.73 (0.22)	0.80 (0.17)

However, finding these differences between the two groups may not be unusual. When we consider the control data we also find there are differences between the Madrid controls and the Columbian controls. For example, the adult Madrid controls demonstrated a far more liberal response bias across all three conditions. They also produced higher critical lures incorrect, studied words correct, and non-studied words incorrect for the word condition and the word *and* picture condition and these results were significant (see Table 21). This is not surprising given the work of Kensinger and Schacter (1999) who use Fuzzy Trace Theory (Reyna & Brainerd, 1995) to argue that as adults age they begin to rely more on gist memory traces than veridical recognition and hence their false recognition to the critical lures increases.

Table 21: Madrid v Columbia Controls

Controls: Columbia v Madrid	t	Sig. (2-tailed)
Age	6.467	.001
Words Critical Incorrect	2.739	.013
Words Studied Correct	4.650	.001
Words Non-Studied Incorrect	3.948	.001
Words Corrected True Recognition	-.200	.844
Words Corrected False Recognition	-.250	.805
Words Response Bias	4.457	.001
Pictures Critical Incorrect	.780	.445
Pictures Studied Correct	1.556	.135
Pictures Non-Studied Incorrect	.980	.339
Pictures Corrected True Recognition	.479	.637
Pictures Corrected False Recognition	.004	.997
Pictures Response Bias	1.636	.118
Words & Pictures Critical Incorrect	1.913	.070
Words & Pictures Studied Correct	2.762	.012
Words & Pictures Non-Studied Incorrect	3.902	.001
Words & Pictures Corrected True Recognition	-1.836	.081
Words & Pictures Corrected False Recognition	-1.636	.117
Words & Pictures Response Bias	3.338	.003

If controls showed this age difference in false and true recognition performance it is not illogical to suggest so too do the individuals with ASD. The comparison between the Madrid and Columbian ASD individuals can be found in Table 22.

Table 22: Madrid v Columbia ASD Individuals

ASD Individuals: Columbia v Madrid	t	Sig. (2-tailed)
Age	6.923	.001
Words Critical Incorrect	5.252	.001
Words Studied Correct	6.114	.001
Words Non-Studied Incorrect	4.798	.001
Words Corrected True Recognition	-1.081	.292
Words Corrected False Recognition	-.636	.532
Words Response Bias	8.111	.001
Pictures Critical Incorrect	4.110	.001
Pictures Studied Correct	1.452	.161
Pictures Non-Studied Incorrect	4.697	.001
Pictures Corrected True Recognition	-3.230	.004
Pictures Corrected False Recognition	-1.363	.187
Pictures Response Bias	1.940	.066
Words & Pictures Critical Incorrect	1.402	.175
Words & Pictures Studied Correct	.794	.436
Words & Pictures Non-Studied Incorrect	3.744	.001
Words & Pictures Corrected True Recognition	-2.648	.015
Words & Pictures Corrected False Recognition	-1.506	.147
Words & Pictures Response Bias	2.216	.038

Although the two ASD groups show comparable true and false recognition for the word condition, there are differing reasons for the results. The adult Madrid ASD group had a more liberal response bias resulting in high incorrect responses to the non-studied words. This in turn produced low corrected true and false recognition (since corrected true recognition = studied correct – non-studied incorrect and corrected false recognition = critical incorrect = non-studied incorrect). The younger Columbian group had a more conservative response bias resulting in lower corrected true and false recognition due to low critical lures incorrect and low studied words correct.

Whilst the Columbian ASD group can improve their corrected true recognition in the picture condition the same is not true for the adult Madrid ASD group. The Madrid group still have high non-studied items correct as a result of a more liberal response bias in comparison with the Columbian group. Both groups are comparable to their control groups for their patterns of responses in the word *and* picture condition, but again the adult Madrid group demonstrate a more liberal response bias.

The findings suggest an age difference in ASD individuals' ability to use gist memory to filter out the non-studied items with older participants demonstrating a more liberal response bias. We carried out correlations between age and the results for the word-only paradigm for all the ASD individuals and controls. The correlations can be found in Table 23.

Table 23: Correlations for Age v Results for the Word-Only paradigm.

Age v	Word Critical Incorrect	Word Studied Correct	Word Non-Studied Incorrect	Corrected True Recognition	Corrected False Recognition	Response Bias
	r *p*	*r* *p*	*r* *p*	*r* *p*	*r* *p*	*r* *p*
Controls n = 23	(.463) .03	(.615) .01	(.487) .02	(.053) .82	(.027) .90	(.623) .01
ASD n = 22	(.578) .01	(.714) .01	(.581) .01	(-.114) .60	(-.148) .50	(.771) .01

As can be seen the results for critical incorrect, studied correct and non-studied correct and response bias all show significant positive correlations for both the ASD and control groups. Both groups show an increase in response bias but this could be for different reasons. For example, as controls age they rely more on gist memory traces, as suggested by Kensinger and Schacter (1999). For the ASD individuals it suggests the reverse is true: as they age the ability to use gist memory to filter out the non-studied words becomes harder resulting in the increase in response bias to a more liberal response.

This age difference in ASD individuals suggests that if intervention is introduced early enough through education by providing materials that offer the binding of both word and picture, there could be the possibility of improving what Whitehouse et al. (2006) describe as the lack of 'inner speech' in individuals with ASD. This offers a further avenue of future research to clearly understand when and why this liberal response bias begins in ASD individuals and if it is a result of the failure to encode perceptual and/or semantic details. It could also be that like older adults, those with ASD cannot make use of the distinctive properties of the pictorial stimuli in a similar manner to older adults on a picture paradigm (e.g. Koutstaal & Schacter, 1997).

In conclusion, the work in this chapter has demonstrated that ASD individuals do not maintain robust gist representation as well as normal individuals resulting in reduced corrected true and false recognition in a word DRM paradigm.

The hypothesis related to the picture paradigm was only supported by the Columbian data in that ASD individuals did improve their corrected true recognition but maintained a static performance for critical lures incorrect. However, the results from Madrid indicated the possibility of an age difference in the development of gist memory, with the adult Madrid group showing little or no ability to maintain any gist representation to filter out their incorrect response to the non-studied items. This more liberal response bias was evident across all three conditions. Both groups could use the additional information in the word and picture condition to aid gist representation, but the adult Madrid group produced less corrected true recognition for words *and* pictures compared with controls (although this just missed significance, $p = 0.07$) indicating that they may not be fully able to utilise all the distinct, semantic and perceptual features. This finding suggests that early intervention is required at school age to help ASD individuals develop normal gist memory.

Chapter Five: False Recognition and Gist Memory in Patients with Functional Memory Disorder

5.1 Introduction

Patients presenting with Functional Memory Disorder, that is memory problems without any obvious underlying disease, often have their symptoms labelled as psychological rather than neurological. Functional Memory Disorder includes psychogenic amnesia, medically unexplained memory problems, psychosomatic amnesia or dissociative memory disorder. Functional Memory Disorder (FMD) has been most recently described by Metternich et al. (2009), who also include the term 'functional memory complaint'. They note that a large number of patients who present with memory problems have no underlying major psychiatric cause but they do often present with elevated stress and depression scores in clinical tests. In some instances a patient may be labelled as malingering, which is defined as fabricating or exaggerating the symptoms of mental or physical disorders for a variety of gains such as financial compensation or simply to gain sympathy. Indeed, Hom and Denney (2002) note that differentiating between patients who are wilfully exaggerating memory symptoms and those who may have, say, conversion or other psychiatric disorders is complicated. However, one of the key differentiations between malingering and FMD is that the malingerers have a motive for their behaviour, for example financial gain, avoiding school/work or lighter crime sentences (Ibid.). FMD patients, in particular those considered in this chapter, do not present with any such overt motive.

Recently, Dr Jon Stone and colleagues have suggested ways in which patients with physical functional symptoms can be more adequately assessed and diagnosed within a neurological framework (Stone et al., 2005a). Furthermore, in a subsequent paper (Stone et al., 2005b) they describe how physical functional symptoms can be managed and treated. However, they also note that it is very difficult to discriminate between consciously and unconsciously produced physical functional symptoms. This is particularly true of FMD (for review see Kihlstrom, 2005) and is further complicated by the fact most patients with FMD perform within normal ranges of clinical neuropsychology tests for memory (Metternich et al., 2009). A common feature of malingerers, specifically when using clinical tests, is they often exaggerate their symptoms on memory tests producing a negative response bias (Hom & Denney, 2002). The same cannot be said of FMD patients.

The main aim of this work is to investigate false recognition and false memory in patients with FMD. Around half the patients referred to 'under-65' memory clinics have memory symptoms that are not due to an underlying disease such as dementia. In NHS settings, such symptoms are usually thought to be genuine and the explanation is usually given as an underlying psychological problem such as depression, although in a significant number of cases no specific psychological problem can be found. In medico-legal settings, such memory symptoms are often thought to be consciously manufactured for the purpose of financial gain. We will investigate FMD by using the Deese (1959), Roediger and McDermott (1995) (DRM) paradigm and comparing this performance with normal, healthy individuals. This is primarily to see whether the DRM is sensitive to FMD which may in turn produce added diagnostic value, rather than the current reliance on questionnaires, which rely on subjective responses.

The second aim of our experiment is to investigate whether patients with FMD are more or less susceptible to provoked confabulation compared with normal individuals, using a simple confabulation experiment. Berlyne was amongst the first to define confabulation as, “a falsification of memory occurring in clear consciousness in association with an organically derived amnesia” (Berlyne, p.38, 1972). Furthermore, he distinguished between what he called ‘momentary’ (or ‘provoked’) confabulations and ‘fantastic (or ‘spontaneous’) confabulations. Provoked confabulations are fleeting and and invariably prompted by specific questions about the subject's memory, sometimes consisting of real memories that are subsequently displaced in their temporal context. When later questioned, patients often recognize their initial responses as being incorrect. In contrast, spontaneous confabulations are characterised by unprompted narratives of irrelevant associations, which Berlyne described as ‘wish-fulfilling fantasies’, which may be held with firm conviction (*Ibid.*). In some cases, these patients may actually act upon their confabulation such as attempting to leave the hospital as the patient believes he/she is in fact leaving work to go home. In all cases, patients present with some form of organic amnesia.

One characteristic of FMD is that patients believe their current memory performance is impaired and they could, therefore, be said to be exhibiting a similar memory illusion as shown by amnesic individuals who suffer from spontaneous confabulation. However, normal individuals can also be provoked into producing confabulations that subsequently lead to false memories. For example, Ackil and Zaragoza (2002) examined this phenomenon in adults and children by the use of leading questions regarding what they had seen on a video about a birthday party. In such a paradigm it may be that FMD patients show a greater susceptibility to producing false memories when provoked by mis-information.

We have shown in previous chapters how the Deese (1959), Roediger and McDermott (1995) list learning and recognition paradigm (DRM) has been used to explore some neurological diseases, particularly those that involve memory impairments (e.g. amnesia, Alzheimer's disease, autistic spectrum disorders). Where there is a reduction in false recognition in the DRM, gist memory is thought to be impaired. For normal individuals good gist memory allows strong links to be formed between semantically related words, for example, *bed, night, pillow, nap, tired*, so that when the critical lure 'sleep' is subsequently presented during the recognition phase they are prompted to falsely respond "yes, the word was on the original list." The ability to maintain the conceptual gist of the studied items also allows normal individuals to strongly reject unrelated new words, such as *cathedral*. However, in patients who lack the ability to integrate or retrieve gist representation (particularly found in amnesia patients with damage to the medial temporal lobes, see Koutstaal et al., 2001), links between studied words and semantically related critical lures are harder to form and so false recall/recognition is reduced as amnesia patients are unable to retain the semantic links between the studied items. Amnesia patients also show a reduction in correct hits for studied items compared with controls (*Ibid.*).

Studies have also looked at individual differences in relationship with increased false recognition in the DRM paradigm. For example, Clancy et al. (2000) found an elevated level of false recognition in women who thought that they might have been sexually assaulted as children compared with normal controls. Furthermore, in a related study using the DRM paradigm, Clancy et al. (2002) found individuals reporting recovered or repressed memories of alien abduction were also more susceptible to false recognition and recall. In the latter case such false beliefs may be regarded as a form of confabulation and individuals suffering from them are at a greater susceptibility to false recognition. Although these individuals showed higher false recall and recognition compared with normal controls, their pattern of correct recall and recognition did not differ from control subjects. Clancy and colleagues argued that hypnotic suggestibility, depressive symptoms and schizotypic features were all significant predictors of false recall and recognition.

The above patterns of either degraded false recall and recognition, or increased false recognition caused by psychological trauma or confabulation provide us with a basis from which we can predict how FMD patients might perform. This in turn gives us four hypotheses. Firstly, if gist memory is impaired in these individuals then we would expect them to show reduced false and/or true recognition on the DRM paradigm, as has been suggested to be found in cases of organic memory problems.

The second hypothesis is that this reduced gist memory function will produce reduced true and false memory in a confabulation experiment in functional patients. In a simple confabulation experiment people are asked leading questions about items not present in the picture (for an example of this methodology see Ackil and Zaragoza, 2002). Good episodic and gist memory allows healthy individuals to answer the true questions, that is questions about items that were present in the picture, and subsequently allow them to recall this information when questioned one week later. Furthermore, good gist memory will lead healthy individuals to ‘fill-in-the-gaps’ when asked leading questions about items not present in the pictures, particularly if those questions are congruent with the overall context of the picture. In contrast the functional patients should again show reduced true and false recognition in immediate recall and when questioned one week later, since their gist representation will not allow them to fill in the missing ‘gaps’ hinted at through the leading questions.

However, our third hypothesis argues that if Functional Memory Disorder is a form of unconscious confabulation then we would expect our participants to perform like patients with a dissociative disorder and show increased false recognition of the critical lures in the DRM paradigm (e.g. Clancy et al, 2002). Our fourth hypothesis suggests that these individuals should also, therefore, show an increased tendency for provoked confabulation and be more susceptible than normal individuals to turn this confabulation into a false memory.

5.2 Neuropsychology Tests

Assessment was carried out in two separate sessions (although for one patient this was carried out over three sessions due to fatigue but it should be noted they carried out the confabulation experiment as per the methodology described below). In the first session participants undertook standard psychometric assessment in order to gain measures of intelligence, executive function, depression, anxiety and memory. They also took the first part of the confabulation experiment, which is based in part on an experiment used by Ackil and Zaragoza (2002), described below in the experimental methodology. The second session took place one week later where participants were asked the same questions in order to see if the provoked confabulation has become a false memory. In the second session they also took part in the Deese (1959), Roediger and McDermott (1998) (DRM) paradigm and undertook assessment for malingering using the Tombaugh Test of Memory Malingering (TOMM) (Tombaugh, 1996).

The psychometric tests used are as follows:

1) National Adult Reading Test (Nelson, 1982).
2) Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999).
3) Wechsler Logic test in Wechsler Memory Scale (WMS-III) (Wechsler, 1998).
4) Controlled Oral Word Association (COWA) letter/word fluency test (Spreen & benton, 1969).
5) Partington's trail making test (TMT) parts A & B (Partington & Leiter, 1949).
6) Beck's Depression Inventory 2nd Ed (BDI-II) (Beck et al., 1996).
7) State-Trait Anxiety Inventory (STAI) (Spielberger et al.,1970).

5.3 Participants and Neuropsychology Results

Fifteen aged-matched controls were recruited via the Psychology department's volunteer panel. All were recompensed for their travel costs. Controls were then matched for pre-morbid IQ using the NART. Three controls were subsequently excluded, as their pre-morbid IQ was too high. Patients were recruited via the memory clinic at the Western General Hospital in Edinburgh. Patients with any previous neurological problems or a history of depression were excluded. Eleven patients were recruited and all were recompensed for their travel costs. One patient was subsequently excluded as it was thought he was exaggerating his memory problems and his scores on the Tombaugh Test of Memory Malingering supported this. His case is discussed in *Chapter Seven*. A second patient was excluded as it was discovered within two weeks of her recruitment that she had a malignant brain tumour.

Of the patients recruited five were still in full-time employment, two worked part-time and two had taken early retirement. All the patients have been followed up subsequent to the research carried out here for a period of twelve months and none had exhibited any organic problems to account for the memory disorder. One patient had a diagnosis of Myalgic Encephlopathy (ME/ chronic fatigue syndrome) but was still in full-time employment. Two patients were taking fluoxetine (selective serotonin reuptake inhibitor) to treat anxiety problems (10 mg once a day). Mild anxiety problems were a common issue amongst all nine patients, specifically related to worrying about forgetting important events/dates/times/losing possessions etc. A commonality in describing their case histories was a gradual onset of symptoms over a twelve-month period, often reported by family members and friends and gradually becoming evident to the patients themselves. Each patient cited at least one major event (such as the loss of a possession, forgetting a payment) that finally made him or her 'aware' of their memory problem and it was usually this that had prompted them to seek medical attention. All nine patients had had an MRI scan in the six months prior to participating in this research. All scans were normal. No further clinical data was available.

The neuropsychology results for the patients and controls are shown in Table 24.

Table 24: Neuropsychology Results for Patients and Controls

TEST	Group	N	Mean	SD
Becks Depression Inventory	Controls	15	8.40	6.54
	Patients	9	16.00	12.08
State Trait Anxiety Scores	Controls	15	73.73	16.04
	Patients	9	87.11	25.84
NART Full Scale IQ	Controls	15	106.40	4.20
(National Adult Reading Test)	Patients	9	100.11	8.57
Wechsler Abbreviated Scale	Controls	15	**112.67***	7.29
of Intelligence (III) Full Scale IQ	Patients	9	**102.00**	6.24
Verbal Fluency	Controls	15	**12.04****	2.73
(Average for C, P, & L)	Patients	9	**8.74**	1.02
Wechsler Logical Memory				
Logical Memory I(Raw Scores)				
Recall	Controls	15	**46.73****	8.72
	Patients	9	**30.89**	60.90
Thematic	Controls	15	**17.33***	3.22
	Patients	9	**13.89**	3.14
Logical Memory II (Raw Scores)				
Recall	Controls	15	**28.53****	5.95
	Patients	9	**17.89**	3.51
Thematic	Controls	15	11.13	2.03
	Patients	9	9.89	2.37
Total Retention %	Controls	15	75.35	10.57
	Patients	9	66.44	10.68
Recognition %	Controls	15	**89.78***	5.69
	Patients	9	**82.15**	9.39
Trail Making A	Controls	15	30.66	6.77
	Patients	9	33.29	8.96
Trail Making B	Controls	15	60.55	13.08
	Patients	9	57.10	13.67
Tombaugh Test of Memory Malingering				
TOMM 1	Controls	15	**49.53****	0.64
	Patients	9	**46.22**	2.94
TOMM 2	Controls	15	50.00	0.00
	Patients	9	49.89	0.33

* Significance between groups $p<0.05$; ** Significance between groups $p<0.01$

There were significant differences between patients and controls for the Wechsler Logical Memory. Patients had significantly lower recall and thematic recall, although the difference in thematic recall was only true for the Logical Memory I. Furthermore, one observation was that the patients also had difficulty with the chronological sequence of the recall, frequently beginning their recall mid-way through the stories and then back-tracking to the start although this was not systematically examined. They also had significantly lower recognition scores than the control group, which suggests at this stage that the functional patients have difficulty with episodic memory. It should be noted that Metternich et al. (2009) did not use the Wechsler Logical Memory in their characterization of FMD patients, and in fact argue that on the methods they do use, differences between controls and patients for clinical memory tests was not a common finding in FMD. However, our findings on the Wechsler Logical Memory do indicate problems in FMD patients, and this harmonises with Metternich et al.'s (2009) observation that many patients complain of everyday memory failures such as missed meetings, encoding deficits (e.g. conversations) and inability to recall familiar numbers.

Secondly, FMD patients had lower verbal fluency than the controls. However, given Metternich et al.'s (2009) characterization of FMD, this could be attributed to poor concentration (one patient forgot what letter she was supposed to be doing) and not a deficit of linguistic or executive capabilities per se. Furthermore there was no difference between the groups on the Trail Making Test.

Although the patients produced significantly lower scores for the Tombaugh Test of Memory Malingering Part 1, none fell within the range of suspected malingering with the exception of one patient who will be discussed separately in *Chapter Seven*.

5.4 Experiment 5: Investigating false recognition in functional memory weakness patients in the DRM paradigm

5.4.1 Method and Materials

Twelve lists of 15 words were used (shown in bold in *Appendix A*) from the original 24-list paradigm used in *Chapter Three*. The reduced number of word lists was chosen so as not to cause the patients fatigue and so have a response that was biased due to tiredness. Participants were told they were taking part in an experiment to investigate memory. Instructions were presented on the computer screen. Participants were told to study the word lists in the first part of the experiment and answer the maths questions (which acted as a distracter task) in between each word list. The order of the word lists was presented randomly as were the words within each list. Participants saw the words at a rate of 1s per word. The maths distracter task ran for 30 seconds. After all 12 lists had been studied participants moved directly on to the recognition phase of the experiment and were instructed to press 'Yes' on the keyboard if they thought the word was in the original study phase, and 'No' if it was not. The 'd' and 'k' keys on the keyboard were labelled and used as the 'yes' and 'no' response keys. Words were presented at a rate of 0.5s per word.

5.4.2 Design

This is a between subject design with Word Type as the main factor and response (Yes/No) as the dependent variable. We will also use Snodgrass and Corwin's (1988) recommendations for signal detection analysis in this type of memory experiment.

5.4.3 Results

The results for the DRM paradigm can be seen in Table 25.

Table 25: Descriptive Statistics for critical incorrect, studied incorrect and non-studied incorrect.

	Controls N = 12 ***M*% (SD)**	**Patients N = 9** ***M*% (SD)**
Critical Incorrect (12 Items)	70.01 (16.00)	64.00 (15.62)
Studied Correct (24 Items)	79.44 (7.46)	63.45 (12.83)
Non-studied Incorrect (12 Items)	11.11 (13.24)	13.96 (13.84)

A repeated measures ANOVA with Word Type as the main factor (3) and response (yes/no) as the dependent variable was carried out. Word Type was shown to be significant, $F(2,44) = 130.02$, $p < 0.01$, that is both controls and patients showed significant false recognition to the critical lures in comparison with the non-studied words.

Post hoc independent samples t-tests indicated that there was a significant difference between patients and controls for correct studied words, $t\ (22) = 3.83$, $p < 0.01$. That is controls produced more true recognition to the studied items than the patients.

Figure 12 shows the results for corrected true and false recognition and discrimination bias (Snodgrass & Corwin, 1988). Corrected true recognition is the studied items correct minus the non-studied items incorrect. Corrected false recognition is the critical items incorrect minus the non-studied items incorrect. Response bias is calculated using the following formula: b' = FA/1-(Hits – FA) where FA = false alarms to critical and non-studied items and Hits = correct studied items.

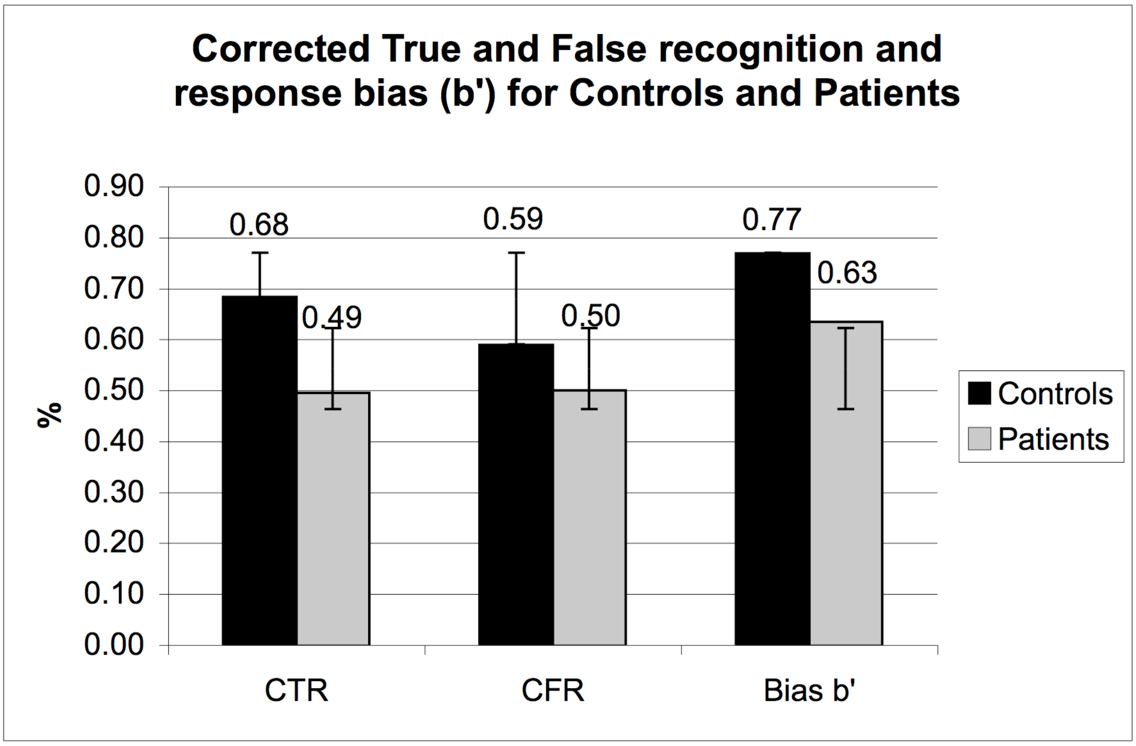


Figure 12: Corrected true and false recognition and response bias.

Independent samples t-tests were carried out which found a significant difference between patients and controls for corrected true recognition, $t\ (22) = 2.50$, $p < 0.05$ but not for corrected false recognition, p n.s. Furthermore there was also a significant difference in response bias, $t\ (22) = 3.075$, $p < 0.01$, that is patients had a more conservative response bias than controls; that is they were more likely to respond 'No'.

We also carried out independent samples t-tests to investigate response latencies between the controls and patient group. The results were insignificant for all three stimuli (critical lures, studied words and non-studied words); that is, patients' response latencies were comparable to controls, see Table 26.

Table 26: Response Latencies for Controls and Patients in the DRM Paradigm.

Response Latencies	Critical Lures	Studied Words	Non-studied Words
Controls *M* (SD)	1115.60 (758.37)	986.55 (300.01)	1031.88 (356.99)
Patients *M* (SD)	1085.33 (259.69)	1006.98 (356.23)	1000.02 (298.69)

5.4.4 Discussion

The results for the DRM paradigm indicate that the FMD patients produced less true recognition than controls. These findings do not support the third hypothesis that suggested FMD patients would be suffering from a form of dissociative disorder and so would be more likely to produce false recognition. Furthermore, they also do not support the first hypothesis, which argued that if there was a problem with gist memory then patients would perform in a similar manner to patients suffering from amnesia (Schacter et al., 1996), or those with Alzheimer's disease (Balota et al., 1999) who produced reduced false recognition to the critical lures. However, given that their true recognition was significantly lower than that of controls does partially support hypothesis one in that true recognition has also been found to be lower in amnesia patients in comparison with controls (Koutstaal et al., 2001).

These findings, and their implications for the role of gist memory, will be discussed further in the general discussion alongside the results from the confabulation experiment.

5.5 Experiment 6: Investigating Provoked Confabulation and False Memories in Functional Memory Weakness patients.

5.5.1 Method and Materials

Participants were presented with five coloured still-photographs of famous celebrities. Each picture was studied for ten seconds before carrying out fifteen-seconds of simple mathematical problems that acted as a distracter task. The pictures were presented randomly. An example of the types of pictures can be seen in Figure 13. All the pictures and questions can be found in *Appendix E*.

Figure 13: Example of picture stimuli used in Experiment 6: The Two Ronnies.

Immediately after seeing the pictures, participants were asked two questions about each picture. One question would be a TRUE question; that is it was about items present in the picture. For example, ‘What colour suit was Ronnie Corbett wearing in the picture?’ A correct response would be ‘Orange’; a miss would be ‘Don’t know’ or the incorrect colour. The second question asked was designed to elicit a confabulated answer; ‘What was on the desk between the Two Ronnies?’ A correct response should be ‘Don’t know’ or ‘Nothing was on the desk’. An incorrect FALSE response would be a confabulated answer such as, ‘A jug of water’. When participants returned one week later they were asked the same questions again to determine if any confabulated answers had subsequently become false memories; that is if participants persisted in the notion that the incorrect FALSE response had been present in the original picture. The questions designed to elicit confabulated responses were all leading questions about items that were congruent with the overall gist of the picture. This is similar to the design of Ackil and Zaragoza (1998) that used leading questions about video pictures.

This was a between subject design with response as the dependent variable for week one and week two, and question type as the independent variable (either TRUE or FALSE questions). The number of correct HITS (that is correct responses to TRUE questions) and FALSE alarms (that is incorrect responses to the FALSE, leading questions) was calculated for each individual.

5.5.2 Design

Independent t-tests will explore the differences between the two groups for correct and incorrect responses and the differences between Week 1 and Week 2 results.

5.5.3 Results

The descriptive statistics for the confabulation experiment can be seen in Figure 14.

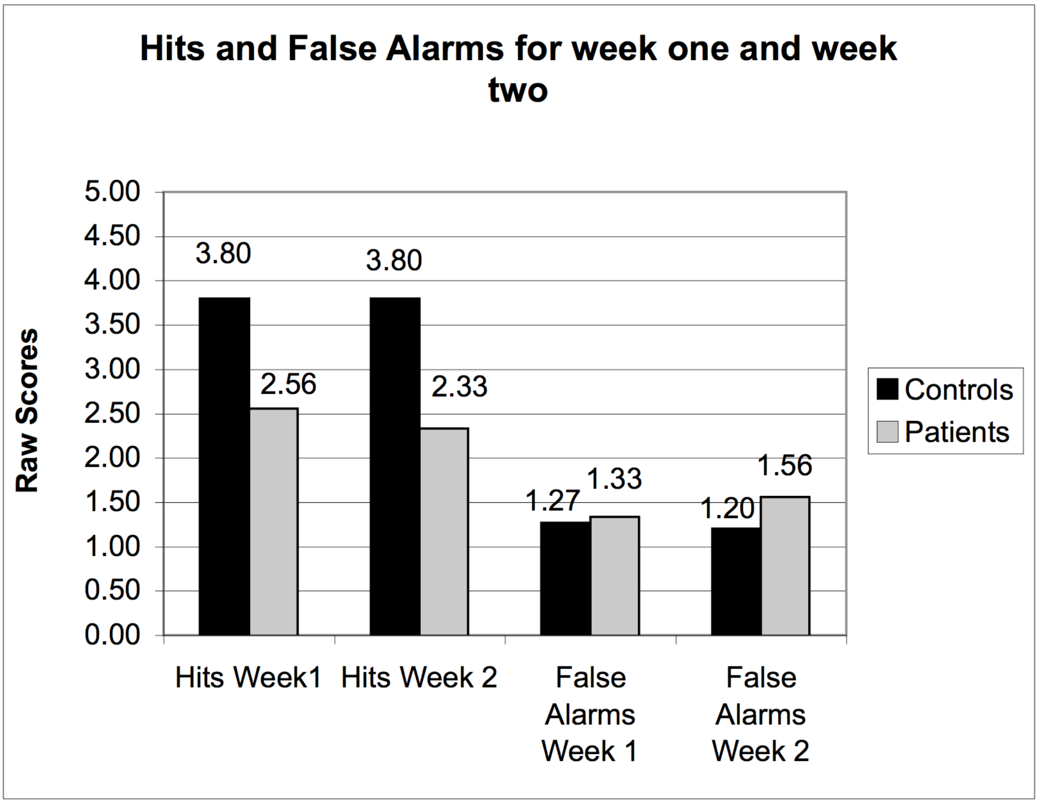


Figure 14: The raw scores for Hits to TRUE questions and FALSE alarms to leading questions

As can be seen from the graph, participants produced false alarms to the leading questions that were then maintained as false memories one week later. However, a related t-test found no significant difference between week one and week two for the rates of false alarms or true recognition within the groups.

However, there were significant differences between the two groups for true recognition. The functional memory patients produced significantly less true recognition to the TRUE questions compared with controls for week one, $t(22) = 2.28$, $p < 0.05$; and for week two, $t(22) = 3.30$, $p < 0.01$.

5.5.4 Discussion

The results for the confabulation experiment showed that patients produced less true recognition compared with controls, but there were no significant differences for false recognition. This does not support the fourth hypothesis that argued if these patients were suffering from some form of unconscious confabulation then they would produce more FALSE answers to the leading questions. It also only partly supports the second hypothesis that suggested that a failure in gist and episodic memory would result in a reduction in the TRUE and FALSE alarms since patients would not be able to maintain the overall thematic gist of each picture.

However, the finding that the FMD patients produce less true recognition supports the results from the DRM paradigm, which found less correct recognition to the studied words in comparison with controls.

5.6 General Discussion and Conclusion

Nine patients who presented with Functional Memory Disorder were tested on both the DRM paradigm and a confabulation experiment to determine if their gist memory was impaired. Although the results did not fully support the hypotheses, specifically that patients would show reduced gist memory and hence reduced false recognition in the DRM and reduced false memory in the confabulation experiment, patients did produce significantly less true recognition in both the DRM paradigm and the confabulation experiment compared with controls.

This reduction in true recognition in the patient group is congruent with the neuropsychology findings in the Wechsler Logical memory. One argument for these findings suggests that patient have problems with their episodic memory. However, gist memory is also required to maintain the associations between the studied items in the DRM paradigm. We saw in *Chapter Three* that individuals who had low correct responses to the studied items also produced low false recognition to the critical lures. It may be that FMD patients have a minor deficit in their gist memory that presents as poor recognition of the studied items. We also found in *Chapter Four* that adolescents and young adults with Autism had significantly lower corrected true recognition that was accompanied by a more conservative response bias in comparison with controls. There was a similar pattern with the FMD patients who also showed a more conservative response bias in comparison with controls.

Additionally, response times between controls and FMD patients in the DRM paradigm were not significantly different. As we will see later in *Chapter Seven* response times are a crucial aspect of the malingering profile in the DRM paradigm, and so these findings suggest FMD patients are not malingering. The comparable response latencies would also rule out the suggestion that FMD patients may not be motivated when undergoing neuropsychology testing.

In conclusion, the exploration of patients with Functional Memory Disorder has shown that in the DRM paradigm (1998) patients produce significantly lower true recognition of the studied items. One of the problems with FMD diagnosis, as pointed out by Metternich et al. (2009), is that the process often relies on subjective questioning and interpretation rather than any objective quantitative analysis. It may be that the DRM offers a clue and a quantitative measure as to the impairments these patients are suffering from with regards to their memory problems. The confabulation experiment is unlikely to offer the same flexibility since it relies heavily on using pictures that are culturally and chronologically significant.

The discovery that the DRM may possibly offer a method to investigate malingering will be discussed in *Chapter Seven*, but in *Chapter Six* we will use a variety of DRM paradigms to investigate a case study of a patient with amnesia.

Chapter Six: DA - A Case study of Amnesia and False Memory Recognition

6.1 Introduction

Investigating the performance of amnesia patients in the DRM paradigm has revealed a pattern of recognition in which patients produce reduced true and false recognition (for review see Schacter, Verfaellie, & Koutstaal, 2002). Schacter and his colleagues have argued that this indicates a failure not only in episodic memory in amnesia patients, but also in their gist memory, that is the memory for semantic features as opposed to just the memory for distinctive features. This chapter explores the relationship of gist and episodic memory further through performance of amnesia patient DA on DRM-style paradigms.

6.2 DA: A Case Study

DA is a 32-year-old woman at the time of testing who was diagnosed with dense, anterograde amnesia. She was first seen at the Royal Hospital for Sick Kids in October 1982 aged 7. Her history revealed that she had suffered anoxia at birth and subsequently had difficulties breathing. She was taken into intensive care where she stayed for two weeks until her respiratory difficulties improved. DA only began walking at 17 months with a tendency to walk on the inside of her right foot and fall off. These problems persisted. The examination at 7 years of age revealed truncated ataxia and minimal right hemiparesis. These were strongly suspected to be the result of the asphyxia at birth. In 1983 a neurology examination noted clumsiness and persistent minor mirror movements and she was later labelled as having mild cerebral palsy. Moreover, specific writing and spelling problems were noted.

DA was referred to the hospital again in 1987 at the age of 12 after an episode of what was later suspected to be temporal lobe epilepsy (TLE). DA had spoken nonsense for several minutes and appeared to have glazed eyes. Afterwards she needed to lie down. Several further episodes of altered awareness and confusion, followed by headaches and tiredness ensued. An EEG was normal but TLE was strongly suspected due to the nature of her episodes and given her history of anoxia and she was prescribed Carbamazepine to control the seizures.

In the same year a letter expressed concerns about her progress in school. She required remedial help in English, maths and geography. In 1989 a further letter from her school stated that, "the greatest problem at school has been that of short term memory failure". Furthermore, a letter from her neurologist states, "She finds that when she is in school she cannot remember something that she has read for example 5 minutes ago or if her father asks her to carry out a message by the time she gets to the shop she often cannot remember what the message was…her long term memory appears intact and if she learns something slowly she will retain it".

Carbamazepine withdrawn in 1989 in order to investigate her memory difficulties further and an assessment in 1989 confirmed severe memory difficulties particularly for verbal information with only 8% immediate recall of stories and she could not recall anything following a 45-minute interval. There were then three further episodes of confusion during which she "wandered about, not knowing what she was doing". Carbamazepine was reinstated.

DA's seizures recurred in 1990 and according to a letter from her neurologist they consisted of "blanking and talking nonsense in keeping with a left sided origin affecting speech". These were typical complex partial seizures and her neurologist further comments, "her eyes glaze over, she becomes unaware of what is going on with no memory of the event. She talks nonsense, flushes, wants to lie down and sleep". Her seizures became worse occurring on alternate days so her Carbamazepine was increased to 600 mgs.

To summarise her early history; DA completed 11 years of formal education having attended school between the ages of five an sixteen. Her medical history includes mild cerebral palsy with clumsiness, mild right hemiparesis and complex partial seizures most likely the result of temporal lobe epilepsy that responded well to Carbamazepine treatment. EEGs were repeatedly normal as was her CT scan. However, she had an anterograde amnesia, which appears to predate her epilepsy, and is strongly suspected to be the result of her birth asphyxia.

There were no reports of further seizures from when she was a teenager although in 2004 she began to suffer from migraines. DA is married with two children and had been working as a nursery assistant. However, she left her job due to concerns about her memory difficulties, which were seriously affecting her work following complaints from staff. DA's husband also reported that during this time he thought her memory had deteriorated. DA had a standard FLAIR and T2 coronal MRI scan of the temporal regions in 2005 that was reported to show no abnormality or sclerosis through routine radiological examination (see *Appendix J*). DA underwent a full clinical neuropsychology assessment in 2006 (see Table 27). At the time of the current study her TLE was under control but she was still on Carbamazepine, 200mgs.

DA's premorbid IQ as predicted by the NART was in the average range. Her Full Scale IQ scale (IQ = 77) is equivalent to the 6^{th} percentile for a normal age-matched population. Although her Digit Span was within the normal range she performs below average on Comprehension (age scaled score 5), Information (age scaled score 5) and Similarities (age scaled score 6). Her Vocabulary is in the Low Average range. Her performance on Matrix Reasoning and Picture Completion are in the Low Average range and her performance on Block Design is in the Average range. DA's immediate recall for the Logical Memory stories (WMS-III) was in the Low Average range or slightly below average and her immediate recall of the thematic content was Average. However, she was unable to recall details from either of the two stories after a thirty-minute delay even when given a reminder.

Her performance on Word list Learning Test (immediate and delayed recall) was below average. She was unable to recall any words following a distracter list or again after a 30 minute delay. However, her word recognition was intact (Total recognition = 23) placing her in the average range. Her results for Trail Making Part A were just below average indicating she may have mild slowing in speed of information processing. In contrast DA's executive functions appeared relatively less affected; her performance on Trail Making Part B was within the average range.

Table 27: DA's Neuropsychology Results

Wechsler Abbreviated Scale of Intelligence III (1999)		
Prorated Full Scale IQ	77	
Prorated Verbal IQ	78	
Prorated Performance IQ	80	
Scaled Scores		
Vocabulary	7	
Information	5	
Similarities	6	
Comprehension	5	
Digit Span (6 forwards, 5 backwards)	9	
Block Design	8	
Picture Completion	6	
Matrix Reasoning	7	
NART		
National Adult Reading Test (Nelson, 1982)		
Total Errors	27	
Predicted full scale IQ	97	
Speed of Information Processing		
Trail Making Test Part A (Partington & Leiter, 1949)		
44s		10th to 25th percentile
Executive Function		
Verbal Fluency, F, A, S		
F	8	
A	11	
S	15	
Total	34	
Animals	21	
Trail Making Test Part B (Partington & Leiter, 1949)		
99 s		25th to 50th percentile
Language Function		
Graded Naming Test (McKenna & Warrington, 1983)		
	15	

Wechsler Memory Scale III (1998)		
Logical Memory 1		
	Score	Age adjusted score
Recall Total	25	6
1st Recall	16	7
Learning Slope	2	8
Thematic Score	17	10
Logical Memory 2		
	Score	Age adjusted score
Recall Total	0	1
% Retention	0	1
Thematic Score	0	1
Word Learning List 1		
	Score	Age adjusted score
1st recall score	3	5
Recall Total score	20	4
Learning slope	2	6
Contrast 1	0	10
Contrast 2	5	4
Word Learning List 2		
	Score	Age adjusted score
Recall Total score	0	5
Recognition Total		
Total Score	23	11
% Retention	0	4
Rey Osterrieth Complex Figure (1944)		
Figure Copy		35/36
Figure recall delayed		0
Figure recall retained		0
Doors & People Test (Baddelely et al., 1994)		
	Raw	Age
scaled score		
People	7	3
Names	20	11
Shapes	9	<1
Doors Test	13	4

Although her score on the letter fluency tasks was relatively low (particularly on the F words) her total score (Total = 24) is consistent with that predicted by her age, years of education and her reading score on the NART. Hence there is no evidence of a disproportionate deficit on this test. This is also the case for her performance on the Similarities subtest (age scale score 6), which is dependent on executive processes.

Although her score is below average, it is in line with her scores on three other Verbal subtests (Information, Comprehension and Vocabulary), which do not rely to the same extent on executive processes. Her score for Animal Naming (Total = 21) was between the 25th and 50th percentile for her age and years of education. Her performance on the Graded Naming Test (15) showed no evidence of any deficit and was consistent with her scores on the NART.

6.3 Experiment 7a: DA and Controls in the word DRM Paradigm

Given the findings of Schacter et al. (2002) and their work on amnesia patients, we can predict that in the DRM paradigm DA would produce reduced true and false recognition in comparison with controls. DA would be unable to maintain robust gist memory and hence discriminate between critical lures, studied words and non-studied words. In this condition she should also demonstrate a more liberal response bias; that is she would be more likely to response ‘Yes’ during the recognition phase in comparison with controls.

6.3.1 Participants

A total of fifteen age-matched controls were recruited via the University of Edinburgh’s careers website. Participants were all dominant right-handed, native speakers of English and were between the ages of 18 and 37 (*M* = 25.5). All were undergraduates or post-graduates at the University. They were paid £5 for their participation. DA was also reimbursed for her time and travel costs across all the experiments.

6.3.2 Method and Materials

Twelve lists of 15 words were used (shown in bold in *Appendix A*) from the original 24-list paradigm used in *Chapter Three*. The reduced number of word lists was chosen so as not to cause DA fatigue and result in a response that was biased due to tiredness. All the participants were told they were taking part in an experiment to investigate memory. Instructions were presented on the computer screen. Participants were told to study the word lists in the first part of the experiment and answer the maths questions (which acted as a distracter task) in between each word list. The order of the word lists was presented randomly as were the words within each list. Participants saw the words at a rate of 1s per word. The maths distracter task ran for 15 seconds. DA was instructed that if she found a math problem too difficult she could just press 'ENTER' and move on to the next question. After all 12 lists had been studied participants moved directly on to the recognition phase of the experiment. They were told a word would appear on the screen and they were to press 'Yes' on the keyboard if they thought the word was in the original study phase, and 'No' if it was not. The 'd' and 'k' keys on the keyboard were labelled and used as the 'yes' and 'no' response keys. Words were presented at a rate of 0.5s per word.

6.3.3 Design

We used Crawford and Garthwaite's (2002) statistical analysis for case studies. We examined signal detection using Snodgrass and Corwin's (1988) recommendations for memory experiments looking at corrected false recognition (critical lure incorrect minus non-studied incorrect) and corrected true recognition (studied correct minus non-studied incorrect). Response bias is calculated using the following formula: b' = FA/1-(Hits – FA) where FA = false alarms to critical and non-studied items and Hits = correct studied items (*Ibid.*). Finally, we also explored signal detection analysis using A' prime as used by Schacter, Israel and Racine (1999) to examine item-related and gist specific signal detection (see below in results).

6.3.4 Results

The descriptive statistics are shown in Table 28. The raw data for all participants in Experiment 7a can be found in *Appendix G*.

Table 28: Descriptive statistics for critical incorrect, studied correct, non-studied incorrect and the corrected true (CTR) and false recognition (CFR) and response bias b'.

	Critical Lures (12 Items)		Studied Words (24 Items)		Non-studied Words (12 Items)				
Words	Correct	Incorrect	Correct	Incorrect	Correct	Incorrect	CTR	CFR	*b'*
DA %	33.33	66.67	62.50	37.50	66.67	33.33	0.25	0.29	0.71
Controls *M%*	34.44	65.60	67.74	32.22	87.47	12.53	0.55	0.53	0.63
Controls SD	*14.73*	*14.73*	*12.90*	*12.90*	*13.05*	*13.05*	*0.19*	*0.21*	*0.23*
n=15						***Significance t =***	-1.53	-1.11	0.33
						p =	0.07	0.14	0.37
						% Below	7.43	14.36	62.9

DA's performance was below average in comparison with controls for both Corrected True (CTR) and Corrected False Recognition (CFR), however, only CTR tended towards significance, $p = 0.07$ (see Figure 15).

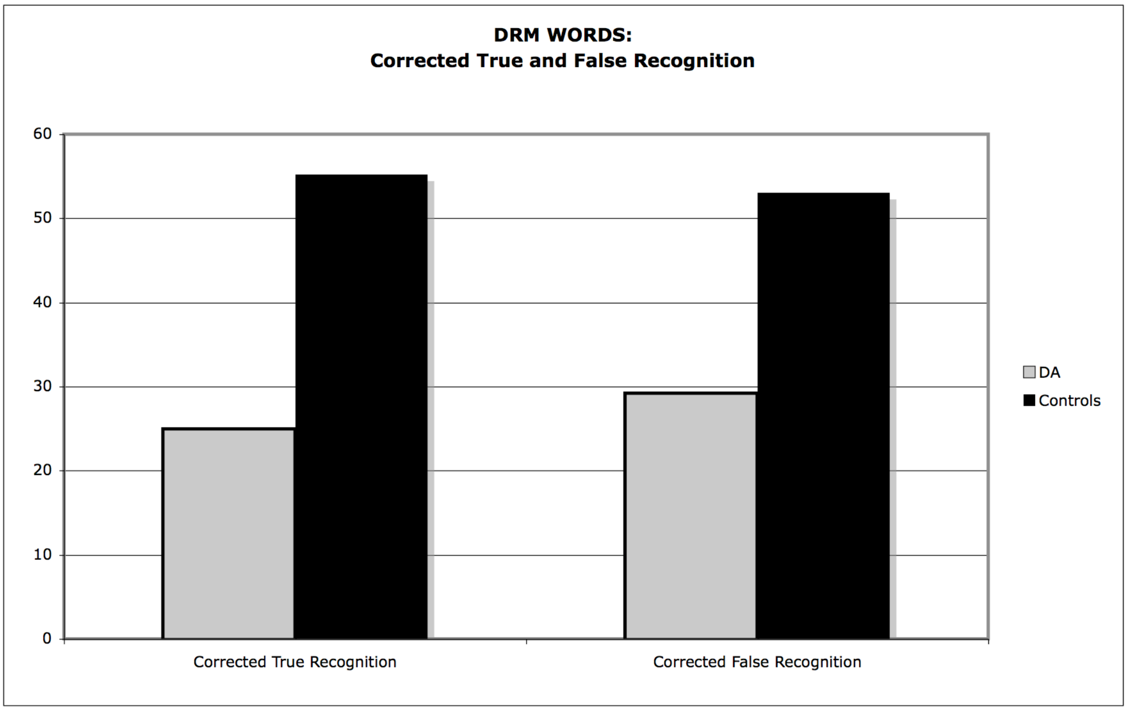


Figure 15: Corrected true and false recognition for DA and controls in the word DRM

Signal Detection Analysis

Schacter et al. (1998) used signal detection analysis to explore their results by dividing up the analysis between item-specific memory for correct studied items versus incorrect non-studied items (unrelated); item-specific memory for correct studied items versus false recognition to the critical lures (related); and finally, false recognition to critical lures versus non-studied items incorrect (gist-specific). We decided to use Schacter et al.'s (*Ibid.*) analysis in order to make our results comparable with Schacter and colleagues work on amnesia patients (see discussion for comparisons).

Snodgrass and Corwin (1988) note that different types of signal detection analysis should not be compared with each other since they work from different assumptions. In recognition of this we will discuss DA's signal detection results separately, but they do add a useful dimension to her results. The results can be seen in Table 29.

Table 29: Signal detection analysis for DA and controls for word stimuli: significant results are in bold

		Item-Specific Related		Item-Specific Unrelated		Gist-Specific	
Words		***A'***	***b***	***A'***	***b***	***A'***	***b***
DA		0.46	0.37	0.70	0.00	0.73	0.06
Controls *M*		0.51	0.47	0.86	-0.59	0.91	-0.62
Controls SD		*0.11*	*0.35*	*0.08*	*0.53*	*0.09*	*0.55*
n=15	***Significance t =***	-0.44	-0.28	-1.94	1.08	-1.94	1.20
	p =	0.33	0.39	**<0.05**	0.15	**<0.05**	0.13
	% Below	33.33	39.30	3.66	85.03	3.66	87.44

The results for item-specific related for both DA and controls show poor discrimination of the correct studied words and false recognition to the critical lures. This is what we would expect in the DRM word paradigm since controls are responding 'yes' to the critical lures as their gist memory associates them to the studied lists. In contrast, DA's signal detection for item-specific unrelated and gist-specific items is significantly lower than controls. This suggests that DA does not have the ability to distinguish between non-studied words and critical lures; and studied words and non-studied words.

6.3.5 Discussion

In the word version of a DRM paradigm DA's performance, although not significant, was in the direction predicted. That is she tended towards reduced CTR and CFR. This is similar to the findings of Schacter et al. (1996) and Verfaellie et al. (2002) as shown in Table 30.

Schacter et al. (1996) and Verfaellie (2002) found that amnesia patients with aetiologies involving medial temporal lobe damage produced higher rates of non-studied incorrect responses compared with controls, resulting in lower corrected true and false recognition.

Table 30: Results for Experiment 7a in comparison with previous research results on amnesia patients (Corrected true & false recognition calculations carried out by this author).

Schacter et al. (1996) (Words)	Amnesics	Controls
Studied Correct	0.54	0.85
Non-studied Incorrect	0.34	0.18
Critical Incorrect	0.6	0.83
Corrected True Recognition	0.2	0.67
Corrected False Recognition	0.26	0.65
Verfaellie et al. (2002) (Words)	Amnesics	Controls
Studied Correct	0.48	0.74
Non-studied Incorrect	0.33	0.12
Critical Incorrect	0.64	0.7
Corrected True Recognition	0.15	0.62
Corrected False Recognition	0.31	0.58
Experiment 7a	DA	Controls
Studied Correct	0.63	0.68
Non-studied Incorrect	0.38	0.13
Critical Incorrect	0.67	0.66
Corrected True Recognition	0.25	0.55
Corrected False Recognition	0.29	0.53

By using A’ Prime signal detection in the same manner as Schacter et al. (1998) to explore our results, DA demonstrated a significant impairment in Item-Specific Unrelated (correct studied items versus incorrect non-studied items). That is she was unable to distinguish the non-studied items from the studied items. Furthermore, DA also had a significant impairment of gist-specific detection (critical lures versus non-studied items incorrect).

Table 31: DA's signal detection results in comparison with Schacter et al. (1998)

Schacter et al. (1998) Trial 1 Signal Detection Data						
	Item-Specific Related		Item-Specific Unrelated		Gist-Specific	
	A'	*b*	*A'*	*b*	*A'*	*b*
Mixed Amnesics	0.73	0.20	0.42	-0.38	0.78	0.14
Controls	0.93	0.44	0.57	-0.68	0.9	0.58
Experiment 7a: Word DRM Paradigm						
	Item-Specific Related		Item-Specific Unrelated		Gist-Specific	
	A'	*b*	*A'*	*b*	*A'*	*b*
DA	0.46	0.37	0.70	0	0.73	0.06
Controls	0.51	0.47	0.86	-0.59	0.91	-0.62

These findings are concurrent with previous work on amnesia patients (e.g. Schacter et al., 1998), that is poor gist-specific and item specific-unrelated memory compared with controls as can be seen in Table 31. Schacter et al (1998) also found a significant difference in item-specific unrelated and gist specific signal detection for amnesia patients in comparison with controls. DA is unable to recognize that she has not seen a non-studied item and it is this that drives the results for signal detection. In Table 31 we compare our signal detection findings with those of Schacter et al. (1998). The next experiment examines whether DA's performance can be improved by providing additional distinctive details to improve her veridical recognition.

6.4 Experiment 7b: DA and Controls in a word and picture DRM Paradigm

6.4.1 Introduction

When given extra information to aid veridical memory traces such as in a word *and* picture paradigm DA should be able to increase her discrimination between studied and non-studied items and so increase both true and false recognition to a level comparable with the controls. This should be in contrast to patients with frontal lobe lesions, who were unable to use distinctive features to suppress false recognition in a picture paradigm (Budson et al., 2005). However, it is unlikely that DA's gist memory will be improved in the word and picture paradigm; Schacter et al. (1998) showed that even increasing study trials did not increase gist representation in amnesia patients although it did aid the performance of non-amnesic Korsakoff patients. DA's episodic memory should be aided by the additional binding of words and pictures. This should help her discriminate between the studied items and the non-studied items and so improve both corrected true recognition and corrected false recognition.

For controls the added distinctive information of the pictures should help suppress false recognition and provide added veridical information, but unlike a picture-only paradigm the words will still offer enough gist traces, so there should still be some false recognition to the critical lures. Hence controls should also show increased discrimination and a slightly more conservative response bias in comparison to their performance in the word-only paradigm. What is important is that in the word and picture paradigm DA's performance should be enhanced so that it is similar to controls. The controls will still produce some false recognition due to gist information from words, while DA will be able to use the distinct information of the pictures to aid her discrimination and improve true recognition.

6.4.2 Participants

Fifteen age-matched controls were recruited via the University of Edinburgh's careers website. Participants were all dominant right-handed, native speakers of English. They were paid £5 for their participation. They were different controls from *Experiment 7a* and were aged between 18 and 40 years (M = 23.6). All were either undergraduates or graduates of the university.

6.4.3 Method and Materials

Twelve lists of 15 words and pictures were used. The lists of words are shown in English in *Appendix C*. And example of the stimuli can be seen in Figure 16.

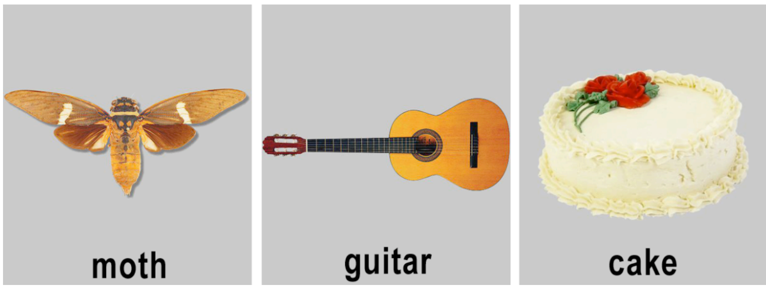


Figure 16: Example of the word and picture stimuli used in the experiment.

The pictures used were the English versions of the ones found in *Experiments 3* and *4* (see Chapter 4 and *Appendix D*). All Participants were told they were taking part in a memory experiment presented on a computer. Participants were instructed to study the picture groups in part one of the experiment. Each picture was presented centrally on a computer screen for a duration of 1 second. The 12 picture groups were presented randomly. In between each group participants carried out simple mathematical problems for 15 seconds, which acted as a distracter task. When all 12 picture groups had been studied participants moved on to the recognition phase. They saw 24 studied pictures (top two items from each list), the 12 critical lures, and 12 non-studied, unrelated pictures. Each picture was shown for a duration of 1 second. They were instructed to respond 'Yes' or 'No' on the keyboard to indicate whether the picture they saw was in the original picture groups or not. The 'd' and 'k' keys on the keyboard were used for the 'Yes' and No' responses.

6.4.4 Results

The descriptive statistics for *Experiment 7b* are shown in Table 32. The raw data for al participants can be found in *Appendix G.*

Table 32: Descriptive statistics for critical incorrect, studied correct, non-studied incorrect and corrected true (CTR) and false (CFR) discrimination and response bias.

Words & Pictures	**Critical Lures (12 Items)**		**Studied Items (24 Items)**		**Non-studied Items (12 Items)**				
	Correct	**Incorrect**	**Correct**	**Incorrect**	**Correct**	**Incorrect**	**CTR**	**CFR**	***b'***
DA	58.33	41.67	87.50	12.50	91.67	8.33	0.79	0.33	0.77
Controls *M%*	68.40	31.60	82.52	17.48	95.00	5.00	0.78	0.27	0.67
Controls SD	*13.77*	*13.77*	*14.60*	*14.60*	*8.80*	*8.80*	*0.17*	*0.15*	*0.19*
n=15						***Significance t =***	0.06	0.39	0.51
						p =	0.48	0.35	0.31
						% Below	52.3	64.78	69.09

As can be seen DA's performance in the word and picture condition is very similar to that of controls. Her true and false recognition discrimination is much improved compared with the word only condition. The discrimination performance for controls is also improved compared with their performance in the word only condition (word only condition CTR = 0.55). Using Crawford and Garthwaite's (2002) single-case study analysis we can see that DA performs well within the control range for corrected true recognition (CTR % below = 52.3), corrected false recognition (CFR % below = 64.8) and response bias (*b'* % below = 69.1).

Signal Detection Analysis

The results for signal detection analysis can be found in Table 33.

Table 33: Signal detection analysis for words and picture condition.

Words and Pictures		Item-specific related		Item-specific unrelated		Gist-specific	
		A'	***b***	***A'***	***b***	***A'***	***b***
DA		0.83	0.47	0.94	-0.12	0.79	-0.8
Controls *M*		0.82	0.31	0.94	-0.68	0.77	-1.5
Controls SD		0.11	0.36	0.05	0.6	0.14	0.55
n=15	***Significance t =***	0.09	0.43	0	0.9	0.138	1.23
	p =	0.47	0.34	0.5	0.19	0.45	0.12
	% Below	53.44	66.32	50.00	80.93	55.40	98.73

In the word and picture condition DA's signal detection is comparable to controls. Both DA and controls improve their discrimination, increasing veridical recognition and suppressing false recognition to the critical lures. In this instance DA also suppresses her false recognition to the non-studied items. Her signal detection for unrelated item-specific memory (correct studied items versus incorrect non-studied items) has increased from her performance in the word-only condition from 0.70 to 0.94. DA's signal detection for related item-specific memory (correct studied items versus incorrect critical lures) has also increased form 0.46 in the word-only condition to 0.83 in the word and picture condition. However, her gist specific memory (critical lures incorrect versus non-studied items incorrect) has not (word DRM A′ = 0.73; word and picture DRM A′ = 0.79).

6.4.5 Discussion

In a word and picture condition DA's performance is comparable to controls both for corrected true and false recognition, and for the signal detection analysis. Koutstaal, Verfaellie and Schacter (2001) found in a categorized picture-only condition that amnesia patients produced less corrected false recognition compared with controls. Schacter et al. (2002) later concluded that the results from these experiments, "further confirm that amnesic patients show reduced false recognition under conditions where memory for gist, rather than source confusions regarding individual items, is the primary determinant of illusory memory" as well as strengthening the claim that gist representation in normal individuals is one of the main drives of false recognition in the DRM paradigm (Schacter, et al., 2002, p. 122). However, they did not explore a word and picture condition. We have found in our experimental condition that the added information of both words *and* pictures provides DA with enough binding information to improve her true recognition and suppress her false recognition to the non-studied items.

This is similar to our findings in *Chapter Four* for individuals with Autism. We found in that series of experiments that the controls increased false recognition in a word and picture condition, where previously they had been able to suppress false recognition in the picture only condition. Schacter's argument is still valid since this suggests that for controls when placed in a word and picture condition the gist memory of the words overrides any advantage controls may have had from the distinct features of the pictures and so they produce false recognition to the critical lures. DA can now use the features of both word and picture and use this additional information to improve her gist representation that was not available to her in a word-only condition, and so her pattern of performance is comparable to controls.

6.5 Experiments 8 a, b & c: Famous Faces DRM Paradigm

6.5.1 Introduction

Face recognition is a specialized cognitive function utilizing different areas of the brain than those used for simple object recognition (for review see, Banich, 2004, Ch. 6, pp.203 – 212). Young, Hay and Ellis (1985) are among several researchers who have explored false facial recognition made by healthy individuals as a result of source monitoring errors.

These source-monitoring errors imply that episodic memory for facial recognition involves several degrees of overlapping information, a model not dissimilar to gist memory. This means that distinctive faces, such as famous people, are more easily recognized than typical faces since they do not have so many overlapping features compared with more ‘typical’ faces (e.g. Light, Kayra-Stuart & Hollander, 1979; Bartlett, Hurry, & Thorley, 1984). However, as we age it would also seem that we misidentify faces more often. Bartlett, Strater and Fulton (1991) investigated older and younger adults’ face recognition skills and found that older adults made more recognition errors for faces than their younger counterparts. Furthermore, older adults were more likely to attribute ‘false fame’ to novel faces that were in fact not famous. Bartlett et al. (1991) concluded that as episodic memory decreases with age so older adults rely more on familiarity features than episodic memory when recognizing faces. This is similar to the over-reliance on gist memory by older adults in the DRM paradigm found by researchers such as Kensinger and Schacter (1999).

Although there has been no research using the DRM paradigm and famous faces, Rapcsak et al. (1999) have examined false facial recognition in frontal lobe patients and medial temporal lobe (MTL) patients within a standard old/new recognition test. The tests varied by the number of faces participants had to remember: 32, 24, 16, and 8 faces. True and false recognition improved as the number of faces decreased across all subjects although frontal patients showed a higher rate of false recognition compared with either temporal patients or controls. Both MTL and frontal patients had lower discrimination rates than controls. Rapcsak et al. (1999) concluded that both MTL and frontal patients have poor item-specific memory for faces, which means they cannot assign distinct ‘memory nodes’ to the individual faces. What differentiated the two patient groups is that frontal patients had a far more liberal response bias. The researchers argued that the MTL patients could still maintain some monitoring and decision making functions not available to the frontal patients.

In a second experiment using a DRM paradigm of faces Rapcsak and his colleagues found frontal patients produced high rates of true and false recognition compared with controls. In contrast the MTL patients had poor true recognition compared with controls, and although the MTL patients produced false recognition of the faces it was not as high as the frontal patients (although it was higher than controls). Rapcsak et al. (1999) argued that the MTL patients were having difficulty not only with their gist memory but also with general encoding and categorization about what the study items had in common. The frontal lobe patients still have this gist-based memory to access, so their false recognition is down to the failure of strategic memory retrieval. The frontal lobe patients' pattern of increased false recognition is very similar to that seen in ageing populations where false recognition responses are due to feelings of false familiarity (Bartlett et al., 1984).

With these findings in mind we can develop a research question investigating DA's false recognition to famous faces in a DRM paradigm. We suggest that although she will be able to gist within the categories of famous faces she will not form enough gist representation to separate the categories from each other, so will again demonstrate false recognition of both critical lures and non-studied items.

6.5.2 Experiment 8a: DA and Controls and Famous Faces (Sports' Personality Condition)

This paradigm uses famous faces categorized according to occupation (actor, singer etc.), nationality (UK or US) and sex. In this experiment we used British sporting personalities as the non-studied items.

6.5.3 Participants

Fifteen controls were recruited via the University of Edinburgh's careers website. Participants were all dominant right-handed, native speakers of English. They were paid £5 for their participation. They were different participants to *Experiments 7a* and *b*. Participants were aged between 21 and 39 years ($M = 27$).

6.5.4 Method and Materials

Photographs of famous people were collected via the internet and then reduced to black and white copy and matched for size using Adobe© Photoshop© CS3. We used head and shoulder pictures. There were two categories of occupation: singers and actors. These were then subdivided according to nationality (UK or US) and sex resulting in eight categories: UK female singer, US female singer, UK male singer, US male singer, UK actress, US actress, UK male actor, US actor. To create the stimuli for the experiment a pilot study was run asking age-matched individuals to name their top ten famous people for each category, including sports personalities.

From this the names were rated with the highest frequency name appearing in position number one. This subsequently became the critical lure. The resulting list of names and recall items can be found in *Appendix F*. Once we had selected the list we piloted the pictures of the faces for familiarity with controls. An example of the stimuli used can be seen in Figure 17.

All Participants were told they were taking part in a memory experiment presented on a computer. Participants were instructed to study the picture groups in part one of the experiment. Each picture was presented centrally on a computer screen for a duration of 1 second. The 8 picture groups were presented randomly. In between each group participants carried out simple mathematical problems for 15 seconds, which acted as a distracter task. When all 8 picture groups had been studied participants moved on to the recognition phase. They saw 16 studied pictures (top two items from each list), the 8 critical lures, and 8 non-studied, unrelated pictures. Each picture was shown for a duration of 1 second. They were instructed to respond 'Yes' or 'No' on the keyboard to indicate whether the picture they saw was in the original picture groups or not. The 'd' and 'k' keys on the keyboard were used for the 'Yes' and No' responses.

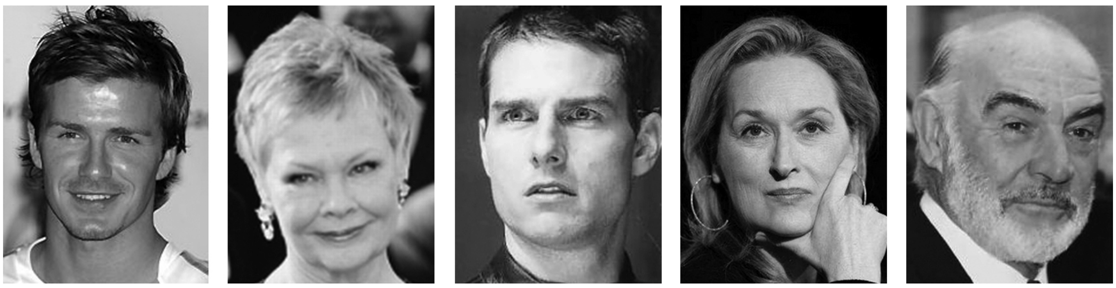


Figure 17: Example of the famous faces stimuli.

6.5.5 Results

The descriptive statistics for *Experiment 8a* are shown in Table 34. The raw data for all participants can be found in *Appendix G*.

Table 34: Probabilities for critical, studied and non-studied items and the corrected true (CTR) and false (CFR) discrimination rates and response bias b'

Faces (Sports)	Critical Items (8 Items)		Studied Items (16 Items)		Non-Studied Items (8 Items)				
	Correct	Incorrect	Correct	Incorrect	Correct	Incorrect	CTR	CFR	*b'*
DA	12.50	87.50	62.50	37.50	50.00	50.00	0.13	0.38	0.63
Controls *M%*	84.78	15.22	86.01	13.99	90.13	9.87	0.76	0.05	0.12
Controls SD	*16.35*	*16.35*	*11.72*	*11.72*	*12.14*	*12.14*	*0.10*	*0.21*	*0.69*
n=15						***Significance t =***	-6.15	1.50	0.72
						p =	**<0.01**	0.08	0.24
						% Below	0.00	92.19	75.70

DA's corrected true recognition (Snodgrass & Corwin, 1988) was significantly lower than that of controls, $p < 0.01$. Her corrected false recognition just misses significance. DA appeared to have a more liberal response bias than controls (a greater tendency to respond 'Yes' in the recognition phase) although this was not significant.

6.5.6 Discussion

In this paradigm DA produced far more false recognition to both critical lures and non-studied items than controls. However, it became clear that DA had problems with familiarity regarding the use of sports personalities as the non-studied items, which may have affected the response bias. To make sure her responses were not just a result of failure to know the people she was seeing we asked her to rate her familiarity with the pictures used. DA was confident of the critical items; and could name many and identify their occupations. However, when it came to the sports personalities she could not name them or identify their occupations, frequently stating they were singers or television presenters. To identify whether she was at least recognizing them as famous faces we used a simple recognition paradigm in which DA was shown individual sports personalities and the critical lures alongside two other non-famous faces that were matched as closely as possible to the famous person, see Figure 18.

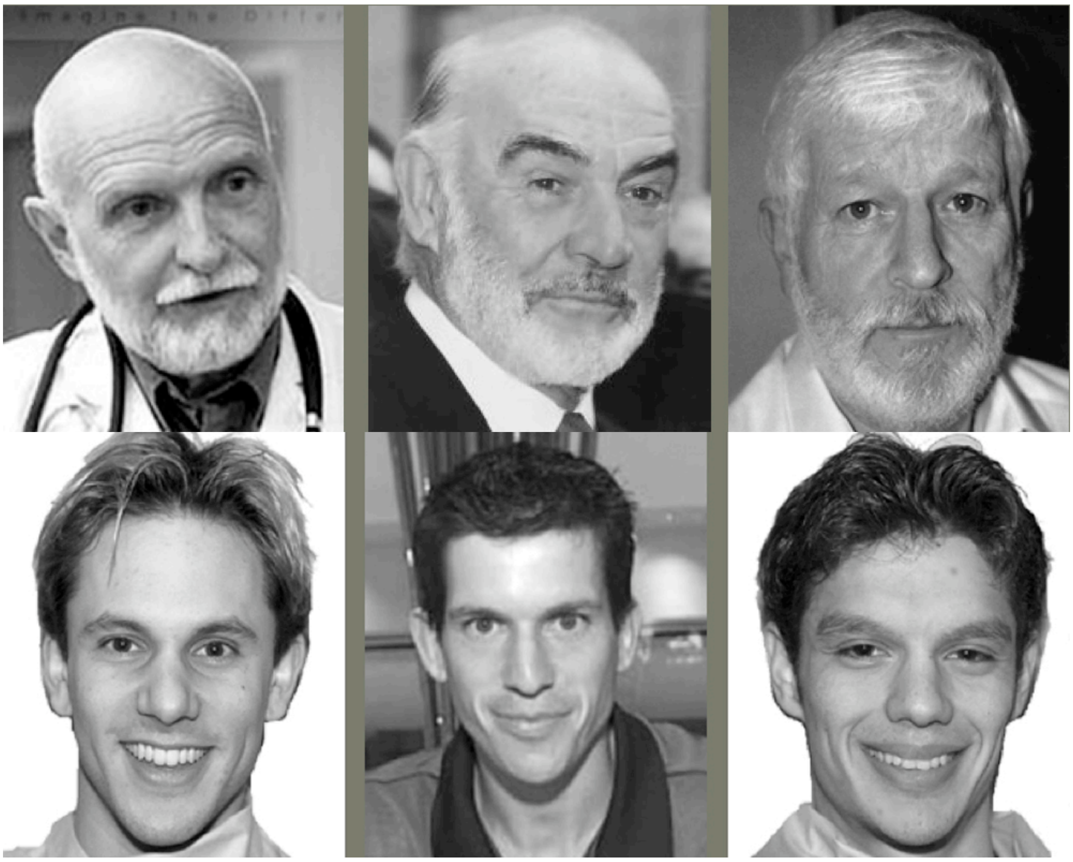


Figure 18: Example of the stimuli used in the familiarity rating experiment.

For each selection DA was asked to point out the famous person (these were presented randomly either in position 1, 2 or 3) and to rate her familiarity on a scale of 1 to 5 with 5 being very familiar and 1 being unfamiliar. We also asked her if she could tell us anything about the person she had selected. In all cases DA was extremely good at identifying the famous face from the selection, what became apparent, however, was her familiarity with the sports personalities was poor. Where as she could identify, for example, Sean Connery and say he was an actor and that she was very familiar with his face, she could select Tim Henman but could not say where she knew him from and hence had poor familiarity ratings for him. DA's familiarity ratings alongside her actual recognition scores in the DRM for the critical and no-studied items are shown in Table 35.

Table 35: Results from the familiarity experiment. DA responded on a scale of 1 to 5, with 1 being unfamiliar and 5 being familiar.

Critical Lures	**Correct Response in DRM**	**DA's Response Given in DRM**	**Correct identification of famous person in familiarity experiment**	**Familiarity**	**Name?**	**Occupation?**
Elvis Presley	No	Yes	Yes	5	Correct	Correct
Tom Cruise	No	Yes	Yes	5	Correct	Correct
Jennifer Aniston	No	Yes	Yes	5	Correct	Correct
Charlotte Church	No	No	Yes	5	Correct	Correct
Barbara Streisand	No	Yes	Yes	5	Correct	Correct
Sean Connery	No	Yes	Yes	5	Correct	Correct
Robbie Williams	No	Yes	Yes	5	Correct	Correct
Kate Winslet	No	Yes	Yes	3	No	No
		Incorrect = 0.875		**Total = 38**		
Non-Studied Pictures						
Jane Torville	No	Yes	Yes	3	No	Incorrect
Tim Henman	No	No	Yes	4	No	No
Kelly Holmes	No	No	Yes	3	No	No
Seb Coe	No	No	Yes	2	No	Incorrect
Steve Redgrave	No	Yes	No	3	No	No
David Beckham	No	Yes	Yes	4	Correct	Correct
Jonathon Edwards	No	No	Yes	2	No	Incorrect
Denise Lewis	No	Yes	No	1	No	Incorrect
		Incorrect = 0.5		**Total = 22**		

DA was unfamiliar with the sports personalities so her discrimination responses may be affected by false responses to the sports personalities based on poor familiarity. Because of this uncertainty as to whether DA's responses were a result of poor discrimination due to unfamiliarity we decided to run the experiment again, this time using non-studied items that we knew DA would be very familiar with, in this case day-time television presenters.

6.5.7 Experiment 8b: DA and Controls and Famous Faces (Day-time TV Personality Condition)

Day-time TV personalities were selected in the same way we accumulated the stimuli for *Experiment 8a,* DA was also asked what sort of programs she enjoyed watching on television. There was a period of 6 months between *Experiment 8a* and *8b*.

6.5.8 Participants

Fifteen controls were recruited via the University of Edinburgh's careers website. They were aged between 23 and 38 years (*M* = 27.89) Participants were all dominant right-handed, native speakers of English. They were paid £5 for their participation and had not taken part in any of the previous experiments. They were either graduates or post-graduates at the University.

6.5.9 Method and Materials

The stimuli were identical to *Experiment 8a* but we switched over the critical lures for the current number one position studied item. So for example, Tom Cruise now became a studied item and Tom Hanks became the critical lure. We used television personalities to replace the sports personalities and an example of the pictures can be seen in Figure 19 (the names are listed in *Appendix F*).

Figure 19: Example of the TV personality pictures.

The experiment methodology and design was identical to that described in *Experiment 8a*.

6.5.10 Results

The descriptive statistics for *Experiment 8b* are shown in Table 36. The raw results for all participants can be found in *Appendix G*.

Table 36: Descriptive statistics for critical incorrect, studied correct and non-studied incorrect and corrected true (CTR) and false (CFR) discrimination and response bias *b'*.

	Critical Lures (8 Items)		Studied Pictures (16 Items)		Non-studied Pictures (8 Items)				
Faces (TV)	**Correct**	**Incorrect**	**Correct**	**Incorrect**	**Correct**	**Incorrect**	**CTR**	**CFR**	***b'***
DA	75.00	25.00	62.50	37.50	100	0	0.625	0.25	0.4
Controls *M%*	87.45	12.52	89.98	10.01	94.93	5.02	0.85	0.08	0.19
Controls SD	*14.13*	*14.13*	*8.09*	*8.09*	*7.86*	*7.86*	*0.11*	*0.11*	*0.65*
n=15						***Significance t =***	-1.98	1.50	0.31
						p =	**<0.05**	0.08	0.38
						% Below	3.38	92.16	62.05

DA's discrimination of the non-studied lures is improved in comparison to *Experiment 7a* and she correctly rejects all the non-studied faces. However, her corrected true recognition is significantly lower than controls, $p < 0.05$ (Snodgrass & Corwin, 1988). DA's discrimination for corrected false recognition just misses significance, $p = 0.08$. DA's responses for the critical lures are very different from *Experiment 8a* (*Experiment 7a* critical lure incorrect = 0.875), presumably due to the change in critical lure for the second most common person for each group.

Signal Detection Analysis

The results for the signal detection analysis can be seen in Table 37.

Table 37: Signal detection analysis for DA and controls in the DRM TV faces paradigm. Significant results are in BOLD.

		Item-Specific Related		Item-Specific Unrelated		Gist-Specific	
Faces (TV)		***A'***	***b***	***A'***	***b***	***A'***	***b***
DA		0.78	-0.18	0.91	-1.39	0.81	-1.88
Controls *M*		0.94	-0.15	0.96	-0.42	0.60	-2.13
Controls SD		*0.05*	*0.54*	*0.03*	*0.58*	*0.17*	*0.95*
n=15	***Significance t =***	-3.09	-0.05	-1.61	-1.62	1.20	0.26
	p =	**<0.05**	0.48	0.06	0.06	0.13	0.40
	% Below	0.39	47.89	6.44	6.38	87.42	59.87

From the signal detection analysis we can see DA has difficulties with her discrimination of studied items and critical lures (item-specific related). This is significantly different from controls, $p < 0.05$, suggesting that she cannot distinguish between studied faces and critical lures as well as controls and produces more false recognition to famous faces.

6.5.11 Discussion

The results for *Experiment 8b* indicate a trend for DA to produce more false recognition to the critical lure famous faces in comparison with controls. We can be more certain in arguing this is the case than in *Experiment 8a* since DA is familiar with the non-studied lures in this paradigm. For the TV famous faces DA produced an overall familiarity rating of 45 (compared with only 22 for the sports personalities). In addition she could name seven of the eight presenters (the exception was David Dickinson) but she correctly identified the type of programme each was associated with. It would seem that DA can form gist between the categories but is unable to use gist within the categories to suppress false recognition, which would explain the significant differences for her corrected true recognition and item-specific related signal detection in comparison with controls.

DA's item-specific unrelated signal detection (that is studied items versus non-studied items) is only at 6% and her corrected true recognition remained relatively worse than controls indicating poor episodic memory.

In *Experiment 7b* we saw how adding words and pictures gave DA enough information to bring her performance to a similar level to that of controls. Can we do the same for famous faces?

6.5.12 Experiment 8c: DA and Controls and Famous Faces and Names (Day-time TV Personalities)

If we can aid DA's episodic memory in a similar manner to *Experiment 7b* then adding the personality names to their pictures should give DA added information to suppress her false recognition to the critical lures.

6.5.13 Participants

Fifteen controls were recruited via the University of Edinburgh's careers website. They were aged between 25 and 43 ($M = 32.2$). Participants were all dominant right-handed, native speakers of English and had not taken part in any of the previous experiments. They were all University graduates. They were paid £5 for their participation. There was a period of approximately twelve months between *Experiment 8b* and *8c*.

6.5.14 Method and Materials

The stimuli and design were identical to those used in *Experiment 8b* but each picture was accompanied by the name of the famous person printed clearly underneath. The methodology for Experiment 8c is identical to that of Experiment 8a.

6.5.15 Results

The descriptive statistics for *Experiment 8c* are shown in Table 38. The raw results for all participants can be found in *Appendix G*.

Table 38: Descriptive statistics for critical incorrect, studied correct and non-studied incorrect and corrected true (CTR) and false (CFR) discrimination and bias response *b'*.

Faces (TV & Names)	**Critical Lures (8 Items)**		**Studied Pictures (16 Items)**		**Non-studied Pictures (8 Items)**				
	Correct	**Incorrect**	**Correct**	**Incorrect**	**Correct**	**Incorrect**	**CTR**	**CFR**	***b'***
DA	50.00	50.00	93.75	6.25	62.50	37.50	0.56	0.13	0.2
Controls *M%*	85.84	14.21	87.54	12.52	95.41	4.61	0.82	0.06	0.1
Controls SD	*10.39*	*10.41*	*11.07*	*11.09*	*5.91*	*6.05*	*0.11*	*0.09*	0.1
n=15						***Significance t =***	-5.25	0.70	0.7
						p =	**<0.01**	0.25	0.2
						% Below	0.01	75.2	75.

DA's corrected true recognition is significantly lower than controls, $p < 0.01$ (Crawford & Garthwaite, 2002). DA's false recognition for the critical lures increases from *Experiment 7b* but she also increases her false recognition to the non-studied items in comparison with the controls (DA = 0.375, Controls = 0.04).

Signal Detection Analysis

The results for the signal detection analysis can be seen in Table 39.

Table 39: Signal detection analyses for DA and controls, significant results are shown in BOLD.

	Item-Specific Related		**Item-Specific Unrelated**		**Gist-Specific**	
Faces (TV &WORDS)	***A'***	***b***	***A'***	***b***	***A'***	***b***
DA	0.84	0.77	0.88	0.61	0.61	0.86
Controls *M* n = 15	0.92	0.14	0.96	-0.37	0.57	0.17
Controls SD	0.07	0.36	0.04	0.70	0.19	0.79
Significance t =	-1.08	1.69	-1.94	1.36	0.20	2.46
p =	0.14	0.06	**<0.05**	0.10	0.42	**<0.05**
% Below	14.36	94.38	3.66	90.16	57.93	98.63

From the signal detection analysis we can see DA still has difficulties with her discrimination of studied items and non-studied items (item-specific unrelated). This is significantly different from controls, $p < 0.05$ and was apparent in her lower corrected true recognition (see above).

6.5.16 Discussion

In the famous faces and names condition DA is unable to use the added information to increase her item specific memory and suppress her false recognition. If anything, the addition of the names seems to have increased her false recognition of not only the critical items but also the non-studied items producing a pattern of response close to chance and not dissimilar to what we found in *Experiment 8a*.

6.6 General Discussion

Table 40 shows the descriptive statistics for all five experiments and Table 41 the signal detection analysis.

Table 40: Overview of the descriptive statistics for Experiments 7a &b, 8a, b, and c.

	Critical Lure (12 Items)		**Studied Word (24 Items)**		**Non-studied Word (12 Items)**				
	Correct	**Incorrect**	**Correct**	**Incorrect**	**Correct**	**Incorrect**			
Words (7a)							**CTR**	**CFR**	***b′***
DA	33.33	66.67	62.50	37.50	66.67	33.33	0.25	0.29	0.71
Controls *M%*	34.44	65.60	67.74	32.22	87.47	12.53	0.55	0.53	0.63
Controls SD	*14.73*	*14.73*	*12.90*	*12.90*	*13.05*	*13.05*	*0.19*	*0.21*	*0.23*
n=15						***Significance t =***	-1.53	-1.11	0.34
						p =	0.07	0.14	0.37
						% Below	7.43	14.36	62.94
Words & Pictures (7b)							**CTR**	**CFR**	***b′***
DA	58.33	41.67	87.50	12.50	91.67	8.33	0.79	0.33	0.77
Controls *M%*	68.40	31.60	82.52	17.48	95.00	5.00	0.78	0.27	0.67
Controls SD	*13.77*	*13.77*	*14.60*	*14.60*	*8.80*	*8.80*	*0.17*	*0.15*	*0.19*
n=15						***Significance t =***	0.06	0.39	0.51
						p =	0.48	0.35	0.31
						% Below	52.3	64.78	69.09
Faces: Sports (8a)							**CTR**	**CFR**	***b′***
DA	12.50	87.50	62.50	37.50	50.00	50.00	0.125	0.375	0.63
Controls *M%*	84.78	15.22	86.01	13.99	90.13	9.87	0.76	0.05	0.12
Controls SD	*16.35*	*16.35*	*11.72*	*11.72*	*12.14*	*12.14*	*0.1*	*0.21*	*0.69*
n=15						***Significance t =***	-6.15	1.50	0.72
						p =	**<0.001**	0.08	0.24
						% Below	0.00	92.19	75.70
Faces: TV (8b)							**CTR**	**CFR**	***b′***
DA	75.00	25.00	62.50	37.50	100	0	0.625	0.25	0.4
Controls *M%*	87.45	12.52	89.98	10.01	94.93	5.02	0.85	0.08	0.19
Controls SD	*14.13*	*14.13*	*8.09*	*8.09*	*7.86*	*7.86*	*0.11*	*0.11*	*0.65*
n=15						***Significance t =***	-1.98	1.50	0.31
						p =	**<0.05**	0.08	0.38
						% Below	3.38	92.16	62.05
Faces: TV & Names (8c)							**CTR**	**CFR**	***b′***
DA	50.00	50.00	93.75	6.25	62.50	37.50	0.56	0.125	0.22
Controls *M%*	85.84	14.21	87.54	12.52	95.41	4.61	0.82	0.06	0.11
Controls SD	*10.39*	*10.41*	*11.07*	*11.09*	*5.91*	*6.05*	*0.11*	*0.09*	0.15
n=15						***Significance t =***	-2.24	0.70	0.71
						p =	**<0.01**	0.26	0.24
						% Below	0.01	75.2	75.5

Across stimuli we have seen that a patient with dense anterograde amnesia can have her performance manipulated to match those of controls only in the word and picture condition. Table 41 shows the combined results for signal detection analysis using A'Prime. This also includes signal detection analysis for *Experiment 8a* which although not reported in our results above is included here simply for comparative purposes only.

How can we explain DA's results in a satisfactory way to understand why her performance only improved in the words and picture condition and not in the words and famous faces condition?

Reder et al. (2006) may suggest an answer to this. They tested subjects for recognition memory of three different types of stimuli: words, photographs and abstract pictures. The subjects were divided into two groups: controls, and those who had been injected with the drug Midazolam, which produces temporary anterograde amnesia. Reder et al. (2006) found that memory was poorer in the Midazolam condition for words compared with controls, but this was smaller in the photographic stimuli and almost absent in the abstract condition. They argue that stimuli with which the amnesia subjects have a greater pre-experimental familiarity (such as words and photographs) are more vulnerable to 'old' judgments because it is easier to bind the stimuli to an episodic 'node'. In contrast, abstract pictures are not subject to this familiarity bias and so cannot provide episodic binding.

We can apply this argument to DA's case and say that for a DRM paradigm using words her poor gist memory makes her more vulnerable to false recognition of the non-studied items based on having prior knowledge of the word stimuli. What she cannot use is any item-specific information to suppress her 'old' judgments of non-studied words as, according to Reder et al.'s argument, DA will have strong episodic binding to these words from previous experience. What DA does not have is the same level of gist differentiation that is available to the control subjects.

Table 41: Overall of the signal detection analysis for Experiments 7a & b, 8a, b & c.

Signal Detection A'Prime	Item-Specific Related		Item-Specific Unrelated		Gist-Specific	
Words Exp. 7a	***A'***	***b***	***A'***	***b***	***A'***	***b***
DA	0.46	0.37	0.7	0	0.73	0.06
Controls *M*	0.51	0.47	0.86	-0.59	0.91	-0.62
Controls SD	*0.11*	*0.35*	*0.08*	*0.53*	*0.09*	*0.55*
n=15 ***Significance t =***	-0.44	-0.28	-1.94	1.08	-1.94	1.2
p =	0.33	0.39	**<0.05**	0.15	**<0.05**	0.13
% Below	33.33	39.30	3.66	85.03	3.66	87.44
	Item-Specific Related		**Item-Specific Unrelated**		**Gist-Specific**	
Words & Pictures Exp. 7b	***A'***	***b***	***A'***	***b***	***A'***	***b***
DA	0.83	0.47	0.94	-0.12	0.79	-0.8
Controls *M*	0.82	0.31	0.94	-0.68	0.77	-1.5
Controls SD	*0.11*	*0.36*	*0.05*	*0.6*	*0.14*	*0.55*
n=15 ***Significance t =***	0.09	0.43	0	0.9	0.138	1.23
p =	0.47	0.34	0.5	0.19	0.45	0.12
% Below	53.44	66.32	50.00	80.93	55.40	98.73
	Item-Specific Related		**Item-Specific Unrelated**		**Gist-Specific**	
Faces (sports) Exp. 8a	***A'***	***b***	***A'***	***b***	***A'***	***b***
DA	0.26	0.73	0.61	0.16	0.79	0.58
Controls *M*	0.9	-0.09	0.93	-0.16	0.57	-1.85
Controls SD	*0.1*	*0.58*	*0.07*	*0.55*	*0.18*	*1.07*
n=15 ***Significance t =***	-6.2	1.37	-4.43	0.563	1.183	-2.19
p =	**<0.01**	0.096	**<0.01**	0.291	0.13	**<0.05**
% Below	0	90.37	0.03	70.89	87.18	97.74
	Item-Specific Related		**Item-Specific Unrelated**		**Gist-Specific**	
Faces (TV) Exp. 8b	***A'***	***b***	***A'***	***b***	***A'***	***b***
DA	0.78	-0.18	0.91	-1.39	0.81	-1.88
Controls *M*	0.94	-0.15	0.96	-0.42	0.6	-2.13
Controls SD	*0.05*	*0.54*	*0.03*	*0.58*	*0.17*	*0.95*
n=15 ***Significance t =***	-3.09	-0.05	-1.61	-1.62	1.2	0.26
p =	**<0.05**	0.48	0.06	0.06	0.13	0.4
% Below	0.39	47.89	6.44	6.38	87.42	59.87
	Item-Specific Related		**Item-Specific Unrelated**		**Gist-Specific**	
Faces (TV &WORDS) Exp. 8c	***A'***	***b***	***A'***	***b***	***A'***	***b***
DA	0.84	0.77	0.88	0.61	0.61	-0.16
Controls *M*	0.92	0.14	0.96	-0.37	0.65	-1.93
Controls SD	*0.07*	*0.36*	*0.04*	*0.7*	*0.15*	*0.79*
n=15 ***Significance t =***	-1.084	1.66	-1.897	1.328	-0.253	2.126
p =	0.14	0.06	**<0.05**	0.1	0.42	**<0.05**
% Below	14.36	94.38	3.66	90.16	57.93	98.63

In contrast, for the words and picture condition, controls can use the distinct features to suppress false recognition, but false recognition still remains in this condition because of the gist information provided by the words due to episodic binding. DA is provided with enough distinctive information from the pictures to suppress her familiarity judgements as a result of episodic binding, especially for the non-studied words. In this condition DA's performance is comparable to the controls.

Reder et al.'s (2006) argument may also help us with the case of the famous faces. Again, DA is likely to be more vulnerable to false recognition in this condition due to her pre-experimental familiarity with the stimuli. Her gist memory is not strong enough to allow the differentiation within the groups leaving her vulnerable to false recognition of the critical lures and non-studied items due to the familiar nature of the stimuli. Poor episodic memory also causes her problems with the studied items resulting in persistent differences in corrected true recognition in comparison with the control groups across all three conditions using famous faces.

Adding the names of the famous faces does not help DA in *Experiment 8c*. Names of people are irrevocably bound to the faces and so only add to the episodic binding described by Reder et al (2006). Perhaps if we had used the occupations of the individuals instead of names we may have provided enough of a novel condition that DA could have used this to suppress her false recognition of the critical and non-studied items.

This may explain the findings of Schacter, Verfaellie, Anes and Racine, (1998). If we recall from *Chapter Two* this study examined whether it was possible to manipulate levels of false recognition in patients with Korsakoff's and non-Korsakoff's amnesia. This was done by increasing the number of study phases of the word lists and then the number of subsequent trials. With each increase in study phase Korsakoff patients increased false recognition whereas controls decreased their false recognition. In contrast the non-Korsakoff amnesia patients remained relatively static in their false recognition performance, which suggests there is no change in their gist memory. Once damaged, it seems this cognitive facility remains impaired.

There are plenty of criticisms against the use of case studies. The first is that the results cannot be used to provide any generality of findings. Comparing DA's performance against that of Schacter et al.'s (1998) patients is tenuous, as they have known pathologies and the experiment paradigms are quite different. The best we can offer is the emergence of a pattern of behaviour that seems replicable across a number of trials, specifically DA's poor gist memory performance. This suggests that in anterograde amnesia not only is episodic memory damaged but so too is gist memory and this cannot be aided by the use of additional distinct information.

There is also the argument that case studies can result in a bias due to the in-depth nature of the research. However, in this instance we could argue that it is the very in-depth nature that has allowed us to explore so many different paradigms with one patient and discover that for DA we can manipulate her performance by using words and pictures to bind properties together. Furthermore, we have found that DA produces false recognition to famous faces and this offers a future opportunity to explore this phenomenon among other anterograde amnesia patients to see if this pattern can be replicated. It may be that DA also has a form of prosopagnosia and this could also be explored in future work.

6.7 Conclusion

DA's performance could only be improved to match controls in a word and picture condition. In the word-only DRM paradigm DA's performance, although not significant, was in the direction predicted, tending towards reduced corrected true and corrected false recognition. This is consistent with the work of previous research on amnesia patients such as Schacter, Verfaellie, & Koutstaal, 2002.

However, DA did not improve her performance in the famous faces and names condition. She persisted in producing false recognition to the critical lures suggesting she may have specific problems related to facial recognition.

Chapter Seven: GC – A case study investigating the use of the DRM paradigm as a test for Memory Malingering

7.1 Introduction

GC is a 43-year-old man who first presented amongst the functional memory weakness patients. There had been some concern that he was exaggerating his memory difficulties and he performed poorly on the Tombuagh Test of Memory Malingering (Tombaugh, 1996). For this reason his data were excluded from the patient set presented in *Chapter Five* and examined separately. For this reason it raised the question, how does someone who is malingering perform on the DRM word paradigm?

Over the course of this thesis we have argued that the DRM paradigm is driven by gist memory resulting in participants producing high levels of false recognition to the critical lures in comparison with the non-studied words. If it is driven by gist memory then this suggests we are looking at an implicit cognitive behaviour that is difficult for participants to overtly control. That is false recognition of the critical lures is difficult to suppress. Furthermore, it should be hard for controls to mimic the behaviour of amnesia patients since this would require memorizing large quantities of data (for example, 12 word lists each consisting of 15 words) in order to replicate the pattern of reduced true and false recognition seen in amnesia patients (e.g. Schacter, Verfaellie & Pradere, 1996).

Current tests of memory malingering rely on the premise that a malingerer will produce a negative response bias to a memory test; that is, they will assume that to produce the same results as an individual with genuine memory problems that the favoured response will be to answer 'no', i.e. 'No, I have not seen this before', or 'No, I do not remember this'. Determining whether an individual is wilfully malingering is a sensitive issue as some may be suffering from conversion disorders, others may not be motivated to concentrate, and others may have genuine memory problems but may be exaggerating these in order to receive help (Hom & Denney, 2002). Furthermore, a number of forensic tests are capable of determining the difference between malingerers and participants with no neurological impairment, but are insensitive to genuine memory impairment (e.g. Tombaugh Test of Memory Malingering, 1996). Other clinicians may rely on a range of established memory tests such as the Wechsler Memory Scale (Wechsler, 1987), in order to determine if a patient's performance is a valid indication of their actually ability (for review see Mittenberg et al. in Hom & Denney, 2002).

However, one concern with the majority of the available forensic tests for malingering is they rely on the malingerer producing a negative response bias and work from the assumption that the participant is always trying their hardest during testing, since the majority focus on forced-choice recognition (i.e. determining whether an item, be it a word or picture for example, was present in the study phase). Unfortunately this opens these tests up to the possibility that the results can be faked. For example, if you know that to pass the Tombaugh Test of Memory Malingering requires adopting a normal response strategy then it becomes impossible to differentiate the malingerer from the normal subject.

The current method of establishing whether a test can be used for identifying malingerers is to ask normal participants to take the test pretending they have a brain injury that affects their memory. Unsurprisingly the participants often adopt a negative response bias. However, a question arises from this methodology: if the participant knew the outcome of a real patient's performance on the test that had genuine memory problems, would they be able to mimic the performance? This is important because despite best intentions someone who is wilfully malingering can (albeit with some cost) obtain copies of the current range of neuropsychology tests and so replicate the desired result. This is increasingly becoming an issue in countries where litigation and 'no win, no fee' injury cases are common.

Clinicians and neuropsychologists are increasingly being called as expert witnesses to testify in courts in cases where malingering is suspected. A test of memory malingering should be able to differentiate between a malingerer, a normal subject and one with neurological impairment. However, we would add to this that a test of memory malingering should also be extremely difficult if not impossible to replicate the actual performance of a memory patient. That is, even if the malingerer were aware of the test methodology and outcome they would still not be able to replicate the performance of a memory-impaired individual.

The DRM paradigm provides us with three hypotheses for testing memory malingering:

1) Performance on the DRM will be different between a malingerer, a genuine memory patient and controls, since someone 'faking' a memory problem will adopt a negative response bias whereas amnesia patients tend towards a positive response bias in the DRM paradigm (e.g. Schacter, Verfaellie & Koutstaal, 2002).
2) An informed participant will not be able to replicate the performance of an amnesia patient in the DRM paradigm since it would require learning not only the word lists but also the pattern of response seen in amnesia patients.
3) Participants who are malingering will have longer response latencies: given that they have to memorize the word lists and then replicate the performance of an amnesia patient, having to actively 'think' about their responses in the DRM paradigm's test phase will significantly increase response latencies.

The three experiments reported below will therefore examine a malingerer's performance on the DRM in comparison with controls and our amnesia patient's data, DA from *Chapter Six*. We will also examine whether by asking a participant group to perform on the DRM paradigm as they think an amnesia patient might perform they can replicate the pattern of response typically seen in amnesia patients. Finally, using participants who are aware of the DRM word lists and the methodology, and who are aware of the performance of a true amnesia patient, we will ask participants to perform like an amnesia patient in the DRM paradigm.

7.2 GC: A Case Study

GC is a 43-year-old man who is retired on incapacity benefit having suffered with a long history of depression. At the time of testing he was separated from his wife and living with his cousin and did very little during the day except walking his dog. GC first came to hospital in 2001 after having a brief period when he could not recall his children's names. He then went blank for an hour but was back to normal upon arriving at hospital. GC was told he had had a ministroke but his MRI scan was normal. He suffered no physical weakness at the time. GC was sent to the Western General Hospital in Edinburgh to meet consultants at the Memory Clinic. Initially he was placed in the functional memory disorder group but there were early concerns he was exaggerating his memory difficulties. There were no issues of compensation other than his disability living allowance. His cousin attended the appointment with him at the Western General and gave a clear history of GC's memory problems. These centred around paying her for household items that she buys on his behalf, forgetting what his intentions are and irritability. She stated that the difficulties GC experienced with his memory seemed to be getting progressively worse over the last 4-5 years. She noted that GC was going out less and less although he was doing some unpaid work for friends who run a garage but his memory difficulties were making that difficult. GC said he had no problems driving but sometimes has difficulty finding the car after he has parked it. He watches television but often has to ask his cousin what the programme is about. He has left the cooker on and forgotten how to work the computer and he spends too much time sleeping.

Since depression was suspected GC was prescribed Venlafaxine and he was referred for a neurospychology assessment that took place in August 2008. (Please note this assessment occurred after GC took part in this experiment which occurred in January 2008). To rule out any other causes GC had a full blood count, routine biochemistry, dementia antibody test, syphilis serology, folate and B12 test and C-reactive protein test. All the results were normal. The notes from the neuropsychology assessment state that his cognitive screening was 64/100 and his Mini-Mental State Examination results were 20/30. His premorbid level was in the average range. However, his performance on tests of episodic memory was disproportionately poor. Some of the scores for GC were available in his notes:

Information processing speed/working memory

Digit Span Age Scaled Score	7
Digit Symbol Aged Scaled Score	5

Visuospatial/Memory Skills

Rey Figure Copy	32 raw (average for age)
Rey Figure Immediate Recall	10.5 raw (below 10th percentile)
Rey Figure Delayed Recall	6.5 raw (below 10th percentile)

Language

Boston Naming Test 46/60

Category Fluency 12 (below 10th percentile)

Rey Auditory Verbal Learning Test Total 13, Delay 0, RI 7, DI 2

COWAT p = 10

Stroop Raw Score 80, Pr value 0.04 (20 – 24th percentile)

Beck's Depression Inventory = 31

His neurospychology assessment at the time of testing can be seen in Table 42.

Table 42: GC's Neuropsychology Results.

Wechsler Abbreviated Scale of Intelligence. Vocabulary score: 37 Matrix Reasoning score: 52 2-subtest IQ: 89	NART Predicted Full Scale: 92.5 Verbal Fluency Average: 4.67 (F= 5, A= 4, S=5: 1 minute each)	
Beck's Depression Inventory: 26 State-Trait Anxiety Inventory: 57	Wechsler Logical Memory Part I 1st Recall Total Score = 4 Recall Total Score = 7 Thematic Total Score = 4 Learning Slope Range = 2 Part II Recall Total Score = 2 Thematic Total Score = 1 Percent Retention = 33.33% Percent Recognition = 50%	Age Scaled Scores 2 1 3 8 1 2
Trail Making Part A: 76.3 secs Trail Making Part B: 210.0 secs	Tombaugh Test of Memory Malingering Trial 1: **18** Trial 2: **31** Retention: **32**	

GC's Beck's Depression Inventory was 26 placing him in the moderate range for depression. His STAIT scores were within the normal range. His performance on the Wechsler Logical Memory Parts I & II was abnormal and he was unable to recall many details even after prompting. In Part II he could recall nothing from the second story. This was congruent with the subsequent assessment in August 2008 that noted his episodic memory performance was disproportionate. His performance on Trail Making Part B is not disproportionate to Trail Making A although it is low (0 to 10th percentile). However, this could be a result of his depression as there can be a relationship between depression and impairment in executive functions (for review see Fossati et al, 2002).

However, his performance on The Tombaugh Test of Memory Malingering (1996) was below the normal range. A score of 35 or below on Trial 1 suggests a patient is exaggerating their memory symptoms. If the patient subsequently scores below 35 on Trial 2 they then carry out the retention part of the test. A score of below 35 suggests that the patient is probably malingering.

7.3 Experiment 9a: Performance of patient GC on the DRM paradigm in comparison with controls and amnesia patient DA.

7.3.1 Participants

Fifteen controls were recruited via the University of Edinburgh's careers website. Participants were all dominant right-handed, native speakers of English. They were paid £5 for their participation. GC was also reimbursed for his time and travel costs across all the experiments.

7.3.2 Method and Materials

12 lists of 15 words were used (shown in bold in *Appendix A*) from the original 24-list paradigm used in *Chapter Three*. These word lists were identical to the ones used for DA. All the participants were told they were taking part in an experiment to investigate memory. Instructions for the experiment appeared on the computer screen. Participants were told to study the word lists in part one of the experiment, and answer the maths questions in between each list that acted as a distracter task. The maths questions lasted for 15 seconds. The word lists were presented randomly as were the words in each list. Participants saw the words at a rate of 1s per word. After all 12 lists had been studied participants moved directly on to the recognition phase of the experiment and were instructed to press 'YES' on the keyboard if they thought the word was in the original study phase, and 'NO' if it was not. The 'd' and

‘k’ keys on the keyboard were labeled and used as the ‘yes’ and ‘no’ response keys. Words were presented at a rate of 0.5s per word.

7.3.3 Results

As in *Chapter Three*, using Snodgrass and Corwin’s (1988) recommendations regarding signal-detection theory in memory recognition we used the two-high-threshold theory to examine corrected true and false recognition rates and bias (b’) for controls, DA and GC. These can be seen in Figure 20.

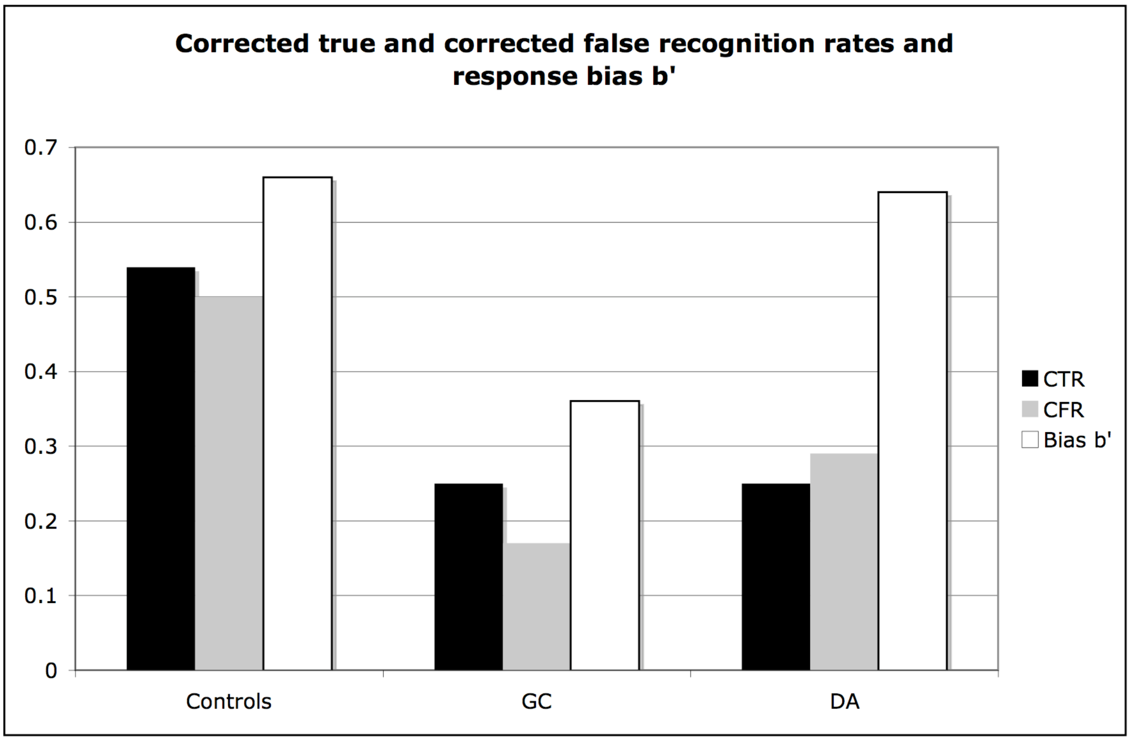


Figure 20: Corrected true (CTR) and corrected false (CFR) recognition rates and response Bias b’.

GC’s corrected true and false recognition rates just missed significance (See Table 43), however, it can be seen from his responses to critical lures incorrect and studied words correct that his responses were significantly different from the Control group, which is in contrast to our amnesia patient DA whose results were comparable with Controls. In addition his response bias was negative (b’ = 0.36) in comparison with the positive response bias of both Controls (b’ = 0.66) and DA (b’ = 0.64). Using Crawford and Garthwaite’s (2002) program for statistical analysis of single case studies we found GC's response bias was significantly different from Controls, p <0.05, in contrast to DA (see Table 43).

Table 43: Descriptive statistics and statistical analysis for Experiment 9a.

Experiment 9a	**Critical Incorrect (12 Items)**	**Studied Correct (24 Items)**	**Non-studied Incorrect (12 Items)**
Controls n = 15 %	63.89 (SD = 15.00)	67.50 (SD = 12.42)	13.89 (SD = 12.37)
DA % DA probability in comparison with controls	66.67 t = 0.19, p = 0.42	62.50 t = -0.48, p = 0.32	33.33 **t = 1.94, p <0.05**
GC % GC probability in comparison with controls	33.33 **t = -2.00, p < 0.05**	41.67 **t =-2.10, p <0.05**	16.67 t = 0.42, p = 0.40
	Corrected True Recognition	**Corrected False Recognition**	**Bias - b'**
Controls n = 15	0.54 (SD = 0.17)	0.50 (SD = 0.20)	0.66 (SD = 0.12)
DA DA probability in comparison with controls	0.25 **t = -1.65, p = 0.06**	0.29 t = -1.02, p = n.s	0.64 t = -0.161, p = n.s
GC GC probability in comparison with controls	0.25 **t = -1.65, p = 0.06**	0.17 **t = -1.60, p = 0.07**	0.36 **t = -2.42, p <0.05**

7.3.4 Discussion

In this initial experiment we found that GC's performance on the DRM paradigm is significantly different to that of Controls in terms of corrected true recognition, false recognition and response bias. Moreover, unlike DA GC produces a negative response bias; that is he has a bias to responding 'no' to the words during the recognition phase of the DRM. In contrast, DA has a positive response bias meaning she is more likely to respond 'yes' during the recognition phase so the non-studied words incorrect are significantly higher than controls, p <0.05. The next step was to examine whether Malingering participants can replicate the performance of an amnesia patient in the DRM paradigm when asked to perform as if they had a memory impairment.

7.4 Experiment 9b: Performance of 'malingering' participants on the DRM paradigm.

7.4.1 Participants

Fifteen controls were recruited via the University of Edinburgh's career's website. Participants were all dominant right-handed, native speakers of English. They were paid £5 for their participation.

7.4.2 Method and Materials

The methods and materials were identical to *Experiment 9a* except in this instance prior to beginning the experiment participants were asked to imagine they had been involved in an accident that had left them with a head injury and were now suffering from amnesia. They were asked to perform the DRM paradigm as if they had memory problems. This is accordance with the current published methodology for examining current tests of memory malingering (see Hom & Denney, 2002).

7.4.3 Results

Using Snodgrass and Corwin's (1988) recommendations regarding signal-detection theory in memory recognition we used the two-high-threshold theory to examine corrected true and false recognition rates and bias response. These can be seen in Figure 21 in comparison with the results for *Experiment 9a* for Controls, Malingerers, DA and GC.

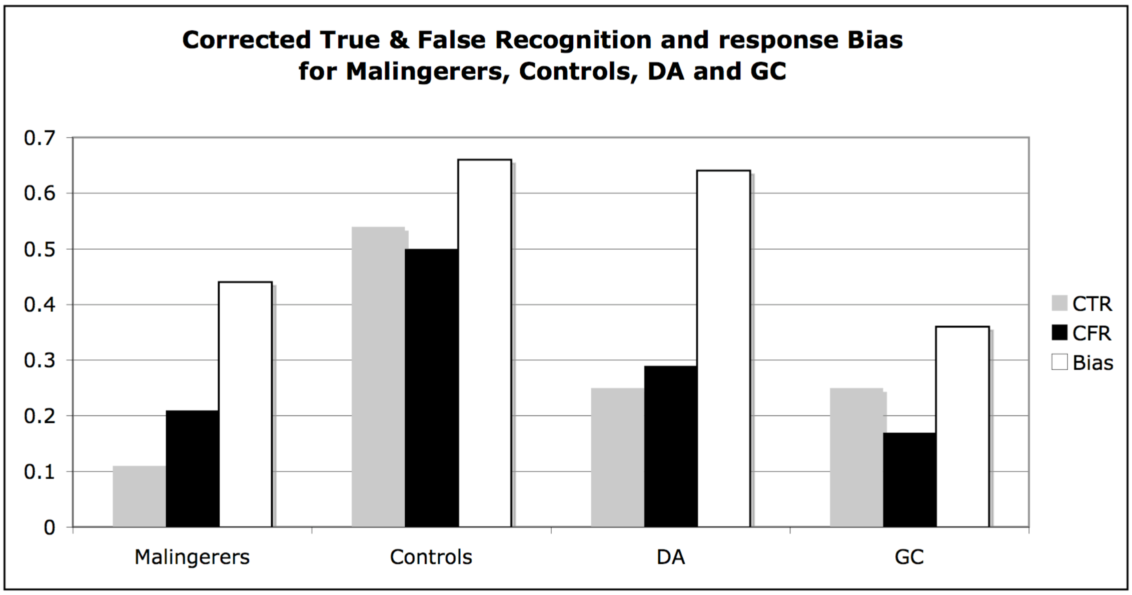


Figure 21: Corrected true and false recognition and response bias for Malingerers, Controls, DA and GC.

At first glance it would appear as though the Malingering group can produce a similar pattern of performance as our amnesia patient, DA. However, the response bias for the Malingering group was negative (b' = 0.44) in comparison with DA who produces a positive response bias (b' = 0.64), that is DA is more likely to respond 'yes' whereas the Malingering group were more likely to respond 'no' in the test phase. This difference in response bias between Malingerers versus DA was significant using Crawford and Garthwaite's (2002) statistical program for case studies, $p < 0.05$ (see Table 44).

An independent sample t-test was run to compare Malingerers with Controls for Corrected True Recognition, Corrected False Recognition and Bias. As can be seen from Table 44 the results were significant ($p < 0.05$) as the Malingerers adopted the negative response bias.

Table 44: Descriptive statistics and statistical analysis for Experiment 9b.

Experiment 8b	Critical Incorrect (12 Items)	Studied Correct (24 Items)	Non-studied Incorrect (12 Items)
Malingering n = 15	52.74 (SD = 18.23)	45.90 (SD = 13.54)	25.52 (SD = 22.18)
DA % DA probability in comparison with malingerers	66.67 t = 0.75, *p* = n.s	62.50 t = 1.11, *p* = n.s	33.33 t = 0.53, *p* = n.s
GC % GC probability in comparison with malingerers	33.33 t = -1.07, *p* = n.s	41.67 t = -0.28, *p* = n.s	16.67 t = -0.40, *p* = n.s
	Corrected True Recognition	**Corrected False Recognition**	**Bias - b'**
Malingering n = 15	0.11 (SD = 0.19)	0.21 (SD = 0.18)	0.44 (SD = 0.10)
DA DA probability in comparison with malingerers	0.25 t = 0.71, *p* = n.s	0.29 t = 0.43, *p* = n.s	0.64 **t = 1.94, *p* <0.05**
GC GC probability in comparison with malingerers	0.25 t = 0.71, *p* = n.s	0.17 t = -0.21, *p* = n.s	0.36 t = -0.78, *p* = n.s
	Corrected True Recognition	**Corrected False Recognition**	**Bias - b'**
Malingering Controls Malingering v Controls	0.11 (SD = 0.19) 0.54 (SD = 0.17) **t = 2.76, p < 0.01**	0.21 (SD = 0.18) 0.50 (SD = 0.20) **t = 2.05, p < 0.05**	0.44 (SD = 0.10) 0.66 (SD = 0.12) **t = 1.64, p < 0.05**

7.4.4 Discussion

Although Malingerers were able to produce the same pattern of reduced corrected true and false recognition as our amnesia patient it is not due to the same response bias, and this finding was significant. Furthermore, when questioned about the tactics they used to mimic the performance of an amnesia patient the Malingerers argued that an amnesia patient was unlikely to remember the studied words so they favoured a negative response in the test phase. This produced significant differences when the Malingerers' results were also compared with the Controls. As we have seen, DA produced a positive response bias. A negative response bias on the part of the Malingerers means the non-studied words are correctly rejected. This is not the case with the amnesia patients who produced false recognition to the non-studied words due to a positive response bias (e.g. Schacter et al., 2000). GC's pattern of response is not significantly different to those of the Malingerers', which suggest he is malingering in order to replicate an amnesia patient. However, one final question remains: if the malingerer knows the pattern of response for an amnesia patient will they then be able to replicate those results more closely in the DRM paradigm?

7.5 Experiment 9c: Performance of Informed-malingering participants on the DRM paradigm.

7.5.1 Participants

Fifteen controls were recruited for this experiment. All were students of the Psychology Department at the University of Edinburgh who had some previous knowledge of the DRM paradigm. All were paid £5 for their participation.

7.5.2 Method and Materials

The methods materials were identical to *Experiment 9a*. Participants were all given one week to study and memorise the word lists. They were also familiarised with Schacter's research on false recognition for amnesia patients. Before undertaking the DRM paradigm they were told to replicate the pattern of response seen in amnesia patients undertaking the DRM paradigm. To help them each had a graph (see Figure 22) depicting the pattern of responses typically seen in the DRM paradigm with amnesia patients (that is the reduced false recognition of critical lures and high false recognition of the non-studied words).

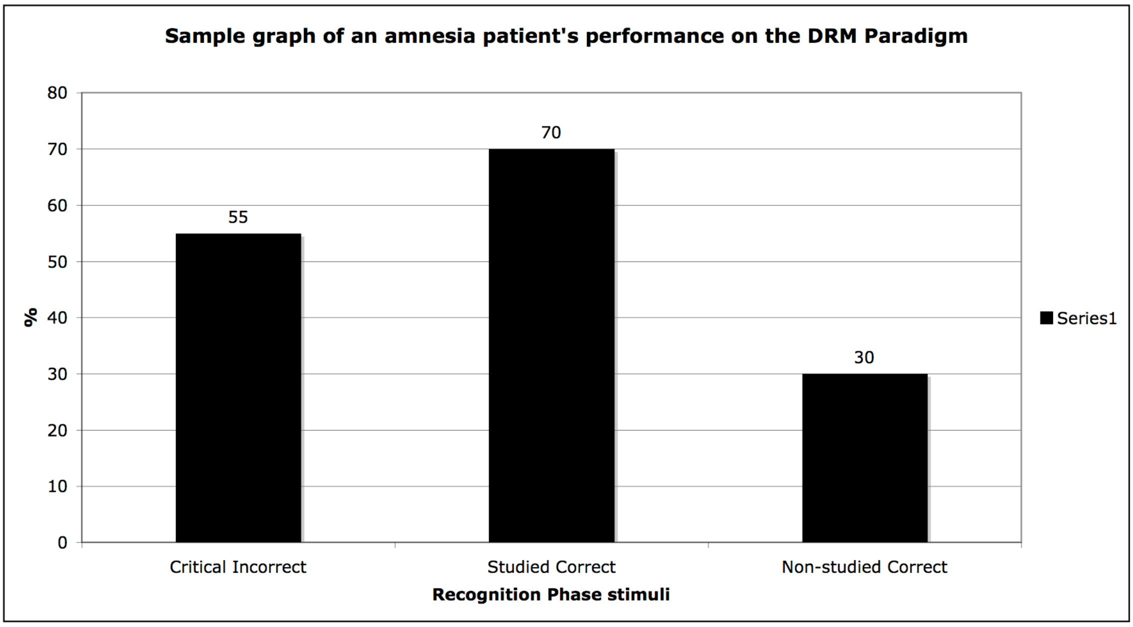


Figure 22: Sample graph given to the Informed Malingering group.

7.5.3 Results

Again we used Snodgrass and Corwin's (1988) recommendations regarding signal-detection theory in memory recognition with the two-high-threshold theory to examine corrected true and false recognition rates and bias response. The Informed Malingering results can be seen in Figure 23 in comparison with the results for *Experiment 9a* for Controls, *Experiment 9b* for Malingerers, and DA and GC.

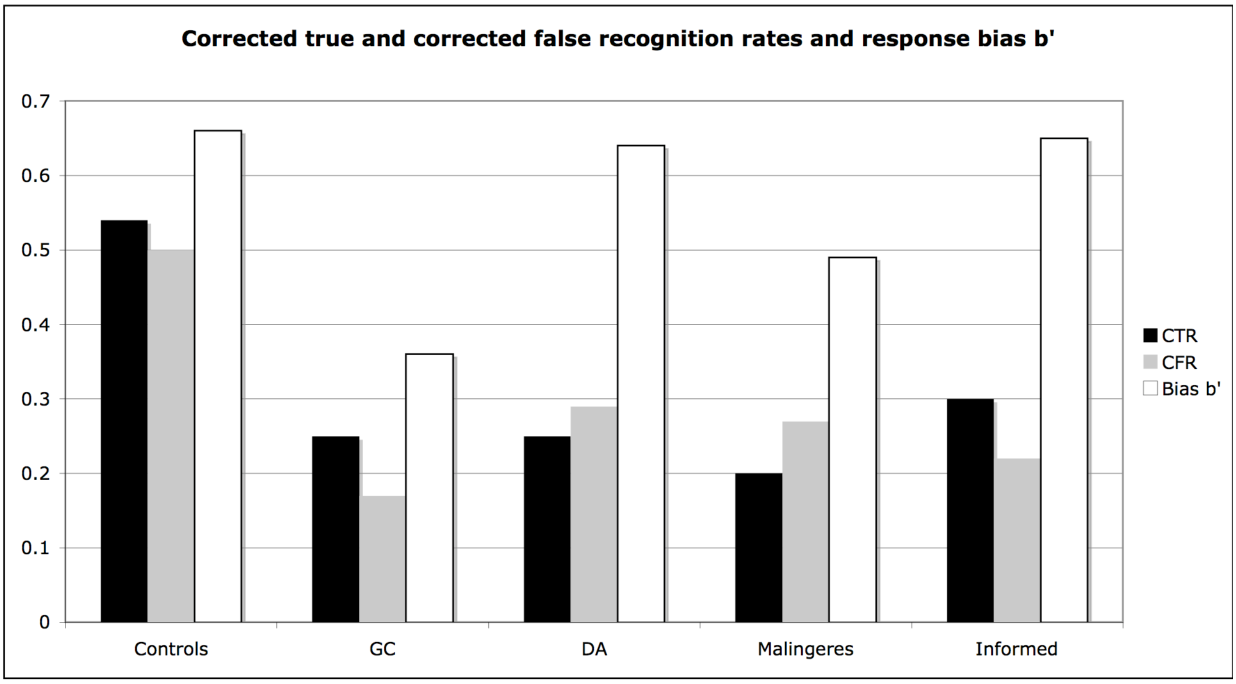


Figure 23: Corrected true (CTR) and corrected false (CFR) recognition rates and response bias b' for Informed malingerers, Malingerers, Controls, GC and DA.

As in *Experiment 9b* it appears at first glance as though the Informed Malingering group can perform like our amnesia patient DA. There were no significant difference for either true or false recognition (see Table 45), moreover the Informed group also produced the positive response bias seen in amnesia patients (e.g. Schacter et al., 2002).

Table 45: Descriptive statistics and statistical analysis for Experiment 9c.

Experiment 9c	**Critical Incorrect (12 Items)**	**Studied Correct (24 Items)**	**Non-studied Incorrect (12 Items)**
Informed Malingering n = 15 (Inform Maling) %	60.31 (SD = 20.30)	68.41 (SD = 13.74)	38.80 (SD = 22.82)
DA %	66.67	62.50	33.33
DA v Inform Maling	t = 0.34, *p* = n.s	t = -0.41, *p* = n.s	t = -0.04, *p* = n.s
GC %	33.33	41.67	16.67
GC v Inform Maling	t = -1.31, *p* = n.s	**t = -1.80, *p* <0.05**	t = -0.93, *p* = n.s
	Corrected True Recognition	**Corrected False Recognition**	**Bias - b'**
Informed Malingering n = 15	0.30 (SD = 0.30)	0.22 (SD = 0.34)	0.65 (SD = 0.15)
DA	0.25	0.29	0.64
DA v Inform Maling	t = -0.16, *p* = n.s	t = 0.20, *p* = n.s	t = -0.06, *p* = n.s
GC	0.25	0.17	0.36
GC v Inform Maling	t = -0.16, *p* = n.s	t = -0.14, *p* = n.s	**t = -1.87, *p* <0.05**

However, the hypothesis stated that attempting to replicate the performance of an amnesia patient in the DRM paradigm would increase the time participants needed to 'think' about their responses in the recognition phase. The response latencies for the Informed Malingering group are shown in comparison with the results for *Experiment 9a*, *9b* and DA and GC in Figure 24. We have also included here the response latencies for the Functional Memory Disorder patients discussed in *Chapter 5*. The response times are shown against the three word types in the recognition phase.

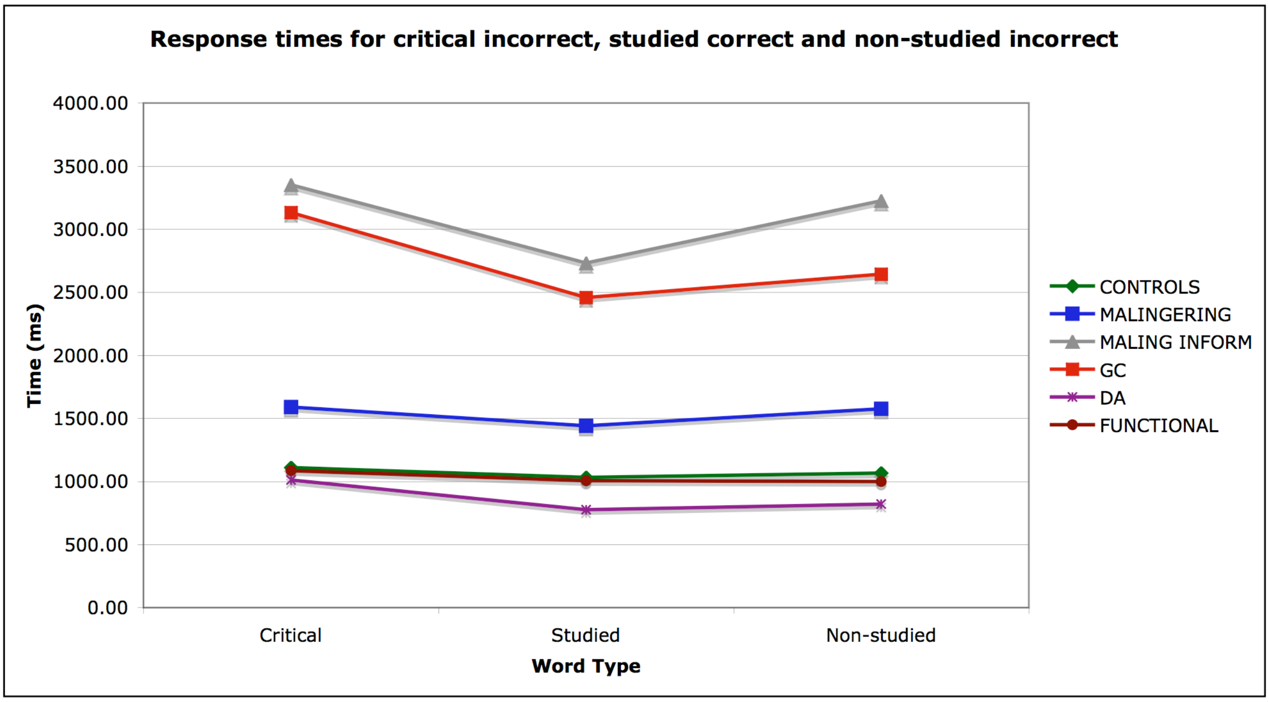


Figure 24: Response Latencies for participants in Experiment 9a, b and c.

Using Crawford and Garthwaite's (2002) case study statistical program we compared the Informed Malingering group's response latencies to that of Controls, DA and GC (see Table 46). Response latencies were first converted to Log $^{(10)}$ to normalise the data.

Table 46: Statistical analysis of response latencies from Experiments 9a, b and c.

Experiment 9c	Critical Lures (Log10)	Studied Words (Log10)	Non-studied Words (Log10)
Controls v Malingerers	*t* = -3.68, $\mathbf{p < 0.01}$	*t* = -2.87, $\mathbf{p < 0.01}$	*t* = -3.64, $\mathbf{p < 0.01}$
Controls v Maling Inform	*t* = -8.84, $\mathbf{p < 0.01}$	*t* = -9.16, $\mathbf{p < 0.01}$	*t* = -7.31, $\mathbf{p < 0.01}$
Malingerers v Maling Inform	*t* = -5.65, $\mathbf{p < 0.01}$	*t* = -5.05, $\mathbf{p < 0.01}$	*t* = -4.58, $\mathbf{p < 0.01}$
	Critical Lures (Log10)	**Studied Words (Log10)**	**Non-studied Words (Log10)**
DA v Controls	*t* = -0.29, *p* n.s	*t* = -1.39, *p* n.s	*t* = -0.74, *p* n.s
DA v Malingerers	*t* = -1.53, *p* n.s	*t* = -1.64, *p* n.s	*t* = -2.01, $\mathbf{p < 0.05}$
DA v Maling Inform	*t* = -2.79, $\mathbf{p < 0.01}$	*t* = -3.42, $\mathbf{p < 0.01}$	*t* = -2.71, $\mathbf{p < 0.01}$
	Critical Lures (Log10)	**Studied Words (Log10)**	**Non-studied Words (Log10)**
GC v Controls	*t* = 4.55, $\mathbf{p < 0.01}$	*t* = 4.08, $\mathbf{p < 0.01}$	*t* = 3.05, $\mathbf{p < 0.01}$
GC v Malingerers	*t* = 2.50, $\mathbf{p < 0.05}$	*t* = 1.67, *p* = 0.06	*t* = 1.79, $\mathbf{p < 0.05}$
GC v Maling Inform	*t* = 0.06, *p* n.s	*t* = -0.13, *p* n.s	*t* = -0.24, *p* n.s

Independent samples t-tests were carried out to compare the response latencies for Controls, Malingerers and Informed Malingerers. There were significant differences across all three groups for all three stimuli (Critical, Studied and Non-studied) with both Malingerers and Informed Malingerers producing slower response latencies than Controls. Furthermore, the Informed Malingerers also performed significantly more slowly than the Malingerers.

The Informed Malingerers had significantly slower response latencies compared with DA across all three word types in the recognition phase, p <0.01. However, DA's response latencies were not significantly different from the original Control group in *Experiment 9a* (see Table 46). We also compared GC's performance with the original Control group participants' response latencies. As can be seen from Table 45 his response latencies were significantly slower than the Control group, p <0.01 for all three stimuli. However, there was no significant difference between GC's response latencies and those of the Informed Malingerers.

We have included the Functional Memory Patients here because one of the arguments that can be used is that these patients are malingering. We have also compared their response latencies to the controls in *Experiment 9a*, GC, DA, Malingeres and Informed Malingeres. Their results can be found in Table 47, with the significant results shown in bold.

Table 47: Comparison of the Functional Memory Disorder patients response latencies to the Controls, Malingerers, Informed Malingerers and DA and GC.

Response Latencies	**Critical Lures (Log10)**	**Studied Words (Log10)**	**Non-studied Words (Log10)**
Functional (n=9) v Controls (n=15)	t = 0.98, p n.s	t = 0.67, p n.s	t = 0.78, p n.s
Functional (n=9) v Malingerers (n=15)	t = 4.51, $\mathbf{p < 0.01}$	t = 2.64, $\mathbf{p < 0.01}$	t = 4.12, $\mathbf{p < 0.01}$
Functional (n=9) v Maling Inform (n=15)	t = 8.31, $\mathbf{p < 0.01}$	t = 8.05, $\mathbf{p < 0.01}$	t = 8.41, $\mathbf{p < 0.01}$
Functional v DA	t = -1.06, p n.s	t = -0.22, p n.s	t = - 0.23, p n.s
Functional v GC	t = 3.24, $\mathbf{p < 0.01}$	t = 4.08, $\mathbf{p < 0.01}$	t = 4.57, $\mathbf{p < 0.01}$

Independent samples t-tests were carried out to compare the response latencies of the Functional Patients with Controls, Malingerers and Informed Malingerers. There were no significant differences in response latencies between the controls and Functional patients. There were significant differences in response latencies between the Functional patients versus Malingerers and Informed Malingerers with the Functional patients having faster response latencies across all three word types. Crawford and Garthwaite's (2002) statistical program for case studies was used to compare the Functional patients with DA and GC. As can be seen from Table 47 the response latencies for the Functional patients did not differ significantly from DA. However, there were significant differences between GC and the Functional patients with GC performing slower across all three words types.

7.5.4 Discussion

The Informed Malingering group could produce the pattern of reduced true and false recognition seen in our amnesia patient, DA. However, the cost of this additional effort during the recognition phase was significantly slower response times in comparison to both DA ($p < 0.01$) and Controls ($p < 0.01$). GC also had significantly slower response latencies than the Control group, in contrast to DA who produced comparable response latencies to Controls.

A common observation from all of the participants who acted as Informed Malingerers was that it was extremely difficult to suppress false recognition to the critical lures and also to force a 'no' response to the studied words. This observation is reflected in the high response latencies for the Informed Malingerers. GC's performance was, therefore, like an Informed Malingerer, possibly because he believed the task required thought to decide which words to reject and which to accept.

We included the response latencies from the Functional Memory Disorder patients from Chapter 5 since a common assumption is that they may be malingering. Their response latencies were comparable with both controls and patient DA suggesting they were not malingering.

7.6 General Discussion and Conclusion

Only the Informed Malingerers could produce a pattern of response similar to the trends found by Daniel Schacter and his colleagues for patients with amnesia. However, since this pattern of response required consideration of the answers during the recognition phase of the DRM paradigm the result was significantly increased response latencies, a pattern that was not found with our amnesia patient DA whose performance was comparable to Controls. The results are summarized in Table 48.

Table 48: Summary of findings for *Experiments 9a*, *b* and *c*.

DA	Reduced corrected true and false recognition compared with Controls, coupled with a significantly positive response bias. DA's response latencies = Controls.
GC	Reduced corrected true and false recognition compared with Controls coupled with a significantly more negative response bias. Response latencies significantly slower than both Controls and DA.
Malingering	Similar to GC with a negative response bias. Slower response latencies in comparison with Controls.
Informed Malingering	Performed like DA but produced significantly slower response latencies.

The underlying theory that the Deese, Roediger and McDermott paradigm is driven by gist memory has presented us with an unusual platform for these experiments, that is, to test for memory malingering. Current tests rely on the assumption that someone attempting to mimic memory problems will produce a negative response bias. Furthermore, a large proportion of the current malingering tests rely on recognition memory for visual stimuli in relation to which participants can, to some extent, overtly monitor their responses (Dom & Henney, 2002).

However, gist memory responding in is implicit making it difficult to suppress false recognition to critical lures in the DRM paradigm whilst at the same time remembering to reject some of the studied words. As we have seen our amnesia patient, DA, produced a positive response bias. Because of this DA produced high rates of 'Yes' responses to the non-studied words as she is unable to exclude them in the recognition phase. Although GC and the Malingering group could perform in a similar pattern to amnesia patients they relied on negative response biases, which is in direct contrast to DA. The Informed Malingering group could perform like DA and produce the positive response bias but there was a cost in deciding what words to reject and accept resulting in significantly slower response latencies.

Sadly, tests for memory malingering are often used improperly for financial gain as they are easy to feign if the participant knows the outcome of the test. For example, The Tombaugh Test for Memory Malingering (1996) relies on the fact that it looks like a difficult test to complete requiring participants to 'memorise' fifty pictures. Because it is, in reality, a test of visual recognition, amnesia patients perform well, usually scoring above 45 out of 50. However, to 'mimic' the performance of an amnesia patient all an informed participant would have to know is that amnesia patients perform like controls. However, the same does not seem to be true for the DRM paradigm as a test for memory malingering. Even our Informed Malingerers could not perform like DA because the recognition required thought in order to mimic the pattern of corrected true and false recognition and this resulted in significantly slower response latencies. Furthermore, by including the response latency data for the Functional Memory Disorder patients in *Chapter 5* we have shown that these patients, given their performance on the DRM paradigm, are very unlikely to be malingering since their results were comparable to controls and DA.

Another advantage of the DRM paradigm is that the stimuli are easy to produce in any language and circumstance and hence multiple parallel versions can be produced for repeated assessment. It is impossible for most people to memorise all the known word association lists of a given language.

Previously, in *Chapter Six* we argued that the use of case studies is always contentious particularly when dealing with cognitive behaviours where all you have is one individual compared with a small group of normal controls. However, sometimes case studies can themselves open up opportunities for further research. GC's performance on the DRM was unusual enough to prompt this researcher to explore why his pattern of responses was different, not only to Controls but also to DA, and subsequently only comparable with someone pretending to have amnesia. However, people who are malingering memory symptoms are quite rare and often do not want to come forward for tests. The value of the DRM paradigm can only be explored by testing further case studies of those suspected of malingering in order to find out if these results can be replicated.

Chapter Eight: Final Discussion

> *Memory is a crazy woman that hoards colored rags and throws away food.*
>
> *~ Austin O'Malley*

The author Austin O'Malley's quote rather succinctly describes the hazards of human memory. This thesis began with an excerpt from Ann Packer's *Clausen's Pier* in which a young woman tries to recall the details of her absent father. She recalls telling her mother about events she can remember from her past involving her father but, to her dismay, her mother discounts these events and says she is mistaken, since her father had already left them by then. The young woman remembers the pain she felt in learning her recollections are not true, since it feels like she is losing her father again. She also relates the frustration she feels that she only has three episodes in her life when she can recall her father, and all three are tied to negative emotions. Yet as O'Malley states what our memory chooses to keep and throw away is not always convenient to our individual desires.

This poses a problem, particularly in the legal sphere, since questioning witnesses in a court of law relies on the premise that human memory is somehow infallible and can play back the necessary events with great detail, as and when needed. But the issue of the reliability of human memory is more complicated: as we found in *Chapter Three*, even within normal populations there is a wide disparity in the extent to which individuals can be affected by false recognition and therefore, presumably, false memory. For some time researchers have tried to find reliable measures of individual susceptibility to false recognition but they have, to some extent, involved clinical population groups. Clancy et al. (2002) looked at people who thought they had been abducted by aliens and also at women who had reported sexually abuse in childhood (Clancy et al., 2000). Bremner et al. (2000) examined women with post-traumatic stress disorder (PTSD) and Moritz et al. (2005) investigated people with depression. The general findings were that all these groups had an increased susceptibility to false recognition. The problem with this generalization is that it gives the impression that false recognition is somehow 'abnormal' since the findings were amongst 'abnormal' populations. However, the huge interest in the Deese (1959), Roediger and McDermott (1995) paradigm (DRM) came about in part because it was 'normal' individuals who were exhibiting false recognition and memory. This suggests that false recognition is a perfectly normal phenomenon of human memory not isolated to clinical populations.

It seemed important, therefore, to find a way of measuring normal false recognition within a general population. The choice of using the Autism Spectrum Quotient (AQ) (Baron-Cohen et al., 2001) and the Toronto Alexithymia Scale (Parker et al, 2003) was driven by the fact both tests were designed to examine traits in normal populations, although the TAS-20 can be used as a diagnostic tool for Alexithymia. Both were designed along the premise that certain human behaviours and patterns of thought fall along a normal continuum. For example, at one end of the Autism Spectrum Quotient are people with more 'male-brained' traits such as Asperger's and Autism, at the other end individuals who express more 'female-brained' traits. We subsequently found that those individuals who expressed more Alexithymic traits had higher scores on the Autism Spectrum Quotient suggesting they were expressing more 'male-brained' attributes. Furthermore, they were less susceptible to false recognition in the DRM paradigm. However, there was a cost to this reduction in false recognition in that they also produced less veridical recognition to the studied words. Conversely, those individuals who had lower TAS-20 and AQ scores produced more veridical recognition to the studied items, their cost being higher false recognition to the critical lures. What is important is that all the subjects exhibited true and false recognition along a continuum. At one end of the continuum we have individuals with more 'male-brain' traits (that is high AQ and Tas-20 scores) who produce less false recognition but also less veridical recognition, and conversely at the other end of the continuum more 'female-brained' individuals who produce more false recognition but also more veridical recognition.

This led us to ask what happens to false recognition within a population that expresses the upper end of these 'male-brained' traits; so we turned our attention to individuals with Autism Spectrum Disorder in *Chapter Four*. We found that within this population individuals expressed both reduced corrected true and false recognition in comparison with controls. Furthermore, there was the suggestion that gist memory in the Autism group would also be subject to developmental changes with the ASD adults in Madrid being unable to use the additional associative information provided by the words *and* picture condition to improve their gist memory, something that the adolescent to young adult group in Columbia could do. We also found a difference between the control groups in Columbia and Madrid. The adults in Madrid were not as good at suppressing false recognition in the picture-only condition as their younger counterparts in Columbia. This was not surprising given past research has also shown differences in false recognition as a result of age development (see *Chapter Two*).

However, what was surprising was that there should be this change in performance for Autistic individuals, which we found in our subsequent correlations for age and responses in the word DRM paradigm. There were significant positive correlations for critical incorrect, studied correct, non-studied incorrect and response bias. For ASD individuals this indicated that as they age they rely more on a positive response bias. This could be argued to be similar to controls who also showed an increase in response bias, which Kensinger and Schacter (1999) argued is an increasing reliance on gist memory as people age. However, as normal adults age although there is an increase in false recognition to the critical lures, they still have the ability to filter out the non-studied words by using gist memory. In contrast, the ASD individuals increased response bias did not seem to be driven by gist memory since they have high rates of false recognition to the non-studied words in comparison with controls suggesting they do not have the gist memory to filter out the unrelated items.

Beversdorf et al. (2000) suggested that ASD individuals' lack of false recognition was due to a lack of gist memory. But if this were true then we would not have found the differences between the two ASD groups in *Chapter Four*. This leads to the suggestion that not only does the level of gist memory fall along a continuum but may also have a developmental property, even within individuals with Autism. In turn, this opens up the possibility that the development of gist memory in ASD individuals might be improved if intervention is given at an early age. Furthermore, the reason that the results of Beversdorf et al. (2000) and Bowler et al. (2000) contradicted one another could be that the one major diagnostic difference between adult individuals with Asperger's Syndrome and adult Autism Spectrum Disorder, is that the Asperger's adults still have intact gist memory due to better linguistic development.

Eysenck (1986) in his *A Handbook of Cognitive Psychology* also suggests that memory falls along a continuum. He noted that the traditional distinction of memory into episodic and semantic memory is somewhat controversial since both are so interdependent. He illustrates his point with the following anecdote:

> I know that two inverted V's on the front of a car indicate that the car is a Citroën, and this information forms part of my semantic memory. However, my daughter Fleur only discovered this fascinating and useful piece of information when I told her about it recently, and it is presumably stored in her episodic memory. In ways that remain unclear, repeated exposure to certain kinds of information seems to produce a shift from episodic to semantic memory.
>
> Eysenck, p.306, 1986.

A suggestion could be that it is gist memory that plays this crucial role of forming the continuum between episodic and semantic memory and that is why we find such wide diversity among normal population groups and between age groups. According to Brainerd et al. (2002) gist memory is the trace of the meaning present in the memory event, and this itself can fall along a continuum of precision according to the context. In this case they use the example of buying a Guiness beer: on one level the individual may only maintain a general gist of the event in terms of 'beers' but on another level they retain the gist of the even in terms of 'stout beers'. We could, therefore, retain just easily the gist of episodic events (i.e. maintaining the gist of all the book purchases I made for this thesis) and the gist of the semantic events (i.e. all the meaning of the knowledge I read in those books). So gist memory does not exist independently of episodic and semantic memory but may play a fundamental role in holding those events together. So when someone asks me what my favourite book on memory is I might rely initially on gist to scan the surface of the episodic and semantic events in order to make my decision based either on the contents or on the events leading to the purchase of the book.

This brings us full circle back to the work of Bartlett (1932) and his theory of memory schemata. Bartlett did not see memory divided into separate commodities but rather as bundles of information loosely connected that were reconstructed in a variety of ways according to the trigger of the situation. Specifically, when discussing his work on story recall such as the *War of the Ghosts* he comments that "So long as the details which can be built up around it are such that they would give it a 'reasonable' setting, most of us are fairly content, and are apt to think that what we built we have literally retained" (1932, p.176) regardless of the fact this reconstructed memory may no longer be true to the original event. Bartlett himself, when constructing his theory on remembering, discusses the idea of memory traces, or groups of traces bound by schemata (*Ibid.*, p.197). In this theory we can perhaps see the first germination of the concept of gist memory because Bartlett disliked the term 'schema' saying "It is at once too definite and too sketchy" when trying to describe a function that is occurring all the time (*Ibid.*, P.201). Perhaps he too would have preferred the term 'gist memory. Since the memory process is, in Bartlett's theory, continuous there is no mention of concepts such as semantic and episodic memory but rather a perpetual renegotiation of memory schema. Any new information must "become not merely a cue setting up a series of reactions all carried out in a fixed temporal order, but a stimulus which enables us to go direct to that portion of the organised setting of past responses which is most relevant to the needs of the moment" (*Ibid.*, p.206). Bartlett's theory can be linked to gist memory in that a cue may inadvertently weight the recall towards the wrong schema. For example, when seeing the critical lures in the recall phase of the DRM paradigm the weight of the schemata (gist) draws normal individuals to incorrectly respond 'yes' because it fits the current need of the situation resulting in false recall. Although Bartlett never refers to semantic and episodic memory, nor did he use the term 'gist', his theory could be likened to a weaving with episodic and semantic memory (or Bartlett's schemata) forming the weft and the warp with gist acting as the shuttle continually threading its way between the two.

Typically, when a patient presents with memory problems, clinicians describe the impairments in terms of episodic and semantic memory deficits. But this raises a key concern: some patients may fall through the cracks of current clinical memory diagnoses because their impairment lies with gist memory which could have subtle repercussions for both episodic memory and semantic memory that are not apparent in current clinical tests. This could be true of Functional Memory Disorder patients in *Chapter Five*, who showed a significant difference in their true recognition to the studied items in comparison with controls in the DRM paradigm. As we saw in *Chapter Three* individual differences indicate that gist memory is implicated in both true and false recognition and early impairment of gist memory could well display itself as a deterioration in true recognition of the studied items, false recognition of the critical lures or the non-studied items.

However, including false memory recognition in a clinical diagnosis of memory impairment may seem counterintuitive to those with no previous awareness of false memory research. False recognition may imply ‘lying’ and as such ‘abnormal’ behaviour, yet research has shown false memories are just as prevalent as true ones and there is a growing awareness that this is part of the normal memory make-up.

Functional Memory patients have usually been labelled as suffering from depressive disorders. Metternich et al. (2009) suggest that it is depression that is causing the memory impairments: as the depression increases so too do the impairments, forming a self-perpetuating circle of symptoms. The association between memory problems and depression is not a new one, (for example, Antikainen et al., 2001) but poses a problem for our patients in *Chapter Five* since their depression scores in the Becks’ Depressive Inventory were only mild as were their scores for the State-Trait Anxiety Scale and none were diagnosed with clinical depression. Furthermore, in research investigating the relationship between false recognition and depression it was found that patient groups produced more false recognition (e.g. Clancy et al., 2002; Zoellner et al., 2000). This was not true of our Functional patients who produced less veridical recognition not only in the DRM, but also in the confabulation experiment after a week’s delay.

The Functional Memory group, it would seem, produce a distinct pattern of impairment that is difficult to detect using current clinical measures. It could reasonably be argued that their results on the DRM paradigm and the Wechsler Logical Memory were due to malingering but as we saw in *Chapter Seven* the pattern of a malingerer on the DRM is itself quite distinctive, the key being the delayed response latencies in the recognition phase and the adoption of a negative response bias. In fact it was the significant difference in response latencies, coupled with a poor performance on the Tombaugh Test of Memory Malingering that raised the suspicion GC was exaggerating his memory problems. No such pattern was found in the Functional Memory patients who had no differences in their response latencies or bias compared with the control group. It is more likely to be that their gist memory is showing early stages of some form of damage or impairment. However, encouraging clinicians to explore false recognition as a matter of routine may be some way off.

Perhaps a better direction is to show how false recognition can give us an insight into gist memory in specific populations and take the stance of examining how we can improve its development. *Chapter Four* introduced our Autism groups and argued that underdeveloped gist memory resulted in reduced true and false recognition. However, we also demonstrated that by providing additional information on items in the form of the words and pictures condition we could aid the gist representation in the younger Autism group in Columbia. Future studies could examine whether our Functional Patients could be aided by using the words *and* picture condition, but the initial aim of that work was primarily to investigate how their memory performance was impaired given the lack of research in that field.

In *Chapter Six* we introduced our amnesia patient, DA, who suffers from anterograde amnesia. With her help we were able to explore a wide range of stimuli in the DRM paradigm, including famous faces. We found that DA's performance on the word-DRM paradigm followed the trend of previous research on amnesia patients (e.g. Schacter et al., 19996) in that she tended towards reduced true and false recognition suggesting impaired gist memory. With this in mind we decided to see if the words *and* picture condition could aid her memory performance in the same way as our Autism patients. In this condition DA's performance matched that of controls.

Her improvements were due to utilising the distinct features of the pictures and hence we saw an improvement in her item-specific discrimination.

In the famous faces condition we could not match DA's performance to controls, even when using the names and faces of the famous people. The work of Reder et al. (2006) suggested that our methodology did not provide sufficiently distinctive and unique stimuli to aid DA's suppression of false recognition. However, we also suggested that DA might suffer from a mild form of prosopagnosia and that this condition itself may be an example of the failure to form correct gist representation of faces. The addition of their names does not provide a significantly unique cue for her to then filter out the non-studied pictures.

Finally, the possibility of the Deese, Roediger and McDermott paradigm being used a clinical tool was no better highlighted than by the discovery that it could possibly be used to detect memory malingering. This helps support a supposition that false recognition is part of normal behaviour since GC's performance was significantly different to both controls and our amnesia patient, DA.

In the light of this thesis there are several areas where work could be extended. Primarily it would be important to see if the malingering work can be extended, specifically using it to explore other suspected cases of memory malingering. It would also be interesting to see if a unique famous faces condition (perhaps using occupations rather than names) could provide distinctive enough features for amnesia patients to suppress false recognition. This could also be extended to explore why as people age they increase false recognition to faces and as Bartlett, Strater and Fulton (1991) discovered, even attribute 'false fame' to photographs of people who are not famous. This could be another avenue for exploring gist memory since we saw that while DA could still maintain some form of gist representation within categories of personalities she was not able to discriminate between the categories. It could be that as we age we are also susceptible to this degeneration of gist memory for faces and this may also be of use in dementia research. For example, do patients with Alzheimer's disease improve their gist representation if given the occupations or the names of famous faces?

The work on Autism patients is also a good area for further research opportunities because it may be a way of improving the underdevelopment of gist memory by increasing the use of educational tools using both words and pictures.

Perhaps a better name for this thesis might have been: *Who needs True Memory anyway*? Greater recognition needs to be given to the role of false recognition and an acceptance that this is, frustratingly, a normal paradox of human recollection. This is important not only from the legal perspective, but also in understanding that what may go wrong with memory may not always be obvious to current clinical testing since, like the legal domain, it relies on the assumption that it is true recollection that is important. Yet false memories are just as important to an individual as the true ones since neither can be distinguished from the other. False recollections are a product of efficient memory systems allowing us to interpret and perceive our world.

When asked why I became so interested in false memory research I often cite an event that I remember with absolutely certainty: One summer's day I returned home from school to sit and watch the 25th lunch of the space shuttle, the 10th for the orbiter Challenger. I sat in the warm sunshine of my parents' living room, switched on the television and like millions around the world watched in horror as the shuttle then exploded seconds after launch.

Yet this memory is not true. The Challenger disaster occurred on 28th January 1986 and so it could not have been a warm summer's day. Furthermore, by January 1986 my parents had divorced and my mother and I had moved out of the marital home. I only discovered this fact a few years ago and perversely felt robbed of a memory that had been so important to me. It made me question the reliability of so-called flash-bulb memories since a great deal of research suggested that these were somehow inviolate (Brown & Kulick, 1977). Yet as Talarico and Rubin (2003) discovered such memories were just as subject to false intrusions as everyday memories it is just that individuals feel more confident about these recollections. Yet with this knowledge in hand I still cannot recall the shuttle disaster in any other way than at my parents' home. At one time I may have wrestled with this issue: Was the event so shocking that all I could do was recall it in the atmosphere of the security of my parents' house? Was the divorce itself a trigger for this false memory? Whatever the cause the memory remains as unchanged as ever and so has become part of the autobiographical details of my life, but what it did help me realise is that memory is fragile and subject to error.

There is a clip of Professor Elizabeth Loftus[1] on the networking site YouTube. Her following words seem a fit conclusion for this work:

[1]"If there were three words that I would come up with to describe what memory is, I would say memory is suggestive, it's subjective, it's malleable."

[1] http://www.youtube.com/watch?v=PQr_IJvYzbA

Bibliography

Ackil, J. K., & Zaragoza, M. S. (1998). Memorial consequences of forced confabulation: Age differences in susceptibility to false memories. *Developmental Psychology, 34 (6),* 1358 – 1372.

Anderson, J. R. (1983). A spreading activation theory of memory. *Journal of Verbal Learning & Verbal behavior, 22*, 261 – 295.

Anderson, J. R., & Schooler, L. J. (1991). Reflections of the environment in memory, *Psychological Science, 2 (6),* 396 – 408.

Antikainen, R., Hanninen, T., Honkalampi, K., Hintikka, J., Koivumaa-Honkanen, H., Tanskanen, A., & Viinamaki, H. (2001). Mood improvement reduces memory complaints in depressed patients. *European Archives of Psychiatry and Clinical Neuroscience, 251*, 6 – 11.

Baddeley, A. D., Emslie, H., & Nimmo-Smith. I. (1994). *The Doors and People Test: A test of visual and Verbal Recall and Recognition.* Bury St Edmunds: Thames Valley Test Company.

Bagby, R. M., Parker, J. D. A., Taylor, G. J. (1994). The twenty-item Toronto Alexithymia Scale: I. Item selection and cross-validation. *Journal of Psychosomatic Research, 38*, 23 – 32.

Balota, D. A., Dolan, Cortese, M. J., Duchek, J. M., Adams, D., Roediger, H. L., III, McDermott, K. B., & Yerys, B. E. (1999). Veridical and false memories in healthy older adults and in dementia of the Alzheimer's type. *Cognitive Neuropsychology, 16,* 361 – 384.

Bancroft, D. M. R. (1985). *The Development of Temporal Reference*. Unpublished Ph.D Thesis, University of Nottingham.

Banich, M. T. (2004). *Cognitive Neuroscience and Neuropsychology*. Houghton Mifflin.

Barnhardt, T. M., Choi, H., Gerkens, D. R., & Smith, S. M. (2006). Output position and word relatedness effects in a DRM paradigm: Support for a dual-retrieval process theory of free recall and false memories. *Journal of Memory and Language*, *55*, 213 – 231.

Baron-Cohen, S., & Hammer, J. (1997). Parents of children with Asperger's Syndrome: what is the cognitive phenotype? *Journal of Cognitive Neuroscience, 9,* 548 – 554.

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The Autism-Spectrum Quotient (AQ): Evidence from Apserger Syndrome/ high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders, 31,* 5 – 17.

Baron-Cohen, S., Hoekstra, R., Knickmeyer, R., & Wheelwright, S. (2006). The Autism-Spectrum Quotient (AQ): Adolescent version. *Journal of Autism and Developmental Disorders, 36 (3)*, 343 – 350.

Bartlett, F. C. (1932)(1995 Ed.): *Remembering: A Study in Experimental and Social Psychology*, Cambridge: Cambridge University Press.

Bartlett, J. C., Hurry, S., & Thorley, W. (1984). Typicality and familiarity of faces. *Memory & Cognition, 12*, 219 – 228.

Bartlett, J. C., Strater, L., & Fulton, A. (1991). False recency and false fame of faces in young adulthood and old age. *Memory and Cognition, 19 (2),* 177 – 188.

Baust, G., & Ferraro, F. R. (2004). Gender differences in false memory production. *Current Psychology, 23 (3),* pp. 238 – 244.

Bear, M. F., Connors, B. W., & Paradiso, M. A. (Eds) (2001). *Neuroscience: Exploring the Brain*, 2nd Edition. Lippincott, Williams & Wilkins.34

Beck, A. T. (1967). *Depression: Clinical, experimental, and theoretical aspects.* New York: Harper and Row.

Beck, A. T. (1976). *Cognitive Therapy and the Emotional Disorders.* New York: International University Press.

Beck, A.T., Steer, R.A., & Brown, G.K. (1996). *Beck Depression Inventory: Manual.* Second Edition. San Antonio, TX: The Psychological Corporation.

Bellamy, K. J., & Shillcock, R. (2007). A right hemisphere bias towards false memory. *Laterality, 12 (20),* 154 – 166.

Berlyne, N. (1972). Confabultion. *British Journal of Psychiatry, 120*, 31 – 39.

Berthoz, S., & Hill, E. L. (2005). The validity of using self-reports to assess emotion regulation abilities in adults with autism spectrum disorder. *European Psychiatry, 20*, 291 – 298.

Beversdorf, D. Q., Smith, B. W., Crucian, G. P., Anderson, J. M., Keillor, J. M., Barrett, A. M., Hughes, J. D., Felopulos, G. J., Bauman, M. L., Nadeau, S. E. & Heilman, K. M. (2000). Increased discrimination of ‘false memories’ in autism spectrum disorder. *Proceedings of the National Academy of Sciences, 97,* 8734 – 8737.

Binet, A. (1900). *La Suggestibilité*. Paris: Schleicher Freres.

Blair, I. V., Lenton, A. P., & Hastie, R. (2002). The reliability of the DRM paradigm as a measure of individual differences in false memories. *Psychonomic Bulletin & Review, 9 (3),* 590 – 596.

Bless, H., & Schwarz, N. (1999). Sufficient and necessary conditions in dual process models: The case of mood and information processing. In S. Chaiken & Y. Trope (Eds.) *Dual-process theories in social psychology* (pp. 423 – 440). New York: Guilford.

Bower, G. H. (1981). Mood and Memory. *American Psychologist, 36 (2),* 129 – 148.

Bowler, D. M., Gardiner, J. M., Grice, S., & Saavalainen, P. (2000). Memory illusions: False recall and recognition in adults with Asperger's Syndrome. *Journal of Abnormal Psychology, 109 (4),* 663 – 672.

Brainerd, C. J., & Reyna, V. F. (1995). Autosuggestibility in memory development. *Cognitive Psychology, 28*, 65 – 101.

Brainerd, C. J., Reyna, V. F., & Brandse, E. (1995). Are children's false memories more persistent than their true memories? *Psychological Science, 6*, 359 – 364.

Brainerd, C. J., & Reyna, V. F. (1998). When things that were never experienced are easier to remember than things that were. *Psychological Science, 9*, 484 – 489.

Brainerd, C. J., Reyna, V. F., & Forrest, T. J. (2002). Are young children susceptible to the false-memory illusion? *Child Development, 73*, 1363 – 1377.

Brainerd, C. J., Wright, R., Reyna, V. F., & Payne, D. G. (2002). Dual-retrieval process in free and associative recall. *Journal of Memory and Language, 46,* 120 – 152.

Bremner, J. D., Krasue Shobe, K., & Kihlstrom, J. F. (2000). False memories in women with self-reported childhood sexual abuse: An empirical study. *Psychological Science, 11 (4),* 333 – 337.

Brown, R., & Kulick, J. (1977). Flashbulb Memories. *Cognition, 5*, 73 – 99.

Bruininks, R., Hill, B., Weatherman, R., & Woodcock, R. (1986). *Examiner's manual: ICAP Inventory for Client and Agency Planning*. Chicago: Riverside.

Budson, A. E., Daffner, K. R., Desikan, R., & Schacter, D. L., (2000). When false recognition is unopposed by true recognition: gist-based memory distortion in Alzheimer's disease. *Neurospychology, 15*, 230 – 243.

Budson, A. E., Desikan, R., Daffner, K. R., & Schacter, D. L., (2001). Perceptual false recognition in Alzheimer's Disease. *Neurospychology, 14*, 277 – 284.

Budson, A. E., Dodson, C. S., Vatner, J. M., Daffner, K. R., Black, P. M., & Schacter, D. L. (2005). Metacognition and false recognition in patients with frontal lobe lesions: the distinctiveness heuristic. *Neuropsychologia, 43,* 860 – 871.

Cabeza, R., Rao, S. M., Wagner, A. D., Mayer, A. R., & Schacter, D. L. (2001). Can medial temporal lobe regions distinguish true from false? An event-related functional MRI study of veridical and illusory recognition memory. *Proceedings of the National Academy of Sciences of the United States, 98 (8),* 4805 – 4810.

Ceci, S. J., Ross, D. F., & Toglia, M. P. (1987). *Children's Eyewitness testimony*. New York: Springer-Verlag.

Christianson, S. (1989). Flashbulb memories: Special, but not so special. *Memory and Cognition, 17 (4),* 435 – 443.

Clancy, S. A., McNally, R. J., Schacter, D. L., Lenzenweger, M. F., & Pitman, R. K. (2002). Memory Distortion in people reporting abduction by aliens. *Journal of Abnormal Psychology, 111,* 455 – 461.

Clancy, S. A., Schacter, D. L., McNally, R. J., & Pitman, R. K. (2000). False recognition in women reporting recovered memories of sexual abuse. *Psychological Science, 11,* 26 – 31.

Conway, M. A., Anderson, S. J., Larsen, S. F. Donnelly, C. M., McDaniel, M. A., McClelland, A. G. R., Rawles, R. E., & Logie, R. H. (1994). The formation of flashbulb memories. *Memory & Cognition, 22*, 326 – 343.

Crawford, J. R., & Garthwaite, P. H. (2002). Investigation of the single case in neuropsychology: Confidence limits on the abnormality of test scores and test score differences. *Neuropsychologia, 40,* 1196 – 1208.

Curran, T., Schacter, D. L., Norma, K. A., & Galluccio, L. (1997). False recognition after a right frontal lobe infarction: Memory for general and specific information. *Neuropsychologia, 35 (7),* 1035 - 1049.

Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology, 58 (1)*, 17 – 22.

Desai, N., Taylor-Davies, A., & Barnett, D. B. (1983). The effects of diazepam and oxprenolol on short term memory in individuals of high and low state anxiety. *British Journal of Clinical Pharmacology, 15 (2)*, pp. 197 – 202.

Dewhurst, S. A., & Parry, L. A. (2000). Emotionality, distinctiveness, and recollective experience. *European Journal of Cognitive Psychology*, *12*, 541 – 551.

Dewhurst, S. A., & Robinson, C. A. (2004). False memories in children: Evidence for a shift from phonological to semantic associations. *Psychological Science, 15, 782 – 786.*

Dodson, C. S., & Krueger, L. E. (2006). I misremember it well: Why older adults are unreliable eyewitnesses. *Psychonomic Bulletin and Review, 13*, 770 – 775.

Ehlers, S., & Gillberg, C. (1993). The epidemiology of Asperger Syndrome. A total Population study. *Journal of Child Psychology & Psychiatry, 34,* 1327 – 1350.

Eisen, M. L., Lorber, W., Kistorian, R., Morgan, D., Yu, S., Tirtabudi, P., & Cardenas, E. (1999) Individual differences in college students susceptibility to misleading information. In M. Eisen (Chair), *Individual difference in suggestibility in memory distortion*. Symposium of the 3rd biennial meeting of the Society for Applied Research in Memory and Cognition, Boulder, CO.

Eysenck, M. W. (1986). *A Handbook of Cognitive Psychology*. Lawrence Erlbaum Associates: London.

Fabiani, M., Stadler, M. A., & Wessels, P. M. (2000). True but not false memories produce a sensory signature in human lateralized brain potentials. *Journal of Cognitive Neuroscience, 12 (6),* 941 – 949.

Fay, W. H. (1988). Infantile Autism. In D. Bishop, & K. Mogford (Eds.) (2000). *Language Development in Exceptional Circumstance,* pp. 190 – 202, Psychology Press: Taylor & Francis.

Felzen, E., & Anisfeld, M. (1970). Semantic and phonological relations in the false recognition of words by third and sixth-grade children. *Developmental Psychology, 3,* 163 – 168.

Fernandez, A., Diez, E., & Alonso, M. A. (2006). *Normas de asociación libre en castellano*. Retrieved September 4, 2006, from Grupo de Investigación en Memoria y Cognición. Web site:http://www.usal.es/gimc.

Fossati, P., Ergis, A. M., Allilaire, J. F. (2002). Executive functioning in unipolar depression: A review. *L'Encéphale, 28 (2),* 97 – 107.

Gallo, D. A., (2006). *Associative Illusions of Memory.* Psychology Press: Taylor & Francis.

Gardiner, J. M., Bowler, D. M., & Grice, S. J. (2003). Further evidence of preserved priming and impaired recall in adults with Asperger's syndrome. *Journal of Autism & Developmental Disorders, 33,* 259 – 269.

Gauld, A., & Stephenson, G. M. (1967). Some experiments related to Bartlett's theory of remembering. *British Journal of Psychology, 58*, 39 - 49.

Gazzaniga, M. S., Ivry, R. B., & Mangun, G. R. (Eds) (2002). *Cognitive Neuroscience: The biology of the mind*. 2nd Edition. Norton: New York, London.

Gonsalves, B., & Paller, K. A. (2000). Neural events that underlie remembering something that never happened. *Nature Neuroscience, 3 (12),* 1316 – 1321.

Grady, C. L., & Craik, F. I. M. (2000). Changes in memory processing with age. *Current Opinion in Neurobiology, 10,* 224 – 231.

Gur, R. C., Gur, R. E., Obrist, W. D., Skolnick, B. E., & Reivitch, M. (1987). Age and regional cerebral blood flow at rest and during cognitive activity. *Archives of General Psychiatry, 44,* 617 – 621.

Harper, C. G., & Kril, J. J. (1990). Neuropathology of alcoholism. *Alcohol and Alcoholism, 25 (2/3)*, pp. 207 – 216.

Hirstein, W. (2005). *Brain Fiction: Self-Deception and the Riddle of Confabulation*. MIT Press: Cambridge.

Hoekstra, R. A., Bartels, M., Cath, D. C., & Boomsma, D. I. (2008). Factor structure, reliability and criterion validity of the Autism-Spectrum Quotient (AQ): A study in Dutch population and patient groups. *Journal of Autism Developmental Disorders, EPub.*

Hom, J., & Denney, R. L. (2002). *Detection of Response Bias in Forensic Neuropsychology.* The Hawthorn Medical Press.

Ito, Y. (2001). Hemispheric asymmetry in the induction of false memories. *Laterality, 6 (4),* 337 – 346.

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source Monitoring. *Psychological Bulletin, 114,* 3 – 28.

Kensinger, E. A., & Schacter, D. L. (1999). When true memories suppress false memories: Effects of aging. *Cognitive Neurospychology, 16,* 399 – 415.

Kihlstrom, J. F. (2005). Dissociative Disorders. *Annual Review of Clinical Psychology*, 227 - 253.

Kopelman, M. D., Thomson, A. D., Guerrini, I., Marshall, E. J. (2009). The Korsakoff Syndrome: Clinical aspects, psychology and treatment. *Alcohol and Alcoholism, 44 (2),* 148 – 154.

Koutstaal, W., & Schacter, D. L. (1997). Gist-based false recognition of pictures in older and younger adults. *Journal of Memory and Language, 37,* 555 – 583.

Koutstaal, W., Schacter, D. L., Verfaellie, M., Brenner, C. J, & Jackson. (1999). Perceptually based false recognition of novel objects in amnesia: effects of category size and similarity to category prototypes. *Cognitive Neurospychology, 16 (3, 4, 5),* 317 – 341.

Koutstaal, W., Verfaellie, M., & Schacter, D. L. (2001). Recognizing identical vs. similar categorically related common objects: further evidence for degraded gist-representation in amnesia. *Neuropsychology,* 268 – 289.

Kwock, M. S., & Winer, G. A. (1986). Overcoming leading questions: Effects of psychosocial task variables. *Journal of Educational Psychology, 78,* 289 – 293.

Lenton, A. P., Blair, I. V., & Hastie, R. (2001). Illusions of gender: Stereotypes evoke false memories. *Journal of Experimental Social Psychology, 37,* 3 – 14.

Light, L. L., Kayra-Stuart, F., & Hollander, S. (1979). Recognition memory for typical and unusual faces. *Journal of Experimental Psychology: Human Learning and Memory, 5,* 212 – 228.

Loftus, E. F., Miller, D. G., & Burns, H. J. (1978). Semantic integration of verbal information into a visual memory. *Journal of Experimental Psychology (Human Learning), 4,* 19 – 31.

Loftus, E. F., & Loftus, G. R. (1980). On the permanence of stored information in the human brain. *American Psychologist*, *35*, pp. 409 – 420.

Loftus, E. F. (1991). Made in Memory: Distortion in recollection after misleading information. In G. H. Bower (Ed.), *The Psychology of learning and motivation: Advances in research and theory* (Vol. 27, pp. 187 – 215). San Diego, CA: Academic Press.

Loftus, E. F., and Ketcham, K. (1991). *Witness for the Defense: The accused, the eyewitness and the expert who puts memory on trial*, St.Martin's Press: New York.

Loftus, E. F., Levidow, B., & Duensing, S. (1992). Who remembers best? Individual differences in memory for events that occurred in a science museum. *Applied Cognitive Psychology, 6 (2),* 93 – 107.

Loftus, E. F., Feldman, J., & Dashiell, R. (1995). In Daniel L. Schacter (Ed.), *Memory Distortions: How minds, brains and societies reconstruct the past* (pp. 47 – 68). Cambridge, MA: Harvard University Press.

Lövdén, M. (2003). The episodic memory and inhibition accounts of age-related increases in false memories: A consistency check. *Journal of Memory & Language, 49*, 268 – 283.

Manning, J. T., Scutt, D., Wilson, J., & Lewis-Jones, D. I. (1998). The ratio of 2nd to 4th digit length: a predictor of sperm numbers and levels of testosterone, LH and oestrogen. *Human Reproduction, 13,* 3000 – 3004.

Manning, J. T., Baron-Cohen, S., Wheelwright, S., & Sanders, G. (2001). The 2nd to 4th digit ratio and autism. *Developmental Medicine & Child Neurology, 43,* 160 – 164.

McClelland, J. L. (1995). Constructive memory and memory distortion. In D. L. Schacter (Ed.)(1995). *Memory distortion: How minds, brains, and societies reconstruct the past* (pp. 69 – 90), Harvard University Press.

McKenna, P., & Warrington, E. K. (1983). *Graded Naming Test Manual*. Windsor, UK: NFER-Nelson.

Melo, B., Winocur, G., & Moscovitch, M. (1999). False recall and false recognition: An examination of the effects of selective and combined lesions to the medial-temporal/diencephalons and frontal structures. *Cognitive Neuropsychology, 16*, 343 – 359.

Metternich, B., Schmidtke, K., & Hüll, M. (2009). How are memory complaints in functional memory disorder related to measures of affect, metameory and cognition? *Journal of Psychosomatic Research, 66 (5)*, 435 – 444.

Mineka, S., & Nugent, K. (1995). Mood-congruent memory biases in anxiety and depression. In D. L. Schacter (Ed.) (1995), *Memory Distortion* (pp. 173 – 193), Harvard Press.

Moritz, S., Gläscher, J., & Brassen, S. (2005). Investigation of mood-congruent false and true recognition in depression. *Depression and Anxiety, 21*, 9 – 17.

Mottron, L., Belleville, S., & Stip, E. (1996). Proper name hypermnesia in an autistic subject. *Brain Language, 53*, 326 – 50

Neisser, U., & Harsch, N. (1992). Phantom flashbulbs: False recollections of hearing the news about Challenger. In E. Winograd & U. Neisser (Eds). *Memory Observed: Remembering in natural contexts* (pp. 139 – 159). San Francisco: Freeman and Co.

Nelson, H.E. (1982). 1st Edition/Part 1. *National Adult Reading Test (NART): Test Manual.* Windsor, UK: NFER Nelson.

Nelson, H.E., & Willison, J. (1991). 2nd Edition/Part 2. *National Adult Reading Test (NART):Test Manual.* Second Edition. Windsor, UK: NFER Nelson.

Oldfield, R. C. (1971). The assessment and analysis of handedness. The Edinburgh Inventory. *Neuropsychologia , 9,* 93 – 113.

Ornstein, P. A., & Haden, C. A. (2002). The development of memory: Toward an understanding of children's testimony. In M. L. Eisen, J. A. Quas & G. S. Goodman (Eds.) (2002). *Memory and Suggestibility in the Forensic Interview* (pp. 29 – 61), Lawrence Erlbaum Associates.

Osterrieth, P. A. (1944). The test of copying a complex figure: A contribution to the study of perception and memory. *Archives de Psychologie, 30*, 286 – 356.

Packer, A. (2002). *The Dive from Clausen's Pier*. Knopf: New York.

Parker, J. D. A., Taylor, G. J., & Bagby, R. M. (2003). The 20-Item Toronto Alexithymia Scale III. Reliability and factorial validity in a community population. *Journal of Psychosomatic Research, 55*, 269 – 275.

Partington, J.E., & Leiter, R.G. (1949). Partington's Pathway Test. *The Psychological Service Center Bulletin, 1,* 9-20.

Payne, D. G., Elie, C. J., Blackwell, J. M., & Neuschatz, J. S. (1996). Memory illusions: Recalling, recognizing, and recollecting events that never occurred. *Journal of Memory and Language, 35*, 261 – 285.

Peichel, C. L., Prabhakaran, B., & Vogt, T. F. (1997). The mouse *Ulnaless* mutation deregulates posterior *Hoxd* gene expression and alters appendicular patterning. *Development, 24,* 3481 – 3491.

Peiffer, L. C., & Trull, T. J. (2000). Predictors of suggestibility and false-memory production in young adult women. *Journal of Personality Assessment, 74,* 384 – 399.

Pezdek, K., & Lam, S. (2007). What research paradigms have cognitive psychologists used to study ''false memory,'' and what are the implications of these choices? *Consciousness and Cognition, 16*, 2–17.

Pezdek, K. (2007). It's just not good science. *Consciousness and Cognition, 16*, 29–30.

Platt, R. D., Lacey, S. C., Iobst, A. D., & Finkelman, D. (1998). Absorption, dissociation, and fantasy-proneness as predictors of memory distortion in autobiographical and laboratory generated memories. *Applied Cognitive Psychology, 12*, 77 – 89.

Rapcsak, S. Z., Reminger, S. L., Glisky, A. L., KAszniak, A. W., & Comer, J. F. (1999). Neuropsychological mechanisms of false facial recognition following frontal lobe damage. *Cognitive Neurospychology, 16 (3/4/5)*, 267 – 292.

Raz, N., Torres, I. J., Spencer, W. D., Baertschie, J. C., Millman, D., & Sarpel, G. (1993). Neuroanatomical correlates of age-sensitive and age-invariant cognitive abilities: An in vivo MRI investigation. *Intelligence, 17,* 407 – 422.

Reder, L. M., Oates, J. M., Thornton, E. R., Quinlan, J. J., Kaufer, A., & Sauer, J. (2006). Drug-induced amnesia hurts recognition, but only for memories that can be unitized. *Neuropsychologia, 17 (7),* 562 – 567.

Reyna, F. (1995). Interference effects in memory and reasoning: A fuzzy-trace theory analysis. In F. N. Dempster & C. J. Brainerd (Eds). *New perspectives on Interference and inhibition in cognition* (pp. 29 – 61). New York Academic Press.

Rivière, A. (2002). *Inventario de Espectro Autista*. Fundec, Buenos Aires.

Roediger, H. L. III., & Gallo, D. A. (2002). Processes affecting accuracy and distortion in memory: An overview. In M. L. Eisen, J. A. Quas, & G. S. Goodman (Eds.), *Memory and Suggestibility in the Forensic Interview,* (pp. 3 – 28).Lawrence Erlbaum Associates.

Roediger, H. L., III., Wheeler, M. A., & Rajarma, S. (1993). Remembering, knowing and reconstructing the past. In D. L. Medin (Ed.), *The Psychology of Learning and Motivation: Advances in Research and Theory*, (pp. 97 - 134). San Diego, CA: Academic Press.

Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology, 21*, 803 – 814.

Saywitz, K. J., & Lyon, T. D. (2002). Coming to grips with children's suggestibility. In M. L. Eisen, J. A. Quas & G. S. Goodman (Eds.) (2002). *Memory and Suggestibility in the Forensic Interview* (pp. 29 – 61), Lawrence Erlbaum Associates.

Schacter, D. L. (Ed.)(1995). *Memory distortion: How minds, brains, and societies reconstruct the past*, Harvard University Press.

Schacter, D. L., Verfaellie, M., & Pradere, D. (1996). The neurospychology of memory illusions: False recall and recognition in amnesic patients. *Journal of Memory and Language, 35*, 319 – 334.

Schacter, D. L., Verfaellie, M., Anes, M. D., & Racine, C. (1998). When true recognition suppresses false recognition: Evidence from amnesic patients. *Journal of Memory and Language, 35,* 319 – 324.

Schacter, D. L., Israel, L., & Racine, C. (1999). Suppressing false recognition in younger and older adults: The distinctiveness heuristic. *Journal of Memory and Language, 40,* 1 – 24.

Schacter, D. L., & Dodson, C. S. (2001). Misattribution, false recognition and the sins of memory. *Philosophical Transactions of the Royal Society, 356(1413),* 1385 – 1393.

Schacter, D. L., Verfaellie, M., & Koutstaal, W. (2002) Memory illusions in amnesic patients. In L. R. Squire & D. L. Schacter (Eds) (2002). *Neuropsychology of Memory,* (pp.113 – 129). The Guilford Press: New York.

Schacter, D. L., & Slotnick, S. D. (2004). The cognitive neuroscience of memory distortion. *Neuron, 44,* 149 – 160.

Seamon, J. G., Guerry, J. D., Marsh, G. P., & Tracy, M. C. (2002). Accurate and false recall in the Deese/Roediger and McDermott procedure: A methodological note on sex of participant. *Psychological Reports, 91,* 423 – 427.

Segal, Z. V., Gemar, M., Truchon, C., Guirguis, M. Horowitz, L. M. (1995). A priming methodology for studying self-representation in major depressive disorder. *Journal of Abnormal Psychology, 104*, 205 – 213.

Semon, R. (1904/1921). *The Mneme*. London: George Allen and Unwin.

Semon, R. (1909/1923). *Mnemic Psychology*. London: George Allen and Unwin.

Sergent, J. (1984). An investigation into component and configural process underlying face perception. *British Journal of Psychology, 75*, 221 – 242.

Sifnéos, P. E. (1973). The prevalence of 'alexithymic' characteristics in psychosomatic patients. *Psychotherapy and Psychosomatics, 22 (2),* 255 – 262.

Snodgrass, J. G., & Corwin, J. (1988). Pragmatics of measuring recognition memory: Applications to dementia and amnesia. *Journal of Experimental Psychology: General, 117 (1),* 34 – 50.

Spielberger, D.S., Gorsuch, R.L., & Luschene, R.E. (1970). *Manual for the State-Trait Anxiety Inventory.* Palo Alto, Calif.: Consulting Psychologists Press.

Spreen, O., & Benton, A.L. (1969, 1977). Controlled Oral Word Association (COWA) letter/word fluency test. In *Neurosensory Center Comprehensive Examination for Aphasia* (NCCEA). Victoria: University of Victoria Neuropsychology Laboratory.

Springer, S. P., & Deutsch, G. (1981). *Left Brain, Right Brain.* W. H. Freeman and Company: San Francisco.

Stadler, M. A., Roediger, H.L. III, & McDermott, K. B. (1999). Norms for word lists that create false memories. *Memory & Cognition*, *27*, 494 – 500.

Stern, W. (1910). Abstracts and lectures on the psychology of testimony and on the study of individuality. *American Journal of Psychology, 21*, 270 - 282.

[a]Stone, J., Carson, A., and Sharpe, M. (2005). Functional symptoms and signs in neurology: assessment and diagnosis. *Journal of Neurology, Neurosurgery and Psychiatry, 76*, 2 - 12.

[b]Stone, J., Carson, A., and Sharpe, M. (2005). Functional symptoms in neurology: Management. *Journal of Neurology, Neurosurgery and Psychiatry, 76*, 13 - 21.

Talarico, J. M., & Rubin, D. C. (2003). Confidence, not consistency, characterizes flashbulb memories. *Psychological Science, 14 (5),* 455 – 461.

Taylor, G. J., Bagby, R. M., & Parker, J. D. A. (2003). The 20-Item Toronto Alexithymia Scale IV. Reliability and factorial validity in different languages and cultures. *Journal of Psychosomatic Research, 55*, 277 – 283.

Tombaugh, T. N. (1996). *The Test of Memory Malingering (TOMM).* Toronto, Canada: Multi-Health Systems.

Tulving, E. (1981). Similarity relations in recognition. *Journal of Verbal Learning and Verbal Behavior, 20,* 479 – 496.

Underwood, B. J. (1965). False recognition produced by implicit verbal responses, *Journal of Experimental Psychology, 70,* 122 – 129.

Verfaellie, M., Schacter, D. L., & Cook, S. P. (2002). The effect of retrieval instructions on false recognition: exploring the nature of gist memory impairment in amnesia. *Neuropsychologia, 40*, 2360 – 2368.

Voyer, D. (1996). On the magnitude of laterality effects and sex differences in functional lateralities. *Laterality, 1 (1),* 51 – 83.

Watts, F. N., Morris, L., & MacLeod, A. K. (1987). Recognition memory in depression. *Journal of Abnormal Psychology, 96, (3)*, 273 – 275.

Watson, J. M., Balota, D. A., & Sergent-Marshall, S. D. (2001). Semantic, phonological, and hybrid veridical and false memories in healthy older adults and in individuals with dementia of the Alzheimer type. *Neurospychology, 15,* 254 – 267.

Watson, J. M., Bunting, M. F., Poole, B. J., & Conway, A. R. A. (2005). Individual differences in susceptibility to false memory in the Deese-Roediger-McDermott paradigm. *Journal of Experimental Psychology: Learning, Memory & Cognition, 31 (1),* 76 – 85.

Wechsler, D. (1992). *Wechsler Intelligence Scale for Children – Third Edition (Spanish): Manual.* The Psychological Corporation, London.

Wechsler, D. (1998). *Wechsler Memory Scale - Third Edition (UK): Administration and scoring manual.* The Psychological Corporation, London.

Wechsler D. (1999). *Wechsler abbreviated scale of intelligence*. San Antonio, TX: Psychological Corporation.

Wells, G. (1986). *The Meaning Makers: children learning language and using language to learn,* London: Hodder & Stoughton.

Whitehouse, A. J. O., Maybery, M. T., and Durkin, K. (2006). Inner speech impairments in autism. *Journal of Child Psychology and Psychiatry, 47* (8), 857 – 865.

Wilkinson, C., & Hyman, I. E. (1998). Individual differences related to two types of memory errors: Word lists may not generalize to autobiographical memory. *Applied Cognitive Psychology, 12*, 529 – 546.

Young, A. W., Hay, D. C., & Ellis, A. W. (1985). The faces that launched a thousand slips: Everyday difficulties and errors in recognizing people. *British Journal of Psychology, 76*, 495 – 523.

Young, A. W., Flude, B. M., Hay, D. C., & Ellis, A. W. (1993). Impaired discriminaition of familiar from unfamiliar faces. *Cortex, 29,* 65 – 75.

Zoellner, L. A., Foa, E. B., Brigidi, B. D., & Przeworski, A. (2000). Are trauma victims susceptible to “false memories”? *Journal of Abnormal Psychology, 109,* 517 – 524.

Appendix

Appendix A: Word Lists for the DRM Paradigm used in Chapter 3, 5, 6 & 7. (Lists in bold are the abbreviated word lists used for patient studies, Chapter 5, 6 & 7).

Studied Phase (Critical Lures at the top are not part of the study phase)

Anger	Black	Bread	Chair	Cold	Doctor	Foot	Fruit
rage	white	**butter**	table	**hot**	nurse	**shoe**	apple
fear	dark	**jam**	legs	**ice**	hospital	**ball**	basket
hate	cat	**board**	stool	**winter**	ill	**mouth**	tree
fury	blue	**sandwich**	seat	**wet**	injection	**toe**	juice
red	funeral	**flour**	back	**freeze**	health	**ankle**	pear
temper	colour	**milk**	desk	**snow**	stethoscope	**sock**	ripe
violence	grief	**yeast**	wood	**frozen**	patient	**sole**	salad
wrath	green	**dough**	sofa	**chilly**	prescription	**walk**	banana
fight	death	**crust**	cushion	**heat**	pills	**smell**	strawberry
chaos	ink	**roll**	sitting	**weather**	treatment	**boot**	orange
hatred	bottom	**slice**	swivel	**fridge**	office	**run**	dessert
mean	coal	**wine**	furniture	**air**	medical	**sore**	vegetables
emotion	brown	**loaf**	arm	**shiver**	surgeon	**step**	bowl
shouting	raven	**toast**	rocking	**Arctic**	clinic	**odour**	cocktail
enrage	grey	**bap**	bench	**frost**	cure	**hand**	berry

Galaxy	High	King	Man	Mountain	Music	Needle	River
stars	**low**	queen	woman	**hill**	note	**thread**	water
universe	**sky**	royal	boy	**steep**	sound	**pin**	stream
planet	**tall**	ruler	uncle	**climb**	pop	**eye**	lake
bar	**tower**	prince	person	**summit**	score	**sewing**	wide
space	**airplane**	crown	wife	**top**	sheet	**sharp**	boat
cosmos	**altitude**	England	male	**molehill**	stave	**point**	tide
infinite	**flying**	palace	father	**peak**	song	**prick**	swim
Milky-Way	**kite**	throne	strong	**plain**	book	**thimble**	flow
black hole	**rise**	chess	friend	**glacier**	stereo	**haystack**	runs
nebula	**far**	sovereign	beard	**goat**	singing	**thorn**	barge
constellation	**vertigo**	subjects	being	**bike**	guitar	**hurt**	creek
satellite	**hopes**	monarch	handsome	**climber**	record	**sting**	brook
moon	**giant**	castle	muscle	**range**	piano	**stitch**	fish
sun	**lofty**	leader	suit	**valley**	tune	**cloth**	bridge
asteroid	**mighty**	reign	old	**ski**	orchestra	**knitting**	winding

Studied Phase continued.

Rough	Sleep	Slow	Soft	Spider	Sweet	Thief	Window
smooth	dreams	**fast**	hard	**web**	sour	**steal**	pane
ready	bed	**down**	warm	**insect**	sugar	**robber**	glass
ground	night	**quick**	comfort	**fly**	tooth	**crook**	ledge
tough	pillow	**snail**	feathers	**arachnid**	chocolate	**burglar**	sill
sandpaper	awake	**stop**	cosy	**crawl**	good	**money**	curtain
stubble	peace	**coach**	cuddly	**tarantula**	taste	**police**	frame
surface	rest	**delay**	gentle	**poison**	sticky	**bad**	house
coarse	slumber	**traffic**	touch	**bite**	nice	**law**	open
uneven	doze	**tortoise**	fluffy	**creepy**	honey	**jail**	broken
justice	tired	**hesitant**	furry	**animal**	syrup	**criminal**	closed
rugged	snore	**speed**	downy	**ugly**	toffee	**villain**	view
cut	nap	**bus**	kitten	**feelers**	heart	**crime**	breeze
bark	nightmares	**sluggish**	skin	**small**	cake	**bank**	sash
rocky	yawn	**wait**	tender	**nasty**	wrapper	**dishonest**	soul
gravel	drowsy	**idle**	snug	**eerie**	pie	**pillage**	shutter

Recall Phase

Studied Words

rage	white	**butter**	table	**hot**	nurse	**shoe**	apple
fear	dark	**jam**	legs	**ice**	hospital	**ball**	basket
stars	**low**	queen	woman	**hill**	note	**thread**	water
universe	**sky**	royal	boy	**steep**	sound	**pin**	stream
smooth	dreams	**fast**	hard	**web**	sour	**steal**	pane
ready	bed	**down**	warm	**insect**	sugar	**robber**	glass

Critical Lures

anger	black	**bread**	chair	**cold**	doctor	**foot**	fruit
galaxy	**high**	king	man	**mountain**	music	**needle**	river
rough	sleep	**slow**	soft	**spider**	sweet	**thief**	window

Non-Studied Words

cathedral	**truth**	enzyme	boomerang	**station**	**exile**	walrus	judge
skeleton	**Orient**	clown	saucepan	**helicopter**	**diamond**	computer	gift
cravat	**canvas**	address	pulley	**briefcase**	**broom**	university	rake

Appendix B: Questionnaires used In Chapter 3.

PARTICIPANT NO:………………………..

TO BE COMPLETED BY PARTICIPANT
ALL INFORMATION REMAINS STRICTLY CONFIDENTIAL

Name:.. Sex:..

Age:.................................. Today's Date................................

The next few pages are a series of questionnaires. Please read the instructions for each one carefully.

The AQ

How to fill out the questionnaire

Below is a list of statements. Please read each statement very carefully and rate how strongly you agree or disagree with it by **circling** your answer.

DO NOT MISS ANY STATEMENT OUT.

1. I prefer to do things with others rather than on my own.	definitely agree	slightly agree	slightly disagree	definitely disagree
2. I prefer to do things the same way over and over again.	definitely agree	slightly agree	slightly disagree	definitely disagree
3. If I try to imagine something, I find it very easy to create a picture in my mind.	definitely agree	slightly agree	slightly disagree	definitely disagree
4. I frequently get so strongly absorbed in one thing that I lose sight of other things.	definitely agree	slightly agree	slightly disagree	definitely disagree
5. I often notice small sounds when others do not.	definitely agree	slightly agree	slightly disagree	definitely disagree
6. I usually notice car number plates or similar strings of information.	definitely agree	slightly agree	slightly disagree	definitely disagree
7. Other people frequently tell me that what I've said is impolite, even though I think it is polite.	definitely agree	slightly agree	slightly disagree	definitely disagree
8. When I'm reading a story, I can easily imagine what the characters might look like.	definitely agree	slightly agree	slightly disagree	definitely disagree
9. I am fascinated by dates.	definitely agree	slightly agree	slightly disagree	definitely disagree

10. In a social group, I can easily keep track of several different people's conversations.	definitely agree	slightly agree	slightly disagree	definitely disagree
11. I find social situations easy.	definitely agree	slightly agree	slightly disagree	definitely disagree
12. I tend to notice details that others do not.	definitely agree	slightly agree	slightly disagree	definitely disagree
13. I would rather go to a library than a party.	definitely agree	slightly agree	slightly disagree	definitely disagree
14. I find making up stories easy.	definitely agree	slightly agree	slightly disagree	definitely disagree
15. I find myself drawn more strongly to people than to things.	definitely agree	slightly agree	slightly disagree	definitely disagree
16. I tend to have very strong interests which I get upset about if I can't pursue.	definitely agree	slightly agree	slightly disagree	definitely disagree
17. I enjoy social chit-chat.	definitely agree	slightly agree	slightly disagree	definitely disagree
18. When I talk, it isn't always easy for others to get a word in edgeways.	definitely agree	slightly agree	slightly disagree	definitely disagree
19. I am fascinated by numbers.	definitely agree	slightly agree	slightly disagree	definitely disagree
20. When I'm reading a story, I find it difficult to work out the characters' intentions.	definitely agree	slightly agree	slightly disagree	definitely disagree
21. I don't particularly enjoy reading fiction.	definitely agree	slightly agree	slightly disagree	definitely disagree
22. I find it hard to make new friends.	definitely agree	slightly agree	slightly disagree	definitely disagree
23. I notice patterns in things all the time.	definitely agree	slightly agree	slightly disagree	definitely disagree
24. I would rather go to the theatre than a museum.	definitely agree	slightly agree	slightly disagree	definitely disagree
25. It does not upset me if my daily routine is disturbed.	definitely agree	slightly agree	slightly disagree	definitely disagree
26. I frequently find that I don't know how to keep a conversation going.	definitely agree	slightly agree	slightly disagree	definitely disagree
27. I find it easy to "read between the lines" when someone is talking to me.	definitely agree	slightly agree	slightly disagree	definitely disagree
28. I usually concentrate more on the whole picture, rather than the small details.	definitely agree	slightly agree	slightly disagree	definitely disagree
29. I am not very good at remembering phone numbers.	definitely agree	slightly agree	slightly disagree	definitely disagree
30. I don't usually notice small changes in a situation, or a person's appearance.	definitely agree	slightly agree	slightly disagree	definitely disagree
31. I know how to tell if someone listening to me is getting bored.	definitely agree	slightly agree	slightly disagree	definitely disagree

32. I find it easy to do more than one thing at once.	definitely agree / slightly agree / slightly disagree / definitely disagree
33. When I talk on the phone, I’m not sure when it’s my turn to speak.	definitely agree / slightly agree / slightly disagree / definitely disagree
34. I enjoy doing things spontaneously.	definitely agree / slightly agree / slightly disagree / definitely disagree
35. I am often the last to understand the point of a joke.	definitely agree / slightly agree / slightly disagree / definitely disagree
36. I find it easy to work out what someone is thinking or feeling just by looking at their face.	definitely agree / slightly agree / slightly disagree / definitely disagree
37. If there is an interruption, I can switch back to what I was doing very quickly.	definitely agree / slightly agree / slightly disagree / definitely disagree
38. I am good at social chit-chat.	definitely agree / slightly agree / slightly disagree / definitely disagree
39. People often tell me that I keep going on and on about the same thing.	definitely agree / slightly agree / slightly disagree / definitely disagree
40. When I was young, I used to enjoy playing games involving pretending with other children.	definitely agree / slightly agree / slightly disagree / definitely disagree
41. I like to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant, etc.).	definitely agree / slightly agree / slightly disagree / definitely disagree
42. I find it difficult to imagine what it would be like to be someone else.	definitely agree / slightly agree / slightly disagree / definitely disagree
43. I like to plan any activities I participate in carefully.	definitely agree / slightly agree / slightly disagree / definitely disagree
44. I enjoy social occasions.	definitely agree / slightly agree / slightly disagree / definitely disagree
45. I find it difficult to work out people’s intentions.	definitely agree / slightly agree / slightly disagree / definitely disagree
46. New situations make me anxious.	definitely agree / slightly agree / slightly disagree / definitely disagree
47. I enjoy meeting new people.	definitely agree / slightly agree / slightly disagree / definitely disagree
48. I am a good diplomat.	definitely agree / slightly agree / slightly disagree / definitely disagree
49. I am not very good at remembering people’s date of birth.	definitely agree / slightly agree / slightly disagree / definitely disagree
50. I find it very easy to play games with children that involve pretending.	definitely agree / slightly agree / slightly disagree / definitely disagree

THE EDINBURGH HANDEDNESS INVENTORY

Please indicate your preferences in the use of hands in the following activities by putting a tick in the appropriate column.

Some of the activities require both hands. In these cases the part of the task, or object, for which hand preference is wanted is indicated in brackets.

Please answer all of the questions, and only leave a blank if you have no experience at all of the object or task.

EDINBURGH HANDEDNESS INVENTORY CONT…

		LEFT	RIGHT
1	Writing		
2	Drawing		
3	Throwing		
4	Scissors		
5	Toothbrush		
6	Knife (without fork)		
7	Spoon		
8	Broom (upper hand)		
9	Striking Match (match)		
10	Opening Box (lid)		
i	Which foot do you prefer to kick with?		
ii	Which eye do you use when using only one?		

L.Q.	

Leave these spaces blank

DECILE	

TAS-20

Using the scale provided as a guide, indicate how much you agree or disagree with each of the following statements by **circling** the corresponding number. Give only one answer for each statement.

Circle 1 if you STRONGLY DISAGREE
Circle 2 if you MODERATELY DISAGREE
Circle 3 if you NEITHER DISAGREE NOT AGREE
Circle 4 if you MODERATELY AGREE
Circle 5 if you STRONGLY AGREE

		Strongly disagree	Moderately Disagree	Neither agree nor disagree	Moderately Agree	Strongly Agree
1.	I am often confused about what emotion I am feeling	**1**	**2**	**3**	**4**	**5**
2.	It is difficult for me to find the right words for my feelings	**1**	**2**	**3**	**4**	**5**
3.	I have physical sensations that even my doctors don't understand.	**1**	**2**	**3**	**4**	**5**
4.	I am able to describe my feelings easily.	**1**	**2**	**3**	**4**	**5**
5.	I prefer to analyze my problems rather than just describe them.	**1**	**2**	**3**	**4**	**5**
6.	When I am upset, I don't know if I am sad, frightened or angry.	**1**	**2**	**3**	**4**	**5**
7.	I am often puzzled by sensations in my body.	**1**	**2**	**3**	**4**	**5**
8.	I prefer to just let things happen rather than to understand why they turned out that way.	**1**	**2**	**3**	**4**	**5**
9.	I have feelings that I can't quite identify.	**1**	**2**	**3**	**4**	**5**
10.	Being in touch with emotions is essential.	**1**	**2**	**3**	**4**	**5**
11.	I find it hard to describe how I feel about people.	**1**	**2**	**3**	**4**	**5**
12.	People tell me to describe my feelings more.	**1**	**2**	**3**	**4**	**5**
13.	I don't know what's going on inside me.	**1**	**2**	**3**	**4**	**5**
14.	I often don't know why I am angry.	**1**	**2**	**3**	**4**	**5**
15.	I prefer talking to people about their daily activities rather than their feelings.	**1**	**2**	**3**	**4**	**5**
16.	I prefer to watch 'light' entertainment shows rather than psychological dramas.	**1**	**2**	**3**	**4**	**5**
17.	It is difficult for me to reveal my innermost feelings, even to close friends.	**1**	**2**	**3**	**4**	**5**

		Strongly disagree	Moderately Disagree	Neither agree nor disagree	Moderately Agree	Strongly Agree
18.	I can feel close to someone, even in moments of silence.	**1**	**2**	**3**	**4**	**5**
19.	I find examination of my feelings useful in solving personal problems.	**1**	**2**	**3**	**4**	**5**
20.	Looking for hidden meanings in movies or plays distracts from their enjoyment.	**1**	**2**	**3**	**4**	**5**

Thank you for your participation.
Please remember all results remain strictly confidential.

Appendix C: Spanish Word Lists for the DRM Paradigm used in Chapter 4 and stimuli list for Chapter 6, Experiment 7b (Word & Picture condition, picture examples in Appendix C).

Studied Phase: Association List as for Latin American Spanish (Columbia, Experiments 3a,b & c), words in brackets are the ones used for the European Spanish speakers (Experiments 4a, b &c).

PIE	FOOT	SILLA	CHAIR	PAN	BREAD
zapato	shoe	mesa	table	comida	meal
mano	hand	sofá	sofa	sanduche (bocadillo)	roll
pierna	leg	estufa (cocina)	cooker	agua	water
medias (calcetín)	sock	cajones	drawers	vino	wine
dedo	finger	taburete	stool	cruasán	croissant
cuerpo	body	cojín	cushion	mantequilla	butter
uña	nail	mecedora	rocking chair	harina	flour
bota	boot	banco	bench	trigo	wheat
tobillo	ankle	biblioteca	bookcase	jamón	ham
rodilla	knee	escritorio	desk	queso	cheese
codo	elbow	armario	wardrobe	tomate	tomato
balón	football	lámpara	lamp	lechuga	lettuce
sandalia	sandal	cama	bed	miel	honey
cuello	neck	televisor	television	huevo	egg
oreja	ear	teléfono	telephone	pastel	cake

REY	KING	MÉDICO	DOCTOR	AGUJA	NEEDLE
reina	queen	ambulancia	ambulance	hilo	thread
corona	crown	enfermera	nurse	coser	sew
león	lion	jeringa	syringe	maquina de coser	sewing machine
espada	sword	estetoscopio	stethoscope	dedal	thimble
príncipe	prince	anatomía	anatomy	pinchar	prick
princesa	princess	bisturí	scalpel	alfilers	pins
caballero	knight	camilla	stretcher	ojal	buttonhole
castillo	castle	enfermero	male nurse	dobladillo	hem
mago	wizard	portero	porter	material	material
bosque	forest	pastilla (píldora)	pill	cactus (cacto)	cactus
trono	throne	venda	bandage	bordar	embroider
estrella	star	tijeras	scissors	botón	button
dragón	dragon	cirujano	surgeon	brújula	compass
cetro	sceptre	tirita	sticking plaster	cremallera	zip
bandera	flag	cabestrillo	sling	tejido	knitting

Studied Phase Continued.

MANZANA	APPLE	VIOLÍN	VIOLIN	SOMBRERO	HAT
plátano	banana	guitarra	guitar	gorro	bonnet
naranja	orange	arpa	harp	jersey	jumper
pera	pear	piano	piano	boina	beret
uvas	grapes	flauta	flute	corbata	tie
melocotón	peach	trompeta	trumpet	chaqueta (abrigo)	coat
melón	melon	trombón	trombone	guante	glove
piña	pineapple	mandolina	mandolin	bufanda	scarf
fresa	strawberry	laúd	lute	camisa	shirt
frambuesa	raspberry	clarinete	clarinet	pantalón	trousers
limón	lemon	fagot	bassoon	correa (cinturón)	belt
lima	lime	oboe	oboe	falda	skirt
grosella	redcurrant	tambor	drum	traje	suit
kiwi	kiwi	platillos (címbalos)	cymbals	vestido	dress
higo	fig	banjo	banjo	camiseta	t-shirt
zarzamora	blackberry	maracas	maracas	bolso	handbag

GATO	CAT	ARAÑA	SPIDER	CARRO (COCHE)	CAR
perro	dog	mariposa	butterfly	bicicleta	bicycle
ratón	mouse	insecto	insect	furgoneta	van
tigre	tiger	libélula	dragonfly	autobús	bus
pantera	panther	grillo	cricket	camión	lorry
ciervo	deer	abeja	bee	autocar	coach
pájaro	bird	babosa	Slug	tren	train
gacela	gazelle	caracol	snail	máquina	steam train
lobo	wolf	ciempiés	centipede	avión	aeroplane
hiena	hyena	polilla	moth	barcaza	canal barge
guepardo	cheetah	tijereta	earwig	coche (carro)	cart
leopardo	leopard	cucaracha	cockroach	helicóptero	helicopter
rata	rat	escarabajo	beetle	motocicleta	motorbike
conejo	rabbit	escorpión	scorpion	ciclomotor	moped
hámster	hamster	oruga	caterpillar	yate	yacht
curi (cobaya)	guinea pig	avispa	wasp	barco	boat

Recognition Phase English

Studied Words

shoe	table	nurse	orange	dog
hand	sofa	banana	ambulance	mouse
queen	meal	thread	beret	guitar
bicycle	roll	sew	jumper	harp
crown	van	fly	butterfly	

Critical Lures

foot	chair	doctor	apple	cat
king	bread	needle	hat	violin
car	spider			

Non-studied Words

book	stapler	ghost	jigsaw	padlock
alarm clock	flower	trophy	torch	snorkel
soldier	dice			

Recognition Phase Spanish

Studied Words

zapato	mesa	ambulancia	plátano	perro
mano	sofá	enfermera	naranja	ratón
reina	comida	hilo	boina	guitarra
corona	sanduche (bocadillo)	coser	jersey	arpa
bicicleta	furgoneta	mariposa	insecto	

Critical Lures

pie	silla	medico	manaza	gato
rey	pan	aguja	sombrero	violín
carro (coche)	araña			

Non-studied Words

libro	grapadora	rompecabezas	candado
despertador	flor	trofeo	esnórkel
soldado	fantasma	dado	linterna

Appendix D: Examples of the picture/ word & picture stimuli used in Chapters 4 and 6.


thread


knitting


butterfly


bee


banana


stapler


flower


belt


snorkel


aeroplane


croissant


dice


moped


coat


table


plaster


doctor


guitar


dog


guinea pig

Appendix E: Pictures and questions used for confabulation experiment in Chapter 5.

True: What colour was Ronnie Corbett's jacket?
False: What was on the desk between the Two Ronnies?

True: What were Laurel and Hardy staring at?
False: What was sticking out of Stan Laurel's hat?

True: What sort of dress was Barbara Streisand wearing?

False: What was on the seat next to her?

True: What was Michael Caine holding in his hands?

False: What time was on the clock on the wall behind him?

True: What sort of suit was Richard Burton wearing?

False: What did Elizabeth Taylor have round her left wrist?

Appendix F: Lists of Famous Faces used in Experiment 8a, b and c in Chapter 6 (Critical lures are in bold).

US Actor	US Actress	UK Actor	UK Actress
Tom Cruise	**Jennifer Aniston**	**Sean Connery**	**Kate Winslet**
Tom Hanks	Meryl Streep	Richard Burton	Helena Bonham-Carter
Harrison Ford	Julia Roberts	Anthony Hopkins	Judy Dench
Brad Pitt	Marilyn Monroe	Ewan McGregor	Minnie Driver
George Clooney	Sigourney Weaver	Hugh Grant	Catherine Zeta-Jones
Kiefer Sutherland	Halle Berry	Ian McKellan	Emma Thompson
Clint Eastwood	Jodie Foster	Michael Caine	Barbara Wndsor
Jack Nicholson	Angelina Jolie	Alan Rickman	Helen Mirrem
Al Pacino	Sandra Bullock	John Cleese	Liz Hurley
Robert De Niro	Susan Sarandon	Jude Law	Joanna Lumley
Leonardo di Caprio	Gwyneth Paltrow	Robbie Coltrane	Maggie Smith

US Male Singer	US Female Singer	UK Male Singer	UK Female Singer
Elvis Presley	**Barbara Streisand**	**Robbie Williams**	**Charlotte Church**
Frank Sinatra	Dolly Parton	Cliff Richard	Shirley Bassey
Michael Jackson	Madonna	Mick Jagger	Annie Lennox
Eminem	Cher	Elton John	Dido
Stevie Wonder	Bette Midler	Ozzy Osbourne	Victoria Beckham
Barry Manilow	Diana Ross	John Lennon	Lulu
Neil Diamond	Aretha Franklin	Freddy Mercury	Emma Bunton
Buddy Holly	Britney Spears	Davod Bwie	Dusty Springfield
Roy Orbison	Tina Turner	Paul McCartney	Geri Halliwell
Bob Dylan	Whitney Houston	Sting	Kate Bush
Prince	Mariah Carey	Phil Collins	Amy Winehouse

<u>Non-studied Sports' Personalities</u>

David Beckham	Tim Henman	Denise Lewis
Steve Redgrave	Kelly Holmes	Jane Torville
Jonathan Edwards	Sebastian Coe	

<u>Non-studied TV Personalities</u>

Fern Britton	Vanessa Feltz	Davina McCall
David Dickinson	Jeremy Kyle	Oprah Winfrey
Noel Edmonds	Richard Madeley	

Appendix G: Control Raw Data for Experiment 7a, b, 8a, b and c.

Experiment 7a: DRM Word Paradigm			Critical Lures (12 Items)		Studied Words (24 Items)		Non-Studied Words (12 Items)	
Subject	Sex	Age	Correct	Incorrect	Correct	Incorrect	Correct	Incorrect
1	M	37	4/12	8/12	13/24	11/24	10/12	2/12
2	F	34	3/12	9/12	16/24	8/24	10/12	2/12
3	F	36	3/12	9/12	20/24	4/24	12/12	0/12
4	F	28	3/12	9/12	19/24	5/24	12/12	0/12
5	M	34	6/12	6/12	16/24	8/24	12/12	0/12
6	M	27	3/12	9/12	14/24	10/24	12/12	0/12
7	F	28	4/12	8/12	19/24	5/24	10/12	2/12
8	M	18	1/12	11/12	18/24	6/24	11/12	1/12
9	F	18	6/12	6/12	12/24	12/24	11/12	1/12
10	M	19	5/12	7/12	14/24	10/24	8/12	4/12
11	F	21	3/12	9/12	20/24	4/24	12/12	0/12
12	F	21	8/12	4/12	10/24	14/24	11/12	1/12
13	M	20	3/12	9/12	19/24	5/24	9/12	3/12
14	M	20	4/12	8/12	18/24	6/24	7/12	5/12
15	F	21	6/12	6/12	16/24	8/24	10/12	2/12
	M%	25.47	34.44	65.60	67.74	32.22	87.47	12.53
	SD	6.96	14.73	14.73	12.90	12.90	13.05	13.05
DA	**F**	**32**	**4/12**	**8/12**	**15/24**	**9/24**	**8/12**	**4/12**

Experiment 7b: Word & Picture DRM			Critical Lures (12 Items)		Studied Items (24 Items)		Non-Studied Items (12 Items)	
Subject	Sex	Age	Correct	Incorrect	Correct	Incorrect	Correct	Incorrect
1	F	18	11/12	1/12	22/24	2/24	10/12	2/12
2	F	20	8/12	4/12	16/24	8/24	10/12	2/12
3	F	23	7/12	5/12	23/24	1/24	12/12	0/12
4	F	20	8/12	4/12	19/24	5/24	12/12	0/12
5	F	23	6/12	6/2	22/24	2/24	0.75	0.25
6	F	27	10/12	2/12	21/24	3/24	12/12	0/12
7	F	19	8/12	4/12	20/24	4/24	0.83	0.17
8	F	24	8/12	4/12	22/24	2/24	12/12	0/12
9	F	27	9/12	3/12	21/24	3/24	12/12	0/12
10	F	22	11/12	1/12	21/24	3/24	12/12	0/12
11	F	25	7/12	5/12	13/24	11/24	12/12	0/12
12	F	40	7/12	5/12	23/24	1/24	12/12	0/12
13	F	19	10/12	2/12	24/24	0/24	12/12	0/12
14	F	22	6/12	6/12	17/24	7/24	12/12	0/12
15	F	25	7/12	5/12	13/24	11/24	12/12	0/12
	M%	23.60	68.40	31.60	82.52	17.48	95.00	5.00
	SD	5.36	13.77	13.77	14.60	14.60	8.80	8.80
DA	**F**	**32**	**7/12**	**5/12**	**21/24**	**3/24**	**11/12**	**1/12**

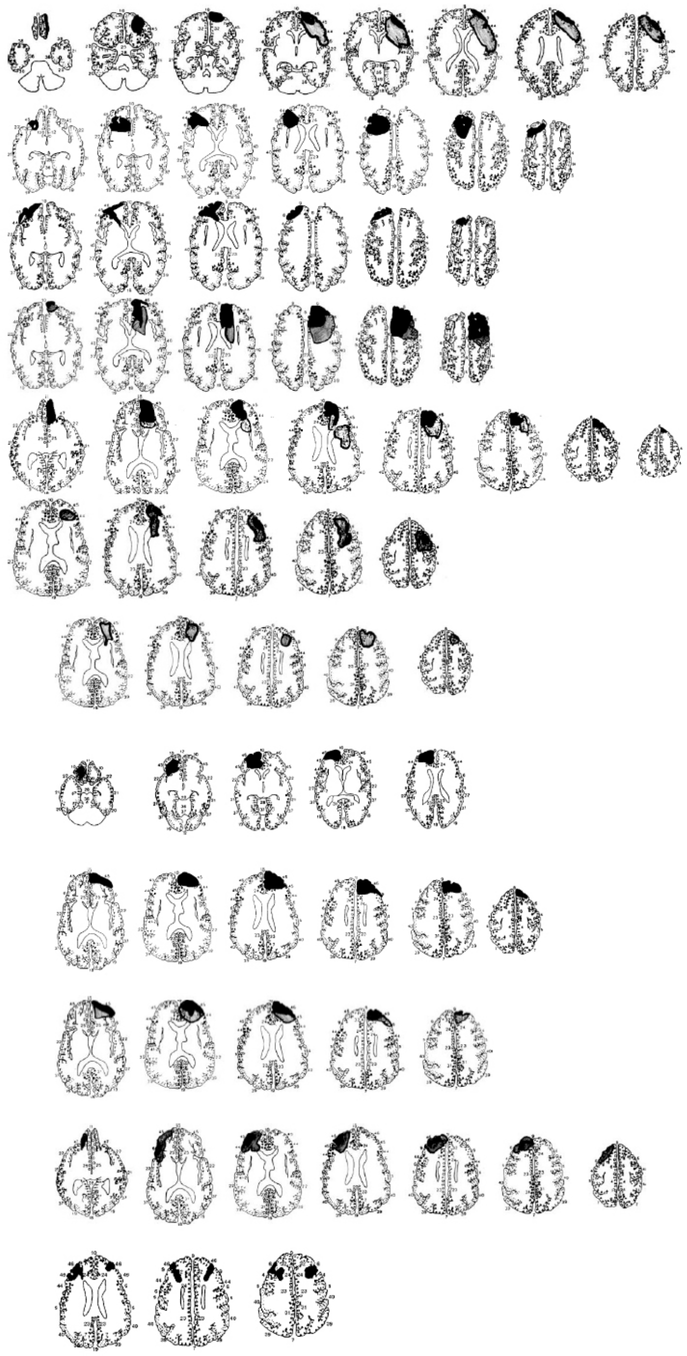
Experiment 8a: Sports			Critical Lures (8 Items)		Studied Pictures (16 Items)		Non-studied Pictures (8 Items)	
Subject	Sex	Age	Correct	Incorrect	Correct	Incorrect	Correct	Incorrect
1	M	23	6/8	2/8	11/16	5/16	7/8	1/8
2	F	25	8/8	0/8	16/16	0/16	8/8	0/8
3	F	26	8/8	0/8	15/16	1/16	8/8	0/8
4	F	29	6/8	2/8	12/16	4/16	7/8	1/8
5	F	24	6/8	2/8	14/16	2/16	7/8	1/8
6	F	29	6/8	2/8	14/16	2/16	8/8	0/8
7	F	21	7/8	1/8	14/16	2/16	6/8	2/8
8	M	20	8/8	0/8	13/16	3/16	5/8	3/8
9	M	28	8/8	0/8	12/16	4/16	8/8	0/8
11	F	32	4/8	4/8	11/16	5/16	6/8	3/8
12	F	30	8/8	0/8	16/16	0/16	8/8	0/8
13	M	39	5/8	3/8	13/16	3/16	7/8	1/8
14	F	26	8/8	0/8	16/16	0/16	8/8	0/8
15	F	21	7/8	1/8	16/16	0/16	8/8	0/8
	M%	27.00	84.78	15.22	86.01	13.99	90.13	9.87
	SD	5.24	16.35	16.35	11.72	11.72	12.14	12.14
DA	**F**	**32**	**1/8**	**7/8**	**10/16**	**6/16**	**4/8**	**4/8**

Experiment 8b: TV Personalities			Critical Lures (8 Items)		Studied Pictures (16 Items)		Non-studied Pictures (8 Items)	
Subject	Sex	Age	Correct	Correct	Incorrect	Correct	Correct	Incorrect
1	F	38	8/8	0/8	14/16	2/16	8/8	0/8
2	M	33	8/8	0/8	11/16	5/16	8/8	0/8
3	M	35	5/8	3/8	15/16	1/16	6/8	2/8
4	F	40	6/8	2/8	14/16	2/16	7/8	1/8
5	F	33	7/8	1/8	14/16	2/16	8/8	0/8
6	F	28	8/8	0/8	16/16	0/16	8/8	0/8
7	F	22	7/8	1/8	15/16	1/16	7/8	1/8
8	F	25	8/8	0/8	15/16	1/16	7/8	1/8
9	F	29	6/8	2/8	14/16	2/16	8/8	0/8
10	F	21	5/8	3/8	13/16	3/16	7/8	1/8
11	F	21	6/8	2/8	14/16	2/16	8/8	0/8
12	F	20	8/8	0/8	16/16	0/16	8/8	0/8
13	F	26	7/8	1/8	14/16	2/16	8/8	0/8
14	F	27	8/8	0/8	15/16	1/16	8/8	0/8
15	F	20	8/8	0/8	16/16	0/16	8/8	0/8
	M%	27.87	87.45	12.52	89.98	10.01	94.93	5.02
	SD	6.65	14.13	14.13	8.09	8.09	7.86	7.86
DA	**F**	**32**	**6/8**	**2/8**	**5/8**	**3/8**	**8/8**	**0/8**

Experiment 8c: TV & Words			Critical Lures (8 Items)		Studied Pictures (16 Items)		Non-studied Pictures (8 Items)	
Subject	Sex	Age	Incorrect	Correct	Correct	Incorrect	Correct	Incorrect
1	F	37	8/8	0/8	16/16	0/16	8/8	0/8
2	F	28	6/8	2/8	15/16	1/16	8/8	0/8
3	F	32	7/8	1/8	16/16	0/16	8/8	0/8
4	F	43	7/8	1/8	12/16	4/16	8/8	0/8
5	M	29	6/8	2/8	14/16	2/16	7/8	1/8
6	F	47	6/8	2/8	12/16	4/16	8/8	0/8
7	M	26	7/8	1/8	12/16	4/16	7/8	1/8
8	F	28	8/8	0/8	16/16	0/16	8/8	0/8
9	F	33	6/8	2/8	11/16	5/16	7/8	1/8
10	F	25	8/8	0/8	12/16	4/16	8/8	0/8
11	F	30	7/8	1/8	14/16	2/16	7/8	1/8
12	F	28	6/8	2/8	15/16	1/16	8/8	0/8
13	M	31	8/8	0/8	15/16	1/16	7/8	1/8
14	F	32	7/8	1/8	16/16	0/16	8/8	0/8
15	F	25	6/8	2/8	14/16	2/16	7/8	1/8
	M%	31.60	85.84	14.21	87.54	12.52	95.41	4.61
	SD	6.36	10.39	10.41	11.07	11.09	5.91	6.05
DA	**F**	**33**	**4/8**	**4/8**	**15/16**	**1/16**	**5/8**	**3/8**

Appendix H: Patient demographics for frontal lesions from Budson et al. (2005).

Patient	Gender/age	Lesion site	
A	M/35	L 6 8 9 10 24	32 44 45 46
B	M/40	R 4 6 8 9 44	45
C	M/48	R 6 8 9 10 44	45 46
D	F/34	L 4 6 8 9 10	24 32 46
E	F/54	L 6 8 9 10 11	24 25 44 45 46
F	F/51	L 4 6 8 9 44	45 46
G	M/45	L 9 24 32 45 46	
H	F/45	R 9 10 11 24 45	46
I	M/58	L 8 9 10 32 45	46
J	F/49	L 9 10 24 44 45	46
K	M/25	R 6 9 10 11 24	32 44 45 46
L	M/67	R 6 45 46	L 6 46



Note: Schematic diagrams of lesion locations are drawn on standardized templates (Damasio & Damasio, 1989). Images are in radiologic convention with the right hemisphere on the left side of the template. Black areas represent regions where brain tissue has been replaced by cerebral spinal fluid. Grey areas represent regions where brain tissue has been severely damaged as indicated by increased signal on T2 weighted MRI. Grey areas are outlined in black for clarity. Lesion site numbers correspond to Brodmann areas. The first six patients participated in the word condition, the second six in the picture condition.

Appendix I: Definitions of Autism, Asperger's Syndrome and Autism Spectrum Disorders.

The following definitions were taken from the National Autistic Society's website at www.autism.org.uk

What is Autism?

Autism is a lifelong developmental disability. It is part of the autism spectrum and is sometimes referred to as an autism spectrum disorder, or an ASD. The word 'spectrum' is used because, while all people with autism share three main areas of difficulty, their condition will affect them in very different ways. Some are able to live relatively 'everyday' lives; others will require a lifetime of specialist support. The three main areas of difficulty which all people with autism share are sometimes known as the 'triad of impairments'. They are:

- difficulty with social communication
- difficulty with social interaction
- difficulty with social imagination.

What are the characteristics of autism?

The characteristics of autism vary from one person to another but are generally divided into three main groups.

Difficulty with social communication

People with autism have difficulties with both verbal and non-verbal language. Many have a very literal understanding of language, and think people always mean exactly what they say. They can find it difficult to use or understand:

- facial expressions or tone of voice
- jokes and sarcasm
- common phrases and sayings

Some people with autism may not speak, or have fairly limited speech. They will usually understand what other people say to them, but prefer to use alternative means of communication themselves, such as sign language or visual symbols.

Others will have good language skills, but they may still find it hard to understand the give-and-take nature of conversations, perhaps repeating what the other person has just said (this is known as echolalia) or talking at length about their own interests.

Difficulty with social interaction

People with autism often have difficulty recognising or understanding other people's emotions and feelings, and expressing their own, which can make it more difficult for them to fit in socially.

Difficulty with social imagination

Social imagination allows us to understand and predict other people's behaviour, make sense of abstract ideas, and to imagine situations outside our immediate daily routine. Difficulties with social imagination mean that people with autism find it hard to:

- understand and interpret other people's thoughts, feelings and actions
- predict what will happen next, or what *could* happen next
- understand the concept of danger
- engage in imaginative play and activities
- prepare for change and plan for the future
- cope in new or unfamiliar situations.

Other related characteristics

- Love of routines
- Sensory sensitivity
- Special interests
- Learning disabilities
-

What is Asperger's syndrome?

While there are similarities with autism, people with Asperger syndrome have fewer problems with speaking and are often of average, or above average, intelligence. They do not usually have the accompanying learning disabilities associated with autism, but they may have specific learning difficulties. These may include dyslexia and dyspraxia or other conditions such as attention deficit hyperactivity disorder (ADHD) and epilepsy.

What is the difference between Autism, High-functioning Autism (HFA) and Asperger's syndrome?

- Both people with HFA and AS are affected by the triad of impairments common to all people with autism.
- Both groups are likely to be of average or above average intelligence.
- The debate as to whether we need two diagnostic terms is ongoing (the term Autism Spectrum Disorder is becoming more popular as a diagnosis).
- However, there may be features such as age of onset and motor skill deficits which differentiate the two conditions.

Diagnostic Tools

There are a variety of tools used by clinicians to diagnose Autism Spectrum Disorder. They include:

American Psychiatric Association. 1994. *Diagnostic and Statistical Manual of mental disorders (DSM-IV-TR)*. 4th ed. Washington, DC: APA.

Baird, G. et al. (2000). A screening instrument for autism at 18 month of age: A six-year follow-up study. *Journal of the American Academy of Child and Adolescent Psychiatry*, 39, 694-702.

Baird, G., et al (2001). Screening and surveillance for autism and pervasive developmental disorders. *Archives of Disease in Childhood*, 84, pp. 468-475.

Baron-Cohen, S. et al (2000). The early identification of autism: the Checklist for Autism in Toddlers (CHAT). *Journal of the Royal Society of Medicine*, 93, 521-525.

Frankenburg, W. K. et al. (1992). The Denver II: A major revision and restandardization of the Denver Developmental Screening Test. *Pediatrics*, 89, pp. 91-97.

Garnett, M.S. and Attwood, A. J. (1998). Australian scale for Asperger's syndrome. In: Attwood, T. *Asperger's syndrome: a guide for parents and professionals*. London: Jessica Kingsley.

Siegel, B. (1998). Early screening and diagnosis in autism spectrum disorders: The Pervasive Developmental Disorders Screening Test (PDDST). Paper presented at the *NIH State of the*

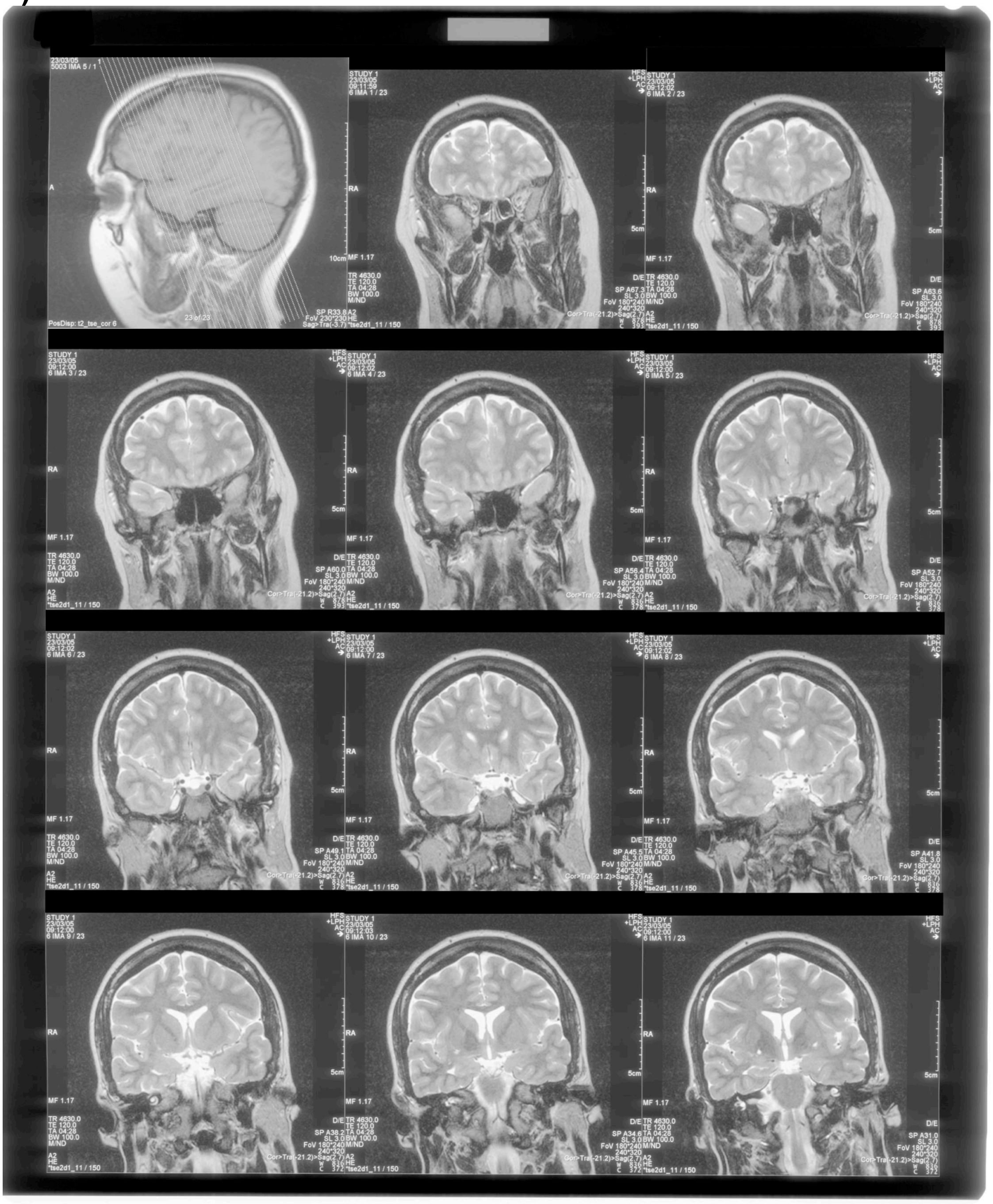
Science in Autism: Screening and Diagnosis working conference, Bethesda, MD, June 15-17.

A comprehensive list can be found at:
http://www.autism.org.uk/nas/jsp/polopoly.jsp?d=1419&a=3280

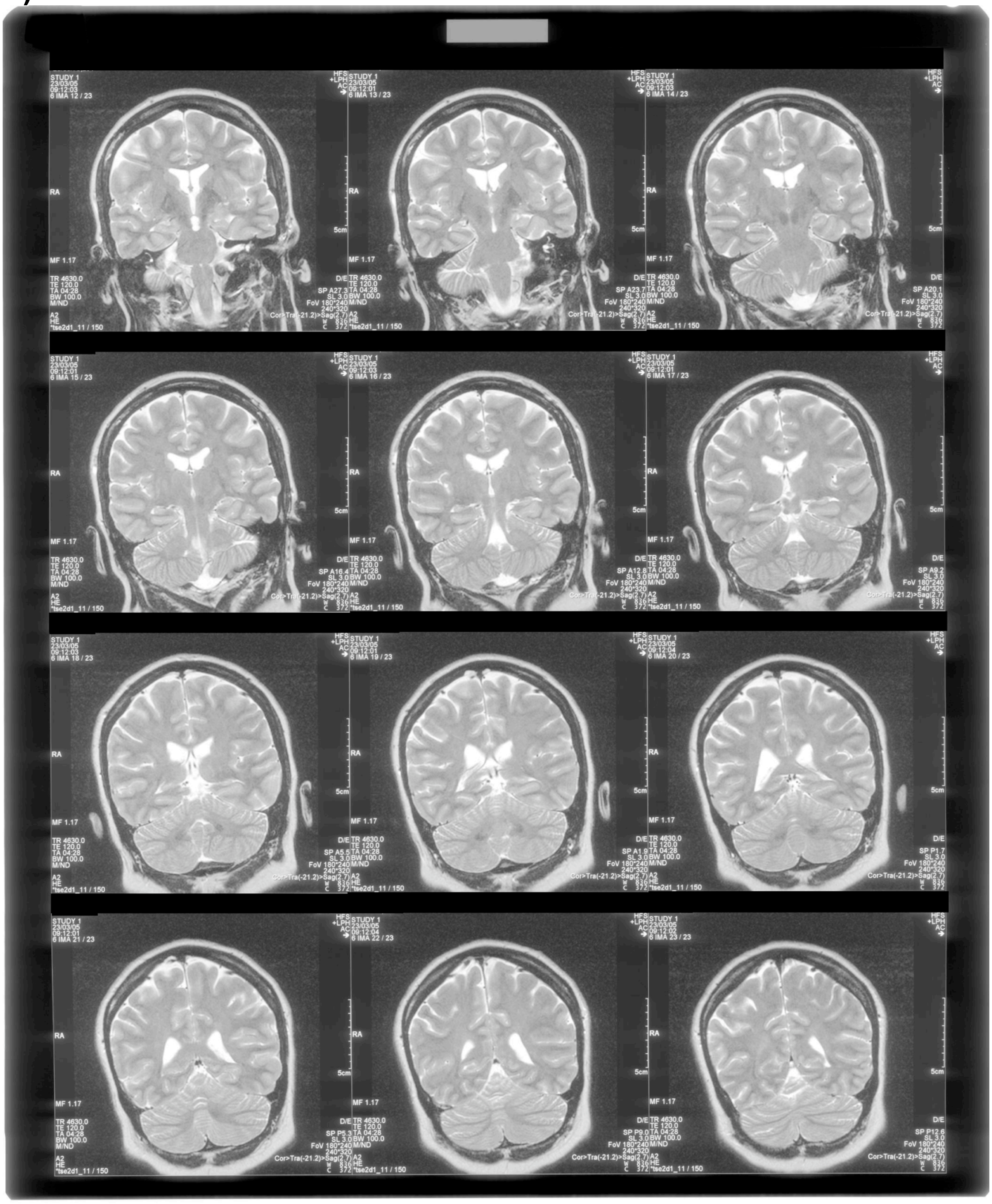
However, the majority of clinical tools outlined above and on the National Autism Website are unavailable in Spanish versions. The Fundación Integrar institute in Colombia uses the I.D.E.A autism spectrum scale (Rivière, 2002) and the Asociación Nuevo Horizonte in Madrid uses the DMV-IV translated by Professor Domingo Garcia-Villamisar.

Appendix J: DA's Clinical MRI Scan. Figures a) and b) are overviews of all slices and c) and d) are slices in which the mesial temporal regions are clearly displayed.

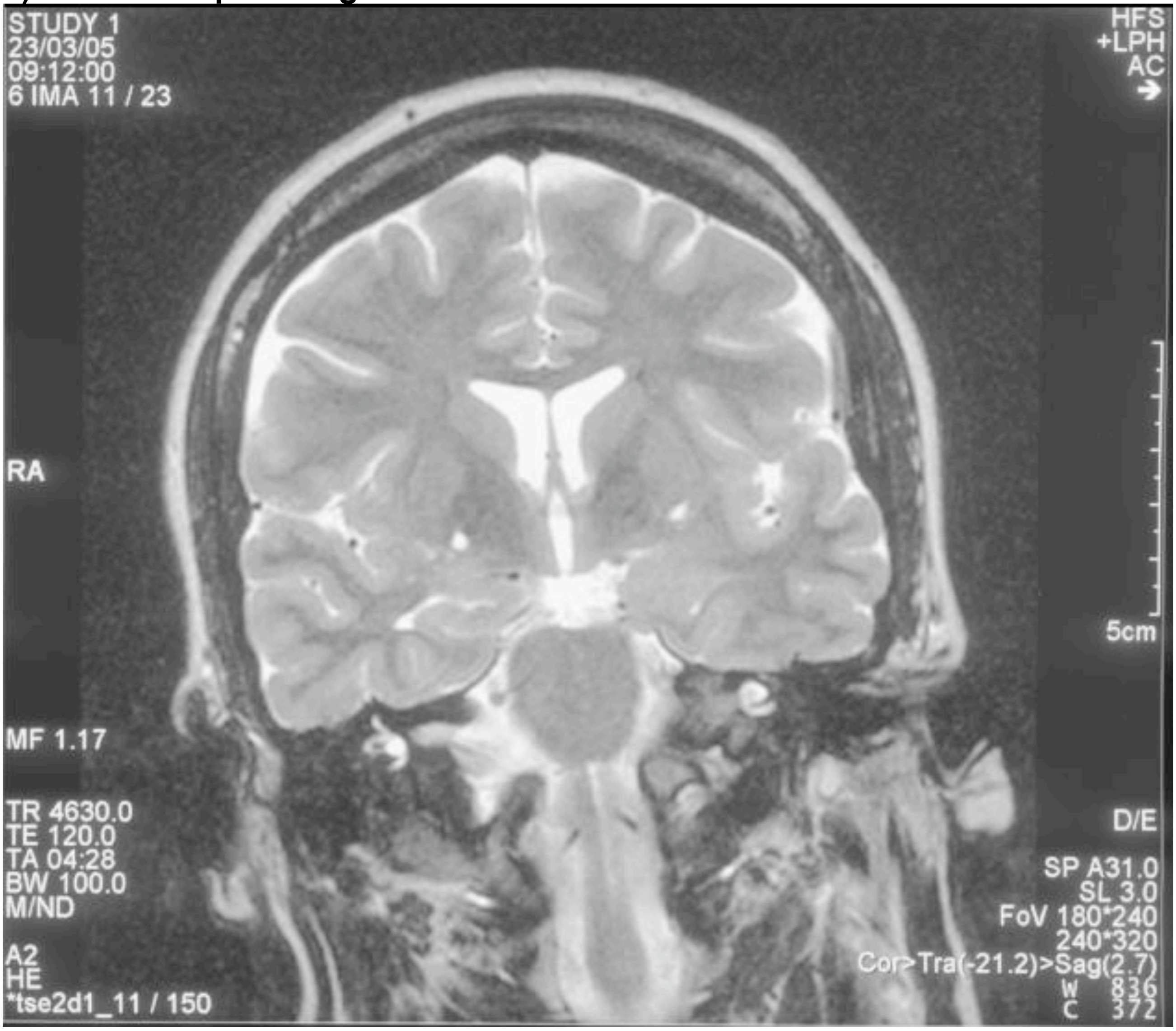
a) Overview



b) Overview



c) Mesial temporal regions



d) Mesial temporal regions