Memory Mistakes and Ageing: How Susceptibility to False Recognition and the lllusory Truth Effect Changes across the Lifespan

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Dedication

To my fantastic Grandma Dicky, whose wise words of support and encouragement got me through undergraduate and to where I am today.

Abstract

The purpose of the current research was to investigate if there was a common susceptibility to false memories and the illusory truth effect, and how performance in these two tasks varied with age. False memories were investigated using the Deese (1959) Roediger and McDermott (1995) (DRM) recognition paradigm, and the illusory truth effect was examined by asking participants to read and rate a set of statements labelled as true or false, and then soon after rate the truth of a subset of the previously presented statements amongst a set of new statements. The study followed a quasi-experimental, within/between-subjects design. The participants were 161 individuals aged from 16 to 92 years old. The sample was divided into three similar-sized age groups: young (16-39), middle (40-60), and old (61+). It was hypothesised that there would be a common susceptibility to DRM false memories and the illusory truth effect, and that older adults would perform more poorly than the young and middle age groups on the two tasks, and that the middle age group would perform more poorly on the two tasks than the young group. The results showed that only the old group demonstrated a common susceptibility to the two tasks. Unexpectedly, there were no age-related differences in the DRM false recognition task. However, in the illusory truth effect task the older groups' performance was poorer compared to the younger two groups, but performance did not differ between the young and middle age groups. These results (along with others) are discussed in relation to the mechanisms believed to underpin performance in the two tasks.

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This project was evaluated and approved by the Massey University Human Ethics Committee: Southern B (Refer to appendix A for approval letter).

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CHAPTER ONE

Introduction

As we age many aspects of memory performance deteriorate and memory errors increase (Law, 1998; Light, 1991; Park, 2000; Tun, Wingfield, Rosen, & Blanchard, 1998). One particularly interesting class of memory error is false memory - the belief that something has happened in the past when it has not. False memories are potentially problematic because incorrect beliefs about the past can lead to inappropriate behaviours in the present. If we become more inclined to construct false memories as we age it stands to reason that we are also more likely to act inappropriately in the present – often these mistakes will be trivial but there may be times when they are not. The mechanisms that are thought to underpin false memory formation bear a striking resemblance to those thought to be active when we make judgements about the veracity of factual claims (see Begg, Anas, & Farinacci, 1992; Brainerd & Reyna, 2002; Hawkins & Hoch, 1992; Roediger & McDermott, 1995). Indeed, poor memory for information sources is no doubt a significant cause of false beliefs – e.g., believing that you learnt about the safety of a particular product from a reputable source rather than from a non-expert friend might make you more likely to believe that the safety claim is true and the consequences of holding such a belief could be serious. The goal of the current study is to explore the hypothesis that susceptibility to the construction of false memories is correlated with an increase in the likelihood that false claims will be judged true and that both will increase with age.

In addition, Dodson, Koutstaal, and Schacter (2000) point out that generally memory is accurate, but illusions and distortions in memory are unavoidable and potentially disturbing, as they increase doubts about memory being a reflection of the past. Great effort

has gone in attempting to determine the mechanisms that enable us to remember accurately (Ferguson, Hashtroudi, & Johnson, 1992; M. Johnson, Hashtroudi, & Lindsay, 1993; M. Johnson & Raye, 1981). Furthermore, research that focuses on the errors people make when remembering is important as it provides information regarding the constructive nature of remembering, including constructive encoding and retrieval processes (M. Johnson et al., 1993). It also has some applicability to real life events, such as eyewitness testimonies (Loftus, 1979; D. Ross, Read, & Toglia, 1994), memories of traumatic events recovered in therapy (Lindsay & Read, 1994; Loftus, 1993), persuasive messages, and conversational inferences (Hilton, 1995).

There are three essential errors that are made when remembering. Forgetting events that happened, 'remembering' events that did not happen, and remembering events differently from how they truly occurred (Roediger & McDermott, 1995, 2000b). Forgetting needs no introduction as it is experienced by everyone (Roediger & McDermott, 2000a; Schacter, 1996; Underwood, 1957). However, the other errors are less well known and are important for the phenomena under study in this research; false memories and the illusory truth effect. Roediger and McDermott (1995) describe false memories as the remembering of events that did not occur, or 'remembering' events differently from how they truly occurred. In the current research false memories are taken to be memories for events that did not happen but are connected, through associations and/or resemblance, to events that did happen (Gallo, 2006).

It is useful to establish how false memories differ from repressed, recovered, and discovered memories. Repressed memories are characterised as memories that have been pushed into an inaccessible area of one's unconscious, often due to their shocking nature (Loftus, 1993). While these memories may remain inaccessible for a long period of time,

even forever, they may re-emerge in one's consciousness, therefore being described as recovered memories (Loftus, 1993). Discovered memories are the same as recovered memories but allow for the possibility that the memories discovered were, at some level, not entirely forgotten or repressed (Schooler, 2001). Furthermore, the term 'discovered' retains the scepticism regarding the precise mapping between what has been discovered and what did really happen, for example, memories could be entirely veridical, entirely false, or somewhere in between (Schooler, 2001).

False memories have been elicited in a number of ways, and they are a robust phenomenon. However, the most commonly used procedure for eliciting false memories, is the Deese (1959) Roediger and McDermott (1995) (DRM) paradigm. This task uses lists of semantically related words to prime a common associated word not presented during learning (critical lure/word). An example of a list is: *steal, robber, crook, burglar, money, cop, bad, rob, jail, gun, villain, crime, bank, bandit, criminal*. After learning this list participants often later falsely recall and/or recognise the word *thief*. The second phenomenon being investigated in the current research is the illusory truth effect (also known as the propaganda effect and the truth effect). The illusory truth effect is caused by repetition. Simple repetition can increase an individual's belief in the information being repeated, be it a product claim (Hawkins & Hoch, 1992), trivia fact (Bacon, 1979), or another type of statement or fact.

A number of mechanisms are believed to be behind the creation of false memories and the illusory truth effect, but there is one factor, source memory, which is used to explain the occurrence of both false memories (Gallo, Roberts, & Seamon, 1997; Norman & Schacter, 1997; Roediger & McDermott, 1995; Roediger, Watson, McDermott, & Gallo, 2001) and the illusory truth effect (Arkes, Boehm, & Xu, 1991; Arkes, Hackett, & Boehm, 1989;

Begg et al., 1992; Hawkins & Hoch, 1992; Law, 1998). An interesting and important point to note here is that, even though both phenomena of interest are believed to rely on misattributing the source of remembered events, to date, no research investigating the two phenomena alongside one another has been published. In addition, with the amount of research conducted with each phenomenon, comparatively little research has been conducted examining the influence age has on performance and susceptibility to these two types of memory failure (which forms the rationale for the present study).

Central to the current research is the fact that previous researchers have illustrated that normal ageing is generally related to deficits in memory for source information (McIntyre & Craik, 1987; Schacter, Osowiecki, Kaszniak, Kihlstrom, & Valdiserri, 1994). Complicating this situation are findings of age-deficits in recognition memory (Howard, Bessette-Symons, Zhang, & Hoyer, 2006; Hoyer & Verhaeghen, 2006) which is also important in the generation of false memories and the illusory truth effect (Bacon, 1979; Boehm, 1994). It thus makes sense to predict that older adults are more likely to create more false memories and have an inflated belief in repeated items than younger adults. However, prior research has tended to focus mostly on the memories of young adults, which raises the question of whether the findings can be generalised to older people. Those studies that have investigated age have typically found mixed results, with older individuals performing both poorer and equally to younger adults on DRM false memory tasks and the illusory truth effect tasks. Further clarifying research is thus called for, and the current research aims to provide clarification and add to the current literature by examining memory mistakes and ageing.

The present study investigates both false memories and the illusory truth effect across three different age groups; 16-39, 40-60, and 61+ years. False memories will be

examined using the DRM paradigm, and the illusory truth effect will be elicited by asking participants to read and rate a set of trivia statements targeted as true or false, and then later rate the credibility of a subset of the previously presented statements amongst a set of new trivia statements. The general aim is to investigate susceptibility to false memories and the illusory truth effect and how performance in the two tasks varies across the three age groups. The present research will add to the current literature that has examined age differences in DRM false memories or the illusory truth effect, and also fill some of the gaps which exist in the current literature which were discussed above. What follows in chapter two is a comprehensive review of the literature regarding the current research.

CHAPTER TWO

Literature Review

Introduction

Memory is an important ability for everyone every day, yet many studies have revealed this precious instrument can fail us. False memories and the illusory truth effect are two theoretically-related phenomena, yet the two phenomena have not been researched alongside one another to see if those individuals susceptible to one are also susceptible to the other. Furthermore, because of age-related source memory deficits, we should expect age-related increases in both false memories and susceptibility to the illusory truth effect. However, very little research has investigated age and the illusory truth effect. More research has been conducted on false memories and age, but findings are mixed.

The current literature review will attend to various areas of research related to false memories and the illusory truth effect. The first part addresses source memory and ageing, followed by a broad overview of false memories and the illusory truth effect, including, their history, what they are, and how they can be elicited. Next, ageing and false memory research is reviewed before a discussion of the underlying mechanisms proposed to explain false memories and how they could explain age-related effects. Then, research on DRM (Deese/Roediger-McDermott) false memories and other moderating factors is briefly reviewed. Subsequently, the mechanisms believed to explain the illusory truth effect, and how they may be used to explain age effects is discussed, followed by research on a possible moderating factor of the illusory truth effect. Finally, a section is devoted to bringing together the information in the review to consider common underlying mechanisms that

may be responsible for performance in the DRM and illusory truth effect task in regards to age.

Source Memory and Ageing

Remembering source information is important as it enables individuals to establish why an item is familiar (Dodson & Schacter, 2002). Source memory is memory for (or beliefs about) the origins of the information encoded in a memory (M. Johnson et al., 1993); that is, source memory refers to recollecting the origin of an item or information (Schacter et al., 1994). Source memory errors (or source monitoring errors) are important in both false memories and the illusory truth effect (as is discussed later) (Gallo et al., 1997; M. Johnson et al., 1993; Norman & Schacter, 1997; Roediger & McDermott, 1995; Roediger et al., 2001; Skinner & Fernandes, 2009). The concept of source monitoring derives from M. Johnson and Raye's (1981) reality monitoring framework. Reality monitoring involves differentiating information that is internally-generated (e.g., imagined) from that that is externally derived (e.g., observed events), which is referred to as internal-external discrimination. In addition to the internal-external differentiations, source monitoring includes external source monitoring; differentiating between different externally obtained sources (e.g., did person one or person two say that?), and internal source monitoring; differentiating between different internal sources (e.g., was it a memory of something thought about or something said?) (M. Johnson et al., 1993).

Results from a number of experiments demonstrate that older adults have problems with memory for source information compared to younger adults (Schacter, Kaszniak, Kihlstrom, & Valdiserri, 1991). For example, McIntyre and Craik (1987) presented participants with a series of fictitious statements, each statement was presented either

visually or auditorily (two external sources). Older adults (mean age 69.7 years), compared to younger adults (mean age 23.3 years), showed marked impairment in memory for the source of retrieved statements. Similar results have been demonstrated by Ferguson et al. (1992) and Schacter et al. (1991) . Other researchers have used the reality monitoring paradigm to investigate source memory and ageing. Hashtroudi, Johnson and Chrosniak (1989) had participants say, think, and listen to words, while Cohen and Faulkner (1989), asked participants to imagine, watch, or perform different actions. Both found older individuals (mean age 69.4 and 76 years, respectively) were less able to correctly remember the original source of the words or actions than younger adults (mean age 19.5 and 31, respectively). In addition, Henkel, Johnson, and De Leonardis (1998) found elderly people (mean age 74.2 years) had more problems judging which items had been seen from those imagined.

However, in the above studies older individuals not only showed source deficits, but also deficits in overall memory, which raises the possibility that source memory problems reflect a general memory decline (Schacter, Koutstaal, & Norman, 1997). This has led to more recent experiments that have investigated if older adult's source memory deficits are disproportionately greater than recall and recognition deficits. Schacter et al. (1991) found that when item memory was equal in old (mean age 69) and young participants (mean age 19.3), older adults illustrated impaired source memory. Ferguson et al. (1992) used a procedure that made multiple source cues available to participants. When recognition memory was equivalent across age groups, older adults (mean age 69.8) exhibited a larger source memory deficit compared to younger adults (mean age 20).

In a second experiment conducted by McIntyre and Craik (1987) participants learnt fictitious facts (about famous and fictional individuals) that were presented aurally or

visually, and later tested participants on source and item memory. Again, they found older adults (mean age 69.7) displayed poorer item and source memory in relation to young adults (mean age 23.3), and when source recall was conditional on correct item recall it was revealed that old adults made more source errors than younger individuals. In particular, elderly participants showed a greater predisposition to incorrectly identify extra-experimental sources for facts learnt in the experimental condition.

In most source memory investigations there are usually two sources, and each source is associated with a number of items (known as many-to-one mapping). Therefore, it could be argued that source memory deficits found in older participants were due to a deficit in dealing with this type of item-to-source mapping, rather than a general deficit in source memory (Schacter et al., 1994). That is, older individuals could be particularly sensitive to the effects of interference that occur when a cue (in this case a source) is overloaded by being linked to a large number of items (Schacter et al., 1994). This idea is based on the cue overload hypothesis in which the probability that an item is recalled decreases as the number of items that are under a specific retrieval cue increases (Watkins & Watkins, 1975). However, Schacter et al. (1994) provided evidence contrary to the cue overload hypothesis – they found older adults (mean age 68.3) had greater source deficits than younger adults (mean age 19.8) when each item had a different source (one-to-one mapping) and when many items were linked to one source (many-to-one). In addition, cue overload procedures have been found to relate to forgetting in laboratory settings, but not to 'real-world' forgetting (Wixted, 2004). From the above evidence it seems that there are age-related source memory deficits independent of other memory difficulties. These age-related source memory deficits would likely decrease performance in false memory and illusory truth effects tasks. However, before discussing the importance of source memory for performance

in false memory and illusory truth effect tasks we must describe what these two phenomena are, and it is this discussion that follows.

False Memories and the DRM Paradigm

F. Bartlett (1932) is credited by numerous authors (Deese, 1959; Gallo et al., 1997; McDermott, 1996; Norman & Schacter, 1997; Roediger & McDermott, 1995) as being the first to investigate false memories. He asked participants to read a Native American folktale, then recall the story several times at differing intervals. F. Bartlett's results showed distortions in participants' memories over the repeated recall attempts. Unfortunately, these results have not been successfully replicated (Gauld & Stephenson, 1967; Roediger, Wheeler, & Rajaram, 1993). Gauld and Stephenson (1967) found that when participants recalled the story with instructions to be as accurate as possible, few errors occurred. They concluded that it was F. Bartlett's instructions – participants were not asked to be as accurate as possible – which lead to the distorted memories. Nonetheless, F. Bartlett's contribution has been enduring as he characterised reconstructive memory as the active process of remembering, in which errors occur (Roediger & McDermott, 1995), and it is thought that F. Bartlett's method was more realistic than asking participants to be as accurate as possible, as people are not often asked to accurately remember material such as folktales (Roediger et al., 1993). F. Bartlett paved the way for numerous other studies investigating false memories. Underwood (1965) used a list learning paradigm in which participants judged if each presented word had been in the list previously. Subsequent words in the list that were related to earlier studied words were often falsely recognised (Underwood, 1965).

Underwood's (1965) research is well known in false memory literature (Roediger & McDermott, 1995). However, an earlier article by Deese (1959) went largely unnoticed until Roediger and McDermott (1995) expanded on it and created what is now the most commonly used procedure for eliciting false memories, the DRM paradigm. Deese tested memory for word lists with a single-trial, free-recall test. His aim was to predict the occurrence of extra-list intrusion errors; words that participants recalled, but were not in the presented list (critical lure word). Deese's investigation found some lists reliably produce false recall of the critical word. Roediger and McDermott replicated Deese's research using both recall and recognition measures using a number of new lists, in addition, Roediger and McDermott developed 24 15-item lists and expanded some of Deese's lists from 12 to 15-items. Their results confirmed and generalised Deese's findings. Participants produced high levels of false recall and recognition as they falsely remembered critical words at almost the same rate as studied words (Roediger & McDermott, 1995). From this study the DRM paradigm evolved to become one of the most commonly used techniques to elicit false memories.

Roediger et al. (2001) stated that there are 55 lists which elicit false recall with rates ranging from 1 to 65%, and it is likely there are more than this now due to the immense amount of research that have used DRM procedures. In addition, Stadler, Roediger, and McDermott (1999) created norms for 24 word lists using 205 participants and found recall and recognition rates ranging from 10 to 65% and 27 to 84% respectively. Unfortunately, the high recognition rates were likely inflated by participants completing a recall test, followed by a recognition test (Stadler et al., 1999). Nevertheless, many researchers have found high recognition rates in the absence of an earlier recall test (see Clancy, McNally, Schacter, Lenzenweger, & Pitman, 2002; Gallo et al., 1997; McDermott & Roediger, 1998; Winograd,

Peluso, & Glover, 1998). False memories have also been found to persist when there is no delay between learning and testing trials, 30 second delay, or two day delay (McDermott, 1996). McDermott (1996) also found false memories for critical words remained after five repeated study-test trials; although false memories decreased, they were not eliminated. Furthermore, they persist after explicitly warning participants about the phenomenon (Gallo et al., 1997; McDermott & Roediger, 1998). Although the DRM paradigm is perhaps the best known procedure for producing false memories there are several others. One lesser know, but equally interesting, approach goes by the name of the illusory truth effect.

The Illusory Truth Effect

The illusory truth effect refers to the increase in the perceived credibility of repeated statements (Arkes et al., 1989). It was first explored by Hasher, Goldstein, and Toppino (1977). In their research participants attended three experimental sessions, with two week intervals between sessions. During each session, participants listened to a list of plausible statements (e.g., *divorce is found only in technically advanced societies*) and were told the statements may or may not be true. Then participants were asked to rate each statement's validity on a 7-point scale (1=definitely false, 7=definitely true). Each list of statements (in each session) contained critical statements that appeared in all three sessions and new statements that had not previously been presented. Hasher et al. found that participants gave repeated statements significantly higher validity[1] ratings than new items. This effect

[1] The terms validity, credibility, and truth are often used interchangeably in the illusory truth effect literature. However, it is important to note that more often than not participants are asked (in one way or another) to rate how true they think each statement is, not how valid or credible they think it is.

has been illustrated in a number of contexts and appears to be a strong and generalisable phenomenon (see Arkes et al., 1989; Bacon, 1979; Begg et al., 1992; Begg & Armour, 1991; Hawkins & Hoch, 1992; Schwartz, 1982).

In fact the increase in the perceived truthfulness of repeated statements has been found for statements not only of unspecified truth (statements are not presented as either true or false) (Bacon, 1979; Hasher et al., 1977), but also for statements that have been identified as being true or false. Begg et al. (1992) conducted research in which each statement was paired with a male or female name (e.g., *Susan Smith says house mice can run an average of four miles per hour*). In the study phase of the experiment participants were told that males were lying and females were telling the truth (or vice versa). They then heard the list of statements. During testing participants were asked to rate the credibility of a second list of statements (e.g., *house mice can run an average of four miles per hour*) that contained statements not heard (new) in the study phase, statements identified to be true (old true) in the study phase, and statements identified to be false (old false) in the study phase. The results revealed credibility judgements where highest for old true statements, followed by old false, then new statements.

Furthermore, the illusory truth effect seems to be generalisable over numerous conditions. It works for general topics (history, sports, current affairs, and science) (Hasher et al., 1977), trivia statements (Bacon, 1979), opinion statements (e.g., *the Soviet Union has never fully complied with its nuclear arms agreements*) (Arkes et al., 1989), product-related claims (Hawkins & Hoch, 1992; Law, 1998), and a false fame paradigm in which non-famous names were presented and 24 hours later incorrectly judged as famous (Jacoby, Kelley, Brown, & Jasechko, 1989). The illusory truth effect has also been shown to occur when participants have been told which of the statements are being repeated and which are new

(Bacon, 1979). Schwartz (1982) demonstrated the effect exists with presentation-test intervals of only a few minutes, when stimuli are presented visually or aurally, that it does not depend on the presence of both old and new statements in the repeated lists, and that the validity rating pattern (old > false > new) occurs regardless of whether participants repeat the rating task across presentations or only after the final presentation. A meta-analysis conducted by Dechêne, Stahl, Hansen, and Wänke (2010) verified Schwartz's findings. In general, the largest increase in truth ratings occurs only after the first repetition; additional repetitions do not significantly increase truth ratings (Arkes et al., 1991). People are also more likely to rate statements judged as contradicting those they had previously heard as more false than statements that seem to reaffirm their knowledge gained from earlier exposure (Bacon, 1979). The most important condition statements require is their ambiguity (not obviously true or false); otherwise truthfulness can be judged independently of repetition (Roggeveen & Johar, 2002). From the overview above it is clear past research has demonstrated that the illusory truth effect is a robust phenomenon across settings and stimuli. Now that a general overview of DRM false memories and the illusory truth effect has been completed, discussion turns to age in relation to these phenomena, starting with ageing and DRM false memories.

Ageing and False Memory

Ageing and the DRM paradigm. From the discussions above and those that follow concerning age-deficits in memory processes that underpin false memories and the illusory truth effect, it would seem plausible to assume that older individuals are more susceptible to both phenomena. However, the evidence is not clear cut. Empirical research indicates that older adults are sometimes, but not always, more likely than their younger counterparts to

recall or recognise events that did not occur (see J. Bartlett, Strater, & Fulton, 1991; Cohen & Faulkner, 1989; Dywan & Jacoby, 1990; Rankin & Kausler, 1979). In the following section evidence for and against an age-related increase in susceptibility to false memories using the DRM paradigm and recall or recognition tests is reviewed.

Recall. Although research studies on false memories use different procedures from one another, Gallo (2006) examined 18 experiments from 12 articles[2] that compared young (mean age 21 years) and old adults (mean age 73 years) by selecting data reported from the most basic DRM recall conditions, which is when participants are presented with one or more DRM lists, then without delay are asked to write down all the words they remember. Averaging across the experiments it was found that correct recall of studied items was significantly lower in old adults compared to young adults (.47 and .62), and false recall of critical lures was significantly greater in older adults (.40 and .33).

However, further examination of the same 12 articles shows that although they all demonstrate older adults have lower recall of studied items, many (about one third) illustrate no, or very small, age differences in false recall in the basic DRM recall paradigm (Intons-Peterson et al., 1999; Kensinger & Schacter, 1999; Rybash & Hrubi-Bopp, 2000; Thomas & Sommers, 2005; Tun et al., 1998). Therefore, even though increases in false recall with age are widely reported, individual studies do not show a consistent pattern, possibly because it is a small effect and thus difficult to detect. Research has also found interesting

[2] Balota et al. (1999), Butler, McDaniel, Dornburg, Price, and Roediger (2004), Intons-Peterson, Rocchi, West, McLellan, and Hackney (1999), Kensinger and Schacter (1999), Lövdén (2003), Norman and Schacter (1997), Rybash and Hrubi-Bopp (2000), Thomas and Sommers (2005), Tun, Wingfield, Rosen, and Blanchard (1998), Waldie and See (2003), Watson, Balota, and Sergent-Marshall (2001), Watson, McDermott, and Balota (2004).

age-related differences when examining false recall after participants have been warned about the phenomenon and when the DRM study-test trials have been repeated. An overview of this research will follow the discussion on ageing and DRM false recognition.

Recognition. As with recall, Gallo (2006) examined 15 experiments from 10 articles[3] that compared young (mean age 20 years) and old adults (mean age 72 years) using data from standard DRM recognition conditions (a final recognition test is administered after participants have been presented with several DRM lists) in which recognition testing was not confounded by preceding recall tests. As with recall, recognition of studied items was significantly lower in old adults compared to young adults, however, false recognition rates were not significantly different across the two age groups (Gallo, 2006). Fewer than half of the studies reported a significant difference in false recognition across age groups (Budson et al., 2003; Intons-Peterson et al., 1999; Schacter et al., 1999; Thomas & Sommers, 2005).

For research in which recall tests are conducted before recognition tests (Balota et al., 1999; Intons-Peterson et al., 1999; Norman & Schacter, 1997; Tun et al., 1998; Waldie & See, 2003) a significant age-related difference *is* found in false recognition. However, Gallo (2006) discusses this difference is most likely due to carryover effects. Therefore, it is not clear whether there is an age effect in false recognition using the DRM paradigm. It is possible that there are issues with the statistical power of these studies, in that, the effect is small and therefore studies require large numbers of participants to detect significant age-

[3] Benjamin (2001), Budson, Daffner, Desikan, and Schacter (2000), Budson, Sullivan, Daffner, and Schacter (2003), Gallo, Bell, Beier, and Schacter (2006), Gallo and Roediger (2003), Intons-Peterson et al. (1999), Kensinger and Schacter (1999), McCabe and Smith (2002), Schacter, Israel, and Racine (1999), Thomas and Sommers (2005).

related differences. A similar conclusion can be drawn from evidence concerning the illusory truth effect (discussed below).

Other age-related differences. The influence of warning participants and repeating presentations has been investigated for both recall and recognition. Dehon and Brédart (2004) and Watson et al. (2004) used warnings prior to study and found the warnings substantially decreased false recall with young adults (mean age 23.1 and 19.2 respectively), but had only a small influence in decreasing false memories with older adults (mean age 71.9 and 73.3 respectively). By contrast similar warnings significantly decreased false recognition in both young (mean age 19.75) and old adults (mean age 71.36) (McCabe & Smith, 2002). The difference between false recall and recognition when participants have been warned is difficult to explain. McCabe and Smith (2002) state that their finding did not fit their prediction, which was that older individuals would be less able to use the warning to decrease false memories, because it involves simultaneous storage and processing of information and this ability is 'impaired' in older people because of age-related deficits in working memory capacity. It is possible that across these studies the warning instructions given to participants vary, which could influence the effectiveness of the strategy an individual uses to avoid false memories.

Furthermore, Kensinger and Schacter (1999) repeated DRM list presentation and recall tests five times and found older adults' (mean age 67.4) false recall did not change, while younger adults (mean age 19.9) quickly reduced false recall across trials. Research testing *recognition* across five trials produced similar results (Budson et al., 2000; Kensinger & Schacter, 1999). Furthermore, when lists are repeated one or three times, older adults' (mean age 74) false recognition increased across trials, while younger adults' (mean age 22.4 and 19.1 respectively) false recognition decreased (Benjamin, 2001; Skinner & Fernandes,

2009). Although age-related differences have been found in both false recall and recognition, it seems that when researchers employ DRM procedures age-related differences are found in false recall more than they are found in false recognition. In addition, research on the illusory truth effect has also found evidence for and against age-related differences – this research will now be examined.

Ageing and the illusory truth effect. It is assumed that age is an important factor in the illusory truth effect because older adults often have poorer memory abilities than younger people (Jacoby, 1999). Unfortunately, most research on the illusory truth effect has used only young adult samples (mean age between 18 to 30 years), and only a limited amount of research has specifically investigated the effect across age groups, finding mixed results (Skinner & Fernandes, 2009).

Law et al. (1998) investigated the relationship between participant age, item recognition, item source memory, and truth ratings. Although they found no main effect of age on truth ratings, their results illustrated that age moderated the effect that perceived repetition had on truth ratings. Items believed to be old were rated truer by older adults than younger adults (mean age 24.2 and 72.3, respectively), and items believed to be new were rated less true by older adults than younger adults. This suggests that older individuals believed statements they recognised, but were more suspicious of statements they did not recognise, compared to their younger counterparts (Law et al., 1998). Law et al. also found that old adults made more source memory errors than young adults, incorrectly contributing statements to sources outside the experiment instead of to the initial presentation of the statements during the experiment.

Skurnik, Yoon, Park, and Schwarz (1998) examined the influence of repeating statements during the study phase (statements were viewed once or three times), test

delays (30 minutes and three days), and age (18-25 and 71-86 years old). In addition to finding an overall illusory truth effect for both age groups, they also found older adults made more errors: responding true to false statements. In the 30 minute delay condition both groups used repetition to their advantage and decreased incorrect true responses. When tested after a three day delay younger adults again demonstrated a decreased likelihood of claiming false statements to be true; however, older adults were *more* likely to incorrectly state false items as true for statements previously viewed once and three times. Furthermore, there was a particularly large bias for those seen three times to be judged as true (40% for three times versus 28% for once) by older adults (Skurnik, Yoon, Park, & Schwarz, 2005).

By contrast, Mutter, Lindsey, and Pliske (1995) explored the influence that familiarity and objective credibility evidence (statements were followed by either the word true or false) had on young and old adults' (mean age 19.8 and 70.6) truth ratings for statements. Mutter et al. demonstrated that the influence of familiarity, being a subjective base for the truthfulness of a statement, is the same for both young and older adults as there was no difference in truth ratings. Also, older adults were as likely as younger adults to use the objective evidence (that was provided by the experimenters) of statements' truthfulness when it confirmed the truth status of statements that they already believed were true (based on their own individual knowledge), but when the objective evidence disconfirmed the statements' credibility and initially they believed the statement was true, they were less likely to use the objective evidence and decrease their truth ratings of false statements.

Mutter et al. (1995) discussed how age-related declines in capabilities for processing disconfirming evidence may cause increases in the tendency to believe statements. In addition, Gilbert (1991) argued that if you believe a fact is true it is easier to process

information that confirms the facts truth status. However, if information were to state this fact was really false (when you believe it to be true) you would find it more difficult to process the information and believe the fact is false. Furthermore, research has shown that when processing resources are decreased during the presentation of credible information the ability to identify true information as true is not decreased, but the ability to identify false information as false is decreased (Gilbert, Krull, & Malone, 1990). As age-related declines in performance on a number of cognitive tasks are believed to be due to decreased working memory capacity and/or decreased processing resources (Light, 1991), the finding by Gilbert et al. (1990) provides an explanation for why ageing impairs the capacity to accept, what is thought by the individual to be true, as false. Older adults may have these problems because the process of recoding knowledge as false is difficult, requiring the use of processing resources that are not available (Mutter et al., 1995).

Furthermore, Parks and Toth (2006) demonstrated that there was no difference between young and older adults' illusory truth susceptibility when examining the influence of manipulations on perceptual fluency (graphic style in which they were presented) or conceptual fluency (the semantic context of a paragraph preceding each statement was manipulated by either continuing the meaning of the statement or not[4])[5]. In addition, Rahhal, May, and Hasher (2002), although not specifically investigating the illusory truth

[4] The following is an example of a fluent contextual paragraph preceding a statement "Vanessa looked at the pictures in the magazine and remarked to her husband that she was always amazed by the quality of the photography. She was even more impressed when he told her that: National Geographic photographers are not allowed to enhance their pictures through computer technology" (Parks & Toth, 2006, p. 241)

[5] Mean age of young and old groups for perceptual fluency experiment was 19.8 and 70.4 years. For the conceptual experiment mean ages of the two groups were 20 and 71.2 years.

effect, had young (19-25 years) and old (61-75 years) adults listen to true/false statements said by a female/male, then either rate the truth of a second list of statements (that contained new and previously heard statements) or recall the source of each statement. Results showed that although there were robust differences in source memory, there was no difference in truth ratings between younger and older adults.

From these five studies (Law et al., 1998; Mutter et al., 1995; Parks & Toth, 2006; Rahhal et al., 2002; Skurnik et al., 2005) it is difficult to conclude whether there is a clear effect of age on the illusory truth effect. Only a limited amount of research has been conducted thus far and the studies use a variety of methods in their research: explicit and/or implicit source memory tests, source memory tests before or after truthfulness ratings, different delay or no delay conditions, truth ratings on a scale or dichotomous decisions, and repetition of statements. Therefore clear conclusions cannot be drawn. However, importantly the evidence suggests that older participants are either equally or more susceptible to both the illusory truth effect and false memories using the DRM paradigm than younger adults, which suggests that an age effect exists under certain conditions. Possibly because different procedures and/or materials used in research studies on DRM false memories and the illusory truth effect influence how cognitively demanding a task is, therefore, performance may vary in relation to both the cognitive demands required for the task and age-related cognitive deficits. For example, performance on a cognitively demanding task is likely to be poorer for older adults with age-related cognitive deficits than younger adults, whereas, if the task was not cognitively demanding results would be less likely to find age-related differences.

Furthermore, it is possible that in the five studies on the illusory truth effect the age of the ‘old’ participants is important. Two of the studies (Law et al., 1998; Mutter et al.,

1995) report similar age ranges of approximately 60 to 86 years. Rahhal et al. (2002) reports an age range of 61 to 75 years, and Skurnik et al. (2005) of 71 to 86 years. Parks et al. (2006) only report the mean ages of 70.4 and 71.2 for their two experiments. It is interesting to note that the results found by Skurnik et al. who had the 'oldest' old group (starting at 71 years unlike the rest which started at approximately 60) found the most robust age effects, and results found by Rahhal et al. who had the 'youngest' old group (60-75 years compared to the other studies 'old' age groups which went up to approximately 86 years) found no age differences in truth ratings of statements.

Underlying Mechanisms of False Memories

The previous section has reviewed a number of studies that focus on the DRM paradigm and the effects of age, finding interesting yet mixed results. This section describes and discusses the underlying mechanisms or processes believed to be involved in the creation of false memories and how each mechanism can be used to explain false memory effects related to age. It is an important section as it will be used later to discuss the idea of a common susceptibility to the illusory truth effect and false memories in relation to age. Three mechanisms are discussed: gist and verbatim memories (as part of fuzzy trace theory), activation, and source monitoring, followed by an examination of how activation and source monitoring are combined in the activation-monitoring theory. It should also be noted, fuzzy trace theory and the activation-monitoring theory are competing explanations for false memories.

Gist and verbatim memories as part of fuzzy trace theory. Fuzzy trace theory was originated by Brainerd and Reyna (Brainerd & Reyna, 2002; Reyna & Brainerd, 1995). According to fuzzy trace theory, during presentation stimuli are encoded using both

verbatim (specific details of each item that are associated with subjective recollection) and gist traces (overall similarity, meaning, and relationships between presented items) (Brainerd & Reyna, 2002; Gallo, 2006). Brainerd and Reyna (2002) claim that false memories do not involve the encoding of exact content, but rather rely on the encoding of semantic features and general gist (overall idea). Memory performance is based on both verbatim and gist retrieval and their accessibility. Verbatim retrieval is preferred when verbatim traces are strong compared to gist traces, and gist retrieval is preferred when gist traces are strong compared to verbatim traces (Brainerd & Reyna, 2002). However, over time verbatim traces deteriorate, while gist traces remain accessible (Brainerd & Reyna, 2002).

In addition, both gist and verbatim retrieval are responsible for true memories, whereas they have opposite influences on false memories; it is the available gist and verbatim memories that are responsible for false memories (Brainerd & Reyna, 2002). Verbatim retrieval is responsible for true memories because the experience can be specifically recollected. Gist retrieval supports true memories because the meaning of an item is familiar; even though the experienced item may not be specifically recollected it is familiar enough to be considered a true memory (Brainerd & Reyna, 2002). Gist retrieval is responsible for false memories the same way it is responsible for true memories, through familiarity (Brainerd & Reyna, 2002). A critical lure is consistent with the gist of a DRM list, therefore, at test the strong gist information results in a signal for a lure having been previously presented (Gallo, 2006). However, verbatim retrieval suppresses false memories by neutralising the perceived familiarity, either at the level of the specific item or at the general cognitive strategy being employed (e.g., an individual only accepting items that they have a specific auditory image of its presentation) (Brainerd & Reyna, 2002). Supporting this view are results based on immediate testing, which is believed to rely on verbatim traces;

and delayed testing, which is believed to rely on gist traces. Roediger et al. (2001), using immediate test conditions, found that accurate recall was negatively associated with false recall, suggesting that true and false memories relied on different representations. By contrast employing a delayed test condition Reyna and Kiernan (1994) found a positive association between true and false memories, indicating accurate responses relied on gist traces.

It has been argued that fuzzy trace theory is a potentially important framework for explaining age effects in false memory research. Research by Norman and Schacter (1997) found that when participants' memories for critical lures and presented items were probed with the Memory Characteristics Questionnaire (MCQ; M. Johnson, Foley, Suengas, & Raye, 1988), older adults (61-72 years) showed significantly less discrimination between presented items and lures in MCQ categories based on perceptual and contextual features than younger adults, supporting the hypothesis that older adults are more susceptible to false memories because of impaired recollection of item-specific information, coupled with preserved retention of gist information.

Furthermore, as described earlier Kensinger and Schacter (1999) used repetition to increase item-specific details of presented items and found that younger adults were able to decrease false memories, but older adults were not, indicating that older adults are more reliant on gist information than younger adults (similar results have also been found by Skinner and Fernandes (2009)). In addition, Tun et al. (1998) created a DRM recognition task that deemphasised gist-based processing so that it was no longer efficient for making recognition decisions. They did this by excluding from study, not only the critical lure, but three weakly associated words from each DRM list, which were then present in the recognition tests. Results found that older individuals remained reliant on gist-based

processes, as there were age-related increases in false recognition of critical lures *and* weakly associated lures. Although, the results above are consistent with the fuzzy trace framework in the formation of false memories, they are also explainable by the activation-monitoring framework, a competing explanation.

Activation. The activation mechanism, in the activation-monitoring theory (discussed below), is based on the implicit associative response model proposed by Underwood (1965). During encoding a list of semantically associated words, such as a DRM list, activates an individual's semantic system (Roediger et al., 2001). Activation may spread to create an implicit associative response, which in the case of DRM lists would be activation of a word (or words) strongly associated with the list items. It is the evoking of concepts that were not presented but are associated with those that were, that creates false memories for critical lures (Roediger et al., 2001). This process is implicit in the sense that people are not aware that activation of the critical lure is produced during the study phase, therefore, the critical lure may be stored at study and then be made available during retrieval (Roediger & McDermott, 1995).

Evidence for the activation mechanism comes from Roediger et al. (2001) who found high correlations between backward associative strength (BAS) and false recall. BAS is the index of the strength of associated connections from the DRM list words to the critical lure. It is obtained by finding the probability each study word will elicit the critical lure in a free association test, then averaging these probabilities to find the mean BAS of the list (Deese, 1959; Roediger et al., 2001). In addition, a multiple regression analysis found BAS to be the

main contributor[6] to false recall (Roediger et al., 2001). Roediger et al. (2001) argued that these findings are consistent with a spreading activation model, because the greater the association between presented items and their critical lure (on a free association test), the more likely that participants will falsely recall or recognise the critical lure. However, encoding features are only partly responsible – retrieval factors, specifically source memory effects, are also important.

Furthermore, Roediger et al. (2001) note that associative activation of critical lures can occur consciously (participants become aware of the lure during presentation and rehearse it) or unconsciously (the lure does not come into conscious awareness). Empirical evidence has suggested that both occur. Results consistent with the conscious activation of critical lures are that participants often show high levels of remembering[7] of the critical items (Gardiner, Ramponi, & Richardson-Klavehn, 2002; Roediger & McDermott, 1995). By contrast, Seamon, Luo, and Gallo (1998) found false memories occurred without recognition of presented list items and with fewer remember judgements when short presentation times were used, suggesting false memories can be based on unconscious activation. Many

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[6] The other predictor variables examined were: veridical recall, inter-item associative strength of the presented words, forward associative strength (the probability a critical lure elicited each presented word in its respective DRM list), concreteness of each critical lure, log frequency (the number of times a critical lure is found in print per a million words, transformed to correct for skewness and distribution frequency), and word length of a critical lure (the number of letters) (Roediger et al., 2001).

[7] After deciding a test item is old, participants judge if they can 'remember' the item (recollect contextual aspects of the study phase), or 'know' the item was present (they cannot retrieve contextual information, but the item is adequately familiar for an old response) (Tulving, 1985). This is known as Tulving's remember/know paradigm.

scholars feel that both conscious and unconscious factors play a role in activation of critical lures (McDermott, 1997; Roediger et al., 2001; Seamon et al., 1998).

Research into the effects of ageing on the activation mechanism behind false memories is limited, as most studies focus on source memory ability. However, researchers who do consider an activation explanation use Hasher and Zacks' (1988) inhibition hypothesis, which proposes that older adults have more problems with memory tasks than younger adults because of an inhibition deficit. Specifically, older adults cannot remove or restrain irrelevant information in their working memory as effectively as younger adults. The inhibition deficit possibly influences activation as older participants' may experience a higher level of activated information (relevant and irrelevant), and the irrelevant information that is unable to be inhibited decreases the performance of older adults (Hasher & Zacks, 1988; Tun et al., 1998). Tun et al. (1998) found evidence to support the inhibition hypothesis as older adults showed greater false recognition for critical lures strongly related to list items and for critical lures weakly associated to list items, suggesting that older adults were less efficient at inhibiting information that was not relevant to the task than younger adults. Dehon and Brédart (2004), Balota et al. (1999), and Tun et al. stated that the extent of the spreading activation in one's semantic network remains relatively stable through ageing, as results in their research indicated that lures were activated as often in old adults as young adults. However, older adults were more likely to indicate that they had heard the lures, while young adults indicated that the lure had come to mind, but they did not think it was presented, which suggests that older adults were less successful at using their source memory than younger adults (Dehon & Brédart, 2004). It is from this point that we move from the activation framework, as it is generally not used on its own to explain false memories; it is part of a more widely used explanation that includes source monitoring.

Source monitoring. As stated earlier source memory is memory (or beliefs) for the origin of information encoded in a memory (M. Johnson et al., 1993) and source memory errors in false memories are also known as source monitoring errors (Gallo et al., 1997; M. Johnson et al., 1993; Norman & Schacter, 1997; Roediger & McDermott, 1995; Roediger et al., 2001; Skinner & Fernandes, 2009). Source monitoring relies on both memory characteristics and judgement processes (M. Johnson et al., 1993). Memory characteristics include records of, perceptual-, contextual-, semantic-, and affective-information (external characteristics), and cognitive operations (internal characteristics, e.g., records of elaboration, organisation, retrieval, and identification), that were created during encoding (M. Johnson et al., 1993). The judgement process requires source monitoring decisions to be made based on the differences between memory characteristics from a variety of sources (e.g., memories for events that truly occurred have more external characteristics associated with them, whereas internally-created memories are more likely to be associated with cognitive operations and reflections) (M. Johnson et al., 1993; Roediger et al., 2001). In addition, source monitoring judgements can be made based on the match between memory characteristics and the activated schemas that correspond to specific sources (e.g., if the auditory characteristics in a memory for a fact matches your schema for Sarah's voice, the fact is attributed to Sarah) (M. Johnson et al., 1993). Jacoby et al. (1989) note that during retrieval, memories that carry experiential details are endorsed as real past occurrences, even though this endorsement may be incorrect. Generally, source monitoring decisions are quick and not deliberate; they are based on characteristics of activated memories, and sources are identified during remembering, without individuals being aware of the decision process (M. Johnson et al., 1993).

Roediger et al. (2001) claim that critical lures in the DRM paradigm are activated strongly at encoding; therefore, during retrieval participants are likely to retrieve the lure as a list item because it has been stored with experiential characteristics similar to the list items. It is the extent to which characteristics of the critical lure are similar to those of real list items that increases false recognition or recall; if a lure were to come to mind consciously at encoding, then was rehearsed like presented list words, the lure would be very similar to presented items in terms of its associated memory characteristics (Roediger et al., 2001). Roediger and McDermott (2000b) believe evidence for this explanation is found when participants misremember the experience of hearing the critical lure (as seen in work by Gallo et al., 1997; Read, 1996; Roediger & McDermott, 1995).

Furthermore, Roediger and McDermott (1995) had participants do a free recall test followed by a recognition test and found that the recall task increased false memories and participants' *remember judgements* in the recognition test. They assumed that when participants generated the lure at recall it increased the participants' belief that the memory for the item was accurate, and provided participants with an additional source to confuse remembering recalling the lure with studying it. On the other hand, even when participants did not complete a recall test before the recognition test high rates of false recognition were recorded (false recognition .65, false recall .79), which suggests participants do not need a recall task to confuse the source of their memories during a recognition test (as they attribute thinking about the critical lure during study to thinking they really heard it). However, it is likely that the recall task provides an additional source that has to be correctly remembered to avoid source monitoring errors (Roediger & McDermott, 1995). According to M. Johnson et al. (1993) both of the above source confusion errors represents source monitoring errors.

In addition, Gallo et al. (1997) believed that warning participants[8] reduced false memories as the lures could be rejected by participants as soon as they were consciously activated and could thus be identified as non-studied words. However, warned participants still produced false memories, which implies that unconsciously activated lures, or lures that were not identified as lures during study, were identified as studied words at test (Gallo et al., 1997). McDermott and Roediger (1998) have also demonstrated that explicit warnings decrease, but do not eliminate false memories. McDermott and Roediger argued that their results (in addition to Gallo's) demonstrated that participants cannot always successfully bring the phenomenon under conscious control. Similarly, Read (1996) claims (based on the findings in his research that showed the majority of participants in his experiment reported that the critical lure appeared at an early list position in a serial position task) that a critical lure is likely activated relatively early during presentation of a DRM list. Subsequent associated list items repeatedly activate the critical lure, reinforcing the rehearsal of the lure and, therefore, increasing its chances of recollection at test. This is reflected by participants' high confidence in their remember judgements (using Tulving's (1985) remember/know paradigm) of critical lures. In addition, Read's results showed that the more rehearsals a critical lure received during the testing period (based on its perceived serial position), the more likely its memory was accompanied by external as well as internal memory characteristics (e.g., sounds and related thoughts).

[8] Participants were given detailed information about the DRM lists (how they were constructed and that prior research has shown they lead to high false recognition rates) and the false recognition effect (the nature of the effect, an example of a DRM list and its corresponding critical lure, and that the goal was to minimise false recognition). The warning also involved participants hearing a DRM list then completing a recognition test, followed by the researchers identifying the critical lure in the test (Gallo et al., 1997).

Based on the discussion in the earlier section about source memory and ageing, it is clear that older adults have poorer source memory than younger adults (e.g., Cohen & Faulkner, 1989; Ferguson et al., 1992; McIntyre & Craik, 1987; Schacter et al., 1991). In addition, research that has focused on source memory and age using the DRM paradigm has proposed that source monitoring requires controlled processes (Skinner & Fernandes, 2009) and, because controlled processes are often impaired with age (Jacoby, Jennings, & Hay, 1996; Shiffrin & Schneider, 1977), research finds higher rates of false memories in older adults than younger adults (Balota et al., 1999; Norman & Schacter, 1997; Skinner & Fernandes, 2009). Similarly, researchers have argued that older adults lack the resources needed to discriminate true memories from false memories by attending to the differences in memory characteristics that represent true and false memories (Norman & Schacter, 1997; Thomas & Sommers, 2005) and those necessary to tag critical lures as self-generated (Skinner & Fernandes, 2009). Therefore, based on the previous points and the fact that source monitoring errors are believed by many researchers to be one of the most important underlying mechanisms (the other being activation) in the formation of false memories (Bredart, 2000; Gerrie & Garry, 2007; Norman & Schacter, 1997; Read, 1996; Roediger & McDermott, 1995; Roediger et al., 2001; Schacter, Koutstaal, & Norman, 1997), it is expected that source monitoring errors cause older adults to incorrectly judge critical lures as presented items, more often than younger adults.

Activation and source monitoring are combined in the most widely endorsed explanation for false memories: the activation-monitoring framework (Dehon & Brédart, 2004; Roediger & McDermott, 1995; Roediger et al., 2001; Skinner & Fernandes, 2009). Put simply, DRM lists (or other priming tasks) activate one's semantic or lexical system so that related non-presented concepts, such as lures are consciously or unconsciously evoked

(Roediger et al., 2001). At retrieval individuals are faced with using the considerable amount of available information, to decide where a memory initially came from (M. Johnson et al., 1993; Roediger et al., 2001). Age effects can be explained by the activation-monitoring framework because spreading activation is believed to be somewhat automatic and is spared as we age (Dehon & Brédart, 2004; Light & Singh, 1987). As noted earlier older adults may, however, have an inhibition deficit making them unable to eliminate or control irrelevant information in their working memory (Hasher & Zacks, 1988). In addition, source monitoring requires controlled processes, and these processes are often impaired with age (Jacoby et al., 1996; Shiffrin & Schneider, 1977; Skinner & Fernandes, 2009). Both of these factors result in higher rates of false memories in older adults than younger adults.

Moderating Factors in DRM False Memories

Based on the underlying mechanisms of false memories and how each can be used to explain results concerning age effects, it is clear that we should expect to find increases in false memories with age. In addition to an age effect, other moderating factors have been examined in DRM false memories, such as working memory, imagery, depression, and dissociation. The following reviews these moderating factors and how they can vary with age.

Working Memory. Watson, Bunting, Poole, and Conway (2005) measured working memory capacity using the operation span task. Their results revealed that when participants were warned about false memory creation prior to study, those with larger working memory spans recalled fewer critical lures than those with poor working memories. However, no differences were found when participants were not warned. The findings suggest that working memory capacity is important for applying cognitive control over false

memories (e.g., identify but not recall critical lures), and those with a higher working memory capacity were better able to critically evaluate a word's source (whether the familiar word occurred in the list or not) when warned (Watson et al., 2005). In addition, Peters, Jelicic, Verbeek, and Merckelbach (2007) measured participants' backward digit spans and reported that low digit span scores were related to elevated false recognition. This result was found in both conditions of warned *and un-warned* participants. Finally, Alberts (2007) found individuals with poor performance on the Stroop task were more prone to false memories, suggesting that inhibitory ability is important, and Lövdén (2003) reported significant correlations with false recall and memory tests believed to reflect processing speed, inhibition, recognition, and true recall, which are probably related to processes involved in monitoring false memories.

Working memory ability and processing speed have been found to be two mechanism that help explain age-related declines in cognitive functioning (another mechanism includes sensory function) (Park, 2000). A study by Park et al. (1996) used a life span sample of 301 adults (aged 20-90 years) and multiple indexes of working memory (backward digit span task, a computational span task, and a reading span task) and processing speed (digit symbol-coding, pattern comparison, letter comparison) . Their results demonstrated a systematic decline in working memory performance and processing speed across the life span.

Furthermore, meta-analyses by R. Johnson (2003) examined 16 studies that investigated working memory spans, ageing, and learning and memory of texts. Results showed a statistically significant age deficit in working memory. Meta-analyses by Bopp and Verhaeghen (2005) compared 123 studies on ageing and working memory span. Results found age differences in all of the verbal working memory span tasks examined and a

significant negative relationship between age and working memory span. Other research has found age-related differences in a variety of measures of working memory (Dobbs & Rule, 1989; Gick, Craik, & Morris, 1988; Salthouse & Babcock, 1991; Salthouse, Kausler, & Saults, 1988), and processing speed (Kail & Salthouse, 1994; Salthouse, 1992; Salthouse & Babcock, 1991; Salthouse et al., 1988). Inhibition, focusing on target information and ignoring irrelevant information, is also believed to decrease with age (Hasher, Stoltzfus, Zacks, & Rypma, 1991; Hasher & Zacks, 1988), as was discussed above. From this and previous discussions it seems clear age-related differences in working memory, processing speed, and inhibition are important processes behind false memories.

Imagery. Winograd et al. (1998) investigated individual differences in mental imagery using the Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973). A significant positive correlation was found between false recognition and VVIQ scores, which indicated those with more vivid mental imagery remembered critical lures more often. In addition, Wilkinson and Hyman (1998) used the Individual Differences Questionnaire (IDQ; Paivio & Harshman, 1983) imagery score. Similar to Winograd et al. they found a significant correlation between remembering critical lures in a recognition test and full IDQ imagery scores. However, Winograd et al. noted that VVIQ scores were related to a social desirability measure, suggesting that demand characteristics could have influenced the relationship between VVIQ and false memories. With regard to age, research has found no difference between younger and older adults on self-report measures of image vividness (Kliegl, Smith, & Baltes, 1990; Pierce & Storandt, 1987). However, tasks that involve construction and manipulation of mental images (e.g., mental rotation) often show age-related deficits in speed and accuracy (Dror & Kosslyn, 1994; Kemps & Newson, 2005; Kliegl et al., 1990). Pierce and Storandt (1987) state that the discrepancy between self-report measures and

objective tasks indicates that self-report measures may not provide an accurate representation of how individuals, especially older individuals, experience images.

Depression. Positive correlations between DRM false memories and depression have been found in numerous studies. Zoellner, Foa, Brigidi, and Przeworski (2000) reported a correlation of .68 between false recall of non-critical lures[9] and scores on the Beck Depression Inventory (BDI; Beck & Steer, 1987, cited in Zoellner et al., 2000). Also, Clancy et al. (2002) used the BDI and found positive correlations between depression and false recall and recognition of critical lures. Furthermore, Peiffer and Trull (2000) found false recall was related to higher levels of negative affect, and a study by Moritz, Gläscher, and Brassen (2005) showed that clinically depressed individuals were more likely than a control group to falsely recognise emotionally-charged critical lures. Although these studies demonstrate that people with depression are more prone to memory mistakes, caution must be taken interpreting the results (Gallo, 2006). All of the studies used special populations, including individuals with abusive histories (Zoellner et al., 2000), beliefs they had been abducted by aliens (Clancy et al., 2002), and only female participants (Peiffer & Trull, 2000). Importantly, other studies have failed to find a relationship between depression and false memories (Bremner, Shobe, & Kihlstrom, 2000; Clancy, Schacter, McNally, & Pitman, 2000). Interestingly, a study by Storbeck and Clore (2005) found that negative mood encouraged item-specific processing (items are encoded based on their distinctive qualities and characteristics), which made false recall significantly *less* likely to occur with participants in a

[9] Non-critical lures are test items that were not presented at study, and were not semantically associated to the DRM word list(s) that were presented.

negative mood compared to individuals in a positive mood[10], or control participants (mood was not manipulated).

Ageing has long been believed to be associated with a higher risk and rate of depression and depressive symptoms, mainly due to older individuals being exposed to stressful and negative events, such as illness, bereavement, disability, and low income (Stuart-Hamilton, 2000). Studies using large samples (2,000 or more participants) have found depressive symptoms are associated with increased age (Blazer & Burchett, 1991; Mirowsky & Ross, 1992; Stordal, Mykletun, & Dahl, 2003). However, this pattern is lessened (Stordal et al., 2003) or reversed (Blazer & Burchett, 1991) when confounding variables such as illness, disability, low income, and cognitive impairment are controlled. Based on the above information, it is difficult to say how age, depression, and false memories would be related to one another. On the other hand, research on dissociation and ageing, has provided evidence for a negative relationship.

Dissociation. Tendencies towards dissociative experiences are possibly the most researched personality characteristic examined in false memory literature (Gallo, 2006). Dissociation is measured using the Dissociative Experiences Scale (DES; Bernstein & Putnam, 1986), which estimates the frequency of various dissociative experiences. Winograd et al. (1998) showed that DES scores had significant positive correlations with recall and recognition of non-critical lures and false recognition (but not recall) of critical lures. In

[10] Mood was manipulated by playing music that has been shown to effectively produce positive and negative affect in those listening to it (Storbeck & Clore, 2005).

addition, Wilkinson and Hyman (1998) reported some DES subscale scores[11], but not overall DES scores, correlated with false recall. A number of other studies have found no significant relationship between DES scores and false memories (Bremner et al., 2000; Platt, Lacey, Iobst, & Finkelman, 1999; Wright, Startup, & Mathews, 2005). However, a few studies have found significant positive correlations between DES scores and false memories when the participant sample included individuals with more extreme DES scores, such as participants with a history of trauma or abuse (Clancy et al., 2002; Clancy et al., 2000; Zoellner et al., 2000), as opposed to scores from a general undergraduate student sample (Platt et al., 1999; Wilkinson & Hyman, 1998; Winograd et al., 1998; Wright et al., 2005), which strengthen conclusions that dissociative predispositions are associated to false memories, when there is adequate variability in a populations DES scores (Gallo, 2006). Importantly, a meta-analysis found age to have a negative relationship with DES scores (Van Ijzendoorn & Schuengel, 1996) and Ross, Joshi, and Currie (1991) found that DES scores based on a sample from the general population decreased from the teenage years until approximately 40 years old, where scores then levelled-off. Walker, Gregory, and Oakley (1996) compared outpatient samples of 35-55 year olds and 60+ year olds and showed that the older participants had significantly lower DES scores than the younger group. The final moderating factors to be examined are based on research investigating false memories and participants' belief in memories for alien abductions or encounters.

Alien abductions or encounters. Clancy et al. (2002) investigated whether individuals who reported they had been abducted by aliens were more susceptible to DRM false

[11] Total lures (non-critical and critical) recalled positively correlated with the DES subscale named memory failures, and recall of non-critical lures was positively related to the DES subscale of depersonalisation.

memories. They found that people who reported recovered or repressed alien abduction memories exhibited greater false recall and recognition. This group also had higher scores than controls in an absorption measure[12], depressive symptoms (BDI), and two measures of schizotypy (a perceptual aberration scale[13] and the Magical Ideation Scale[14]). Furthermore, the BDI, Magical Ideation Scale, and the absorption measure were all significant predictors of false memories, which indicate that the alien abduction factor may have been irrelevant. French, Santomauro, Hamilton, Fox, and Thalbourne (2008) also conducted research using a sample who believed to have had contact with aliens. They found no difference between those who reported contact with aliens and a control group, but in line with Clancy et al. they found that absorption was positively correlated with false recognition.

Unfortunately, interpreting the results found in the alien abduction/encounter research is difficult as they have not been replicated across studies and often the measures correlate with only one facet of the DRM task (Gallo, 2006). Therefore, it is not clear which factors are primarily responsible for increased susceptibility to false recall and recognition. It is also not clear how these factors vary with age, but it is possible that age is an important moderating variable, because research has reported a negative relationship with age and schizotypal self-report questionnaire scores (Mata, Mataix-Cols, & Peralta, 2005; Verdoux &

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[12] Tellegen and Atkinson (1974) define absorption "as a predisposition for having episodes of 'total' attention that fully engage one's representational (i.e., perceptual, enactive, imaginative, and ideational) resources" (p. 268).

[13] The scale used here was Chapman, Chapman, and Raulin's (1978) Body-Image Aberration Scale. This is a measurement of a person's accuracy in their perception of their body.

[14] Magical Ideation "is defined as belief in forms of causation that by conventional standards are invalid." (Eckblad & Chapman, 1983, p. 215)

Van Os, 2002). Also, because absorption is considered to be a factor in DES scores and DES scores decrease with age (Van Ijzendoorn & Schuengel, 1996), it is possible that absorption scores decrease with age. However, finding evidence to support this proves difficult. Furthermore, an age-related effect on belief in memories of alien abductions or encounters is difficult to gauge. Reliable sources generally investigate how belief in alien abduction/encounters are associated with psychological and personality traits, and do not focus on age (e.g., McNally & Clancy, 2005; Spanos, Cross, Dickson, & DuBreuil, 1993). In addition, the abduction/encounter may be believed to have happened years before the research is conducted, and when an individual started to believe in their encounter/abduction may be different from when they believed it occurred (e.g., an individual may believe they were abducted as a young child, however, their belief in the abduction started during adulthood), and neither the age when the abduction/encounter was believed to have occurred or the age they began to believe in their abduction/encounter is reported (e.g., Clancy et al., 2002; Clancy et al., 2000; French et al., 2008). This section completes the discussion on the DRM paradigm (possibly the best known procedure to elicit false memories). DRM false memories are robust and easily elicited through recall and/or recognition tests, their proposed underlying mechanisms are supported by prior research and have strong theoretical backgrounds. However, as described earlier another approach used to create false memories is the illusory truth effect – discussion now turns to the underlying mechanisms believed to be involved with the false memories produced by the illusory truth effect and how they may be used to explain age-related differences in it.

Underlying Mechanisms of the Illusory Truth Effect

Frequency of occurrence. The Frequency in which a statement was presented to participants was one of the earlier explanations (possibly the earliest) for the illusory truth effect and is not used to explain the effect in current research. In their original research on the illusory truth effect Hasher et al. (1977) suggested that the simple repetition of statements increased their perceived credibility. The participants in their experiment discriminated between true and false statements (they assigned higher truth ratings to true statements compared to false ones). They also gave higher truth ratings for both true and false repeated statements. Hasher et al. claimed that because participants had no feedback regarding the truth status of each statement, frequency of exposure was used by participants as a cue to judge the truthfulness of the statements. They argued that people are extremely sensitive to frequency with the ability to accurately judge the frequency of events and test items. In other words Hasher et al. assumed that participants were able to correctly judge the frequency with which an item had occurred, which was important for its truth rating.

Frequency can be used to explain age effects in the illusory truth effect because research has found that frequency-of-occurrence information is encoded automatically (Hasher & Zacks, 1979) and the automatic encoding is spared with age (Kausler, Lichty, & Hakami, 1984). However, older adults are less accurate in *judgements* of the frequency of occurrence than younger adults, and this age-related deficit in accuracy of frequency judgements is believed to be due to a deficit in the retrieval of frequency-of-occurrence information (Kausler et al., 1984; Kausler, Wright, & Hakami, 1981). These findings suggest that in the illusory truth effect task older adults make more frequency judgement errors, considering new statements to be old and vice versa, which would likely impact on truth

ratings. This idea (incorrectly judging old as new and new as old) is also directly related to recognition memory discussed below.

Recognition. Unconvinced by the frequency explanation, Bacon (1979), conducted research attempting to differentiate the alternative explanations for the illusory truth effect. Participants were asked to judge the truth of a set of statements (half true and half false). Three weeks later participants were presented with a second set of statements and were asked to judge the truth of each, and classify each statement as old or new (a recognition memory test). Bacon concluded that it was not the repetition status of the statement that mattered for truth ratings; it was participants' judgement of the statement as being old or new that was the important factor. That is, items judged as old were rated more true than items judged to be new, *even when those judged old were in fact new and had not previously been presented.* In addition, old items incorrectly judged to be new were less likely to be judged true (Bacon, 1979). Similar results have been replicated by other researchers (see Arkes et al., 1989; Begg & Armour, 1991; Hawkins & Hoch, 1992; Roggeveen & Johar, 2002).

The recognition framework might be able to explain age effects because evidence suggests that older adults are more likely than younger adults to incorrectly judge new items as old (Law, 1998). J. Bartlett et al. (1991) presented participants with faces, one half were presented once, the other half twice. Participants were asked to decide which faces were repeated. Results demonstrated that older adults incorrectly judged non-repeated faces as repeated more than younger adults. In an experiment using actions as stimuli, Cohen and Faulkner (1989), asked participants to imagine, watch, or perform different actions. Later, new actions and previously imagined, watched, or performed actions were presented. Results showed that older adults were significantly more likely to classify new actions as old. In addition, Jennings and Jacoby (1993) used a fame judgement task and found old adults

made more errors, judging new non-famous names to be famous when only old names were really famous. Similar results have also been found by Hashtroudi et al. (1989) and Smith (1977). These results suggest that older individuals use a more liberal criterion (such as familiarity, discussed below) for deciding whether something is old compared to younger adults. In terms of the illusory truth effect, this can explain why older people judge new items to be truer than young people do – they are more likely to judge new items as old and old items are more likely to be considered true.

Familiarity. Before discussing familiarity as an underlying mechanism of the illusory truth effect it is important to discuss current concepts in theories of recognition memory, as one of the components of the 'dual process' models of recognition memory is familiarity. Therefore, current concepts in recognition memory are discussed next, followed by an examination of the claim that familiarity is a key underlying mechanism of the illusory truth effect.

Current concepts in recognition memory. 'Dual process' models of recognition memory with two different components have been conceptualised in memory research. The first component, familiarity, is considered somewhat effortless (Gardiner, 1988; Jacoby & Dallas, 1981; Jacoby & Whitehouse, 1989), participants feel they have experienced the item earlier due to its seemingly fluent processing (Jacoby & Dallas, 1981). By contrast, the other component, often called recollection, involves more effortful searching for context information regarding the conditions surrounding a memory (e.g., its source or origin, and social context) (Gardiner, 1988; Tulving, 1985). In the latter case participants judge items as a reoccurrence because they recollect the specific context information of the item's initial appearance (Jacoby & Dallas, 1981).

Mandler (1980) posits a similar view, in which, one component involves internal activation of mental representations giving rise to content familiarity. The second component is *elaboration*; it involves encoding the inter-event and inter-item relations between mental representations, such as the functional significance of an event, its name, context(s) in which it has been encountered, and relation to other concepts. Elaboration is also related to recollecting details of prior occurrence. If precise retrieval of features and attributes of events or items can be recollected then complete identification of an event or item can occur, because not only is it familiar, but questions such as, why and how it is familiar are answered. During recognition an individual makes a familiarity judgement and uses retrieval processes to decide if the item was really present (Mandler, 1980).

Three different approaches have been used to assess recollection and familiarity's contributions to memory performance across age. Jacoby's (1991) process dissociation procedure (PDP) is used to separate the controlled (recollection) and automatic (familiarity) facets of recognition responses. Jennings and Jacoby (1993, 1997) showed that recollection estimates declined with age, yet familiarity estimates remained the same when participants were tested using the false fame paradigm (Jennings & Jacoby, 1993) and repeated lists of words (Jennings & Jacoby, 1997). Parallel results using word-stem (Zelazo, Craik, & Booth, 2004) and word-pair (Jacoby, Debner, & Hay, 2001) completion tasks have also been found.

A second approach involves the use of remember/know judgements (Tulving, 1985). After deciding a test item is old, participants judge if they can 'remember' the item (recollect contextual aspects of the study phase), or cannot remember it but 'know' the item was present (they cannot retrieve contextual details, but the item is adequately familiar for an old response) (Tulving, 1985). Often these judgements have been assumed to reflect the underlying processes of recollection (remember judgement) and familiarity (know

judgement) (Light, 2004). Light, Prull, La Voie, and Healy (2000) examined nine articles[15] comparing young and older adults using this procedure. Across the nine studies they found that young adults showed more correct recall/recognition (hits) and fewer false memories than older adults. Young adults also produced more hits and fewer false memories than older adults when examining items with remember judgements. However, when looking at know judgements older adults demonstrated a greater number of both hits and false alarms, thus indicating that with ageing correct remember judgements decrease and incorrect remember judgements increase, but correct and incorrect know responses increase (Light et al., 2000).

A third method uses confidence ratings from the test phase for old presented items and new non-presented items to fit estimates of familiarity and recollection into receiver operating characteristic (ROC) curves, which show the relation between correct old/new judgements (hits) and incorrect old/new judgements (false alarms) (Yonelinas, 1997). Using this type of analysis a number of researchers have found significant age-related deficits in recollection (Healy, Light, & Chung, 2005; Howard et al., 2006; Light, 2004; Light et al., 2000)[16], and some evidence for age-related deficits in familiarity (Light, 2004; Light et al., 2000). It seems that analyses of age differences in familiarity estimates are sensitive to the method in which they are estimated. Specifically, Jacoby's (1991) PDP approach suggests there are no age differences in familiarity estimates, while the remember/know paradigm

[15] Fell (1992), Jacoby, Jennings, and Hay (1996), Java (1996), Mark and Rugg (1998), Norman and Schacter (1997), Parkin and Walter (1992), Perfect and Dasgupta (1997), Perfect, Williams, and Anderton-Brown (1995), Schacter, Koutstaal, Johnson, Gross, and Angell (1997).

[16] Light et al. (2000) created ROC curves using data from Harkins, Chapman, and Eisdorfe (1979).

shows age-related deficits, and ROC curve analyses provide mixed results. These findings are also important in relation to source memory, because remembering the source of an item or information is part of recollection (Gardiner, 1988; Schacter et al., 1994; Tulving, 1985).

***Familiarity as an underlying mechanism*.** As discussed above 'dual process' theories of recognition hold that familiarity is one aspect of recognition, however, familiarity functions on a more general plane than recollection as repetition increases the familiarity of a statements semantic content; participants may not recollect a full statement or retrieve the context of its occurrence, but have a sense that the item was previously encountered (Hawkins & Hoch, 1992). The familiarity of a statements' semantic content is increased because it has been repeated, the familiarity then works as a cue to the statements' truth value, which is independent of participants' ability to recognise that the statement has been repeated (Roggeveen & Johar, 2002).

Arkes et al. (1991) were amongst the first to examine familiarity. They used structural equation modelling and found that familiarity had a direct relationship with statement credibility. Unfortunately, due to the method they used they could not distinguish the familiarity influence from other indirect influences (Roggeveen & Johar, 2002). Hawkins and Hoch (1992) were the first to present explicit evidence for the mediating role of familiarity. Hawkins and Hoch provided a path analytic model of causal relationships between perceived familiarity, repetition, and truth ratings, which verified familiarity as a crucial mediator of the illusory truth effect. Furthermore, although repetition was related to higher truth ratings, when familiarity was included in the analysis, the contribution of repetition was eliminated, illustrating that familiarity (even when inaccurate) is crucial for higher truth ratings (Hawkins & Hoch, 1992). In addition, this pattern of results was reproduced in conditions where participants were instructed to deeply elaborate items (evaluating each statement's truth at

the first presentation) as well as when participants were under instructions that involved less elaboration (rating their comprehension of each statement) (Hawkins & Hoch, 1992) (see also Boehm, 1994).

More recently familiarity has been explained using the concept of processing fluency (the ease or speed with which information is processed) (Parks & Toth, 2006). The experience of fluent processing (defined as processing an item or information more quickly or easily than a comparison standard or norm (Whittlesea & Leboe, 2003)) gives rise to the feeling of familiarity, and thus is used as a cue in truth ratings (Unkelbach, 2007). An item that is processed fluently may be correctly or incorrectly attributed to past experiences, therefore, seeming familiar (Whittlesea & Williams, 2000). Repeated statements are rated as being more truthful because when presented to individuals they are processed more fluently than new statements (Unkelbach, 2007). Reber and Schwarz (1999) directly tested processing fluency by manipulating the contrast of the colour of presented statements, with the assumption that high colour contrast can be processed more easily; statements with high colour contrast were judged more true more often than low colour contrast statements. Further support comes from comparing research that uses only old (within-items criterion), or, old and new (between-items criterion) statements in the second presentation (Dechêne et al., 2010). When the within-items criterion is used, the illusory truth effect is measured through the increase in truth ratings from the first to the second set of statements. Whereas the between-items criterion is the difference in truth ratings between new and repeated statements (Dechêne et al., 2010). Dechêne et al. (2010) argue that using new statements provides a comparison standard because old statements are processed more fluently than new statements. When only old statements are presented a comparison based on processing fluency is less likely to be used as it is not as easily available

(Whittlesea & Leboe, 2003). A meta-analysis by Dechêne et al. (2010) supports this explanation as they found the between-item effect was larger than the within-items effect.

Familiarity can be employed to explain age effects in the illusory truth effect because as indicated earlier older adults may be more likely than younger adults to use a more liberal criterion, such as familiarity, for deciding if an item is old or new, and, because perceived familiarity plays a mediating role on truth ratings (Boehm, 1994; Hawkins & Hoch, 1992), we could expect older adults' reliance on familiarity over recollection (as discussed with 'dual process' models of recognition above) (Jacoby et al., 1996; Jennings & Jacoby, 1993; Light et al., 2000) to increase truth ratings. In addition, familiarity remains stable with age, and this is thought to relate to poorer performance on the illusory truth effect tasks. However, familiarity is not the only process thought to underpin performance. The majority of scholars state that both familiarity and source errors play a role in the illusory truth effect (Arkes et al., 1991; Begg et al., 1992; Begg & Armour, 1991; Boehm, 1994; Dechêne et al., 2010; Hawkins & Hoch, 1992; Law, 1998; Law et al., 1998). The importance of source memory for performance in the illusory truth effect task is discussed next.

Source memory. In the illusory truth effect, source memory has mainly been investigated in two ways; by examining whether items were thought to be learnt during or outside the experimental setting (Arkes et al., 1989, 1991; Boehm, 1994; Hawkins & Hoch, 1992; Law, 1998; Schwartz, 1982), or through differential credibility, such as statements being targeted as true or false, using different sources, in the initial presentation (Begg et al., 1992; Law, 1998). The source of a fact is believed to be an important predictor of credibility ratings (Law, 1998). An early study on source memory's influence on belief was conducted by Sitton and Griffon (1980). Participants read a case study and answered true/false questions about the case. Participants in the experimental condition received questions

containing misinformation about the case, such as saying John was an only child, when the case study stated he was not an only child. Retest seven days later showed those in the experimental condition were more likely to mistakenly identify memories from the true/false test as memories from the case study (Sitton & Griffin, 1980).

More recent research investigating participants attributing statements to either sources within or outside of the experimental condition have also found source attributions are influential. Arkes et al. (1991) and Boehm (1994) found that if statements are attributed to previous exposure outside the experiment (which is incorrect as the stimuli were fabricated) participants will believe them to be more likely true than those they believe have been seen in the experiment. Law (1998) assumes participants feel the extra-experimental sources are more trustworthy than experimental setting sources. Furthermore Begg et al. (1992) explicitly manipulated source credibility by pairing statements with female or male names and told participants to believe one or the other. Generally, their experiments illustrated that when participants recalled the source of a statement as an unreliable source then truth ratings decreased, including when participants attributed the wrong source (whether female or male) to a statement. Unfortunately, from Begg et al.'s results it is difficult to find conclusive evidence for the relationship between source memory and truth ratings as one of their experiments revealed independence of source memory accuracy and credibility ratings, while two showed accurate source memory significantly influenced truth ratings (Law, 1998).

It has been established that source memory influences credibility ratings of items, but how it does this is less clear (Law, 1998). The source dissociation hypothesis is one explanation. This hypothesis posits that if participants are exposed to a statement that they think they have come across outside the experiment, they conclude that the statement

comes from two separate sources (Arkes et al., 1991). The hypothesis also suggests a decline in source memory accuracy is likely with larger intervals between statement presentations, resulting in increased credibility ratings (Arkes et al., 1991). As discussed earlier items categorised as being seen outside the study are rated truer. However, an increase in source errors with increased intervals between sessions has not been found (Arkes et al., 1991; Boehm, 1994). Because of these results the adequacy of a source dissociation explanation is questionable (Law, 1998).

Law (1998) proposed a multi-cause explanation of source memory that argued that source attributions, source misattributions (Arkes et al., 1991), and source forgetting, significantly influence statement credibility judgements. Law replicated Begg et al.'s (1992) findings in which source recollection influenced truth ratings, as well as showing that perceived source credibility at both encoding and retrieval influenced truth ratings. Law's results also found that perceived source credibility at retrieval had a greater effect than perceived source credibility at encoding. Law explains these finding by incorporating the encoding tag hypothesis and the retrieval evaluation hypothesis. The former states that a source presented during encoding will impact truth ratings despite which source is attributed to a statement at retrieval (or test), the latter states that source retrieval influences truth ratings. Law believes that during encoding validity is tagged to a statement which is later modified by the source that is retrieved.

A source memory framework can explain age effects in the illusory truth effect due to age-related deficits in source memory. It is clear from discussions above that older adults have less accurate source memory than younger adults in a number of tasks (e.g., Cohen & Faulkner, 1989; Ferguson et al., 1992; Hashtroudi et al., 1989; McIntyre & Craik, 1987), including the illusory truth effect (Law, 1998; Rahhal et al., 2002). Age-related source

memory deficits indicate that in the illusory truth effect task older adults will be more likely to incorrectly remember the source linked to a statement that verifies its truthfulness or falsity, and attributing the incorrect source to a statement will inflate or deflate its truth rating. This is illustrated in Law's (1998) research – although she found no main effect of age on truth ratings, she did find that older adults made more source errors which contributed to higher or lower truth ratings depending on which source was remembered at retrieval. Source memory deteriorates with age and this deterioration is thought to underpin poorer performance on illusory truth effect tasks by older people. However, source memory is not the only mechanism that is thought to underpin performance in the illusory truth effect. Researchers have also examined the relationship between people's need for cognition (e.g., an individual's predisposition to engage in and take pleasure in thinking) and illusory truth effect performance – it is to the examination of this research that follows.

Moderating Factors in the Illusory Truth Effect

Research investigating moderating factors in performance on the illusory truth effect is lacking (Dechêne et al., 2010). Two studies (Arkes et al., 1991; Boehm, 1994) used Cacioppo and Petty's (1982) Need for Cognition Scale, because past research found participants high in the need for cognition were more aware of argument quality, source information, and message content (Cacioppo, Petty, & Morris, 1983). However, both studies revealed that Need for Cognition scores were not related to susceptibility to the illusory truth effect (Arkes et al., 1991; Boehm, 1994). However, it is possible that if Need for Cognition and the illusory truth effect were investigated across a wider age range (Arkes et al. (1991) and Boehm (1994) used undergraduate students) a relationship would be found, because research has shown age-related decreases in cognitive abilities are significantly

related to decreases in Need for Cognition scores (Spotts, 1994). Given that the illusory truth effect is firmly established, it would be valuable for future research to focus on moderating factors (Dechêne et al., 2010). The next section combines information from the discussions above to focus on common underlying mechanism(s) responsible for performance on the DRM and illusory truth effect task.

Common Susceptibility and Age in DRM False Memories and The Illusory Truth Effect

Many of the hypothesised processes underlying false memories appear to be similar to the proposed underlying mechanisms of the illusory truth effect. The following section will describe the common processes hypothesised to underpin false memories and the illusory truth effect, along with research related to the influence ageing may have on these processes.

Fuzzy trace theory and recognition memory. Gist and verbatim traces, described in the fuzzy trace theory of false memories, are very similar to the concepts of familiarity and recollection which make up the 'dual process' model of recognition memory. As discussed earlier, fuzzy trace theory states that gist retrieval supports true and false memories based on an item's familiarity while verbatim traces, which only support true memories, require recollection of the experience surrounding an item or event (Brainerd & Reyna, 2002). These are important for understanding whether there exists a common susceptibility and an age-mediated or moderated common susceptibility because research discussed above has shown that older adults are more likely to rely on gist information (Kensinger & Schacter, 1999; Skinner & Fernandes, 2009; Tun et al., 1998) and familiarity (Dywan & Jacoby, 1990; Jennings & Jacoby, 1993; Law, 1998), and are less able to recollect and use item-specific information

to guard against false memory creation (Kensinger & Schacter, 1999; Norman & Schacter, 1997; Skinner & Fernandes, 2009).

Similarly, because research has found older adults are significantly more likely to judge a new item as old (J. Bartlett et al., 1991; Cohen & Faulkner, 1989; Jennings & Jacoby, 1993; Smith, 1977), this indicates that older adults tend to use a more liberal criterion than younger adults for decisions about whether an item is old. In addition, older individuals have been found to have deficits with recollection processes, but not with familiarity processes (Healy et al., 2005; Jennings & Jacoby, 1993, 1997; Light et al., 2000). Because familiarity is (a) believed to mediate truth ratings (Boehm, 1994; Hawkins & Hoch, 1992), and (b) is related to an increased likelihood of false memory creation (Brainerd & Reyna, 2002) we should expect older adults to be more susceptible to both false memories and the illusory truth effect. Older adults will be more likely to base judgements on the perceived familiarity of items and not on recollection, and therefore, believe critical lures were presented and judge familiar statements to be truer than non-familiar statements. In addition cognitive deficits likely play a role in false memories and the illusory truth effect, and as a number of cognitive abilities have been found to deteriorate with age, there is an expectation that this factor is important. It is to this issue that we turn to in the following section.

Age-related cognitive functioning. Even though inhibition has not been implicated as an underlying mechanism in the illusory truth effect, it is possible that Hasher and Zacks' (1988) inhibition hypothesis is relevant, because during the test phase of illusory truth effect tasks participants have to consider information from a number of different statements, such as recollection and familiarity of the statement and its content, the source of each statement, and if the source indicated a statement was true or false. Hasher and Zacks believe that the efficiency and effectiveness of one's ability to manage interference of

irrelevant information decreases with age. This claim is supported by research that has found that inhibitory mechanisms become less efficient as we age (Persad, Abeles, Zacks, & Denburg, 2002), and older participants are less likely to inhibit irrelevant information and more likely to retrieve it than younger participants (Borella, Carretti, & De Beni, 2008; Hamm & Hasher, 1992; Hartman & Hasher, 1991).

Inhibition is also believed to be an important factor in managing working memory, and working memory cognitive functioning (Hasher et al., 1991; Hasher & Zacks, 1988). As discussed above age-related declines in working memory are well established (Bopp & Verhaeghen, 2005; R. Johnson, 2003; Park, 2000), and working memory ability has been found to be important in 'protecting' against false memories in at least some circumstances (Peters et al., 2007; Watson et al., 2005). In addition, Alberts' research (2007), outlined earlier, suggests that people with poor inhibition capabilities may be prone to false memories. Also, Lövdén (2003) states that poor inhibition abilities increase false memories not directly, but through its effect on one's episodic memory performance.

Furthermore, it has been argued that age affects performance in illusory truth effect tasks because of age-related deficits in memory abilities. For example, source memory, recognition memory (Law et al., 1998; McIntyre & Craik, 1987), processing speed, working memory, and episodic memory (Lövdén, 2003). There is some evidence supporting this claim. For instance, older adults are less able to accept that a statement is really false if they initially believed the statement to be true (Mutter et al., 1995), and when participants are instructed to use mental imagery at encoding to compensate for age-related deficits in source memory and recognition memory, older adults perform at the same level as younger adults on recognition memory, source memory, and truth ratings (Law et al., 1998).

Source memory and monitoring. Research consistently finds age-related deficits in source memory performance, including when recall and recognition performance is equalised across age groups (Schacter et al., 1991; Schacter, Koutstaal, & Norman, 1997), and when many-to-one and one-to-one item-to-source mapping is used (Schacter et al., 1994). Older adults have also been shown to have source memory deficits when differentiating external and internal information (Cohen & Faulkner, 1989; Hashtroudi et al., 1989; Henkel et al., 1998) – which is very important in false memories – and when differentiating between external sources (Ferguson et al., 1992; McIntyre & Craik, 1987) which is important in the illusory truth effect.

Furthermore, evidence from false memory and illusory truth effect research has illustrated the importance of source memory for correctly recalling and recognising DRM list items and correctly judging statements' truth value. Using Tulving's (1985) remember/know procedure Norman and Schacter (1997) found older adults were significantly more likely to make remember judgements for critical lures, while younger adults were more likely to make know judgements. This suggests that older adults have more trouble monitoring and differentiating true memories from false memories (Norman & Schacter, 1997). However, a know judgement (more likely to be made by younger adults) potentially means participants are still not distinguishing real from false memories. In relation to the illusory truth effect, Law (1998) found older adults made more source memory errors on repeated and new statements, which increased truth ratings for those claims believed to have come from a true source, and decreased truth ratings on statements believed to be new or from a false source (even when the latter were old and true).

Thus, it is not surprising that researchers expect and often find age-related increases in false memories and the illusory truth effect. During retrieval in these tasks participants are

faced with taking into account all of the available information in one's memory, in an attempt to figure out where a memory initially came from (M. Johnson et al., 1993). Because source monitoring and source memory require controlled processes, which are believed to be impaired with age (Balota et al., 1999; Law et al., 1998; Skinner & Fernandes, 2009), there is likely to be a common, age-related, susceptibility to false memories and the illusory truth effect.

Summary

This chapter has shown that false memories and the illusory truth effect are well researched phenomena. Both have been shown to be elicited in a number of ways and using various stimuli. In addition, the proposed underlying mechanisms of false memories and the illusory truth effect have been rigorously examined, and are reasonably well established. All of the proposed mechanisms can be used to help explain possible age-related differences in performance of the tasks. Furthermore, because research and theory on source memory and recognition memory shows older adults have deficits in source memory and the processes which underpin recognition memory, it is unsurprising that various studies have examined the relationship between false memory production and age. However, much less research has examined the relationship between the illusory truth effect and age. Moreover, because researchers suggest that the mechanisms that underpin susceptibility to the two phenomena are the same, we should expect to find a high positive correlation between DRM false memories and the illusory truth effect performance. However, no published research has investigated this possibility. The current research thus aims to fill this gap by investigating the relationship between false memories, the illusory truth effect, and ageing.

The current research will investigate the possibility that there is a common susceptibility to false memories and the illusory truth effect, and that performance in the tasks will decrease with age. This will be done by examining performance across three age groups (16-39, 40-60, and 61+ years) on false memory and illusory truth effect tasks. The false memory task will be based on the DRM paradigm, using DRM semantic word lists and immediate recognition tests. The illusory truth effect task will be examined by asking participants to read one set of statements that are labelled as true or false, then making truth judgements about a second set of statements which contains some of the statements presented previously together with several new statements. The main hypotheses are that there will be a common susceptibility to DRM false memories and the illusory truth effect, and that older adults (61+ years) will be more susceptible to the two phenomena than the young (16-39), and middle age (40-60 years) groups, and that the middle age group will be more susceptible to the two phenomena than the young group.

CHAPTER THREE

Method

The aim of this research was to investigate the possibility that there is a common susceptibility to false memories and the illusory truth effect that increases with age. The current study followed a quantitative quasi-experimental, within-subjects design, using three different age groups: young (16-39 years), middle-aged (40-60), and older adults (61+). Individuals participated in a number of pen and paper tests, including, eight false memory recognition tests using DRM (Deese/Roediger-McDermott) word lists, and an illusory truth effect task containing two sets of 50 statements.

Participants

Overall there were 161 participants (89 females and 72 males); their ages ranged from 16 to 92 years (mean 49.72, SD 19.57). The young age group consisted of 55 participants (34 females and 21 males), their average age was 27.47 years (SD = 6.39, range: 16-39 years). The middle-aged group had 53 participants (29 female and 24 male), their mean age was 50.36 years (SD = 5.94, range: 40-60 years). The older adult group contained 53 participants (26 female and 27 male), the groups mean age was 72.17 (SD = 7.92, range: 61-92 years). All participants were asked to use their hearing and reading aids if they needed to. Participants were volunteers, recruited via community groups and by word of mouth, from Marlborough, and the Palmerston North and wider Manawatu region.

Measures

The false recognition task. For this measure the DRM paradigm was employed. Eight lists, each consisting of 15 words, were used. Six lists were taken from Roediger and McDermott's (1995) original 24 lists, and two (smell and city) were from Stadler et al. (1999) that had been taken from unpublished work by McDermott (1995). Based on findings by Roediger and McDermott, and Stadler et al.'s follow-up research, and with the aim to achieve a range of false memory scores, four lists found to reliably elicit the critical lure were chosen, alongside four lists moderately likely to elicit the critical lure. Both recall and recognition scores from Stadler et al.'s research were used to examine the likelihood that each list would create a false memory because in their design recognition tests followed, and were likely influenced by, prior recall tests. Table 3.1, below, displays the eight DRM critical lures and list items used, along with the rankings given to each from Stadler et al.'s research.

Each DRM list had its own separate 15-item recognition test. Each test consisted of 11 list items, one critical lure, and three non-critical lures[17] from DRM lists not used in the current research. Tests were constructed by randomly selecting, out of a hat, cards numbered 1-15. First the critical lure's position in the test was established by picking a number. Then using random number generation on a Casio fx-82W the three non-critical lures were chosen, using only numbers 1-448 as each corresponded to one DRM item (including lures) of 28 non-used DRM lists stated in Stadler et al.'s (1999) appendix. Then three numbers were drawn from the hat to assign their position in the test. Note no non-critical lures were used more than once in all of the eight tests. Lastly, all 15 numbers

[17] Non-critical lures are test items that were not presented at study, and were not semantically associated to the DRM word list(s) that were presented.

Table 3.1

DRM Critical Lures, List Items, and Their Rankings Based on Research by Stadler et al. (1999).

Lure	List Items	Rankings[a]	
		Recall	Recog.
Window	Door, glass, pane, shade, ledge, sill, house, open, curtain, frame, view, breeze, sash, screen, shutter	1	1
Sleep	Bed, rest, awake, tired, dream, wake, snooze, blanket, doze, slumber, snore, nap, peace, yawn, drowsy	2	7
Smell	Nose, breathe, sniff, aroma, hear, see, nostril, whiff, scent, reek, stench, fragrance, perfume, salts, rose	3	2
Rough	Smooth, bumpy, road, tough, sandpaper, jagged, ready, coarse, uneven, riders, rugged, sand, boards, ground, gravel	8	4
Mountain	Hill, valley, climb, summit, top, molehill, peak, plain, glacier, goat, bike, climber, range, steep, ski	16	16
Slow	Fast, lethargic, stop, listless, snail, cautious, delay, traffic, turtle, hesitant, speed, quick, sluggish, wait, molasses	17	17
River	Water, stream, lake, Mississippi, boat, tide, swim, flow, run, barge, creek, brook, fish, bridge, winding	18	20
city	Town, crowded, state, capital, streets, subway, country, New York, village, metropolis, big, Chicago, suburb, county, urban	13	22

Note. Recog. = Recognition.

[a] Rankings are based on results from 36 DRM lists ranked highest (#1) to lowest (#36) on their ability to elicit the critical lure (false memory).

were returned to the hat, this time each of the 15 numbers corresponded to one DRM list word (based on the order the items in each DRM list were written in Stadler et al.'s and Roediger and McDermott's (1995) research). From the hat 11 numbers were haphazardly drawn and this determined which DRM words went in the test and their order (see Appendix B for all eight recognition tests).

In an attempt to control for order effects a balanced Latin square was used to organise the order in which participants heard the lists and completed the tests in the DRM task. This was used to ensure each list appeared before and after each other list an equal number of times, and each list had the opportunity to be an early, middle, and late item, in the presentation order. Table 3.2 below illustrates the eight list presentation conditions created using the balanced Latin square algorithm. Participants were randomly assigned to one of the conditions, with all conditions being used, approximately, an equal number of times across the three different age groups.

Table 3.2

The Eight DRM List Presentation Conditions, Ordered Using the Balanced Latin Square Algorithm

Condition	DRM list presentation order
1	window, mountain, rough, sleep, river, city, smell, slow
2	mountain, rough, sleep, river, city, smell, slow, window
3	slow, window, mountain, rough, sleep, river, city, smell
4	rough, sleep, river, city, smell, slow, window, mountain
5	smell, slow, window, mountain, rough, sleep, river, city
6	sleep, river, city, smell, slow, window, mountain, rough
7	city, smell, slow, window, mountain, rough, sleep, river
8	river, city, smell, slow, window, mountain, rough, sleep

The illusory truth effect task. This task was adapted from Begg et al.'s (1992) research in which 196 statements, each with a true and false version (created by modifying a detail such as a name or number) were used. Begg et al. labelled statements as true or false by using female and male sources (e.g., *John Smith says toenails grow faster than fingernails*). To define true versus false sources, participants were told that statements said by a female were true, and those said by a male were false, or vice versa. In the current study two different sets of 50 statements were created for the two different tasks (a learning set and a test set). To make statements applicable to the New Zealand culture many of the American-oriented statements were eliminated, all imperial units were changed to their metric equivalents, and words not commonly used in New Zealand language were change to those that are (e.g., 'the down of ten cashmere goats' changed to 'the wool of ten

cashmere goats'. In addition, when deciding to use either the true or false version of statements an attempt was made to evenly distribute longer and shorter statements between true and false categories. This was to avoid cueing participants to the truth of statements in the second illusory truth task (e.g., all false statements being long and true being short).

To create the learning set of statements (the first set of statements) all of Beggs et al.'s (1992) statements (except those eliminated as stated above) were placed in a box and 50 were haphazardly picked out. This determined which statements would be used and their presentation order. They were then divided into short and long statements, and again haphazardly divided so there was the same number of long and short statements in true and false categories. Female and male names were chosen using Van Overschelde, Rawson, and Dunlosky's (2004) research on common female and male names. Names that could be considered appropriate for both genders (for example, Jamie, Alex, Pat) were excluded to avoid confusion and random number generation was used to pair names to statements.

The learning set of statements had two versions. One version (given to half the participants) had male names paired with true statements and female names with false statements. The second version (given to the other half of participants) was the same list of statements, in the same order, but female names were paired with true statements and male paired with false. This counterbalancing and confound check strategy was used in case there was a tendency for participants to view one gender as inherently more truthful than the other. In addition, next to each statement was a 6-point scale as the task required participants to indicate how interesting they thought each statement was (6 = very interesting, 1 = not interesting). See Appendix C for one version of the learning set of statements.

The test set of statements (the second set of statements) was developed to test participant's memory for the truthfulness of the first set of statements, and again is based on Begg et al.'s (1992) study. The test set of statements contained 17 previously presented true statements (old true), 17 previously presented false statements (old false), and 16 statements that were not presented in the first set of statements (new); they were also drawn from Begg et al.'s list, randomly chosen in a haphazard fashion by drawing them from a box. Again, approximately the same number of long and short statements were used in each statement category. The 50 statements were then numbered 1-50 and random number generation was used to determine the order they appeared in the test. The only specification for the order was that no more than three of the same type of statements (old true, old false, new) would appear one after the other. The test consisted of an instruction cover page, and six pages of statements. Next to each statement was a 6-point scale for participants to rate how true they thought each statement was (6 = certainly true, 1 = certainly false). See Appendix D for a copy of the test set of statements.

Apparatus

DRM word lists were read by a female and recorded onto a computer. Recording onto computer permitted precise timing of one word every 1.5 seconds. Each list was a separate mp3 audio file, and a bell sound indicated the end of each list. Lists were played at an appropriate volume depending on the size of each group, their physical spread, and hearing ability, through two Genius multimedia high-fidelity speakers connected to a Sansa mp3 player which was controlled during data collection by the researcher.

Procedure

Participants participated individually or in small groups of up to four. Because recruitment of participants was conducted in a variety of ways (stated earlier), a number of different sites were used to collect data. They included personal residences, community group meeting places, and participants' workplaces. In all cases it was ensured that the room was quiet, private, and free from distractions.

Firstly, participants were asked to read an information sheet detailing the nature of the study (Appendix E) and sign an informed consent form (Appendix F). Following this, participants began the first task, which was the learning set of statements of the illusory truth task (Appendix C). Participants were verbally informed they would be given a set of 50 statements. They were asked to read each of these statements and rate each on the six point scale, by circling the number, to indicate how interesting they thought each statement was (six was 'very interesting' and one was 'not interesting'). Depending on which version of the statements they were given they were told either that, statements said by a male are true, and those said by a female are false, or, statements said by a female are true, and those said by a male are false. In addition, participants were told the task had no time limit, and they could tear off the instructional cover page to keep in front of them to use as a reference while completing the task. They were also encouraged to ask questions if they needed further clarification. They were then given the learning set of statements, with the instructional cover page. This task took approximately 10-20 minutes for participants to complete.

Once participants completed reading and rating the learning set of statements the DRM task commenced. This task took approximately 10 minutes. For the DRM task, participants were told that they would hear eight lists of words, each made up of

approximately 15 words, played through speakers. They were told at the end of each list they would hear a bell sound, and after this sound the researcher would hand them a 15-word memory test (see Appendix B for the eight tests), on which they were to place a tick next to all the words they could remember from the previous list that was played. In addition, participants were told the test had no time limit, although it was not expected to take longer than two or three minutes. Participants were encouraged to ask any questions if they needed further clarification on the task. Once participants said they understood the task the first DRM list was played. After the bell sound each participant was given the recognition test to complete. Once the test was completed, turned upside down, and moved to the side, the next DRM recording was played, followed by a recognition test. This procedure continued until they had heard and completed recognition tests for all eight DRM lists.

After completion of the DRM tests, the third task involved the test set of the illusory truth effect statements (Appendix D). Participants were told they would be given another set of 50 statements, similar to those seen earlier. They were asked to read each of the statements, and rate each on the six point scale, by circling the number, to indicate how true or false they thought it was (six was 'certainly true' one was 'certainly false'). In addition, they were told that there were no 'tricks' involved – the researcher had not altered any details, such as names or dates, from the first set of statements to the second set to confuse them; the statement was either in the first set of statements or not. Participants were then told there was no time limit on the task, and they could tear off the instructional cover page to keep in front of them to use as a reference while completing the task. They were also encouraged to ask questions if they required further clarification on the process. When

participants were ready they were given the test set of statements with the instructional cover page. This task took approximately 10-20 minutes to complete.

The last task for participants was a simple questionnaire with two questions regarding age and identification as female or male (Appendix G). Participants were then asked if they knew what the purpose of the (DRM) word-list and recognition test was. This was to establish if participants had figured out that it was investigating if a critical lure was falsely remembered, which could alter their results. Only two people correctly guessed the purpose, and this was noted on their participant questionnaire with an asterisk. However, both felt it would have made no difference to their recognition results. The remainder of participants did not know what the task was investigating or thought that is was somehow related to the fact each list was made up of associated words.

Finally, because the research involved a low level of concealment, as participants were not specifically told that the study examines susceptibility to false memories and the illusory truth effect, participants were debriefed. Debriefing occurred immediately after data collection with each participant. The researcher first provided an explanation in lay terms of the types of memory 'mistakes' (the illusory truth effect and false memories in the DRM paradigm) that the project investigated and how they were investigated. Participants were also told this information was somewhat concealed because if they knew exactly what was being examined they may have been able use strategies to avoid making the mistakes. Participants were then encouraged to ask any questions they wished to have answered, or, voice any concerns, which were discussed. They were also reminded they could contact the researcher or supervisor at any time with further queries or concerns. Lastly, participants were asked not to tell other people about the information discussed during debriefing, or

the exact nature of the tasks, as these people may later be participants in the project and having them know this information could influence the results.

CHAPTER FOUR

Results

Introduction

As discussed in earlier sections, this research, and therefore the data analysis, focused on performance on the DRM (Deese/Roediger-McDermott) false memory and illusory truth effect tasks, across three age groups: 16-39 years, 40-60, and 61+. The data were analysed using the software programme Statistical Package for the Social Sciences (SPSS; version 17.0). This section has the following structure: a discussion of the decisions that were made after initial analyses regarding outliers in each age group across the dependent variables (data cleaning) and the demographic information of the age groups of those included in the data analysis, discussion of the normality and homogeneity assumptions, followed by analyses which examine whether or not there was a common susceptibility to false memories and the illusory truth effect in each age group, and analyses of correct and false recognition. Then the illusory truth effect results are analysed, looking at each statement type[18] separately with both between group differences and within group differences to establish the pattern of statement truth ratings in each age group. The final section is exploratory analyses of the data when the sample is divided into seven age groups, in order to examine whether the broad age ranges used in the study might have obscured effects.

[18] As mentioned earlier there are three statement types old true (OT), old false (OF), and new (N).

Initial Analyses

After examining outliers across the three age groups it was established that data from three participants would be excluded from any further analysis. One participant recognised a very high number of non-critical lures[19] (22 out of 33). Another participant rated all three types of illusory truth effect statements at or close to the maximum value of six. The third participant to be excluded rated all three types of illusory truth effect statements near the minimum value of one. In addition to conducting data analyses excluding the three outliers, all analyses were conducted using data which also excluded participants who in the illusory truth effect task had missed rating some of the statements. The missed ratings seemed to have occurred accidentally as generally only one or two out of 50 items were missed. Because average truth ratings of the three types of illusory truth statements were used in the analyses these participants could still be included. None of these participants were considered outliers. Examining the two sets of data used across the different statistical analyses showed no differences in results, therefore, the following results are based on the set which excludes the three outliers and includes those who missed statements. Demographics for the three age groups (N = 158) used in the following analyses are provided in table 4.1. Table 4.2 provides the means and standard deviations across the three groups on the different dependent variables.

[19] Non-critical lures are test items that were not presented at study, and were not semantically associated to the DRM word list(s) that were presented.

Table 4.1

Demographic Data for the Three Age Groups

Age Group	Age Range	M age (SD)	n Females	n Males	n Total
Young	16-39	27.47 (6.39)	34	21	55
Middle	40-60	50.50 (5.91)	28	24	52
Old	61-92	71.84 (7.84)	26	25	51

Table 4.2

Group Means and Standard Deviations of the Dependent Variables

	Dependent Variables					
Age Group	Total CL[a]	Total Recognition[b]	Total NCL[c]	Old True Rating[d]	Old False Rating[d]	New Rating[d]
Young	5.49 (2.40)	70.22 (10.69)	0.31 (.69)	4.45 (.84)	3.03 (1.05)	3.33 (.54)
Middle	5.50 (2.07)	71.33 (7.66)	0.15 (.42)	4.33 (.98)	3.38 (1.00)	3.27 (.57)
Old	6.18 (1.97)	73.25 (9.86)	0.43 (1.12)	3.90 (.79)	3.66 (.82)	3.71 (.63)

Note. CL = critical lures, NCL = non-critical lures. Old true, old false, and new ratings refer to the different statements in the illusory truth effect task.

[a]Out of a total of 8. [b]Out of a total of 88. [c]Out of a total of 24. [d]From a 6-point rating scale, minimum 1 and maximum 6.

As the following analyses, multivariate analysis of variance (MANOVA) and analysis of variance (ANOVA), assume normality and homogeneity (ANOVA), and multivariate normality (MANOVA) and homogeneity of covariance (MANOVA) to be met, the initial analyses also investigated whether or not these assumptions had been violated in any of the dependent

variables. Importantly, with reasonably sized samples normality and homogeneity tests may provide significant results even when score distributions differ only slightly from the normal and when group variances are not especially different (Field, 2009; Stevens, 2009). Therefore, with larger samples violations to assumptions are not as problematic as with small samples (Field, 2009; Pallant, 2007; Stevens, 2009). In addition, research reviewed by Stevens (2009) has found that deviations from multivariate and univariate normality have only a small effect on type 1 error, and skewness has a negligible effect on univariate power (which is likely to be the same for multivariate power), but platykurtosis can have a strong influence on power. However, platykurtosis is not a problem in this project as will be explained next.

Normality. Normality was assessed using a number of factors, including, the Kolmogorov-Smirnov normality test, skewness and kurtosis values and their respective z-scores, Q-Q plots, histograms, and Mahalanobis distances[20]. The Kolmogorov-Smirnov tests indicated that the total number of critical lures recognised deviated from a normal distribution in all three age groups, for the young group $D(55) = 0.19$, $p < .001$, middle-aged group $D(52) = 0.17$, $p < .001$, and for the old group $D(51) = 0.23$, $p < .001$. However, when examining skewness and kurtosis values across variables the critical lure values do not differ substantially from other skewness and kurtosis values which, based on Kolmogorov-Smirnov tests, were considered normal. In addition, using z-scores only, the old groups' critical lure z-score for skewness was significant, $z_{skewness} = -3.23$, a z-score greater than 2.58 (ignoring the

[20] Mahalanobis distances are used to investigate multivariate normality via inspection of multivariate outliers. All other factors investigate univariate normality, which is also important and necessary for multivariate normality.

negative sign) is significant at $p < .01$. This significance level can be adopted due to the reasonable sample size (30+) (see Field, 2009). Critical lure total histograms and Q-Q plots (figures H1 to H6 provided in appendix H) between the groups do not seem to differ substantially.

Additional variables that deviated from normality according to the normality test were old true statements from the middle and old age groups. However, skewness and kurtosis values did not differ greatly from old true statements of the young group and z-scores were not significant (histograms and Q-Q plots, figures I1 to I6, are presented in appendix I). Non-critical lure scores also had significant results for normality tests in all age groups. Their skewness and kurtosis values (approximately 3-4 and 8-15 respectively) were large compared to other variables, and z-scores were significant. Histograms and Q-Q plots also showed large deviations from the normal distribution (see appendix J, figures J1 to J6). Therefore non-critical lures were not used in any analyses. Lastly, there were no multivariate outliers based on examination of Mahalanobis distances.

Homogeneity. Equality of covariance matrices (MANOVA) is assessed by first examining univariate equality of variances using Levene's test. For all dependent variables Levene's test was non-significant therefore homogeneity of variance is assumed: critical lure total/proportion $F(2, 155) = 1.87$, *ns*; correct recognition total/proportion $F(2, 155) = .07$, *ns*; old true average $F(2, 155) = 1.94$, *ns*; old false average $F(2, 155) = 2.11$, *ns*; new average $F(2, 155) = 0.71$, *ns*. Since Levene's test statistics were non-significant, Box's test for homogeneity of covariance matrices can be assessed. Box's test was non-significant ($p = .065$), indicating that the assumption of homogeneity of covariance matrices was met.

Based on the above discussion Pillai-Bartlett's trace test statistic was chosen for the following analyses because when sample sizes are equal this statistic is the most robust in regards to assumption violations (Field, 2009).

Common Susceptibility to Memory Mistakes related to Age

Bray and Maxwell (1985) state that a MANOVA is appropriate when research "is interested in the *set* of measures as they represent some underlying construct(s)" (p. 11), as is the case in the current research. In addition, previous researchers have employed MANOVAs to analyse data from illusory truth effect tasks (Hawkins & Hoch, 1992; Law et al., 1998). Therefore, a one-way between-groups MANOVA was performed to investigate age differences in false memories and the illusory truth effect. The four dependent variables used were: critical lure total, old true statement average rating, old false statement average rating, and new statement average rating. The independent variable was age (young 16-39, middle 40-60, and old 61+). Preliminary assumptions (including those stated above) were investigated to check for normality, linearity, univariate and multivariate outliers, homogeneity of variance-covariance matrices, and multicollinearity. No serious violations were found.

Results of the MANOVA, using Pillai's trace, found a statistically significant difference between the three age groups on the combined dependent variable, $F(8, 306) = 4.48$, $p < .001$; $V = 0.21$; $\eta^2_{partial} = .11$. When the results for the dependent variables were considered separately (using a Bonferroni adjusted alpha level of .01) the difference between the critical lure totals did not reach statistical significance $F(2, 430) = 1.72$, $p = .18$, $\eta^2_{partial} = .02$. However, all three of the illusory truth effect statements showed statistically significant group differences: old true statements $F(2, 430) = 5.56$, $p = .005$, $\eta^2_{partial} = .07$; old false

statements $F(2, 430) = 5.68$, $p = .004$, $\eta^2_{partial} = .07$; new statements $F(2, 430) = 9.05$, $p < .001$, $\eta^2_{partial} = .11$. Based on these findings we can conclude there was not a common susceptibility to both phenomena in the three age groups.

Interestingly, old false truth ratings were significantly related to critical lure totals in the old age group $r_s = .30$, $p = .03$, but not in the young ($r_s = .02$, $p = .91$), or middle age group ($r_s = .12$, $p = .39$). (Spearman's rho was used because critical lure totals violated normality as they were negatively skewed). These relationships are depicted in figure 4.1 below and suggest that in the old age group there *was* a common susceptibility (as critical lure totals increased so did truth ratings of old false statements).

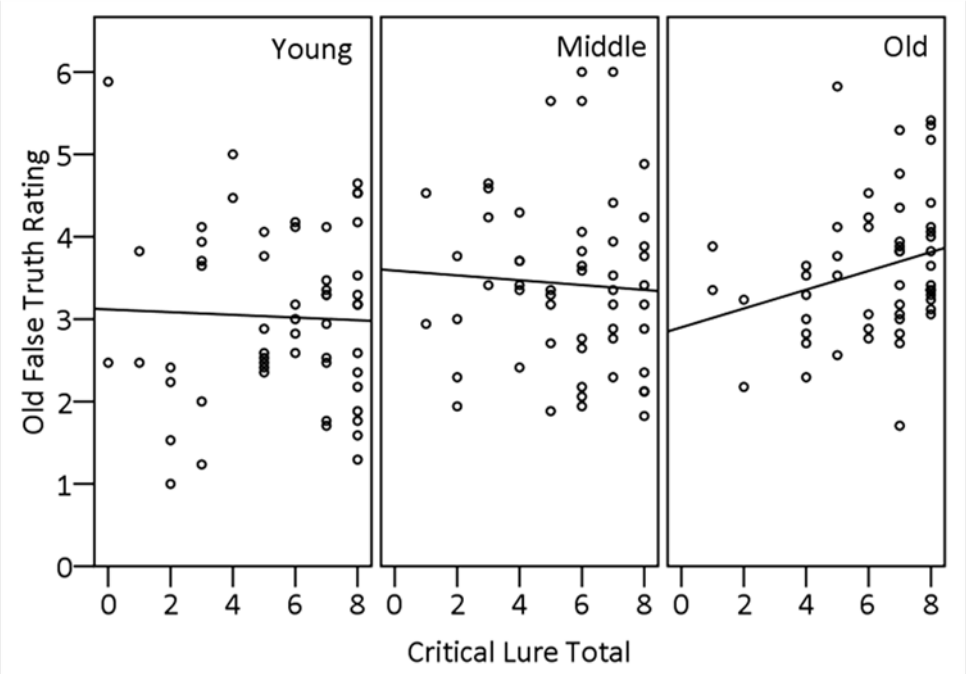

Figure 4.1. Scatter graph (with fit lines) of the correlation relationship between old false statement truth ratings and critical lure totals in each age group.

Correct and False Recognition in the DRM Task

On initial inspection the mean proportion of critical lures incorrectly recognised was similar to that for correct recognition for all of the age groups. This indicates that all participants found it difficult to distinguish between the two (in the young group correct recognition was .80 and critical lure recognition was .69, for the middle group correct recognition was .81 and critical lures was .69, and for the old group .83 and .77 respectively). In addition, in all three age groups the critical lure recognition significantly correlated with correct recognition – for the young group $r_s = .70$, $p < .001$, for the middle age group $r_s = .66$, $p < .001$, and for the old group $r_s = .73$, $p < .001$ (Spearman's *r* was used because critical lure total violated normality as they were negatively skewed).

To further investigate the relationship between correct and false recognition, a mixed between-within subjects ANOVA was conducted to assess the impact of the three age groups on correct and false recognition proportions. There was no significant interaction between age group and recognition type (correct and false), $F(2, 155) = 1.29$, $p = .28$, $V = 0.02$, $\eta^2_{partial} = .02$, indicating that the change in recognition scores for the two types of recognition were the same across the three age groups. There was a main effect for item type, $F(1, 155) = 34.19$, $p < .001$, $V = 0.18$, $\eta^2_{partial} = .18$, with all three age groups showing a higher proportion for correct recognition than false recognition (see figure 4.2 below). This provides evidence against the initial observation in which correct and false recognition appeared to be equal. The main effect comparing the two types of recognition was not significant, $F(2, 155) = 1.81$, $p = .17$, $= \eta^2_{partial} = .02$, suggesting no difference between age groups in correct or false recognition.

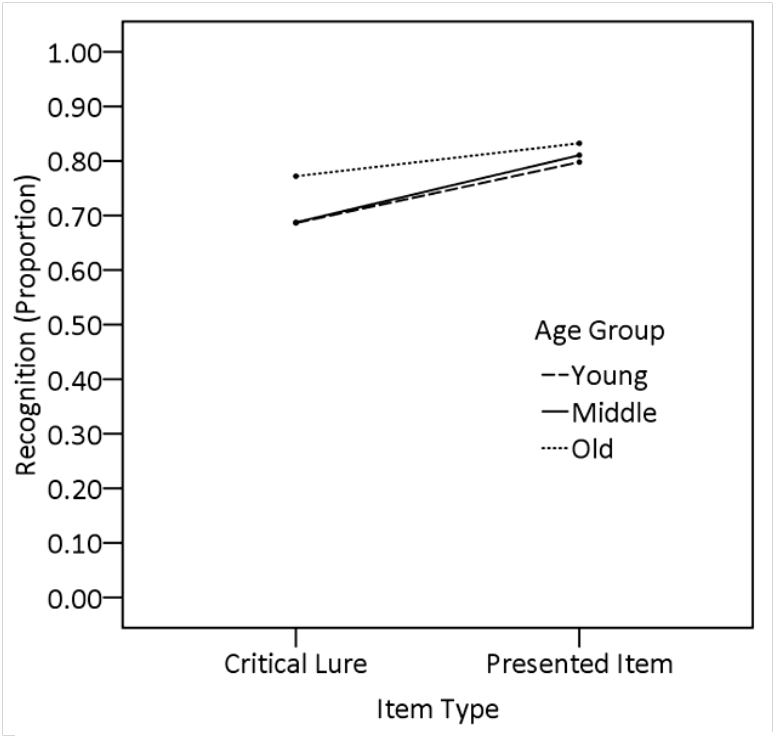

Figure 4.2. Proportion of critical lure recognition and presented item recognition in each age group.

To supplement the mixed between-within subjects ANOVA, a one-way repeated measures ANOVA was conducted to examine the differences between the proportions of false and correct item recognition in each age group (the split file command was utilised to examine the three age groups separately) and the results indicated that in each age group there was a significant effect for item type: young $F(1, 54) = 12.49$, $p = .001$, $\eta^2_{partial} = .19$; middle $F(1, 51) = 16.94$, $p < .001$, $\eta^2_{partial} = .25$; and for the old group $F(1, 50) = 5.86$, $p = .02$, $\eta^2_{partial} = .11$. These results show that each group recognised a smaller proportion of critical lures than presented items (see figure 4.2 above). However, because there was no main effect of age for critical lure total the majority of the remaining results will focus on the illusory truth effect.

The Illusory Truth Effect

Differences between the three age groups. The initial MANOVA (on combined DRM and the illusory truth effect variables) was followed by a second one-way between-groups MANOVA (this analyses excluded the critical lure totals, therefore, it examined only the illusory truth effect statements and the age group differences for each type of statement).The three dependent variables used were: old true statement average rating, old false statement average rating, and new statement average rating. The independent variable was age (young 16-39, middle 40-60, and old 61+). A MANOVA was used instead of repeated-measures ANOVA because a MANOVA has greater power with the current sample size and when the assumption of sphericity (required for repeated-measures ANOVA) is violated (Stevens, 2009), as was the case here ($x^2(2) = 18.39$, $p < .05$). MANOVA also allows for *post hoc* tests to be conducted to find where (which age group and which statement type) the significant differences lie, whereas repeated-measures ANOVA does not (Field, 2009).

As before there were no serious violations of assumptions and Pillai's trace was used. A statistically significant difference between the three age groups on the combined dependent variable was found, $F(6, 306) = 5.75$, $p < .001$; $V = 0.20$; $\eta^2_{partial} = .10$ (because this MANOVA excluded the critical lure totals this result is different from what was found in the initial MANOVA). When the results for the dependent variables were considered separately (using a Bonferroni adjusted alpha level of .02) results were the same as the first MANOVA, all three statement types showed statistically significant group differences: old true statements $F(2, 430) = 5.56$, $p = .005$, $\eta^2_{partial} = .07$; old false statements $F(2, 430) = 5.68$, $p = .004$, $\eta^2_{partial} = .07$; new statements: $F(2, 430) = 9.05$, $p < .001$, $\eta^2_{partial} = .11$. Figure 4.3 represents the truth ratings for each statement type between the three age groups.

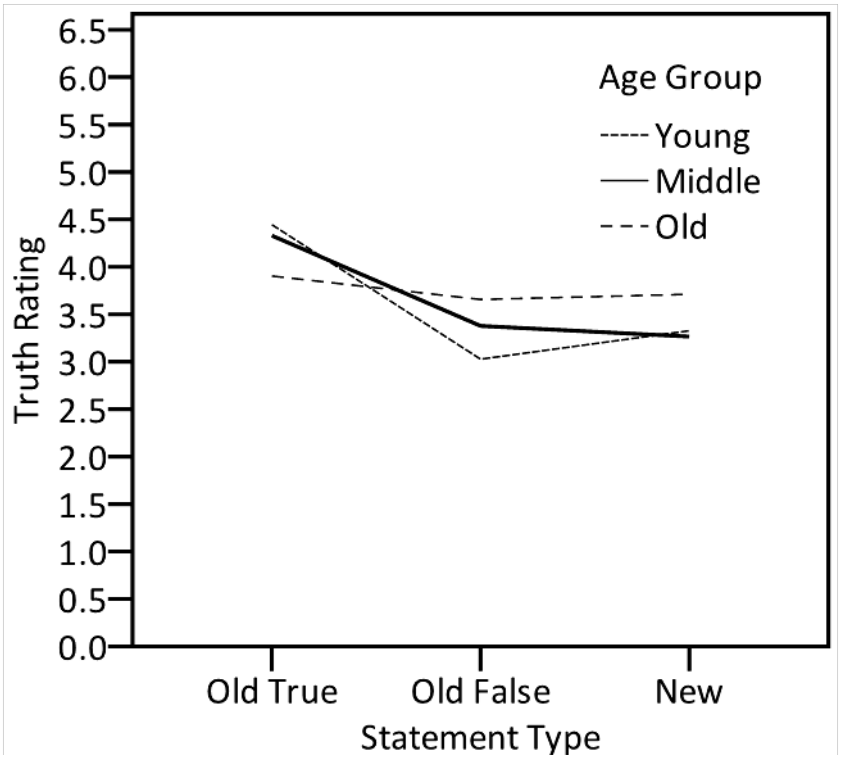

Figure 4.3. Truth ratings (estimated marginal means) for illusory truth statements in each age group.

Post hoc tests were conducted for all significant main effects. Two *post hoc* tests were used (as recommended by Field (2009)); Tukey's honestly significant difference test and Gabriel's pairwise comparisons test, and the results of each were very similar. However, Gabriel's will be reported here because it is more appropriate for the current data which has group sizes that are slightly different and the possibility of normality violations (old true statements for middle and old groups as stated earlier). Again, a Bonferroni alpha adjustment was used, this time .01 (three groups and three independent variables is nine comparisons; .05/9 = .01 (rounded 2 decimal places)).

Gabriel's *post hoc* comparisons of the three groups indicated that for the old true statements the young age group (M = 4.45, 95% CI [4.21, 4.68]) gave significantly higher truth ratings than the old age group (M = 3.90, 95% CI [3.66, 4.15]) p = .005. Comparisons

between the middle (M = 4.33, CI [4.09, 4.57]) and old group were not statistically significant at $p < .01$, but at $p < .05$ they were significant; the middle group rated old true statements as truer than the older group, $p = .04$. Comparisons between the young and middle groups were not statistically significant ($p = .15$). For old false statements the only statistically significant comparison was between the young (M = 3.03, 95% CI [2.77, 3.29]) and old groups (M = 3.66, 95% CI [3.39, 3.92]) $p = .003$, which indicated the old group rated old false statements as more true than the young group. Comparisons of the new statements showed the old group (M = 3.71, 95% CI [3.55, 3.87]) rated new statements as truer than the young (M = 3.33, 95% CI [3.17, 3.48]) and middle (M = 3.27, 95% CI [3.11, 3.42]) age group, $p = .002$ and $p < .001$ respectively. The young and middle age groups did not rate new statements significantly different ($p = .93$).

To summarise the statistically significant *post hoc* comparisons discussed above, when examining the differences between age groups' ratings of each type of statement, the old group showed differences from the young and middle group in all statement types, however, no differences were found between the young and middle age groups. Referring to figure 4.4 below, these results show: (a) the old group rated old true statements as less true than the young and middle groups, (b) the old group rated old false statements as more true than the young and middle[21] groups did, and (c) for new statements the old group rated them as more true than the young and middle groups.

[21] It is important to remember that this difference was significant at $p < .05$ not $p < .01$.

Figure 4.4. Truth rating (estimated marginal means) and 95% confidence intervals for each illusory truth statement in each age group.

Differences within each age group. To investigate the pattern in truth ratings of the illusory truth statements (the expected pattern is OT > OF > N) within each group a one-way repeated measures ANOVA was conducted, with the split file command in SPSS utilised to organise results by the three age groups. *Post hoc* pairwise comparisons using Bonferroni corrected values were also conducted to compare the main effects of the illusory truth effect statements in each age group. The Bonferroni method was utilised, as although it is conservative, it is considered the most robust in terms of power and controlling type one error rates in repeated measures analyses (Field, 2009). Results for the young group will be outlined first, followed by the middle, then old age groups.

In the young age group the assumption of sphericity, based on Mauchly's test, was violated $x^2(2) = 15.20$, $p < .05$, therefore degrees of freedom were corrected[22] using Huynh-Feldt estimates of sphericity ($\varepsilon_{h\text{-}f} = .82$). The Huynh-Feldt estimate was appropriate to use (instead of Greenhouse-Geisser) because when estimates of sphericity are greater than 0.75 (as is the case here) Greenhouse-Geisser is too conservative (Cardinal & Aitken, 2006; Stevens, 2009). For the young group a statistically significant result was found in the test of within-subjects effects, indicating that the truth rating was significantly affected by the type of statement, $F(1.64, 88.68) = 41.99$, $p < .001$, $\eta^2_{partial} = .44$. The pair wise comparison indicated that old true (M = 4.45, 95% CI [4.22, 4.67]) ratings were different from old false (M = 3.03, 95% CI [2.74, 3.31]) and new ratings (M = 3.33, 95% CI [3.18, 3.47]), $p < .001$ for both. However, old false statements were not rated significantly differently from new statements. The pattern the young group followed for truth ratings was: old true was rated truer than old false and new, and old false had truth ratings the same as new statements (OT > OF = N).

Turning to the middle age group, the assumption of sphericity, based on Mauchly's test, was not significant $x^2(2) = 4.54$, $p = .10$, therefore, degrees of freedom did not need to be corrected. For the middle age group a statistically significant result was found in the test of within-subjects effects, indicating that the truth rating was significantly affected by the type of statement, $F(2, 102) = 24.89$, $p < .001$, $\eta^2_{partial} = .33$. Pairwise comparisons showed the same pattern as the young group; old true statements (M = 4.33, 95% CI [4.06, 4.60])

[22] Even though a corrected value for the degrees of freedom was utilised comparisons of the *F*-ratio values, significance values, and effect sizes did not differ across the different estimates of sphericity (this was also the case for the middle group and old group).

were rated significantly truer than old false (M = 3.38, 95% CI [3.10, 3.66]) and new statements (M = 3.27, 95% CI [3.11, 3.42]), for both comparisons $p < .001$. There was no significant difference between old false and new statements (OT > OF = N).

Compared to the above findings the pattern of truth ratings in the old group was somewhat different. The results for the old group in the within-subjects test showed that the assumption of sphericity was met, $x^2(2) = 1.06$, $p = .59$, therefore, degrees of freedom were not corrected, and that truth ratings were not influenced by the type of statement, $F(2, 100) = 2.29$, $p = .11$, $\eta^2_{partial} = .04$, indicating that there was no difference between the truth ratings of old true (M = 3.90, 95% CI [3.68, 4.13]), old false (M = 3.66, 95% CI [3.43, 3.89]), and new (M = 3.71, 95% CI [3.54, 3.89]) statements; OT = OF = N. Therefore, the young and middle group showed the same truth rating pattern (OT > OF = N) which was different to the old groups pattern, and all three of the patterns deviated from the expected pattern (OT > OF > N). These findings are displayed below in figure 4.5. Interestingly, the effect size estimates decrease with increasing age (across groups; young $\eta^2_{partial} = .44$, middle $\eta^2_{partial} = .33$, and old $\eta^2_{partial} = .04$), suggesting that with increased age the different statement types become less important determinants of average truth ratings.

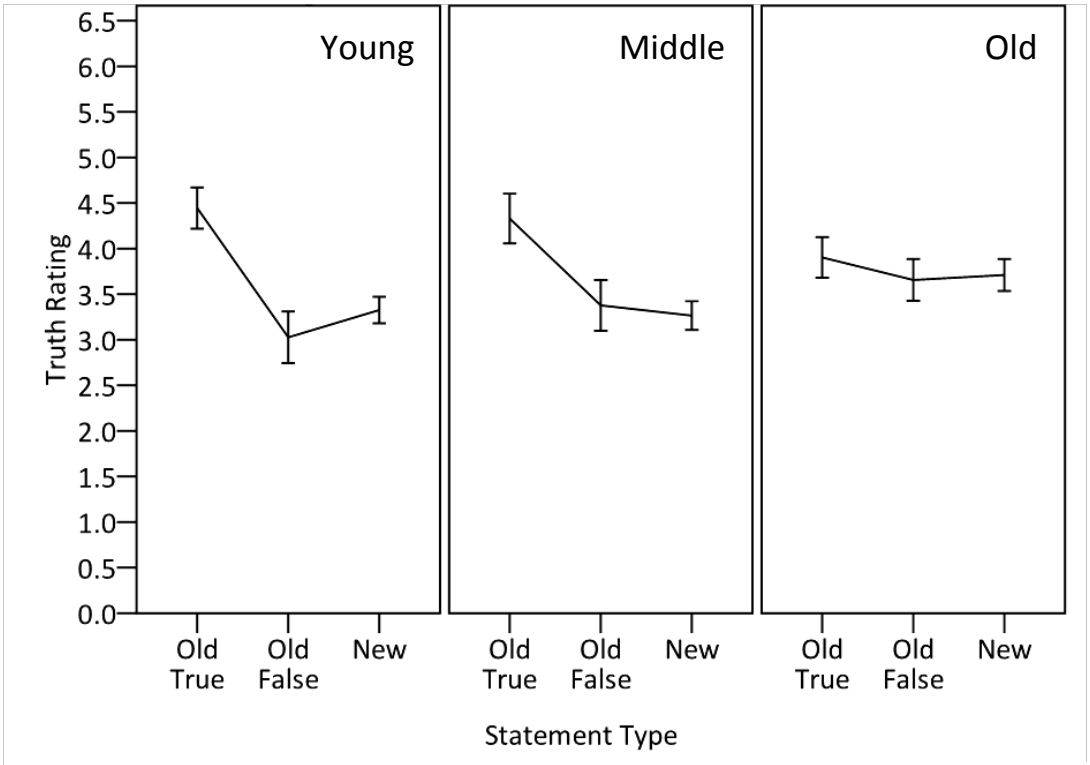

Figure 4.5. Truth ratings (estimated marginal means) and 95% confidence intervals for each age group on the three types of statements for the illusory truth effect.

Illusory Truth Effect Statements and Age (simple correlations)

In order to further investigate the relationship between age and truth ratings in the illusory truth effect task the following correlation analysis was conducted. This analysis used age, in years instead of age groups, and all three illusory truth effect statements. Age was significantly related to old true ratings $r = -.22$, $p = < .005$, old false ratings $r = .23$, $p = .004$, and new statement ratings $r = .28$, $p < .001$. These relationships are depicted in figure 4.6 below and suggest that with ageing comes a decrease in the accuracy of truth ratings for each statement type in the illusory truth effect task.

Figure 4.6. Scatter graphs and fit lines of the relationship between each illusory truth statement and

Additional Exploratory Analyses

These analyses were conducted based on the possibility that the broad age ranges used in this study may have obscured effects, and the fact that a large percentage of the sample recognised a high number of critical lures in the DRM task (46% of all the participants falsely recognised 7-8 critical lures[23], and 61% falsely recognised 6-8 critical lures[24]). Figure 4.7 below shows that a large proportion of individuals aged between 16-25 and 37-47 incorrectly recognised 7-8 critical lures, whereas the other five age groups follow the expected pattern (as age increases critical lure total increases). Based on these a further analysis was conducted to investigate results using seven (similar-sized) age groups. Importantly, the current research was not powered to explore seven age-groups, so conclusions drawn from the following analysis are tentative.

[23] Comparing groups, young = 45.45%, middle = 36.54%, and old = 56.86%

[24] Comparing groups, young = 56.36%, middle = 57.69%, and old = 68.63%

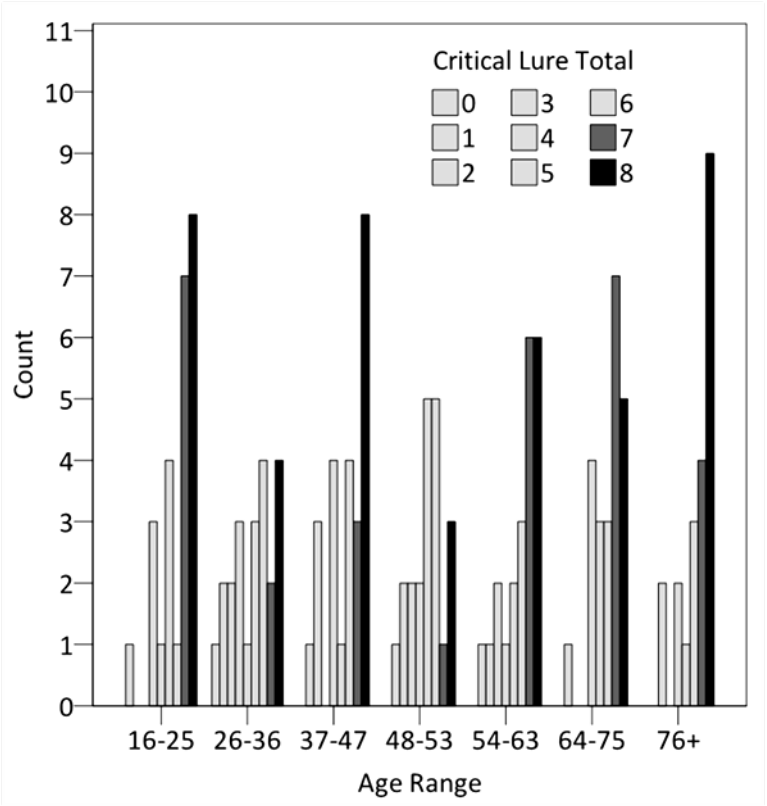

Figure 4.7. Total critical lure frequency when sample is split into seven age groups. Bars from left to right, for each age range, represent total critical lures 1/8 to 8/8. Note, 1-6 are the same shade because this figure is more concerned with total critical lure values 7 and 8.

A one-way between-groups MANOVA was conducted to look into the four dependent variables (old true average, old false average, new average, and critical lure total) when the sample was divided into seven age groups. Again, the assumptions for a MANOVA were investigated and no serious violations were noted. In addition, because this was an exploratory analysis and the groups sizes were small (21-25 in each age group) an alpha level of .15 was used (as recommended by Stevens (2009)). The MANOVA reported a statistically significant difference of age on the combined dependent variable, $F(24, 604) = 2.10$, $p = .002$; $V = .31$; $\eta^2_{partial} = .08$. Considering the results for the dependent variables separately (with alpha set at .15) the critical lure total reached statistical significance $F(6, 151) = 1.82$, p

= .10, $\eta^2_{partial}$ = .07, as did old false truth ratings $F(6, 151) = 1.78$, $p = .11$, $\eta^2_{partial}$ = .07, and new statement ratings $F(6, 151) = 5.25$, $p < .001$, $\eta^2_{partial}$ = .17. The following graph, figure 4.8, shows the pattern of results based on group means. Again, when looking at the under 25 and 37-47 year olds, there is a spike in mean critical lure totals, whereas the old true statements show the expected trend; a decrease in truth ratings as age increases. When considering only age groups older than 47 the expected pattern is followed with an increase in critical lure recognition, old false truth ratings, and new truth ratings, along with a decrease in old true statement ratings.

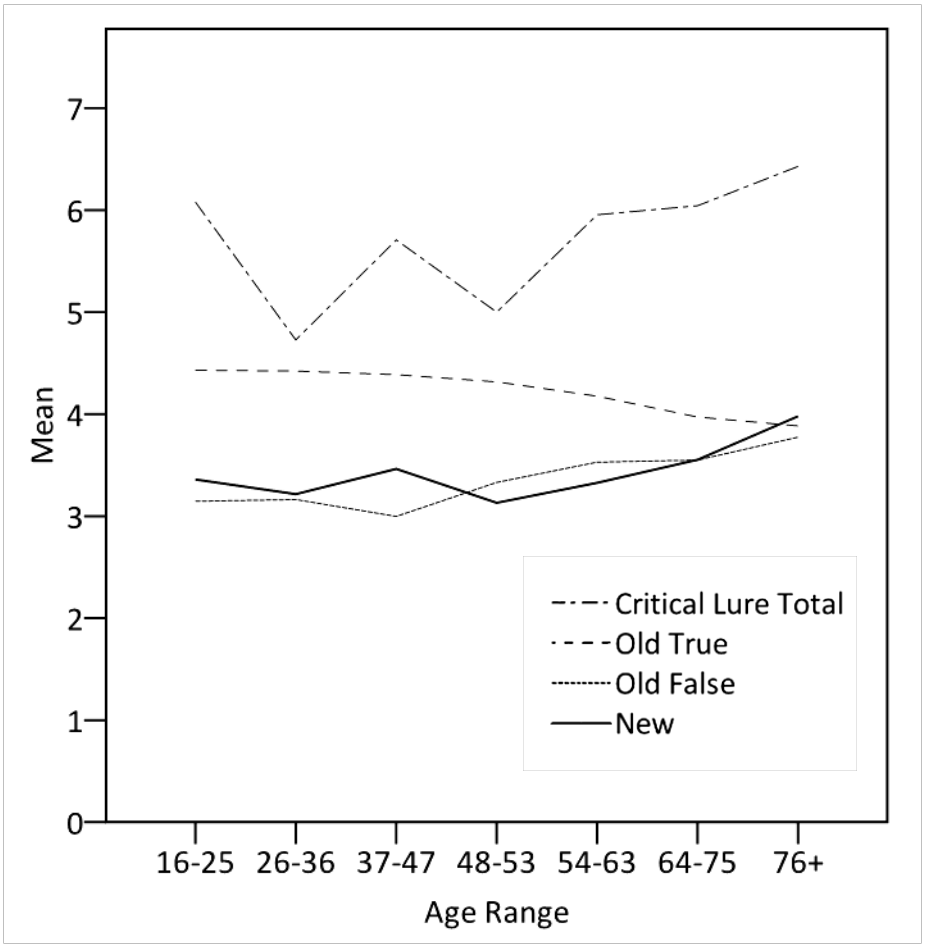

Figure 4.8. Means for each dependent variable across the seven age groups.

Summary

Data from three age groups (young 16-39, middle 40-60, and old 61+) were examined to investigate if there was a common susceptibility to false memories and the illusory truth effect that increased with age. MANOVA analyses indicated that there was no significant difference between the three age groups on total critical lure scores, however, there were differences in the three types of illusory truth statements (old true, old false, and new). Therefore the main hypothesis regarding a common susceptibility was not supported. This lack of support was possibly due to a ceiling effect for the DRM task as a large percentage of participants incorrectly recognised a high number (6 to 8 out of 8) of critical lures. However, critical lure totals were found to be related to old false truth ratings in the old age group, suggesting an underlying common susceptibility in this age group.

Further analyses of the illusory truth effect highlighted interesting and unexpected results. Performance between each age group showed the old groups' accuracy in truth ratings was worse than the young group on all three statement types. Unexpectedly, none of the age groups followed the expected truth rating pattern of rating old true statements truer than old false statements, and old false statements as truer than new statements (OT > OF > N). The pattern for the young and middle age groups was OT > OF = N, and the old groups pattern was OT = OF = N. Also of interest, were the results of the simple correlations which indicated as age increased truth ratings on old true statements decreased, and truth ratings on old false and new statements increased.

In addition, the exploratory analyses which categorised participants into seven age groups suggested an interesting pattern of results across all four dependent variables, with truth ratings for the three types of statements following the expected patterns with ageing (old false and new truth ratings increase and old false truth ratings decrease). Furthermore,

aside from two of the younger age groups' critical lure totals; the other five age groups followed the expected increase with age. This demonstrates a need for additional research, an issue which will be considered thoroughly, along with the meaning of these results, in the next section.

CHAPTER FIVE

Discussion

Generally memory is accurate, but memory illusions and distortions are unavoidable (Dodson et al., 2000). Research on the errors people make when remembering is important as it provides information regarding the constructive nature of remembering (M. Johnson et al., 1993). As stated earlier there are three major types of memory error when remembering: (a) forgetting events that happened, (b) remembering events that did not happen, and (c) remembering events differently from how they truly occurred (Roediger & McDermott, 1995, 2000b). The latter two types of error are the focus of the current study.

In the present research the type of false memory focused on was memories for events that did not happen but were connected, through associations and/or resemblance, to events that did happen (Gallo, 2006). The illusory truth effect was investigated through repetition of statements, which is believed to increase an individual's belief in the information being repeated (Bacon, 1979; Hawkins & Hoch, 1992). A number of mechanisms have been hypothesised to lie behind these phenomena, and there is one underlying mechanism, source monitoring, which is used to explain the occurrence of both false memories and the illusory truth effect. In addition, the major alternative hypothesised mechanism believed to be responsible for false memories (gist and verbatim memories) bears a strong resemblance to the most common explanation for the illusory truth effect (familiarity).

Ageing was also central in the current research. Normal ageing is often related to deficits in source memory (McIntyre & Craik, 1987; Schacter et al., 1994), and recognition memory (Howard et al., 2006; Hoyer & Verhaeghen, 2006). Both of these age-related deficits

are important for the production of false memories and the illusory truth effect (Bacon, 1979; Boehm, 1994). Thus, the purpose of the present study was to determine how susceptibility to false memories and the illusory truth effect varies with age, and if there is a common susceptibility to both. Previous research examining age-related changes for these two phenomena is somewhat limited (especially for the illusory truth effect), and currently there is no published research investigating a common susceptibility to both; as a result, the intent of this study was to fill this gap. This chapter examines the implications of the results of the current research for understanding a common susceptibility to the illusory truth effect and DRM (Deese/Roediger-McDermott) false recognition, the lack of age-related changes in the DRM task performance, and limitations and recommendations for future research.

Common Susceptibility to Memory Mistakes related to Age

The DRM false memory task and the illusory truth effect task were designed to assess if there was a common susceptibility to the two types of memory errors evoked during the tasks. Although, there were statistically significant differences between the three age groups on their average truth ratings for each type of illusory truth effect statement, there were no statistically significant age group differences in DRM false recognition. This finding is consistent with the idea that the mechanisms that underpin performance in the two tasks are different or are not related strongly enough to constitute a common susceptibility. However, in the old group (and only the old group) false recognition scores were positively correlated with truth ratings for old false statements. This correlation shows that only the old group demonstrated a common susceptibility to the two tasks. This common susceptibility in the old group is consistent with the idea that the underlying mechanisms and/or strategies involved in at least one of the two tasks changes across a lifespan. The

following will outline previous research (that has also been discussed in earlier chapters) which has found similar results to the current research, examine the possibility that different mechanisms and/or strategies underpin each task, and then consider the possibility that the mechanisms and/or strategies change across the lifespan.

Previous Research with Similar Results to the Current Research

The DRM false recognition task. The DRM false memory results of the present research are similar to those found by Tun et al. (1998) and seven[25] of the 15 experiments reviewed by Gallo (2006), in which no age-related differences in recognition of critical lures were found. The researchers who discussed the fact they found no age-related differences in false recognition state the lack of age differences was most likely due to participants (young and old) employing the use of gist-based memory strategies over verbatim strategies, which causes younger participants (who normally use gist- and verbatim-based memory strategies) to perform the same as older participants (who generally use gist-based memory strategies) (McCabe & Smith, 2002; Tun et al., 1998). A second explanation for the lack of age differences was that neither young nor old participants used a source monitoring strategy, thus, both age groups confused the internally generated source of critical lures with the external source of presented items (Budson et al., 2000; Intons-Peterson et al., 1999).

The illusory truth effect task. By contrast with the results found in the DRM recognition task, in the illusory truth effect task group differences were found for truth ratings of all statement types. To recap, the old group differed from the young and middle

[25] Benjamin (2001), Budson et al. (2000), Gallo and Roediger (2003), Intons-Peterson et al. (1999), Kensinger and Schacter (1999), and two experiments conducted by McCabe and Smith (2002).

groups for all statement types; rating old true statements as less true and rating old false[26] and new statements as more true. Therefore, the young and middle groups performed similarly in the illusory truth effect task, while the older adults' accuracy was worse than the young and middle groups on all three statement types.

It is difficult to relate these age-related results to other research because currently there is very little published research that examines the relationship between age and illusory truth effect tasks that utilises two different sources (female or male names) to manipulate the truth status of statements. Similar research has used tasks that either state the items are true or false (Budson et al., 2000; Mutter et al., 1995; Skurnik et al., 2005), or do not provide statement truth status information (Law et al., 1998; Mutter et al., 1995). In line with the current study's findings Skurnik et al. (2005) showed older adults made more errors than younger adults, responding true to false statements more often. On the other hand Mutter et al. (1995) did not find age-related differences in ratings for old true and old false statements when objective credibility evidence (statements were followed by either the word true or false) confirmed the truth of their own knowledge (e.g., objective evidence states a statement is false when they already believed the statement was false). Also, research that uses a very similar procedure to that used in the current research (manipulating the truth value of a statement by using female and male names), has shown that, although older adults had poorer memory for which source (female or male) was associated with a statement, there were no age differences in truth ratings (Rahhal et al., 2002).

[26] It is important to note that this difference was significant at $p < .05$ not a Bonferroni adjusted level of $p < .01$.

Furthermore, researchers who have investigated age-related differences in the illusory truth effect, but employed procedures in which participants are not provided with the truth status of statements, have found results rather different from those of the current research. Mutter et al. (1995) found old statements were rated truer than new statements by young and old participants. However, there were no significant differences between the young and old groups' truth ratings of repeated (old) or new statements. In addition, Law et al. (1998) found no main effect of age on truth ratings, but showed that age moderated the effect that perceived repetition had on truth ratings (e.g., statements believed to be presented twice were rated truer than those believed to be presented once, even when the statement believed to be presented twice had in fact been presented once). The results found in the current research add to the mixed age-related findings from other research on both phenomena being studied.

Different Mechanisms and/or Strategies Underpin Each Task

As stated earlier the results found in the present research could signify that different mechanisms lie behind the formation of DRM false memories and the illusory truth effect, but only if there are no methodological reasons that could explain the lack of a relationship, such as the potential ceiling effect of the DRM false recognition task (which will be discussed later). Based on the fact that there were no differences between the three age groups in their critical lure totals (the discussion below specifically on the critical lure result helps explain why no age-related differences were found) and correct recognition totals, it would seem the mechanisms behind the task and the strategies employed by each age group in the DRM task were the same.

Mechanisms underpinning DRM false recognition performance. Below is a discussion on the possible explanations of the mechanisms underpinning DRM false memory formation from three different perspectives; the fuzzy trace framework, the 'dual process' model of recognition, and the activation-monitoring framework.

The fuzzy trace framework. According to the fuzzy trace framework the results might suggest that the performance was underpinned by gist memories, with the majority of participants employing memory strategies based on the gist of items over verbatim memories. However, discussions by Brainerd and Reyna (2002) state that immediately testing participants after DRM list presentation (as done in the current study), should promote a dissociation between correct and false memories, because immediate testing responses are believed to rely more on verbatim memory traces than gist traces and false and true memories are supported by different representations in memory (Brainerd & Reyna, 2002). Therefore, immediate testing should support and thus produce more true memories and fewer false memories. However, the current research provides evidence against this idea as there was a strong positive association between recognition of critical lures and presented list items for each age group, as well as each age group recognising high proportions of both types of memories. If participants had been relying on verbatim and gist memory traces results would probably not indicate such high numbers of false memories, because verbatim traces support true memories and suppress false memories. On the other hand, if only gist based memories were used research would expect to find positive associations between correct and false recognition (Brainerd & Reyna, 2002). Such as the strong positive relationship found in the current research between true and false recognition. By employing the fuzzy trace framework, the DRM recognition results found in

the current research would indicate that participants in each age group relied much more heavily on gist memories, with little to no consideration given to verbatim memories.

The 'dual process' model of recognition. In a similar vein, the above argument can also be viewed using the 'dual process' (recollection and familiarity) model of recognition memory; a critical lure will be accepted as a studied item only when the lure is highly familiar and when the lure's recollection is poor enough that it provides justification to rely on memory strategies based only on familiarity (Lövdén, 2003). This situation is more likely in older adults because recollection is often impaired (J. Bartlett et al., 1991; Benjamin, 2001; Dywan & Jacoby, 1990). In the current research the learning phase for each of the DRM lists possibly gave participants (of all age groups) such a high level of familiarity for the critical lure that relying exclusively on that sense of familiarity at test was justified. Therefore, instead of only older adults responding based on the familiarity of an item, which is expected because of age-related deficits in recollection memory, all of the age groups decisions were based on familiarity.

The activation-monitoring framework. Predictions based on the activation-monitoring framework suggest that older adults will perform poorly when compared to younger groups, with an increase in false recognition and a decrease in correct recognition. This prediction is based on the belief that the extent of spreading activation in one's semantic system remains stable as we age (Balota et al., 1999; Dehon & Brédart, 2004; Tun et al., 1998), but older adults generally have both impaired source memory and recognition memory compared to younger adults (Ferguson et al., 1992; Schacter et al., 1991). Nonetheless, and it would seem to be fitting for the current study, research does not always find age-related decreases in source memory performance (Dywan & Jacoby, 1990; Hashtroudi et al., 1989) or recognition performance (Craik, Morris, Morris, & Loewen, 1990;

Ferguson et al., 1992; McIntyre & Craik, 1987). In the current research the high level of false recognition seen in each age group means that the eight DRM lists used strongly activated their corresponding critical lure in most participants, and the majority of those participants did not (or could not) use source monitoring strategies to avoid identifying the lures as old items during the recognition test. Alternatively, correct recognition was significantly higher than false recognition for all age groups, suggesting that participants did employ some type of strategy (possibly source monitoring) to avoid recognising the critical lures as often as presented items (but with limited success).

Therefore, the results of the present study coupled with the mixed evidence for age-related changes in source memory support the idea that sometimes younger adults, as well as older adults avoid using (or are unable to use) helpful source monitoring strategies. As a result participants are unsuccessful at automatically or consistently considering evidence which would help them evade source errors and false memories (Schacter, Koutstaal, & Norman, 1997). The fuzzy trace framework, the 'dual process' model of recognition, and the activation-monitoring framework can each provide possible explanations for the results obtained in the present research that showed no age-related differences in false recognition. Regardless of the explanation that is employed it appears that in the current research, performance in the DRM false recognition task was caused by each age group utilising a memory strategy (whether it be employing a gist-based memory strategy, a familiarity-based strategy, and/or not utilising a source monitoring standard) that made them more likely to indicate that they recognised an item (correct or incorrect) than indicate that they did not recognise an item.

Mechanisms underpinning performance in the illusory truth effect. In the illusory truth effect task, the young and middle age groups' performance (accuracy in truth ratings)

was equal, whereas the old groups' performance was worse than the younger groups on all statement types. In addition, as age increased truth ratings for old true statements decreased, and truth ratings for old false and new statements increased. The discussion below describes how both source memory and familiarity mechanisms provide possible explanations for the findings in the current research.

Source memory. The fact that older adults rated old true statements less true, and old false statements as more true than the younger groups did suggests that, as was expected, the older group had poorer source memory for the repeated statements and thus the statements' truthfulness than the young and middle age groups. Therefore, responding true to false statements and vice versa. Age-related recognition memory deficits may also have been important for source memory, because if older adults did not recognise a statement as an item that was presented in the learning set of statements (incorrectly remembering old items as new), they would have had no reason to utilise their source memory when they rated how true they thought a statement was.

Familiarity. The results that illustrate that the older adults rated old false statements as truer than either the young or middle group suggests that older adults relied more on familiarity than the recollection of the true/false details of statements (compared to middle-aged or young adults). Yet, when taking into account truth ratings of the new statements the results suggest that older people were simply more likely to judge a statement as true than young or middle-aged people (the old groups' mean scores in table 4.2 showed they rated all types of statements as true – a rating greater than 3.50 is considered true because the rating scale was 1-6). The positive relationship between age and old false and new statement truth ratings also supports the suggestion that with ageing the likelihood of believing a statement is true increases. Familiarity and source memory as underlying mechanisms in the illusory

truth effect were briefly mentioned here; their involvement will be more thoroughly discussed and becomes clearer in the next section which takes into consideration the results for the three statement types within each of the three age groups.

The Mechanisms and/or Strategies that Underpin Performance in the Illusory Truth Effect Change across the Lifespan

The common susceptibility found in the old group is consistent with the idea that the underlying mechanisms and/or strategies used in the two tasks are related in this group, but not in the younger two groups. Furthermore, because the groups performed equally in the DRM recognition task it appears the same mechanism and/or strategy underpinned performance in the DRM task in each age group. However, the accuracy in truth ratings and the pattern of truth ratings (e.g., OT > OF > N) for the three types of statements in the illusory truth effect task was different for the old group and the two younger groups, suggesting that different underlying mechanisms and/or strategies were involved in the old group compared to the younger two groups in this task.

Performance in the old age group. To recap, the old group showed no significant differences in truth ratings for any of the statements (old true M = 3.90, old false M = 3.66, and new M = 3.71; OT = OF = N). In addition, the relationship between old false truth ratings and critical lure totals (common susceptibility) in the old group, and the lack of this relationship in the other two age groups, is important because incorrectly rating an old false statement as true constitutes a source memory error (Begg et al., 1992; Rahhal et al., 2002) and/or a judgement based on the familiarity of a statement (Begg et al., 1992; Mutter et al., 1995). Furthermore, incorrectly recognising a critical lure is either a source monitoring error (Gallo et al., 1997; M. Johnson et al., 1993; Norman & Schacter, 1997; Roediger &

McDermott, 1995; Roediger et al., 2001; Skinner & Fernandes, 2009) or a recognition judgement based on gist memories (Brainerd & Reyna, 2002).

As a result, because the old group exhibited a significant positive correlation between performance on the DRM task and illusory truth effect task and they rated old false statements as true on average (M = 3.66), it seems that in older adults the underlying mechanisms for both tasks were gist memories and/or familiarity (which are two similar mechanisms) – possibly a side-effect of age-related deficits in recollection (Brainerd & Reyna, 2002; Tun et al., 1998) and the stability of the familiarity mechanism throughout life (Jennings & Jacoby, 1993, 1997; Zelazo et al., 2004). Unfortunately, because the old group rated all three types of illusory truth effect statements the same it is difficult to gauge the importance and role of familiarity in their performance, because if the underlying mechanism was familiarity old true and old false statements should be rated truer than new statements. By employing the 'dual process' model of recognition at this point, these results would indicate that in the old group the sense of familiarity with an item being used as a signal for its truth value was an unsuccessful strategy. This is likely because of their poorer ability to recollect contextual information and item-specific details, or more generally their poorer ability to recognise a statement as old or new.

Furthermore, if we employ the source memory framework to explain these results (that older adults showed no significant differences between truth ratings for the three types of statements) it implies that the older adults made a number of source memory errors. These source memory errors include rating a number of old true statements as false, and old false statements as true, which brought old true and old false statement ratings in line with new statements truth ratings. However, what seems to be the case with the older adults (as stated earlier) is that they are simply more likely to judge a statement as true,

than they are to say a statement is false. This can possibly be explained by the results found by Law (1998) which showed older adults had a predisposition to incorrectly judge new illusory truth effect statements as old, and more often incorrectly remember the source of a statement (compared to younger adults). It could also be that older adults are simply less suspicious and/or critical of seemingly new information.

In addition, the obtained effect sizes for the illusory truth effect task demonstrate that the older the age group the less important the different statement types were for the average truth ratings, possibly because source and recognition memory decline with age (Cohen & Faulkner, 1989; Hashtroudi et al., 1989; McIntyre & Craik, 1987). Therefore, suggesting that the older adults rely on their general knowledge and/or guess the truth value of a statement. It is possible that in the illusory truth effect task older age corresponds to a decrease in the ability to correctly remember source information and therefore results in less variation between truth ratings of the different statement types. Also, the effect sizes found when comparing correct and false recognition within each age group, showed that the young and middle age groups had similar effect sizes, whereas, for the old age group the effect size was much smaller, which would indicate the younger two groups were able to better discriminate true and false items in the DRM recognition test.

Based on the above discussion, it seems apt to say that the older participants had more trouble discriminating the two types of recognition items (correct and false), and the different statements in the illusory truth effect task than the younger groups. In addition, the results that showed that the older individuals performed more poorly in the illusory truth effect task, and that only the older groups' performance in the DRM task was related to their performance in the illusory truth effect task, can potentially be explained by age-related memory deficits. However, pinpointing exactly what age-related deficit (source

memory, recognition memory, or verbatim memory) is the cause of the older groups poorer performance is difficult, and it possibly involves a combination of factors rather than one.

Performance in the young and middle age groups. Firstly, the young group rated old true (M = 4.45) statements as truer than old false (M = 3.03) statements, and old false statements were rated the same as new (M = 3.33) statements (OT > OF = N), and the middle group showed the same pattern of significant results as the young group (old true M = 4.33, old false M = 3.38, and new M = 3.27; OT > OF = N). By contrast to the old age group the younger groups' performance in the illusory truth effect task, appeared to be underpinned by source memory and familiarity mechanisms (discussed below), because they rated old false the same as new statements. This is unlike their performance in the DRM task which appeared to rely on gist memory and/or familiarity mechanisms.

Initially, the results for the three types of illusory truth effect statements can be interpreted as providing evidence against a familiarity mechanism being behind the effect, because the young and middle age groups rated old false statements as true as new statements. If the underlying mechanism of the illusory truth effect was familiarity old false statements should have been rated truer than new statements simply because participants had come across the statements earlier. For this reason, it is likely source memory was responsible for performance in the illusory truth effect task. The fact that the young and middle groups rated old true statements the same as new statements is a sign that they had trouble remembering the source of information to the point that they could not rate statements that they had been told were false earlier, in a different manner to new statements. This source memory explanation differs substantially from the views of other researchers who feel that source errors are not necessary for the illusory truth effect to occur (Begg et al., 1992; Boehm, 1994), although they might have effect on familiarity and

thereby have an indirect effect on truth ratings (Arkes et al., 1991). The indirect relationship between source memory errors and truth ratings is made clearer below.

These results (OF > OT = N) might indicate that both source memory and familiarity mechanisms are important for explaining the illusory truth effect results in the current research. If only the source memory mechanism was important, truth ratings for old false statements should be lower than truth ratings for new statements. If only the familiarity mechanism was important, old false statements should be rated truer than new statements. Therefore, because old true statements were rated truer than old false and new statements (which were rated equally), truth ratings must have been based on both familiarity and source memory. This is because if participants had a sense of familiarity for an item the truth rating given to that item would increase (compared to a new and unfamiliar item), but if the correct or incorrect source was remembered the truth rating would indicate this by either increasing (true source) or decreasing (false source). In the current research the relationship between familiarity and source memory is illustrated by the lack of difference between old false and new statements' truth ratings in the young and middle group. An old false statement should be rated truer than a new statement because of its familiarity, but if the correct source were recollected the truth rating would decrease and, as in the current research, be rated more like a new statement.

Based on the considerations in the above discussion it appears that both source memory and familiarity mechanisms were important for performance in both tasks to some degree. Nevertheless, it is possible that source memory and familiarity were not the only processes affecting performance on the two tasks in the present study; it is possible that the task materials and procedure employed shaped how participants responded to the tasks. Therefore, the next section will examine factors relating to the DRM task that can help to

explain why no age-related differences in false recognition were found. In addition, the section later that considers the results found in the exploratory analyses (conducted in chapter four) will also shed some light on why no age-related differences were found.

DRM Task Factors That May Explain the Lack of Age-Related Differences

The lack of age-related differences in false recognition was unexpected for a number of reasons. It was expected that the majority of participants would not be easily lured into recognising critical lures in the DRM tasks, and would spend more time focusing on source monitoring. This is because the information sheet (appendix E) that participants read outlined the procedure that the research would follow and informed the participants that the research was investigating memory mistakes. It was thought that the contents of the information sheet would possibly work as a cue for participants to be suspicious of the task and aware of what the task was exploring, or even work as a warning. Therefore, because participants knew that their memory was going to be tested, and, more specifically, that the mistakes that they would make would be examined, participants would respond differently (recognise fewer critical lures) than if they were only told in the information sheet that the research was related to memory performance. However, this was not the case as 61% of the participants recognised a high number of critical lures (6 to 8 out of 8 lures).

Furthermore, as outlined earlier, performance on an immediate test following DRM list presentation should encourage use of verbatim memory traces over gist traces (Brainerd & Reyna, 2002). However, based on earlier discussions, this does not seem to be the case in the present research. In addition, the matter of testing procedures that support one memory trace type (gist or verbatim) over the other becomes less clear when taking into consideration the research methods used by Tun et al. (1998). Tun et al.'s first experiment

was expected to rely on the use of gist traces rather than verbatim traces, while their second experiment was expected to encourage the use of verbatim traces rather than gist traces. In Tun et al.'s first experiment participants listened to 10 DRM lists. After the presentation of each DRM list an immediate recall test was completed, followed by a recognition test (each recognition test contained seven presented items, six non-critical lures, and the critical lure). The recognition test was believed to foster reliance on gist memories, because recognition decisions could rely on the thematic associations of items. The results showed no differences in the number of false memories generated when comparing young and old age groups (Tun et al., 1998). Their second experiment was expected to foster use of a verbatim memory strategy; because the 10 DRM lists participants heard excluded three DRM list words that were weakly associated to the lure (the three weakly associated lures were included in the recognition test). This meant that recognition decisions could not be successfully made based on only the thematic associations (gist traces) between the test items. The results of this experiment found differences between the two age groups on false recognition of both critical lures and weakly associated lures. In considering the procedures used and the results found by Tun et al. in their experiments it makes more sense that the procedure used in the current research (similar to Tun et al.'s first experiment) encouraged participants to use a gist-based memory strategy over a verbatim strategy, as recognition decisions could rely on the thematic associations of items (gist traces), instead of item-specific information (verbatim traces). This would explain why no age-related differences were found, as the three groups relied equally on their gist memories rather than verbatim memories. It is possible that when recognition decisions can be made effectively using only a gist memory strategy, little consideration will be given to verbatim memories (Kensinger & Schacter, 1999; Reder, Wible, & Martin, 1986; Tun et al., 1998). Therefore, because older individuals

are believed to rely more heavily on gist strategies than younger individuals, when successful performance in a test can appear[27] to be accomplished by using gist strategies younger adults will perform more like older adults. However, when successful performance must rely on both gist and verbatim strategies older adults will perform worse than younger adults (Kensinger & Schacter, 1999; Koutstaal & Schacter, 1997; Tun et al., 1998).

In addition, the results of the DRM task were surprising because standard recognition tests[28] are affected by errors based on familiarity – which are believed to increase with age (Gallo, 2006). The lack of age-related differences could have been due to the fact that source monitoring during the recognition test was likely not very beneficial, because there were limited item-specific differences among the items to recollect (e.g., how items were presented) and limited semantic variation among studied items available for making accurate recognition judgements (Gallo, 2006). In the present research (and in standard DRM procedures) all DRM lists were presented by means of the same source (a female voice), and had similar semantic qualities (each DRM list was strongly associated with its corresponding critical lure, which is suggested by the high false recognition rates for the DRM lists used (64-84%) found in Stadler et al.'s (1999) norms). Both of these factors influence false recognition in participants of any age, because there are fewer item-specific qualities to differentiate critical lures from presented items (Gallo, 2006). Support for this explanation can be seen in Hashtroudi et al.'s (1989) results in which older and younger

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[27] The word 'appear' is used here because often (unless specifically warned) participants are not aware that the research they are taking part in is examining the creation of false memories.

[28] A recognition test in which there are no 'lure' distracter items, therefore, false recognition is relatively infrequent.

adults performed equally discriminating the source of items when they were based on either internal (participants said a word or thought of themselves saying a word) or external characteristics (listening to someone else say a word), providing a high-level of contextual variation between items. Furthermore, Hicks and Marsh (1999) showed that when half of the DRM lists were generated by participants from anagrams and the other half were heard by participants (providing one internal and one external source) overall false recall was reduced.

Another important concern, and possibly the reason why the current research did not finding an age-related increase in DRM false recognition, relates to the procedure used. Specifically there was perhaps a ceiling effect for the false memory measure (results from the eight recognition tests), indicated by the high percentage of participants who recognised a high number of critical lures over the three age groups. False memory research that employs recognition tests generally involves asking participants to complete a recognition test after they have learnt, and often immediately recalled, a number of DRM lists. In doing this the results frequently report high rates of false memories in the recognition test (e.g., Gallo & Roediger, 2003; Roediger & McDermott, 1995; Stadler et al., 1999; Tun et al., 1998). The present research was designed to avoid a ceiling effect by using recognition tests immediately after learning each of the DRM lists. Unfortunately this manipulation did not achieve this objective (the ceiling effect will be discussed further in the limitations and recommendation section below).

This section has reviewed some of the factors that can explain why no age-related DRM false recognition differences were found. Nevertheless, there are other considerations of the current research that need to be discussed. The next section examines why the ceiling effect is a limitation and how it can be remedied in future research, as well as discussing a

number of other limitations found while conducting the present research, and recommendations based on these limitations.

Limitations and Recommendations

Limitations and recommendations based on the tasks. Even though age group differences in the results of the illusory truth effect task and false memories were found, there were several important limitations to the current study. The first limitation, which has been mentioned above, was related to the DRM procedure used and the possibility that there was a measurement-related ceiling effect. The ceiling effect is problematic because it decreases the variation in the critical lure totals (Vogt, 2005), increasing the likelihood that no significant group differences will be found, leading to claims the independent variable (age) had no influence on the dependent variable (false recognition) (Cramer & Howitt, 2004). The present research has demonstrated that immediate recognition tests (or more specifically the DRM lists and their corresponding recognition tests used in the current research) result in high levels of false recognition for individuals of all ages. Therefore, if immediate recognition tests were to be used in future research it would be important that the tests were constructed differently in an attempt to avoid a ceiling effect. For example, they might include fewer studied items and more non-studied distracter items. Also, using additional DRM lists that have been found to produce lower false recognition rates (e.g., the lists associated with the critical lures king, lion, and black[29]) would be expected to provide greater variation in overall false recognition scores. Another possibility would be to employ

[29] The false recognition rates found for the critical lure king were 27%, lion 33%, and black 49% (Stadler et al., 1999).

the procedure used by Tun et al. (1998) (described earlier) so that successful performance in the DRM recognition test would need to rely on source monitoring and recollection instead of gist memories. Furthermore, this procedure provides data for three weakly associated critical lures per DRM list in addition to the one 'strong' critical lure (as in most research utilising DRM procedures) – this should also increase inter-individual variation.

An additional issue found with the DRM procedure used was that a small number of participants, both young and old, stated they had problems with understanding some of the DRM list words played through the speakers because of how they were pronounced. In one or two cases this led to participants interrupting while the list was playing in an attempt to get clarification on what the word was. In all cases the recording was only stopped at the end of each list. In the cases in which interruption or lack of comprehension arose, after participants had completed the recognition test, they were asked by the researcher if they thought that their performance in the test had been negatively impacted – in all cases participants felt they would not have performed any differently. Even though this happened only a couple of times it could have been avoided by telling participants to 'listen very carefully to each list as it will only be played once and will not be stopped until the end of the list, so any questions need to wait until the list has been heard and the test completed'.

During data collection issues regarding the two sets of statements in the illusory truth effect task also came to light. For the first set of statements a number of the older individuals had trouble understanding the instructions that stated, 'those statements said by a female are true, and those said by a male are false' (or vice versa). Some required further clarification, while a small number said that they understood the task, but then later when the second set of statements was provided they would mention in one way or another how they did not understand the female/male true/false part of the learning set of statements.

Although, it was only a small number of elderly individuals that stated they did not understand, it is possible that there were others who felt this way but did not say anything. In a worst case scenario this potentially explains why the results for the old group showed no significant differences between the three types of statements in the illusory truth effect task, because when reading the statements the older participants did not take into account or realise they were either true or false. A recommendation for future research would be to make the task instructions as clear as possible and include examples of the types of items that would be in the task, and explanations of what the examples mean, especially when working with older adults.

Another issue specific to the old group in the illusory truth effect task was with the measurements used in some statements (e.g., *the greatest distance a baseball has ever been thrown was 130 metres*). The original set of statements created by Begg et al. (1992) used imperial units. However, because New Zealand uses the metric system the imperial units were changed to their metric equivalents. Unfortunately, the Weights and Measurements Amendment Act changed New Zealand to the metric system in 1976, 34 years before the current study took place. Thus, many of the older individuals would have spent over half of their life using imperial units, and this showed in the task because some had trouble thinking about the measurements in the statements and presumably calculating whether the figures were realistic or not. Although this would seem to be a problem for only new statements, it could also be a problem for old true and old false statements if the individual did not recognise the statement or feel it was familiar enough to be considered old. A preferable way to present statements that contained measurements would be to provide both metric and imperial units (e.g., *the greatest distance a baseball has ever been thrown was 130 metres (426 feet and 9.5 inches)*).

Another potentially important factor concerned the length of the delay between learning and rating statements in the illusory truth effect. The fact that data collection was completed in one session instead of having a longer delay than 10 minutes (how long it took to do the false memory task) between the two sets of illusory truth effect statements could explain why none of the groups followed the expected truth rating pattern (OT > OF > N) found in previous studies (Arkes et al., 1989; Begg et al., 1992; Skurnik et al., 2005). Although the illusory truth effect has been observed for brief delays (Schwartz, 1982) it is likely to be stronger with larger delays[30] because it is possible that with only a 10 minute delay contextual details of the statements, such as source information, are still accessible enough to participants that they do not have to rely on the familiarity of the statements to make their truth judgements (Skurnik et al., 2005). However, this cannot explain why old false statements were rated the same as new statements (for all age groups); if truth ratings were based on recollection and/or source memory old false statements should have been rated *less* true than new statements.

Another point to consider is that the illusory truth effect statements utilised in the present study were taken from research by Begg et al. (1992) and Bacon[31] (1979), and these statements were originally drawn from a book of trivia. The intended audience for the book that Bacon (1979) drew on for material was North Americans, therefore, the statements would be of less relevance to New Zealanders. That is the North American focus of the questions may have meant that the statements' subject matter was less familiar and less

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[30] Jacoby et al.'s (1989) 'false fame' study showed that the effect occurs when participants are tested after a 24-hour delay, but not when participants are tested immediately.

[31] 'Bacon' was in fact a pseudonym used by Begg and associates.

interesting to New Zealanders (e.g., baseball instead of rugby), thereby, making participants less likely to pay attention to whether a statement was true or false. A recommendation for future research on the illusory truth effect with New Zealand samples would be to create a pool of statements based on trivia more appropriate to New Zealanders. The above procedural and material factors specific to each of the tasks are important and need to be considered in future research, yet, there are also more general limitations and recommendations that can be made – it is to these general limitations and recommendations that discussion now turns to.

General limitations and recommendations. A general concern relates to the sample of older adults used in the study. They were all community dwelling individuals recruited through community groups. Previous research has acknowledged that the extent of age-related memory deficits can vary according to certain characteristics of an individual. For example, a study by Craik, Byrd, and Swanson (1987) revealed that elderly individuals who lived in a retirement village that provided physical and mental stimulation performed substantially better on a number of memory tasks than older adults living less active lifestyles. In fact the more active older group performed as well on the memory tasks as the group of young undergraduate students, and of the young and old participants who were considered to have a low level of education memory performance of the older adults was worse than their younger counterparts. Therefore, education seems to serve as a buffer to some age-related memory impairments. The results found by Craik et al. indicate that sub-populations of the elderly perform quite differently from one another, and if these sub-populations were to be examined separately, or as part of a larger more representative sample, the findings may be quite different from those in the present research.

There were further limitations relating to the setting (most often a participant's personal residence) and the time of day (various times ranging from 9am to 9pm) in which data gathering took place. Generally, the setting was appropriate for carrying out the research and the tasks were completed without distractions or disturbances. However, distractions and disturbances could not be controlled and this was a problem in some cases. Variation in time of day of testing was problematic for older individuals, because elderly individuals generally perform better on cognitive tasks if tested in the morning (Intons-Peterson, Rocchi, West, McLellan, & Hackney, 1998). Research investigating age and optimal testing times has found that when comparing older adults not tested at their optimal time of day to older adults tested at their optimal time they were more likely to falsely recall (.66 compared to .38) and recognise critical lures (.86 verse .69) and non-critical lures[32] (.30 compared to . 16) (Intons-Peterson et al., 1999). Intons-Peterson et al. (1999) also found that when comparing non-optimally tested groups, older adults recalled and recognised more critical lures, but with optimally tested age groups no age-related differences in false memory occurrence was found. Therefore, the age-related differences found here regarding the illusory truth effect could be confounded by the time of day participants were tested. Although, it would be better to test participants all at the same time of day instead of various times, from a practical point of view (e.g., cost and time involved) this may not be realistic, but it could be incorporated into research as a covariate.

In addition, the time involved in participation for some individuals was quite a lot longer than others, especially when considering the time it took for the young and middle

[32] Non-critical lures are test items that were not presented at study, and were not semantically associated to the DRM word list(s) that were presented.

age groups (approximately 20-40 minutes) compared to some of those in the old age group (up to 60 minutes). It is possible that the time it took the older adults, coupled with the cognitive demands of the tasks, may have had a negative impact on the performance of the older individuals, and their performance could have benefited from a break between the tasks. However, none of the participants (old, middle, or young) said they found the tasks too difficult or that they wished to have a break or stop participation altogether.

Moreover, although the underlying mechanisms believed to be involved in the phenomena under study are thoroughly discussed and used to explain the results, none were explicitly investigated. For example source memory could have been examined by including a separate source memory task or including a source memory question in one of the tasks (e.g., in the second set of statements for the illusory truth effect task ask participants to state if they could remember if it was a male or female who said a given statement). Similarly, recollection/verbatim memory could be examined by employing Tulving's (1985) remember/know paradigm in one or both of the tasks. Data from these questions would likely provide greater evidence for the underlying mechanisms that have been discussed.

In addition, the following two ideas would also provide greater insight into processes that underpin age-related changes in the tasks. Schacter et al. (1997) describe that a number of different factors, on their own or in combination, potentially contribute to higher levels of false recognition in older individuals. The factors include age-related changes towards: (a) using more liberal response criteria, (b) judging items as old based on gist memory strategies, (c) a decrease in the capacity to differentiate target and non-target items, (d) and a deficit in item-specific memory. It is likely that these four factors will also affect illusory truth effect statement ratings because of the similarities in the mechanisms that underpin

the two tasks. Hence, future research should be conducted to investigate which of these factors, or what combination of these factors, cause older adults to often recognise more critical lures and rate old false and new statements as more true than younger adults. This could be done by including questions that require participants to make old/new judgements (e.g., Law et al., 1998; Roggeveen & Johar, 2002), or remember/know judgements (Tulving, 1985). In addition, varying the number of DRM list words presented before testing is believed to influence activation (the fewer DRM list words that are presented the less likely a critical lure will be activated) and thus source monitoring and item-specific details (e.g., Gallo & Roediger, 2003). Similarly, altering the precise details in the test set of illusory truth effect statements, from those that were presented in the learning set, would make item-specific details and recollection more important than familiarity or gist memories in judging the truthfulness of the statements (e.g., in the first set of statements a true statement is presented as *house mice can run approximately 19 km per hour*, while in the second set of statements it becomes a false statement, similar to the true statement that was presented, but now it states *house mice can run approximately 12 km per hour*).

Another point to consider is whether or not the research (described earlier) in which false memory creation is reduced when a combination of external and internal sources are used to present DRM list items (Hashtroudi et al., 1989; Hicks & Marsh, 1999) could be adapted for use with the illusory truth effect task. For example, if the true statements were heard by participants, while the false statements were read by participants, there may be a decrease in the illusory truth effect, with old false statements being rated less true than new statements and new statements being rated neither true nor false (guessing), because the old true and old false statements have more salient source variation (compared to simply using female or male names) and they can be remembered better based on more item-

specific details and characteristics. Taking into consideration the above points it is clear that future research will benefit from the knowledge gained concerning the limitations that came to light while conducting the current research. In addition, the exploratory analyses conducted in chapter four provide added support and recommendations for future research.

Recommendations Based on the Exploratory Analyses

In chapter four the exploratory analyses (that had the sample divided into seven similar-sized age groups) suggests a useful strategy for conducting further research into the claim that there exists a common susceptibility to false memories and the illusory truth effect. The results found that the critical lure total, old false truth ratings, and new statement truth ratings had significant age group differences. In addition figure 4.7 and figure 4.8 illustrated that there were two younger age groups (16-25 and 37-47 year olds) with surprisingly high critical lure totals. The other five age groups showed a steady age-related increase in mean critical lure totals. The subset of participants aged 16-25 and 37-47 who recognised a high number of critical lures[33] (7 or 8 out of 8 lures) brought the mean critical lure total up for those age groups (and therefore both the young and middle age groups) so they appeared as though they performed as poorly as individuals 54 years and older.

In addition, the exploratory analyses showed the expected age-related pattern between the groups' mean truth ratings of each statement type (this is also supported by the correlation analyses between age and the three types of illusory truth effect

[33] In the 16-25 year olds 15 out of 25 participants recognised a high number of critical lures, and in the 37-47 year olds 11 out of 24 participants recognised a high number of critical lures.

statements). These analyses are promising and based on these and other results found in the present research, it is reasonable to expect that further research will find evidence for a common susceptibility to DRM false memories and the illusory truth effect.

Conclusions

Several conclusions can be made based on the results of this study. One of the conclusions is that the mechanisms and/or strategies that underpin performance in the tasks in the three age groups (young 16-39, middle 40-60, and old 61+) appear to be the same, but the mechanisms and/or strategies which underpinned the DRM false memory task were different from those behind the illusory truth effect task. Another conclusion is that with ageing the mechanisms and/or strategies which underlie performance in the illusory truth effect task change. A third conclusion is that the current research uncovered some salient findings within the area of false memory that raise important questions to be answered by future research.

The results of the present study found no age-related differences in the DRM false memory task and each group had high critical lure and correct recognition scores. This indicates that either gist memory strategies were used in the task or that participants did not use spontaneous source monitoring strategies to avoid false memories. On the other hand, the results which found the young and middle-age groups performed equally, and better than the older group, in the illusory truth effect task, implies that source memory was utilised by the younger groups and, by contrast, the older group was let down by their source memory. In addition to source memory, familiarity was likely also an underlying mechanism driving performance in the illusory truth task, because old false statements were rated as being as true as new statements (they should have been rated as less true).

Therefore, it would seem that each of the three age groups were as likely as the next group to state they recognised critical lures and presented items, while in the illusory truth task participants took into account the familiarity of an item as well as memory for its true/false source.

The second conclusion takes into consideration the findings that the old groups' old false ratings were correlated with their critical lure totals and that they rated all three types of illusory truth effect statements equally, suggesting that, unlike the younger two groups, susceptibility to the two tasks was related. This behaviour is consistent with the idea that the mechanisms and/or strategies underpinning the tasks were the same or similar. Therefore, the older groups' illusory truth effect performance was based on a different mechanism than the younger two groups' performance. In addition, the fact that the older group rated all three types of illusory truth effect statements the same can possibly be explained by age-related source and recognition memory deficits which have been found in similar research (Koutstaal & Schacter, 1997; Law, 1998; Norman & Schacter, 1997; Rahhal et al., 2002; Schacter, Koutstaal, Johnson, et al., 1997), and it would imply that older individuals (people older than 61) are more likely than younger adults to believe claims they hear from a friend, read in a magazine, or see on the television (to provide a few examples). Even if older people had been presented with the idea earlier and they were told it was false they are more likely to believe it than a younger person would. Furthermore, these results have some applicability to persuasive messages (Hilton, 1995) and eyewitness testimonies (Loftus, 1979). Indicating that older adults (compared to younger adults) might be easily led into believing persuasive messages, following leading questions, and incorrectly remembering information presented by others (e.g., a lawyer) as their own memories.

Finally, the present research has highlighted a number of interesting findings, especially in relation to age-related differences in the illusory truth effect task, not only in the differences between each group, but also in the different patterns of how the three types of statements were rated when comparing the younger two groups to the older group. The fact that no age-related differences were found in the DRM false recognition task was also interesting, simply because it was an unexpected result. The results from the current research raise interesting questions that can be answered in future research. Such as, attempting to figure out under what conditions, if any, will research find a common susceptibility to the two tasks (e.g., employing different DRM procedures and illusory truth effect tasks). Also, attempting to figure out which of the different age-related changes contribute to higher levels of false memories, and what underlying mechanisms are involved when older adults perform similarly to younger adults in false memory tasks compared to the underlying mechanisms involved when older and younger adults perform differently.

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List of Appendices

Appendix A: Ethics Approval Letter

MASSEY UNIVERSITY

26 March 2010

Rachael Sim
101 Worcester Street
ASHURST 4810

Dear Rachael

Re: HEC: Southern B Application – 10/03
Effects of age on memory mistakes

Thank you for your letter dated 23 March 2010.

On behalf of the Massey University Human Ethics Committee: Southern B I am pleased to advise you that the ethics of your application are now approved. Approval is for three years. If this project has not been completed within three years from the date of this letter, reapproval must be requested.

If the nature, content, location, procedures or personnel of your approved application change, please advise the Secretary of the Committee.

Yours sincerely

J. O'Neill

Prof John O'Neill, on behalf of Acting Chair
Massey University Human Ethics Committee: Southern B

cc Dr Stephen Hill
School of Psychology
PN320

A/Prof Mandy Morgan, HoS
School of Psychology
PN320

Massey University Human Ethics Committee
Accredited by the Health Research Council
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E humanethics@massey.ac.nz animalethics@massey.ac.nz gtc@massey.ac.nz
www.massey.ac.nz

Te Kunenga
ki Pūrehuroa

Appendix B: DRM Recognition Tests

Dream	
Rest	
Awake	
Doze	
Train	
Yawn	
Sleep	
Blanket	
Bed	
American	
Snore	
Tired	
Sister	
Nap	
Drowsy	

Hesitant	
Molasses	
Delay	
Wait	
Stool	
Turtle	
Snail	
Lethargic	
Traffic	
Slow	
Cautious	
Pear	
Fast	
Elastic	
Stop	

Mad	
Door	
Shade	
Screen	
View	
Sill	
Curtain	
Chilly	
Sash	
Window	
Shutter	
Open	
Frame	
Leader	
Pane	

Village	
Country	
City	
Capital	
Metropolis	
Urban	
Suburb	
Crowded	
Physician	
Big	
New York	
State	
Aunt	
Dive	
Subway	

Climb	
Bike	
Ski	
Temper	
Climber	
Summit	
Range	
Mountain	
Hospital	
Glacier	
Peak	
Date	
Hill	
Top	
Valley	

Brook	
Water	
Tide	
Sandwich	
Stream	
Run	
Lake	
Coffee	
River	
Winding	
Mississippi	
Barge	
Creek	
Winter	
Bridge	

Boards	
Rugged	
Rough	
Garage	
Tough	
Ground	
Bumpy	
Gravel	
Sandpaper	
Lion	
Sand	
Smooth	
Noon	
Riders	
Course	

Reek	
Perfume	
Scent	
Web	
Aroma	
Smell	
Hear	
Breathe	
Rose	
Cake	
Whiff	
See	
Nose	
Nostril	
Bank	

Appendix C: One Version of the Learning Set of Statements and Instructions

Tear off this sheet to assist you with the following task

Please read each of these statements and rate each on the six point scale (by circling the number) to indicate how interesting you think each is.

Note, those statements said by a **female** are **true**, and those said by a **male** are **false**

6 = very interesting

1 = not interesting

Statements	How interesting is this statement? (6= very interesting, 1= not interesting)					
Kathy says eighteen newborn possums can be placed in a teaspoon	6	5	4	3	2	1
Ben says toenails grow faster than fingernails	6	5	4	3	2	1
William says two nails driven into a tree trunk, one above the other, will become further apart as the tree grows	6	5	4	3	2	1
Kyle says the bazooka, developed by the British Army, was first used in 1942	6	5	4	3	2	1
Sue says in 1904 the ice-cream cone made its debut on the American scene	6	5	4	3	2	1
Anna says Boogie Woogie music originated in the lumber and turpentine camps of Texas and Louisiana	6	5	4	3	2	1
Nick says the temperature of a hen's body is about forty degrees Celsius	6	5	4	3	2	1
George says two different kinds of sugar are found in honey: Glucose and fructose	6	5	4	3	2	1
Melissa says the greatest distance a baseball has ever been thrown was 130 metres	6	5	4	3	2	1
Bill says the normal life of a canary is about twelve years	6	5	4	3	2	1

Annie says sixty days are required for a housefly to become a great-grandmother	6	5	4	3	2	1
Kathryn says one baby in 1,000 is born with harelip	6	5	4	3	2	1
Zack says Daniel Webster spent twenty years making his famous dictionary of the English language	6	5	4	3	2	1
Eric says the population of the world is increasing at the rate of about 5,000 every day	6	5	4	3	2	1
Tom says Cardinal Messofanti spoke thirty-seven languages fluently	6	5	4	3	2	1
Mary says it is estimated that the world's average rainfall is sixteen million tons per second	6	5	4	3	2	1
Brandon says about six hours are required to hard-boil an ostrich egg	6	5	4	3	2	1
Kate says the blood of a human being makes a complete circuit of the body every twenty-three seconds	6	5	4	3	2	1
Billy says Stephen Foster, famed writer of songs, died a pauper and an alcoholic at the age of forty-two	6	5	4	3	2	1
Heather says Buenos Aires, Argentina, is the largest city south of the equator	6	5	4	3	2	1
John says the wool from ten cashmere goats is required to produce enough material for one overcoat	6	5	4	3	2	1

Stephanie says in 1896, J. J. Thomson, of Cambridge University, announced his discovery of electrons	6	5	4	3	2	1
Amanda says the average housewife will wash two and a half million articles of cooking and eating utensils in her lifetime	6	5	4	3	2	1
Matt says the heart of a snake is located about on-half the distance from its head to its tail	6	5	4	3	2	1
Elizabeth says in 1923, Thomas Buck Hine invented the first smoke screen for concealing the movement of troops and ships	6	5	4	3	2	1
Katie says Egypt has the lowest suicide rate in the world	6	5	4	3	2	1
Michael says five kilograms of nitrogen per acre falls on the earth each year as a result of rain	6	5	4	3	2	1
Emily says the largest elephant tusk on record measured three and a half metres in length and forty-six centimetres in circumference at its girth	6	5	4	3	2	1
Lauren says chemically, corn sugar is the same as cane and beet sugar	6	5	4	3	2	1
Sally says the speed of a homing pigeon in still air is forty-eight to sixty-four kilometres per hour	6	5	4	3	2	1
Phillip says a baby elephant sucks with its trunk, not with its mouth	6	5	4	3	2	1
Robert says the rattlesnake sheds its skin five or six times a year	6	5	4	3	2	1

Daniel says the neck of the giraffe contains fourteen vertebrae. The flexible necks of birds contain seven vertebrae	6	5	4	3	2	1
Allison says the American robin is not a robin. It is a thrush	6	5	4	3	2	1
Megan says in the country of Greece, fifty percent of dentists are women	6	5	4	3	2	1
Frank says in March 1810, Louis XVI was married by proxy to Mary Louise, daughter of Emperor Frances I of Austria	6	5	4	3	2	1
David says Henry Ford forgot to put brakes in his first automobile	6	5	4	3	2	1
Laura says an ordinary white oak tree may give off as much as 567 litres of moisture through its leaves in a single summer day	6	5	4	3	2	1
Kelly says Butterflies taste with their feet	6	5	4	3	2	1
Michelle says usually it is easier to teach the male parrot to talk than the female	6	5	4	3	2	1
Paul says a bear cub at birth weighs only five to six kilograms	6	5	4	3	2	1
Courtney says a beech tree can consume more than 189 litres of water per day	6	5	4	3	2	1
Andrew says the most prevalent infection in the world today is cholera	6	5	4	3	2	1

Jason says the first seeing eye dog was presented to a blind person on May 25, 1938	6	5	4	3	2	1
Jennifer says sheep have three times as many red corpuscles as humans do	6	5	4	3	2	1
Jessica says there are only about 11,000 kilometres of railroads in Belgium	6	5	4	3	2	1
Aaron says the three predominating colours in flowers are: red, white, and blue. In that order	6	5	4	3	2	1
Tyler says a temperature of about twenty-five degrees below zero is required to freeze pure alcohol	6	5	4	3	2	1
Mark says the record high jump for a flea is sixty-eight centimetres	6	5	4	3	2	1
Karen says the inside of a cucumber is often seven degrees cooler than the surrounding air	6	5	4	3	2	1

Appendix D: Test Set of Statements and Instructions

Tear off this sheet to assist you with the following task

Please read each of these statements and rate each on the six point scale (by circling the number) to indicate how **true** or **false** you think it is.

6 = certainly true

1 = certainly false

Statements	True or False (6=certainly true, 1=certainly false)					
Crocodiles sleep with their eyes open	6	5	4	3	2	1
Twenty-nine kilometres per hour is the highest measured speed for a reptile on land	6	5	4	3	2	1
The inside of a cucumber is often seven degrees cooler than the surrounding air	6	5	4	3	2	1
Toenails grow faster than fingernails	6	5	4	3	2	1
A temperature of about twenty-five degrees below zero is required to freeze pure alcohol	6	5	4	3	2	1
Airmail stamps were first issued May 13, 1926	6	5	4	3	2	1
The neck of the giraffe contains fourteen vertebrae. The flexible necks of birds contain seven vertebrae	6	5	4	3	2	1
Chemically, corn sugar is the same as cane and beet sugar	6	5	4	3	2	1
The average housewife will wash two and a half million articles of cooking and eating utensils in her lifetime	6	5	4	3	2	1
Five kilograms of nitrogen per acre falls on the earth each year as a result of rain	6	5	4	3	2	1

The American robin is not a robin. It is a thrush	6	5	4	3	2	1
A beech tree can consume more than 189 litres of water per day	6	5	4	3	2	1
More earthquakes occur in Japan than in any other country; Chile ranks second	6	5	4	3	2	1
The smallest known species of fish in the world reaches an average length of nine and a half millimetres and a maximum length of eleven and a half millimetres	6	5	4	3	2	1
In 1923, Thomas Buck Hine invented the first smoke screen for concealing the movement of troops and ships	6	5	4	3	2	1
There is no place on earth that is entirely free from electrical storms	6	5	4	3	2	1
Stephen Foster, famed writer of songs, died a pauper and an alcoholic at the age of forty-two	6	5	4	3	2	1
The population of the world is increasing at the rate of about 5,000 every day	6	5	4	3	2	1
Sixty percent of people will never have any "wisdom teeth"	6	5	4	3	2	1
Boogie Woogie music originated in the lumber and turpentine camps of Texas and Louisiana	6	5	4	3	2	1
In the country of Greece, fifty percent of dentists are women	6	5	4	3	2	1

The push-key typewriter was patented on February 5, 1850	6	5	4	3	2	1
Henry Ford forgot to put brakes in his first automobile	6	5	4	3	2	1
One baby in 1,000 is born with harelip	6	5	4	3	2	1
About six hours are required to hard-boil an ostrich egg	6	5	4	3	2	1
It was Aristarchus who theorised that without a medium of propagation, man would not hear sound	6	5	4	3	2	1
The most prevalent infection in the world today is cholera	6	5	4	3	2	1
Sheep have three times as many red corpuscles as humans do	6	5	4	3	2	1
The normal life of a canary is about twelve years	6	5	4	3	2	1
A bear cub at birth weighs only five to six kilograms	6	5	4	3	2	1
Banana stalks are not trees in the correct sense of the term. They are large grasses that reach their full growth in one season	6	5	4	3	2	1
Egypt has the lowest suicide rate in the world	6	5	4	3	2	1

The rattlesnake sheds its skin five or six times a year	6	5	4	3	2	1
In 1904 the ice-cream cone made its debut on the American scene	6	5	4	3	2	1
An ordinary white oak tree may give off as much as 567 litres of moisture through its leaves in a single summer day	6	5	4	3	2	1
The earliest system as yet discovered for delivering water to cities was built by the Phoenicians	6	5	4	3	2	1
The wool from ten cashmere goats is required to produce enough material for one overcoat	6	5	4	3	2	1
Sixty days are required for a housefly to become a great-grandmother	6	5	4	3	2	1
Two different kinds of sugar are found in honey: Glucose and fructose	6	5	4	3	2	1
In 205 B. C, the Romans passed a law prohibiting women from driving chariots	6	5	4	3	2	1
Daniel Webster spent twenty years making his famous dictionary of the English language	6	5	4	3	2	1
There are 3,070 counties in Canada	6	5	4	3	2	1
The bazooka, developed by the British Army, was first used in 1942	6	5	4	3	2	1

There are only about 11,000 kilometres of railroads in Belgium	6	5	4	3	2	1
At its greatest depth the Pacific Ocean measures eleven kilometres deep	6	5	4	3	2	1
A human being has about 639 muscles	6	5	4	3	2	1
The greatest distance a baseball has ever been thrown was 130 metres	6	5	4	3	2	1
The record high jump for a flea is sixty-eight centimetres	6	5	4	3	2	1
When the London dentists were first incorporated in 1461, they were the only persons practicing surgery in the city	6	5	4	3	2	1
Eighteen newborn possums can be placed in a teaspoon	6	5	4	3	2	1

Appendix E: Information Sheet

MASSEY UNIVERSITY
COLLEGE OF HUMANITIES
AND SOCIAL SCIENCES
TE KURA PŪKENGA TANGATA

Effects of age on memory mistakes

INFORMATION SHEET

Who is doing this project?

Hello, my name is Rachael Sim and I am currently working on my Master of Arts degree in psychology. This research is part of the requirements to complete this qualification from Massey University. The supervisor for my research is Dr. Stephen Hill, who is based at Massey University in Palmerston North. If at any stage you have any questions regarding this research, please feel free to contact myself or Stephen Hill in the following ways:

Rachael Sim

Phone 027 6252277
Email rachael_sim@yahoo.com

Dr. Stephen Hill

Phone (06) 356 9099 ext. 7566
Email s.r.hill@massey.ac.nz
Mail School of Psychology
Massey University
Private Bag 11-222
Palmerston north

What is the project about?

This project is interested in the way you remember lists of words and facts. We are not only interested in how many you accurately remember; we're also interested in the kinds of mistakes you make, and what kinds of things you remember better than others. Memory mistakes are normal in everyone and the mistakes we make provide interesting information about the way normal, everyday memory works.

This is an invitation for you to participate in this project. If you wish to participate please contact me (Rachael) using the contact information above and we can arrange a time and place so you can take part in the project.

How are participants being identified and recruited?

Approximately 150 participants aged 16 years and older are being asked to voluntarily participate in this research. 150 are required because we are comparing three different age groups and we need approximately 50 in each group to detect the patterns and effects in the data.

Participants are being recruited a number of ways, including, through community groups, undergraduate Massey classes, and by word of mouth. The only requirements are that your over 16 years old, are proficient in the English language, and have reasonable ability to read, write, and hear (including with the use of aids).

There should be no discomforts or risks to participants as a result of participation. However, there will be a debriefing period after participation should any problems arise.

What does the study involve?

The project consists of the following four phases:

- You will be asked to read and rate 50 true or false statements.
- You will then be asked to listen to a recording of a list of approximately 15 words, which will be followed by a short recognition test. This phase will be completed eight times, with eight different recorded lists and recognition tests.
- The third phase requires you to read and rate another set of 50 statements.
- Lastly, you will be asked to complete a very short questionnaire.

The time involved for the entire process, including, reading information sheets, signing consent forms, and the final debrief, is about 25-45 minutes.

What will happen with the information?

The responses given during the four phases will be recorded and collated with those of other participants'. The collated results will then be used to evaluate the study questions discussed earlier in this form. All information given will be kept confidential, and individual results will not be personally identifiable in the research findings. Data will be kept separate from consent forms, and both will be kept securely for a period of five years before being destroyed.

The consent form offers a space where you can provide your personal e-mail or postal address so that we can provide you with a written summary of the research findings.

Your right as a participant

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- Withdraw from the study at any time, but please note to remain in the study you must complete all tasks because data from all tasks is required for the study to be viable.
- Ask any questions about the study at any time during participation.
- Provide information on the understanding that your name will not be used unless you give permission to the researcher.
- Be given access to a summary of the project findings when it is concluded.

For student participants, neither grades nor academic relationships with the School of Psychology or members of staff will be affected by your refusal or agreement to participate.

Ethical approval information

This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern B, Application 10/03. If you have any concerns about the conduct of this research, please contact Dr Karl Pajo, Chair, Massey University Human Ethics Committee: Southern B, telephone 04 801 5799 x 6929, email humanethicsouthb@massey.ac.nz

Thank you for your interest in this study and taking the time to read this.

Appendix F: Participant Consent Form

Effects of age on memory mistakes

PARTICIPANT CONSENT FORM

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature: ..... **Date:** .....

Full Name (printed) .....

I would like to be sent a summary of the overall research findings when they become available.

(Please tick one) ☐ via e-mail

☐ via post

(Please write clearly your e-mail or postal address)

E-mail .....

Address .....

.....

.....

.....

Appendix G: Participant Questionnaire

Effects of age on memory mistakes

Participant Questionnaire

Please clearly write your age (in years) _____

Do you identify as (Please tick one)

Female ☐

Male ☐

Appendix H: Critical Lure Total Histograms and Q-Q Normality Plots

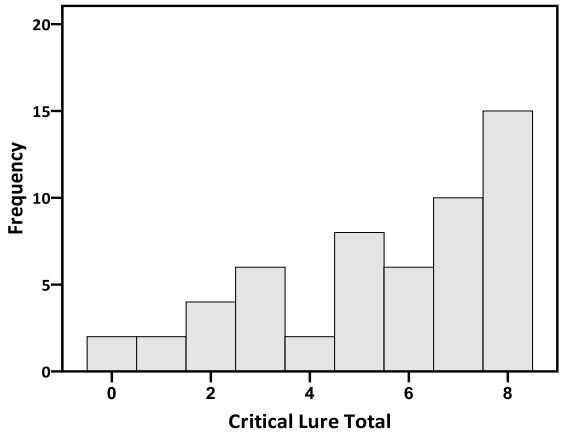

Figure H1. Histogram of critical lure totals in the young age group.

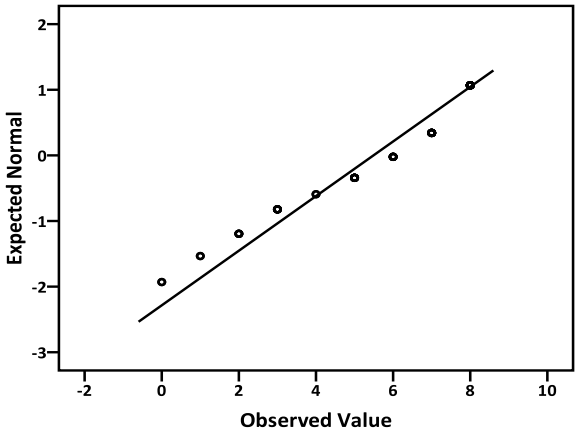

Figure H2. Normal Q-Q plot of critical lure totals in the young age group.

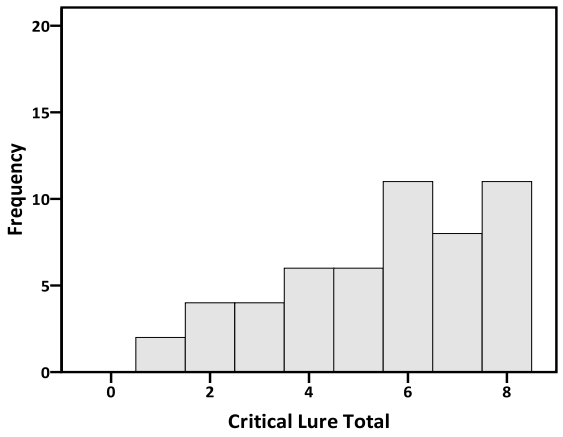

Figure H3. Histogram of critical lure totals in the middle age group.

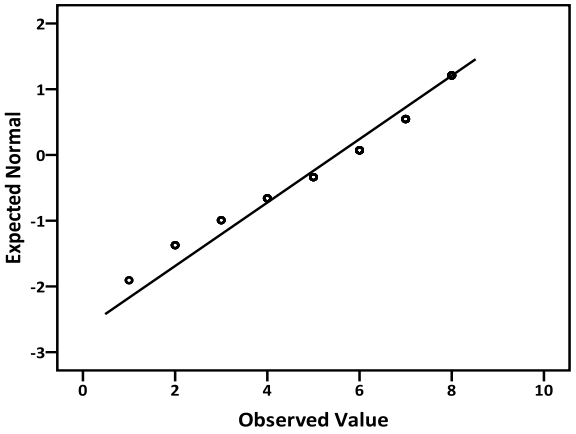

Figure H4. Normal Q-Q plot of critical lure totals in the middle age group.

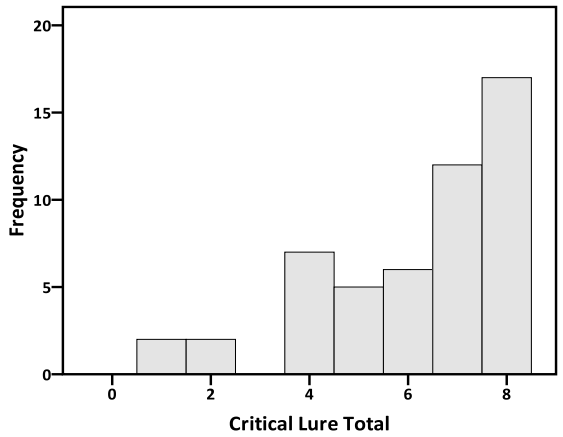

Figure H5. Histogram of critical lure totals in the old age group.

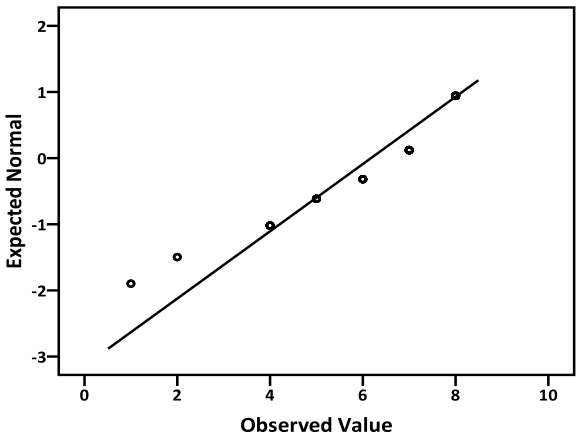

Figure H6. Normal Q-Q plot of critical lure totals in the old age group.

Appendix I: Old True Statement Average Rating Histograms and Q-Q Normality Plots

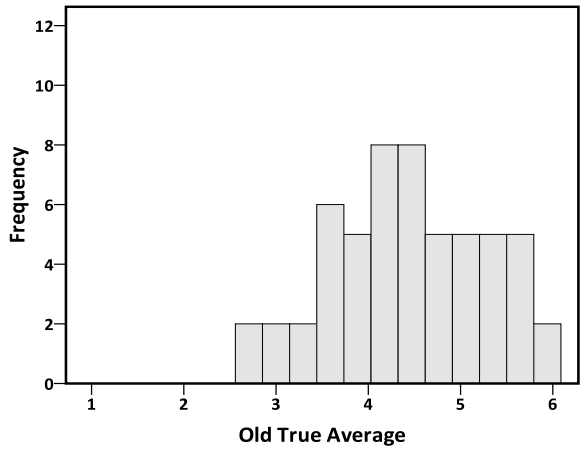

Figure I1. Histogram of old true statement ratings in the young age group.

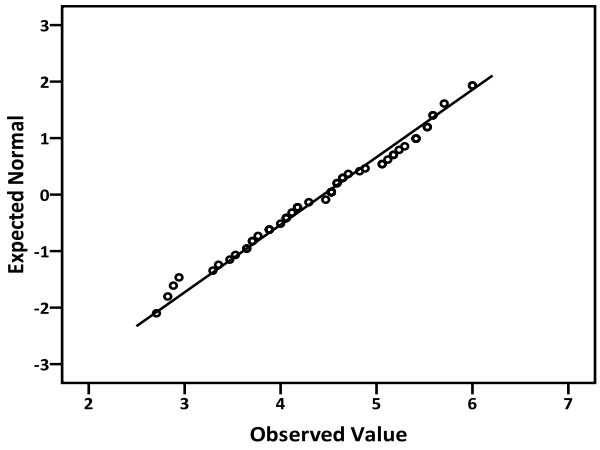

Figure I2. Normal Q-Q plot of old true statement ratings in the young group.

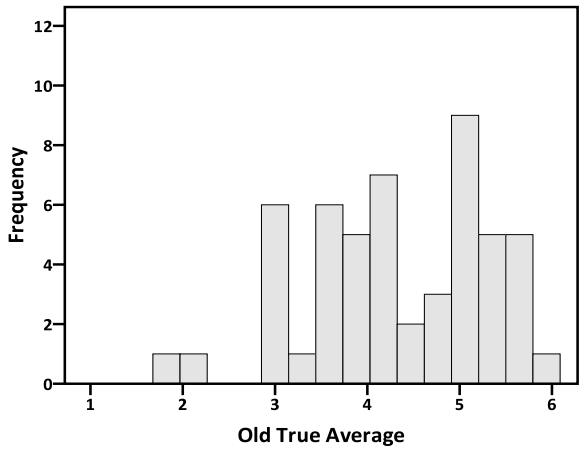

Figure I3. Histogram of old true statement ratings in the middle age group.

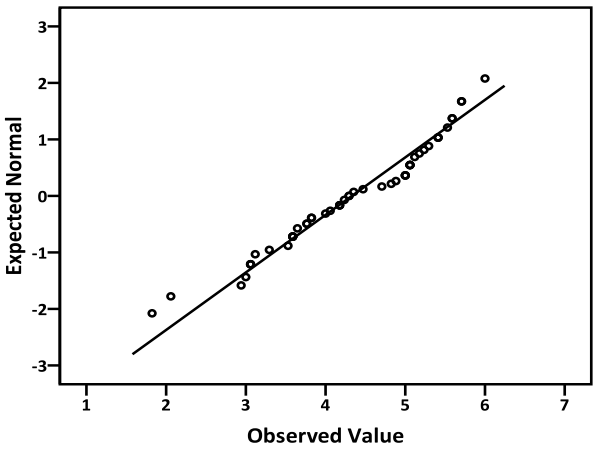

Figure I4. Normal Q-Q plot of old true statement ratings in the middle age group.

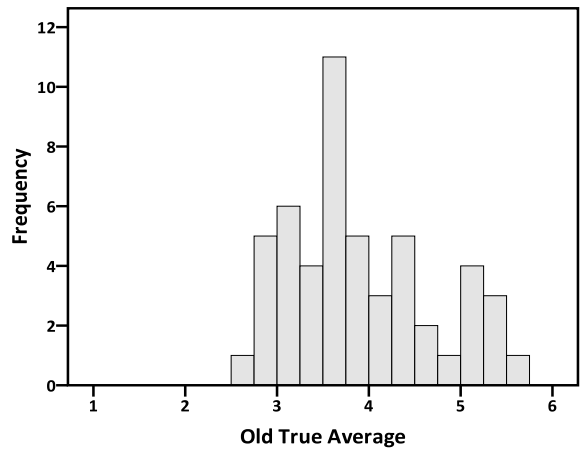

Figure I5. Histogram of old true statement ratings in the old age group.

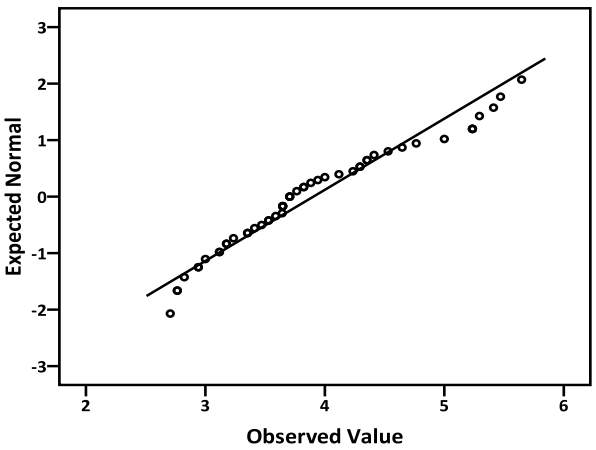

Figure I6. Normal Q-Q plot of old true statement ratings in the old age group.

Appendix J: Non-Critical Lure Total Histograms and Q-Q Normality Plots

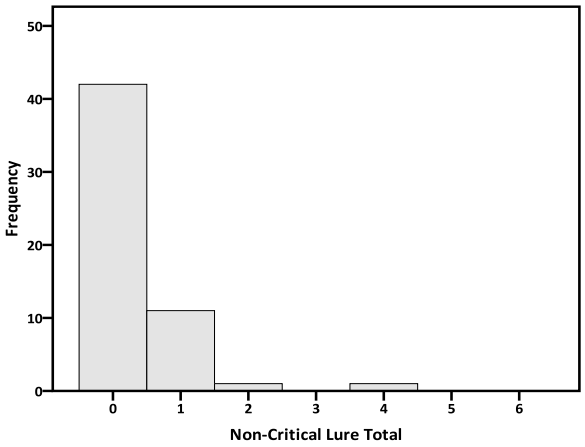

Figure J1. Histogram of non-critical lure totals in the young age group.

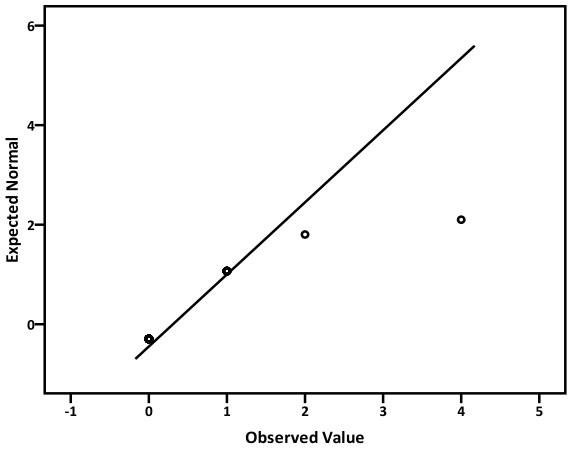

Figure J2. Normal Q-Q plot of non-critical lure totals in the young age group.

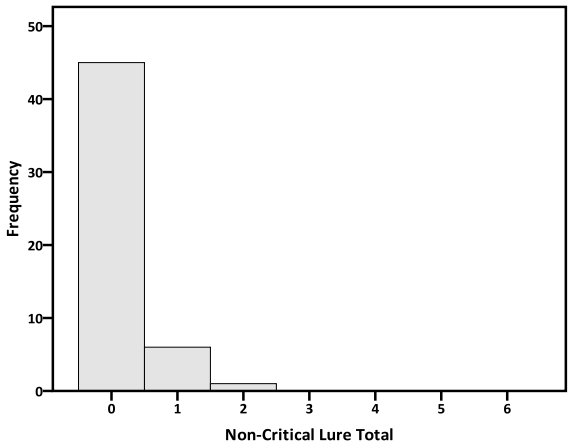

Figure J3. Histogram of non-critical lure totals in the middle age group.

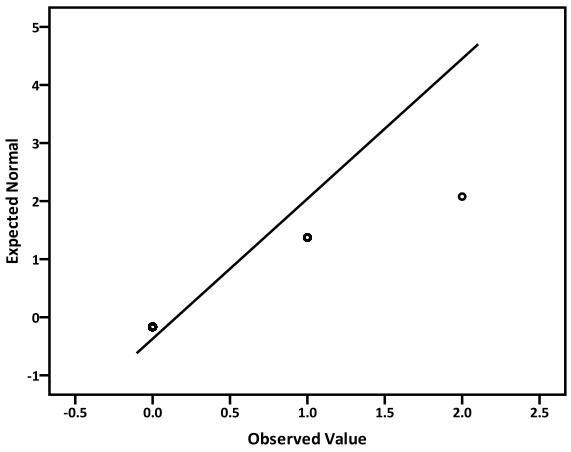

Figure J4. Normal Q-Q plot of non-critical lure totals in the middle age group.

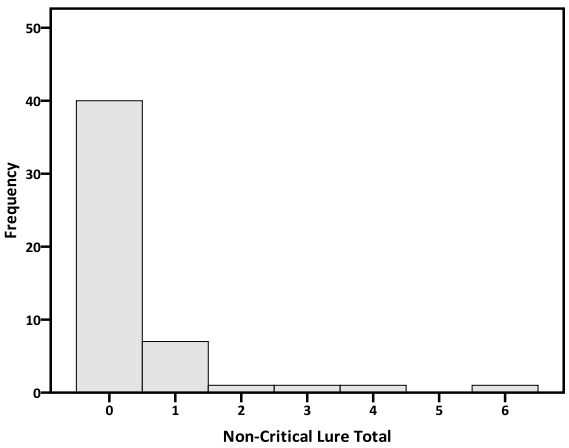

Figure J5. Histogram of non-critical lure totals in the old age group.

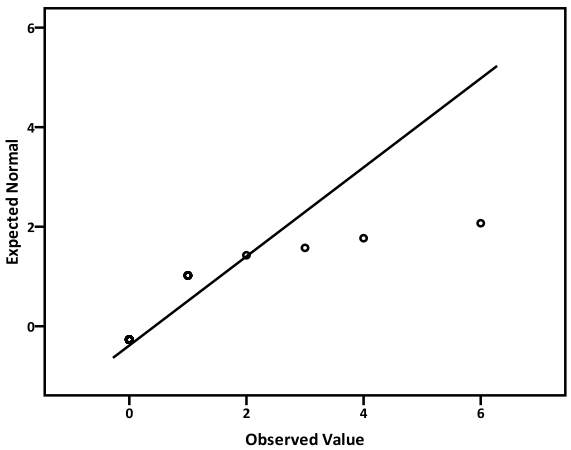

Figure J6. Normal Q-Q plot of non-critical lure totals in the old age group.