Modulating false and veridical memory: The effects of repetition and alcohol at encoding.

by

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Declaration

I hereby declare that this thesis has not been submitted, either in the same or different form, to this or any other University for a degree.

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22nd December 2005

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ABSTRACT

Alcohol and study list repetition were used to manipulate encoding quality to gain insight into the mechanisms underlying false memories. The DRM paradigm (Deese 1959b; Roediger & McDermott 1995) was used to elicit false memories. Participants studied lists of words (veridical items) which were semantically related to a critical non-presented item, which, if erroneously endorsed, served as the measure of false memory. Implicit and explicit tests of memory were used, and remember know judgments were also taken. An anterograde impairment of memory after alcohol was obtained for veridical items using explicit tests, although no effect of alcohol was found using implicit measures. Alcohol reduced false memory levels relative to placebo for material viewed once at encoding. In accordance with previous empirical research, repetition was found to increase, decrease or have no effect on false memory levels. The introduction of distinctive pictorial stimuli at encoding resulted in an inverted U-shaped relationship between repetition and false memories, though this effect was confined to remember judgments only. The increase in false memories as a function of repetition was greater in the alcohol group than in the placebo group, whilst the placebo group was better able to use extended repetitions to reduce false memories. These results are accounted for using the Activation and Monitoring Framework (Gallo & Roediger 2002). It is suggested that reduced levels of false memories under alcohol for material viewed once can be attributed to reduced activation within semantic networks resulting from superficial encoding under alcohol (Craik 1977) and impoverished attentional resources when intoxicated (Steele & Josephs 1988). The selective impairment of recollective traces under alcohol (Duka *et al.* 2001) may limit the potential for extended repetitions to diminish false memories under alcohol. The role of metacognitive factors in affecting false memory endorsement is also discussed.

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Chapter 1. General introduction

1.1. False memory

Empirical investigators have not adopted any one standardised definition of what constitutes a false memory, yet there is broad agreement that they occur when "people believe that they have experienced an item or event which is actually novel" (Dodson *et al.* 2000, pg. 392). This process is thought to involve either "remembering events that never happened, or remembering them quite differently from the way they happened" (Roediger & McDermott 1995, pg. 803). The first empirical research into the reconstructive nature of memory is largely credited to Bartlett (1932), who made the distinction between reproductive and reconstructive memory. The principle of reconstruction suggests that remembering is not necessarily a faithful reproduction of the past, but instead is an active process that is guided and shaped by people's knowledge and beliefs about the world. Bartlett (1932) thus established a potential theoretical basis for erroneous accounts of past occurrences. It was almost half a century later, however, before research into the nature of the malleability of memory began in earnest. This was initially fuelled by an acknowledgement on the part of non-psychologists of the implications of the possibility that memory is not a faithful representation of the past, especially with regard to the legal system (Wright & Loftus 1998). Initially, false memory research was preoccupied with the aetiology and consequences of inaccurate, yet 'honest' eyewitness testimonies. Research focused on the potential role of impassioned questioning in 'instilling' false memories through the power of suggestion (e.g. Loftus 1997). In addition, Roediger and McDermott (1995) attributed the primary impetus for the surge of interest in false memory research to an increase in the number of cases in which memories of previously unrecognised abuse were reported during therapy. Such a claim is substantiated by research which indicated that the nature of therapeutic practices themselves in 'recovering' such memories could actually lead to their inception (Lindsay & Read 1994; Loftus 1993). Beckett (1996) noted that, between the years 1992-1994, a shift occurred in the way in which the media portrayed sexual abuse allegations, whereby an emphasis was placed on the inaccuracy of memories, along with their potential for false allegations. It was in reference to contested memories of sexual abuse that the actual term 'false memory' initially gained prominence (DePrince *et al.* 2004).

DePrince *et al.* (2004) observe that once the term 'false memory' gained notoriety in the popular media, it then started to be adopted in the cognitive empirical literature. By the early 1990s, the genesis of memory errors had become one of the principle issues for memory research (Stadler *et al.* 1999). This interest went beyond question of the validity of eyewitness testimony and the recovered memory debate, and moved on to a consideration of the intrinsic worth and implications of memory inaccuracies. Previously, errors in memory were largely only deemed relevant insofar as they obscured the true values of accurate memory (Roediger *et al.* 2001). Consequently, they were incorporated in the calculations of researchers to correct veridical memory from what were viewed simply as guesses. Such erroneous memories were thus considered a nuisance, as opposed to being seen as interesting in their own right. In his article 'The seven sins of memory', Schacter (1999) identifies seven distinct transgressions of memory, labelled transience, absentmindedness, blocking, persistence, misattribution, suggestibility and bias. The first three reflect different types of forgetting, persistence refers to pathological remembrances, whilst the final three are concerned with memory distortion and hence are implicated in false memories. Schacter (1999) argues that these 'sins' should not be viewed as flaws in the system, but rather as by-products of an adaptive memory system. Crucially, this reflects a shift in how false memories are considered, and a new acknowledgement that investigation into the habitual ways in which memory fails has the potential to provide insight into the nature of underlying memory processes. Similarly, through the use of variables at encoding – such as alcohol – further insight can be gained into the mechanisms underlying false memories and the effect of such variables on memory processes.

1.1.1. Paradigms

There are different paradigms for the empirical investigation of false memories. yet it has been proposed that the distinct ways in which they elicit false memories reflect different underlying processes (e.g. Schacter 1999). False memory paradigms which feature eye witness testimonies depend largely upon suggestibility, the phenomenon whereby the memory for an event incorporates extraneous information, such as misleading questions (e.g. Loftus *et al.* 1978). In such studies, 'witnesses' typically observe an event and are subsequently subjected to misleading questions or information which is later incorporated into the memory for the initial event (see Loftus *et al.* 1995). Empirical eye witness studies gained prominence under the pioneering work of Loftus and colleagues in the late 1970s, fuelled by the apparent real world implications of the vulnerability of eye witness testimony to suggestion. The principle of suggestion also gained notoriety due to the controversy surrounding the debate concerning the validity of recovered memories for childhood sexual abuse. Consequently, studies were conducted which did not incorporate an initial encoding episode, but were able to demonstrate that suggestion alone had the potential to instill false recollections of autobiographical episodes in a substantial proportion of preschool children (Ceci & Bruck 1993). In addition, hypnotic suggestions have been shown to implant illusory events within up to 50% of highly hypnotisable individuals (Laurence & Perry 1983), and 'dream interpretation' by an experimenter has been shown to lead to the recall of events in accordance with a particular dream interpretation (Mazzoni & Loftus, 1998).

Schacter (1999) argues that, whilst such studies demonstrating false memories of real occurrences may be compelling, they are constrained by the fact that experimenters can not determine definitively whether a target event actually did occur or not. Studies which control the encoding of the initial event in question as a means to overcome this failing (e.g. Loftus *et al.* 1978), are dependent upon the presence of extraneous information provided by the experimenter as a means to instill the false memory.

In contrast, paradigms exist which can give rise to 'spontaneous' false memories, which can occur due to perceptual or conceptual similarity to experienced events (Schacter 1999). In 1959 Deese published a paper that reported a false memory effect whereby people erroneously recalled a word which was associated with a list of studied semantically related words. This paradigm remained largely neglected until it was subsequently revived and restructured by Roediger and McDermott (1995) (see also Read *et al.* 1996). Now termed the DRM paradigm, it is composed of lists of associated veridical words which are viewed in the encoding phase (e.g. *hill, valley, climb, summit,* etc.), with each list related to a non-presented semantic associate (e.g. *mountain*), termed the critical item. The probability that this non-presented critical item will subsequently be erroneously recalled or recognised as having been previously presented serves as the measure for false memory. Thus the DRM procedure offers an unadorned technique to elicit and to investigate false memories in a standard list-learning paradigm.

Since its revival, the DRM paradigm has been the basis for much recent empirical false memory research. Its popularity can in part be attributed to the robustness with which it generates false memories in both recall and recognition. Roediger and McDermott (1995) found mean levels of false recognition memory to be marginally greater than veridical recognition for items within the centre of the serial position curve. Many subsequent studies found roughly equivalent levels of false and veridical memory using the DRM paradigm (e.g. Mather *et al.* 97; Payne *et al.* 1996). More recently Stadler *et al.* (1999) developed a series of norms denoting the standard false recall and recognition rates for various lists. The probability that a given list would give rise to a subsequent false memory varied considerably for different lists. For example, the probability of erroneously recalling the critical false memory item window was .65. This value was far higher than the probability of erroneously recalling the critical item king, which was calculated to be .10 (Stadler *et al.* 1999). Whilst these two examples are polarised extremes, they are indicative of the variation inherent within individual lists in giving rise to different false memory levels. Consequently, when designing experiments, it is imperative that lists are matched for levels of false memory and that a fully counter-balanced design is employed to ensure that group variations in false memory levels to not stem from the materials.

1.2. Models of memory

The DRM procedure generates quantitative measures of both veridical and false memory. Consequently, cognitive models of both veridical memory and false memory will be discussed. It is necessary to match the theoretical underpinnings of models which account for veridical memory with false memory models. This will ensure consistency for the mechanisms addressed. A number of studies have investigated the extent to which single-process signal detection models are in accordance with false memory data (e.g. Westerberg & Marsolek 2003). Certain theorists have argued that the graded RTs and confidence ratings for false memory items are compatible with a single dimension model of recognition memory based upon familiarity (e.g. Jou *et al.* 2004). Brainerd *et al.* (2003), however, state that there is a "general consensus that some type of dual-process theory is necessary to account for false recognition and false recall data that have been reported for the DRM paradigm" (*pg.* 462). Consequently, discussions of memory models will be limited to dual process models.

1.2.1. Veridical Memory

Dual-process models of recognition memory have dominated over single strength memory models over the last 40 years. They typically postulate the existence of two distinct memory processes which serve to affect memory judgements - one which is based upon familiarity, and another which requires recollection (e.g. Atkinson & Juola 1974; Jacoby 1991; Mandler 1980; Yonelinas 1994). Familiarity is assumed to be the faster process, reflecting global memory strength (e.g. Yonelinas 2001; Yonelinas 1999). In contrast, recollection is consider to be a slower process, whereby, when making a memory decision, individuals 'search' their memories as a means to recall quantitative aspects of studied stimuli.

Dual-process theories, whilst all postulating the existence of recollective and familiarity processes, differ in how they conceptualise these distinct processes and in how these processes should be measured (Yonelinas 2001). Jacoby (1991) argued that recollection and familiarity should be perceived in terms of attentional control; therefore the relative contributions of these processes in memory decisions should be reliant on the degree to which control over the memories can be exercised. The *process dissociation procedure* was devised by Jacoby as a means to assess quantitative estimates of recollection and familiarity. Jacoby argued that tasks were not process pure, thus by putting these two processes both in opposition to each other and in concert with each other, their relative contributions to a given task could be determined.

Yonelinas (1994) proposed an alternative approach to distinguish between recollective and familiarity based processes. He put forward a dual-process model which incorporated a signal-detection component based on familiarity (see Figure 1.1), and a threshold-based retrieval component founded upon recollection (see Figure 1.2).

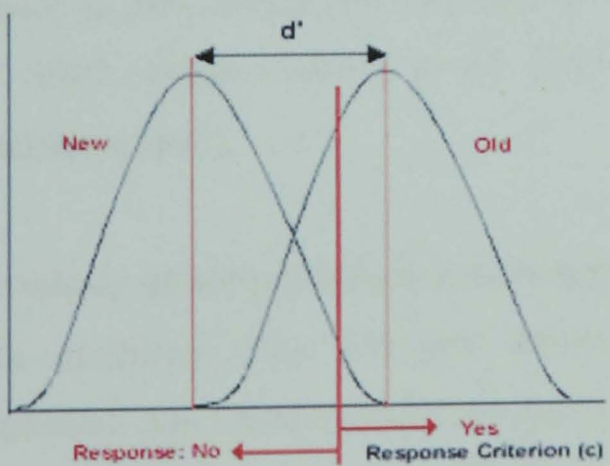

Figure 1.1. **Familiarity distributions for old and new items.**

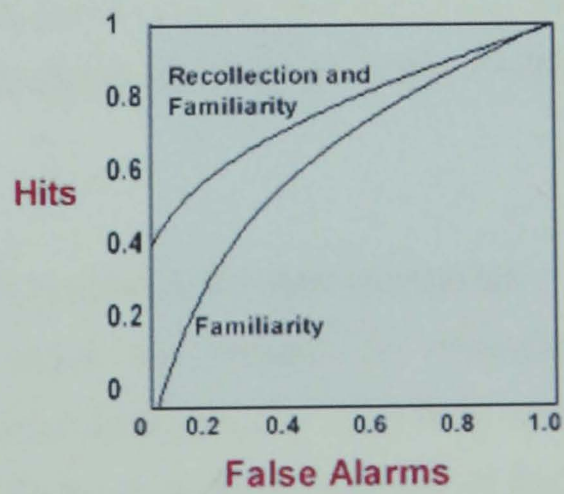

Figure 1.2. **Relationship between recollection and familiarity.**

It is assumed that, during retrieval, both processes aid responses, but that recollection processes lead to high confidence responses, whilst familiarity assessment supports a wider range of memory confidence responses (Yonelinas 2001). Thus the distinction which Yonelinas makes between recollection and familiarity can be differentiated based upon response confidence (Yonelinas 2001).

In contrast to both Yonelinas and Jacoby, Tulving (1985) argued that recollection and familiarity are distinguished as a function of conscious experience associated with the act of remembering. He postulated that familiarity was founded upon the principle of 'noetic consciousness' which constituted memory in the absence of conscious awareness for the learning episode, whereby at test, the item in question elicited a sense of 'knowing' that the item was previously presented. In contrast, recollection was associated with 'autonoetic consciousness', which, at retrieval, resulted in the conscious re-experience of episodic aspects of the memory in question. Tulving developed the remember / know procedure to measure these distinct types of memory which required positive recognition decisions to be accompanied by a remember or know response, with remember responses reflecting recollective processes, and know responses being indicative of familiarity based processes. In the adult false memory literature, the use of the remember / know procedure has tended to be the method of choice to gain insight into recollective and familiarity based processes (e.g. Mather *et al.* 1997; Pernot-Marino *et al.* 2004; Dewhurst & Farrand 2004; Dewhurst & Anderson 1999).

Problems of the prominence of remember responses for false memories

The empirical false memory literature which has utilised the remember/know procedure has found recollective experience for false memory items to be comparable to remember responses found for hits (e.g. Gallo *et al.* 2001; Roediger & McDermott 1995). Higham and Vokey (2004) point out that, according to dual process theory, recollection is thought to involve "the conscious retrieval of veridical episodic information from an earlier encounter with a stimulus and gives rise to a feeling of reliving a past event" (pg. 714) and familiarity is "associated with fluent conceptual and perceptual processing, stimulus similarity and a vague, source non-specific feeling of remembrance" (pg. 714). Consequently, they argue, it follows on from dual process theory that both familiarity and recollective processes potentially underlie veridical memory, whereas false recognition decisions are based only on familiarity (Higham & Vokey 2004). Indeed, Yonelinas (2002) assumes that recollection is always accurate. Higham and Vokey make the argument that dual process theory – as it is traditionally conceived – cannot account for false remember data. Higham and Vokey acknowledge the different theories which have attempted to account for false recollection in a dual process framework (see pg. 716). In addition, they propose two alternative revisions which could be made to the assumptions underlying dual process theory to accommodate false recollection. They favour a revision to the recollection-remember identity assumption – this would allow for familiarity processes to affect recollection judgements (see pages 733-734).

1.2.2. False Memory Models

Different theories have been proposed to account for the mechanisms underlying false memories. Benjamin (2001) argues that these theories can broadly be classified into two distinct types. Those labelled *multistorage* theories, account for false memories in terms of different types of memory traces, the leading example being fuzzy trace theory (FTT) (e.g. Reyna & Brainerd 1995). In contrast, those theories termed *multioperational*, posit the presence of additional processes. The Activation Monitoring Framework (AMF) (Gallo & Roediger 2002) is a recent framework that incorporates a number of these processes, uniting them in a unitary framework. FTT will firstly be defined, and the reasons for not pursuing it as the principle explanatory framework with be outlined. Discussion will then centre upon the AMF, with an initial theoretical focus on the mechanisms it incorporates, followed by supportive empirical evidence.

1.2.2.1. Fuzzy Trace Theory

Fuzzy Trace Theory (FTT) was first introduced in two seminal papers by Reyna and Brainerd in 1990 (Brainerd & Reyna, 1990). The most comprehensive account of FTT was outlined by Reyna and Brainerd (1995), though peripheral revisions have occurred since then (Reyna & Brainerd 1998). It was devised to address the mechanisms underlying false and veridical memory, and specifically to address the issue of age variability for false memory generation, by relating this to developmental changes in the nature of memory traces (e.g. Reyna & Lloyd 1997). FTT is a dual process theory, and its central assumption is that memories are not unitary representations. Instead, FTT argues that memories involve two distinct traces; verbatim traces, which are thought to be perceptual in nature and composed of an item's surface form, and gist traces, which are considered to represent the semantic, relational and elaborative processes of a stimulus (Brainerd & Reyna 1998). Non-unitary, in this context, refers to the core assumption of FTT that gist and verbatim representations are stochastically independent (Reyna & Brainerd 1990). When applying FTT to the DRM paradigm, both verbatim and gist traces can underlie veridical items, but memory for critical items is supported by gist traces alone, as no perceptual traces exist for these non-presented items (Payne *et al.* 1996). In order to address how gist memories give rise to false recollections of perceptual details, three mechanisms have been suggested using FTT: firstly, through gist reconstruction (Reyna 1992); secondly, due to the process of forgetting induced by trace disintegration, isolated perceptual details may survive and be recalled in conjunction with gist traces (Brainerd *et al.* 1990; Reyna & Brainerd 1995); lastly, repeated cueing of gist traces has been hypothesised to give rise to a process termed 'phantom recollection' whereby gist memories are strengthened untill they give rise to vivid recollections (Brainerd *et al.* 2001).

Whilst FTT was born out of the investigation of developmental variations in false memories, many studies exist which demonstrate the breadth of explanatory and power inherent within FTT. As noted by Reyna (2000), FTT has contributed to the understanding of infantile amnesia (Leichtman & Ceci 1995), ageing (e.g. Koutstaal & Schacter 1997) and a variety of brain disorders, such as amnesia (e.g. Schacter *et al.* 1996). With regard to the false memory literature, empirical research exists which supports the notion that memory is composed of two distinct traces with different properties. In particular, a prolonged retention interval has shown that false memories persist to a greater extent than true memories; a finding which is consistent with the differential deterioration rates of gist and verbatim traces (Thapar & McDermot, 2001). Crucially, active manipulation of encoding strategies which emphasised either verbatim or gist encoding, found corresponding changes in false memory levels as predicted by FTT (e.g. Libby & Neisser, 2001)

FTT, although it is a number of researchers theoretical framework of choice to account for false memories (e.g. Brainerd *et al.* 2001; Reyna, 2000), will not be pursued within this thesis. Fierce battles currently exist within the literature regarding the relative merits of different explanatory frameworks to account for false memories (e.g. Reyna 2000; Lindsay & Johnson 2000). As argued by Higham and Vokey (2004), the explanatory power of FTT comes at the cost of 'precision and testability'. This stems from the fact it posits more than one mechanism which can give rise to false memories – allowing for post-hoc accounts which best fit the patterns of data (Higham & Vokey 2004). In addition, FTT is classified as a *multistorage* theory, in that factors which serve to inhibit or facilitate both false and veridical memories are accounted for in terms of their differential effect on gist and verbatim traces. This poses a problem if it is not known how the factors in question impact upon these traces. In contrast, *multiprocess* based theories use terminology and processes (e.g. source monitoring and semantic activation) which are consistent with memory research that was conducted outside the sphere of false memory research. When, for example, doing investigative research with factors which have limited previous research in false memories, it is possible to devise grounded predictions about the way in which these factors will affect false memory levels, provided empirical research exists which document how these factors affect processes thought to underlie false memories.

1.2.2.2. Activation Monitoring Framework

The Activation Monitoring Framework (AMF) was proposed by Roediger and colleagues (e.g. Roediger *et al.* 2001; Gallo & Roediger 2002). It postulates dual opponent processes which determine false memory levels; an activation component and a monitoring component. False memories are thought to be elicited via their activation, and false remembering is thought to subsequently occur when monitoring fails and individuals misattribute the source of this activation to prior presentation. Under the AMF, activation of the critical item can occur via two discrete pathways. Firstly, conscious thought of the critical item during the processing of list items results in its representation within semantic networks being directly activated. This pathway builds on the theory proposed by Underwood (1965) and is founded upon the assumption that critical items come to conscious thought as the result of the formation of explicit associations between veridical items at encoding. Goodwin *et al.* (2001) designed an experiment to investigate the conscious activation route. During the encoding of word lists, participants were required to verbalise semantic elaborations. Using a path analysis, it was demonstrated that participants' verbalisation of critical items during encoding served to predict subsequent levels of false recall. Seamon, Lee *et al.* (2002), following on from the findings of Goodwin *et al.* (2001), designed a study to determine whether such conscious thought of the critical item was essential for subsequent false recall. It was found that overt-rehearsal of the critical-word at study enhanced false recall, thus supporting Goodwin *et al.* (2001). In contrast, conscious thought of the critical item had no effect on false recognition or remember judgments for falsely recognised critical words. Thus, thinking of critical words during study was demonstrated to enhance false recall but have no effect on false recognition levels and consequently cannot be deemed as essential for eliciting a false memory, particularly in regard to recognition testing. The alternative route leading to activation of the critical item is thought to be the automatic spread of activation within semantic networks. Under this route, conscious thought of the critical item is not deemed necessary, as the mere processing of veridical items is considered sufficient for activation to spread to the critical item. The monitoring component within the AMF functions to ascertain the source of this activation, with erroneous attribution of familiarity thought to derive from prior presentation leading to false memory. Correctly identifying the source of the activation reflects a successful 'reality monitoring process' (e.g. Johnson *et al.* 1993), as it supposedly demonstrates the ability of individuals to successfully attribute the activation of the critical items to internal (e.g. thinking of the critical items) as opposed to external (e.g. prior presentation) factors. It has been argued that such a process is dependent upon intact recollective memory (e.g. Benjamin 2001).

A large body of empirical evidence exists which is in accordance with the AMF. As the AMF is formed of opponent processes, it can accommodate both an increase and decrease in false memory levels dependent upon the extent to which factors differentially affect activation and monitoring potential. Fundamentally, one can predict that any process which selectively enhances activation should lead to an increase in false memory, whilst any manipulation that increases monitoring should cause a decrease in false memory. A review of how factors which selectively affect activation and monitoring process serve to affect false memory processes will be conducted.

1.2.2.2.1. Activation

Empirical research has demonstrated that the manipulation of factors which increase semantic activation can result in a consequential increase in false memories, in particular: level of processing manipulations (Toglia *et al.*, 1999; Thapar & McDermott, 2001; Rhodes & Anastasi, 2000), semantic relatedness, particularly in regard to backwards associative strength, (Gallo & Roediger 2002; Deese, 1959b; Roediger *et al.*, 2001; Robinson & Roediger 1997) and the role of expertise (Baird 2001).

Levels of processing

The levels of processing (LOP) framework was originally devised by Craik and Lockhart (1972). It detracted from the view of memory as a series of stores and stages, and stated that the depth at which information is processed denotes the probability the information will be remembered. Processing depth was assumed to run along a spectrum from shallow perceptual and sensory analysis requiring little attention, to deep semantic elaborative processing. As semantic processing is thought to involve the interpretation and enrichment of stimuli through the use of associations within stored knowledge, manipulation of processing depth thus serves to vary the extent to which semantic networks in the brain are activated. Consequently, LOP manipulations serve as a methodological construct with which to investigate the degree of semantic activation on subsequent false memory levels.

Toglia *et al.* (1999) manipulated the task performed during encoding. Subjects were required to perform a semantic task (pleasantness rating) or a graphemic task (does the word contain the letter "a"). The standard level of processing effect was found for veridical items as semantic processing increased the number of words recalled relative to graphemic processing. In addition, an increase in false recall paralleled this finding; more semantic false memories were produced under semantic processing than under graphemic processing. This finding was replicated by Rhodes and Anastasi (2000), who demonstrated that participants who engaged in deeper levels of processing (concrete/abstract ratings and category sorting) recalled significantly more veridical and critical items than participants who engaged in more superficial processing tasks (vowel counting). Thapar and McDermott (2001) also demonstrated this level of processing effect for the recall of both veridical and critical items, and expanded this finding to the domain of false and veridical recognition. Depth of processing by definition increases semantic processing and the extent of semantic processing is thought to directly impact the degree of activation within semantic networks. Consequently, the monotonic relationship found between processing depth and false memory levels supports the activation component of the AMF as being integral to the formation of false memories.

Backwards associative strength (BAS)

Another way in which to investigate how semantic activation affects false memories is to examine the way in which semantic relatedness of veridical to critical items affects subsequent false memory. Backwards associative strength is a value indicative of the strength of connections from the veridical item to the critical item, and can thus be taken as a measure of the degree of activation of the critical item when processing corresponding veridical items (Gallo & Roediger 2002).

Deese (1959) found that false recall was highly correlated (r = .87) to the mean associative strength of veridical items to the critical item. This finding was supported by a series of experiments performed by Gallo and Roediger (2002), who found a strong positive correlation between mean backwards associative strength (MBAS) and probability of false recall. In addition, a multiple regression analysis performed by Roediger *et al.* (2001) isolated BAS (associative connections from the study words to the critical item) as the single most predictive factor determining subsequent false recognition.

Experiments performed by Robinson and Roediger (1997) appeared to indicate that total BAS, as opposed to MBAS appeared to be the dominant determinant of FM. They manipulated list length (3, 6, 9, 12 or 15 words) and found that a proportionate relationship existed between list length and probability of false recall. When filler words were added as a means to standardise list length, length of list did not increase false memories. The lists which had the fewer items tended to have a higher MBAS; the greatest associates are presented at the beginning, and thus longer list have a tendency to have a lower MBAS due to the inclusion of less related associates. Consequently, the sum of the total associative strength appeared to be the determinant factor of FM levels.

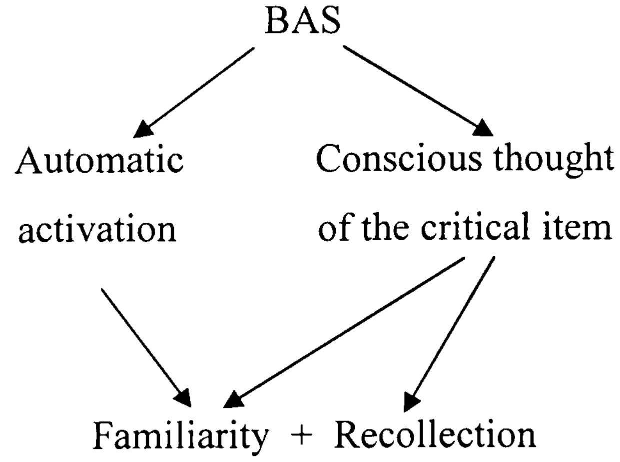

Figure 1.3. **The hypothesised phenomenological consequences of the different activation routes**

Increased BAS would serve to increase the activation of the critical item, either through the spread of activation within semantic networks, or through an increased likelihood that the critical item will come to conscious thought. Gallo and Roediger (2002) hypothesise that these two distinct routes could be considered to increase the familiarity of the item in question. In addition, increased probability of conscious activation could subsequently increase the strength of 'remember responses' due to subsequent recall and misattribution at test (see figure 1.3). This theorising appears to be supported by confidence ratings made to critical items. It was found their confidence levels for both familiarity and recollection based judgments for critical items increased as MBAS increased. Such a finding is compatible with activation based explanations: if BAS increases the familiarity and/or recollection felt for critical items, then the concordant increase in confidence ratings serves as a behavioural manifestation of supposedly increased activation.

Expertise

Expertise within a particular domain has been found to increase the number and strength of associations between terms and concepts within that domain (Baird 2001). Under principles of semantic activation, items processed within a particular knowledge framework should be more likely to activate associative but non-presented words (i.e. the critical items). In addition, the strength of the connection is more likely to lead to a superthreshold activation of the non-presented item and should thus lead to the increased endorsement of the critical item, providing this activation is misattributed to prior presentation.

Baird (2001) tested students with and without expertise in the domain of investment. Veridical and false memory was tested for words either in the domain of investment (domain-relevant), or words in a different area (domain-irrelevant). It was found that investment and non-investment students did not differ in their levels of false or veridical memory for domain-irrelevant words, indicating comparable base-line veridical and false memory across the two populations. In contrast, investment students recalled significantly more veridical and false investment-related words. As investment students were found to have more connections between investment related terms (Baird 2001), this result is compatible with a notion of the integral role of associative connections within semantic networks in the aetiology of false memories.

1.2.2.2.2. Monitoring

The monitoring component of the AMF is based upon the source monitoring framework (SMF) (e.g. Johnson *et al.* 1993). The SMF assumes that memory for an item is composed of a number of components such as semantic and perceptual features, in addition to records of the cognitive operations performed on the item in question. These can take the form of emotional responses to the item, cognitive processes performed in interpreting the item and associations with the item. At retrieval, participants have the potential to assess the qualitative nature of the memories to determine their source, with source confusions arising from misattribution of the memory to an erroneous source. For example, in the DRM paradigm, participants may mistakenly attribute the familiarity of a critical item to prior presentation, whereas it actually derives from semantic relatedness to presented items, and hence should lack the perceptual detail accompanying memory for veridical items. Indeed, studies have demonstrated that phenomenological differences between true and false memories exist. When the memory characteristics questionnaire was used to assess the qualitative nature of veridical and false memories, it was found that false memory items contained less auditory detail and fewer remembered reactions and feelings than were reported for veridical memories (Mather *et al.* 1997). It follows that if studied material is presented from distinct sources, participants are better equipped to utilise their enriched memories for veridical items to 'suppress' familiarity from critical items and consequently reduce their false memories.

Hicks and Marsh (1999) performed a series of experiments in an attempt to reduce false recall levels by employing source monitoring techniques. They investigated the assumption that when false memories were learnt from more than one source, the incidence of false memories would decline. It was found that such a decline was only found when sources were sufficiently distinct from one another. For example, sources which were both external (e.g. pronounced by a male versus female experimenter) were not found to reduce false recall, relative to a single source control condition. Similarly, when sources were both internal in nature (e.g. words given pleasantness ratings versus words given frequency ratings) no subsequent reduction in false memories was found. In contrast, when sources were either internal or external (e.g. words generated from anagrams versus words pronounced by a male experimenter), the incidence of false recall was found to decline relative to a single source control by approximately 50% (Hicks & Marsh 1999). Hicks and Marsh (1999) interpreted their findings within the context of the source monitoring framework, arguing that presenting the DRM paradigm from different sources potentially provides diagnostic evidence which can be used to 'edit out' false memories. It was also argued that sources which were sufficiently distinct provided enriched memories which served to make the decision process at retrieval more conservative. Thus if the recalled memory lacked accompanying source-specific detail, it was thought that participants would reject it. As the benefits afforded by source were only found for reality monitoring judgments (i.e. internal versus external sources), Hicks and Marsh (1999) argued that only highly discriminable sources enriched memories sufficiently to enable individuals, as a means to suppress false recall, to differentiate between items from the two presented sources and critical non-presented items.

Distinctiveness

Varying the degree of distinctiveness of stimuli (e.g. presenting veridical words with accompanying pictures) at encoding acts to enrich memories and thus could be viewed as increasing the potential for source monitoring. Much recent work on false memories has used distinctiveness at encoding as a way to reduce subsequent false memories (e.g. Israel & Schacter 1997). Research has shown that veridical and false memories differ in phenomenological complexity, specifically in regard to the detail inherent in them, and the reported feelings when 'encoding' them (Neuschatz *et al.* 2001). Consequently, as critical words were never encountered at encoding, increasing the complexity of veridical items increases the potential for a greater phenomenological disparity between veridical and critical words. This would thus aid their differentiation when monitoring, which could account for the decrease in false memories when information at encoding is made distinctive.

Retention interval

Empirical investigations have been conducted which investigated the role of varying retention intervals on true and false memories using the DRM. Retention interval has been shown to affect veridical and false memory differently, but studies have been somewhat inconsistent in the methodologies they have employed, and thus their findings differ. McDermott (1996) found a pattern whereby, as retention interval increased, the relative proportion of false memory to veridical memory increase. Veridical memory initially exceeded false memory on immediate testing, but a delay of 2 days produced a greater proportion of false memory than veridical memory. However, this study can be criticised for not equating the memory tests used; initially memory was assessed using single test recognition, whereas memory was assessed after 2 days using free recall, and memory for all presented lists was tested. Toglia *et al.* (1999) also varied retention interval, and found that veridical memory always exceeded false memory, but that whilst veridical memory declined as retention interval increased, false memory remained constant. This finding mirrored that of Seamon, Luo *et al.* (2002), who found an inverse relationship between retention interval and veridical memory levels, but that retention interval had no effect on false memory. One can interpret these findings as being in accordance with the AMF, as they can be accounted for in terms of the effect of retention interval on source monitoring ability. Traces become less distinct with time, leading to their demise and a subsequent drop in memory levels (Thapar & McDermot, 2001). This decline is likely to be more detrimental for veridical memories, since any eroding of their traces simply results in a reduced probability of later memory of that item. In contrast, whilst the erosion of memory traces for critical items also reduces the probability of memory for those items, memory for critical items also benefits from retention induced 'lack of clarity' for veridical items. This is because as memories for the words become less distinct, participants are less able to source monitor and counteract the familiarity elicited by critical items, a process which could increase the probability of false memory. These two opponent processes could be hypothesised to 'cancel each other out', which could account for the finding that retention interval has not been found to affect false memory levels (Toglia *et al.* 1999; Seamon *et al.* 2002).

Ageing and false memories

Older adults have been found to be more susceptible to false memories, despite possessing equivalent or reduced veridical memory relative to younger adults (e.g. Balota *et al.* 1999; Norman & Schacter, 1997). One of the mechanisms proposed to account for this finding is a reduced ability for the elderly to source monitor. The elderly have been found to be less accurate than younger adults at determining whether an event was witnessed in a videotape or viewed in a photograph (Schacter *et al.* 1997), and at distinguishing between whether an item was seen or imagined (Henkel *et al.* 1998). The impairment amongst the elderly in source monitoring ability cannot be viewed as an artefact stemming from poorer overall memory, for even when their veridical memory is equivalent to younger adults, their source memory has been found to be impaired (e.g. Henkel *et al.* 1998). Benjamin (2001) investigated how false memory levels varied with the repetition of DRM study lists in young and older adults. It was found that in the younger group, false memory levels were reduced with subsequent repetitions, whereas in the elderly group repetition of study lists increased false memory levels. Benjamin (2001) accounted for this finding by arguing that with successive repetitions, younger adults were able to recollect veridical items, whist critical items were supported primarily by familiarity based proceses. At retrieval, younger participants were better able to utilise these recollections as a means to derive more accurate allocations of source – prior presentation versus familiarity deriving from semantic relatedness to veridical items. Consequently, younger participants were thought to counteract the familiarity of critical items with an absence of their recollection[1], leading to a reduction in false memories with repetition. In contrast, repetition served to increase false memories in the elderly. Benjamin argued that an impairment of recollection in the elderly (e.g. Cohen & Faulkner 1989) meant they did not increase their potential to source monitor with successive repetitions, and

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[1] Although not acknowledged by Benjamin (2001), theories have been proposed to account for the erroneous recollection of false memory items - such as 'phantom recall' (Brainerd *et al.* 2003).

consequently false memories increased monotonically with repetition. Such a finding indicates that the potential to source monitor is largely dependent on participants' ability to recollect.

1.3. Repetition at encoding

It can be argued that repetition has the potential to affect both the activation and monitoring processes hypothesised to underlie false memory. With increased repetition, there is the potential for repeated activation of critical associates, resulting in a greater net strength and a subsequent rise in false memories. In addition, increased repetitions also provide the opportunity for richer encoding, which would aid monitoring processes and hence assist subjects in differentiating between items which were presented and those which were not, resulting in a decrease in false memories. The potential for repetition to both increase activation of critical associates and increase monitoring ability, and the divergent effect that these two processes have on false memory levels, can account for the differential effect of repetition on false memory. Repetition has been shown to both increase false memories (e.g. Seamon *et al.* 2002; Benjamin 2001; Schacter *et al.* 1998) and decrease them (e.g. Benjamin 2001; Schacter *et al.* 1998;). In the cases where false memory has been shown to increase with repetition, specific methodologies employed, or the nature of the subjects used, meant that monitoring processes were impaired. For example, Seamon *et al.* 2002 showed an increase in false memory with repetition when subjects encoded the DRM lists at a 20m/s exposure rate. Seamon *et al.* (2002) hypothesised that such an exposure rate was sufficient for participants to encode the words and for this encoding process to give rise to automatic activation within semantic networks. Yet it was hypothesised that this time was insufficient for participants to encode item specific information. Consequently, at test, subjects were impaired in their ability to differentiate between familiarity incurred from previously viewing a word, and familiarity which derived from semantic activation. In contrast, when Seamon *et al.* (2002) gave more time for subjects to encode the lists, repetition served to decrease false memory. Seamon *et al.* (2002) claimed that this time was sufficient for item-specific information to be encoded, aiding the processes of determining which items were indeed presented. Similarly, Benjamin (2001) found an increase in false recognition with repetition when subjects were forced to make speeded recognition decisions. Consequently, as argued by Benjamin, these subjects were reliant on familiarity alone as the criterion for prior presentation as they did not have time employ monitoring processes which could have served to derive the source of that familiarity. In addition, Schacter *et al.* (1998) found that repetition of study lists and testing trials increased false memories in Korsakoff amnesic patients. Schacter *et al.* (1998) argue that this is evidence for how veridical episodic memory can suppress levels of false memory. In addition, that subjects can use veridical episodic traces as evidence for prior presentation, and use the lack of such traces for critical items as evidence that they were not presented during encoding (Schacter *et al.* 1998). Such episodic traces are impaired amongst Korsakoff amnesics, thus reducing their potential to counteract the increased familiarity engendered by critical items due to repetition. In contrast, adults who did not have Korsakoff amnesia, demonstrated a reduction of false memory with repetition (Schacter *et al.* 1998).

1.3.1. Inverted U-shaped curve

As previously mentioned, a number of experiments have independently demonstrated the potential for repetition of DRM study lists to selectively increase or decrease false memory. To date, only one experiment has used, within a single study trial, varying amounts of repetition on a within-subjects basis to demonstrate a rise, and then subsequent fall, of false memory with repetition (Seamon *et al.* 2002). One can equate repetition with the degree of learning. This differential effect of repetition can be accounted for by inferring a relationship between the extent activation and monitoring processes will influence memory decisions based upon the degree of learning. Initially, activation of critical items occurs, accounting for the initial increase in false memories with repetition. With increased repetitions, at some point, the potential for monitoring and thus distinguishing between items presented and those which were not is possible, and a subsequent drop in false memories results. Benjamin (2001) forms a parallel between activation and familiarity based processes. He argues that the activation of critical items results in a subjective sense of familiarity felt for those items which underlies their endorsement at test. Benjamin then goes on to argue that with increased learning, the potential to recollect veridical items and thus better distinguish between items which were presented and those which were not is increased. Consequently, based on arguments by Benjamin (2001) a causal relationship between increased learning, recollection and the ability to source monitor is formed. This perspective is somewhat simplified as it fails to acknowledge the potential for the erroneous recollection of false memory items (e.g. Brainerd *et al.* 2003). Nevertheless, recollection of false and veridical items has been shown to differ in the complexity of the memories (Neuschatz *et al.* 2001), thus when source monitoring, it should still be able to differentiate between present and non-presented items. Using the AMF and familiarity/recollection distinctions, it should be possible to modify the inverted u-shaped curve by manipulating factors which differentially affect these dual processes. Alcohol serves as a variable with which do this.

1.4. Alcohol and memory

The effects of alcohol on veridical memories has been researched extensively since the mid 1960s (see section 1.4.1). In contrast, the effect of alcohol on false memories has received very little attention (the noticeable exceptions being Milani & Curran 2000; Mintzer & Griffiths 2001, see section 1.4.2.). Further research into the way in which alcohol affects false memories thus warrants investigation. Moreover, alcohol can also be used as a tool to investigate the mechanisms underlying false memories. This follows on from a tradition where researchers have used pharmacological agents as a means to provide insight into underlying mechanisms: "A number of investigators, however, have systematically used drugs as tools to explore cognition; for these researchers drugs are seen as tools with which to create reversible and graded lesions which can be used to investigate dissociations in different cognitive domains. Their agenda is clearly driven by cognitive issues rather than by pure psychopharmacology" (Duka *et al.* 1996, pg. 408).

1.4.1. Alcohol and veridical memory

The effect of alcohol on memory – whether it has a deleterious or facilitative effect – has been shown to be dependent upon the temporal relationship between alcohol administration, the encoding of stimuli and the administration of the test (Brinbaum & Parker 1977). Alcohol can have a deleterious effect on memory for information encoded when intoxicated, and this effect is well established (e.g. Parker and Birnbaum 1976). In contrast, memory for information encoded prior to an alcoholic drink has been shown to be enhanced relative to when a placebo is consumed (e.g. Parker *et al.* 1980). Both these effects will be addressed in turn.

1.4.1.1. Anterograde effects

The detrimental anterograde effects of alcohol on episodic long term memory are now well established. Alcohol, like other psychoactive drugs such as benzodiazepines, has consistently been shown to result in a dose-dependent amnesia for material learnt post-consumption (e.g. Parker & Birnbaum 1976). For example, Parker *et al.* (1974) found that the ability of participants to recall words and organise material decreased with increasing doses of alcohol. Ryback (1971) characterised the detrimental effects of alcohol on memory as a dose-related continuum, with minor impairments at one end, and with far greater doses culminating in the alcoholic blackout. (e.g. Goodwin *et al.* 1970). Experiments which have manipulated the time of intoxication have determined that the locus of the anterograde impairment is thought to act primarily at encoding (Parker *et al.* 1976). For example, Birnbaum *et al.* (1978) equated the initial storage of two groups, and provided alcohol only at retrieval for one of the groups. It was found that alcohol intoxication [mean BAC = .8g/l] did not impair memory relative to a placebo control on measures of speed, accuracy nor the benefit afforded by cues, yet alcohol was found to impair new learning [when mean BAC = .07g/ml].

The effect of alcohol for material learnt whilst intoxicated has been found to be more marked for recall than for recognition; for example, Hashtroudi *et al.* (1984) found that verbal recognition memory tasks appeared to be relatively resistant to the effect of alcohol. Such a finding indicates that the anterograde amnesic effect induced by alcohol does not affect all memory processes equally and consequently cannot be viewed as a unitary phenomenon. In line with this analysis is the consistent finding that alcohol differentially affects dual memory processes, with the greater impairment reserved for controlled explicit memory processes. In contrast, automatic familiarity based processes, especially when assessed using implicit tasks, appear largely unaffected by alcohol intoxication (e.g. Kirschner & Sayette 2003). The differential effect of alcohol on implicit and explicit and explicit memory was empirically demonstrated by Lister *et al.* (1991). In an elegantly designed experiment, it was demonstrated that a dose of 0.6g/kg of alcohol served to impair significantly free recall of material relative to a placebo control group. In contrast, they were able to show that memory for the same material was found to remain intact when tested under implicit conditions, as demonstrated using both backwards reading and stem completion. Similarly, alcohol has been found to affect controlled memory processes, as assessed by free recall, whilst leaving automatic memory processes, such as frequency estimations, largely unaffected (Tracey & Bates, 1999). These findings have been substantiated by recent work done by Kirchner and Sayette (2003) who used the process dissociation procedure (PDP) (see Jacoby 1998) to derive quantitative estimates of controlled and automatic memory processes and their relative impairment under alcohol. They concluded that alcohol affected controlled influences on a memory task, whilst appearing to not affect automatic influences, and, through the use of the PDP, they were able to demonstrate the magnitude of this differential impairment.

1.4.1.2. Retrograde effects

The effects of alcohol on memory are not confined to memory reduction, instead, the temporal relation between drinking and encoding has been demonstrated to determine whether alcohol can serve to facilitate or impair memory. Material learned prior to alcohol consumption has been demonstrated to be enhanced, relative to a placebo control. Parker *et al.* (1980) found that 1.0ml/kg [0.8g/kg] of alcohol consumed immediately after encoding served to improve significantly next day recall, relative to a placebo control group. Lamberty *et al.* (1990) demonstrated that this retrograde facilitation could be extended to the domain of recognition for prose leant prior to consuming 1.0ml/kg [0.8g/kg] alcohol relative to a placebo control group. In addition, the conception of alcohol-induced retrograde facilitation has been demonstrated using recognition of scenic slides (Parker *et al.* 1981). Two principle theories exist with which to account for the mechanism underlying the facilitation effect, one which utilises principles of interference, the other which focuses upon the significance of trace consolidation. Proponents of the consolidation hypothesis (Parker *et al.* 1980; Parker *et al.* 1981) argued that the consolidation of memory traces were enhanced by the neural stimulant properties of alcohol, an effect thought to be particularly influenced by rising blood alcohol concentrations. In contrast, interference based explanations argue that the facilitation effect under alcohol can be accounted for using principles of retroactive interference. It is specifically argued that a reduced ability for intoxicated subjects to form new memories serves to reduce the degree of retroactive interference for the material learnt prior to the drink being consumed (Mensink & Raaijmakers 1988; Moulton *et al.* 2005). The findings that alcohol affects memory acquisition and that there are stronger retroactive effects on recall than on recognition, have been cited as evidence for interference based explanations (Tyson & Schirmuly 1993). In addition, an experiment conducted by Mueller *et al.* (1983) specifically to investigate the validity of both the interference and consolidation based explanations, found an immunity to time delays for the retroactive effect. As the degree of consolidation is thought to be time-specific, a corresponding variation in the extent of the retroactive facilitation would have been predicted. Consequently, this finding has been interpreted as ceding support for the interference based account.

1.4.2. Alcohol and False Memory

To date, only two published studies have investigated the effect of alcohol on false memories using the DRM paradigm (Mintzer and Griffiths, 2001; Milani and Curran, 2000), with somewhat equivocal findings.

Milani and Curran (2000) conducted double-blind cross-over design, and either a relatively small dose of alcohol (0.26-0.28 g/kg) or a placebo beverage was administered before the encoding phase. An almost immediate free recall test revealed no significant differences between the placebo and alcohol group in either mean levels of veridical recall (mean respective levels of 54 and 51 percent) nor critical recall (39 and 40 percent respectively). Results from the subsequent recognition test demonstrated that the placebo participants provided a significantly larger proportion of studied words than critical items, but that this difference was not significant in the alcohol condition. Thus alcohol did not reduce veridical recognition relative to the placebo group (72 versus 74 percent respectively) but the increase in false recall for the alcohol group relative to the placebo group (65 versus 54 percent) rendered the difference between false and veridical memory non-significant in the alcohol condition, but significant in the placebo group. This meant recognition was more accurate in the placebo group. In addition, alcohol affected the nature of recollective experience for critical items recognised (as measured using remember / know responses, Gardiner (1988)), resulting in significantly more *remember* responses for critical items in the alcohol condition relative to the placebo group.

The second study investigating the effect of alcohol on false memories using the DRM paradigm was a dose-response study devised by Mintzer and Griffiths (2001). Either a placebo beverage, or one of two doses of alcohol were administered prior to the encoding phase, one of which was comparable to the dose used by Milani and Curran (0.27 g/kg), the other was a somewhat larger dose of 0.60 g/kg. The study was conducted in response to the finding of Milani and Curran (2000) which found the tendency for false recognition rates to increase under alcohol. It was this finding which Mintzer and Griffiths found counter intuitive based upon the similarities between alcohol and benzodiazepines. Recent findings that benzodiazepines have no effect on false memory using the DRM paradigm (Huron *et al.* 2001) or serve to decrease false memory (Mintzer & Griffiths 2001) thus led Minzer and Griffiths to conduct a dose response study to investigate further the effect of alcohol on false memories. Furthermore, Mintzer and Griffiths (2001) argued that a limitation of

Milani and Curran (2000) was that the increase in remember responses to critical items in the recognition test amongst the alcohol group relative to the placebo controls, occurred only for words which had been previously recalled in a free recall test. They argued that such a difference in recollective experience could be accounted for by an alcohol induced impairment in distinguishing between items presented to them in the study phase, and items they had recalled in the free recall test. This would amount to a source monitoring error, as opposed to increased susceptibility to false memories per se.

Mintzer and Griffiths (2001) found a significant effect of alcohol on false recognition only for the high alcohol dose (0.6 g/kg), where alcohol significantly reduced the amount of veridical recognition responses. Neither dose affected the proportion of recognition responses made to critical items. This applied to relative false remember and know responses, for both doses relative to the placebo, and was thus in contrast to the finding by Millani and Curran (2000). This lead Mintzer and Griffiths (2001) to conclude that Miliani and Curran (2000) had simply detected more false remember recognition responses due to source confusion. This source confusion was hypothesised to have arisen from an alcohol induced impairment in participants ability to distinguish between words that had been presented to them during the initial study phase and words they had falsely recalled during the free recall test.

1.4.2.1. Benzodiazepines and false memory

To date, there have only been two studies investigating the effect of alcohol on false memories using the DRM paradigm. Insight into the way in which alcohol may affect false memories can be gained through looking at the ways in which other drugs have been found to effect false memories. Benzodiazepines are known to have a similar pharmacology to alcohol, with both drugs acting to enhance the actions of the neurotransmitter GABA. The effects of benzodiazepines on veridical memory are well established (e.g. see Taylor and Tinklenberg 1987 for a review). The transient anterograde amnesia induced by benzodiazepines for events encoded prior to their consumption has been compared to the effects of alcohol (Duka *et al.* 1996). Thus, the findings of studies that have assessed the effects of benzodiazepines on false memory using the DRM paradigm are worth noting, as one could predict that since alcohol mirrors the effects of benzodiazepines in veridical memory, such parallels may also exist in false memory (Mintzer & Griffiths 2001). Hurron *et al.* (2001) tested the affects of lorazepam and diazepam, two widely prescribed benzodiazepines, on false memories using the DRM paradigm. The study employed a double-blind placebo controlled design, and participants were assigned to either one of three groups; lorazepam, diazepam or the placebo control group. Drugs were administered prior to the encoding phase, and timed such that learning would coincide with their peak plasma concentrations. Immediate free recall was performed after the presentation of each list, and a recognition test was performed 15 minutes after the learning phase was completed. Analysis of the veridical items demonstrated that both lorazepam and diazepam served to reduce correct recognition, and exploration of this effect revealed that this was primarily due to a reduction in 'remember responses', with levels of veridical 'know' responses remaining comparable, and indeed slightly elevated, compared to the placebo group. In contrast, neither lorazepam nor diazepam reduced levels of false memory relative to the placebo control group, in terms of overall false recognition rates, and rates of 'remember' responses to false memory items. Huron *et al.* (2001) account for this pharmacological dissociation by proposing that benzodiazepines seemingly do not impair the 'gist' trace which is formed during encoding. Consequently the preservation of this trace results in levels of false memory which do not differ from the placebo control group. In addition, they argue that, in accordance with Curran *et al.* (1993), benzodiazepines impair the encoding of contextual episodic information and/or the binding of this information to studied items. This can account for the selective impairment of veridical 'remember' responses. Since no such reduction was found for false remember responses, they argue that, "Evidence that false recognition was intact indicates that benzodiazepines do not affect the ability to form a representation of the semantic gist of the study list, generate episodic content and context from studied items and bind this information to the more general gist information" (pg. 208). Whilst such an argument fits the data obtained, Huron *et al.* (2001) do not offer an explanation of why the processing of contextual episodic information and/or its subsequent binding to memory traces should be impaired for veridicical verbatim traces, but remain intact for gist traces. Without proposing a mechanism which acts selectively to processes and bind contextual information for gist traces and not verbatim traces, this interpretation is lacking. Such an explanation can be classified as falling within a *multistorage* framework (Benjamin 2001), as it is dependent upon the explanatory power of distinct gist and verbatim traces to account for the effect in question, in accordance with the terminology used in fuzzy trace theory. However, an alternative hypothesis can be formed using the AMF. Under this explanatory framework, the presence of contextual episodic information for veridical items serves to *lower* false memories, providing participants accurately monitor at test and use the absence of such information to 'edit out' false memories. Thus, providing that the activation of critical items remains intact, an absence of such contextual information would act to *increase* false memory levels, and indeed a trend increase in critical items was observed for participants in the Lorazepam condition, but not for participants in the diazepam group.

1.4.2.2. Alcohol and false memory: Mechanisms of action

Investigation into the effect of alcohol on false memories is still required for a number of reasons. Firstly, based on previous research, the results obtained to date (Millani & Curran 2000; Mintzer & Griffiths 2001) are still equivocal and have yet to be empirically reconciled. Secondly, regarding the theoretical basis of how alcohol may impair false memories, only highly limited speculations currently exist (Millani & Curran 2000) and these are not grounded in contemporary theories of false memories.

The AMF provides a compatible framework to combine with the known effects of alcohol as a means to make grounded predictions about the way in which alcohol should modulate false memory levels. Indeed, a strong prediction can be made that alcohol might *impair* false memory levels. Such a hypothesis is founded on alcohol's propensity to impair semantic encoding (e.g. Weissenborn & Duka 2000), blocking the activation of critical items. In addition, a tentative prediction can be formed regarding the propensity for alcohol to impair monitoring. Whilst such a speculation is not yet demonstrated in the literature, empirical evidence does exist which substantiates its formation. As previously established, the AMF is an opponent process theory as it postulates the existence of two distinct mechanisms; an activation component, which, when enhanced, can result in an increase in false memories, and a monitoring component, which, when successfully executed, can decrease false memories. Consequently, arguments surrounding the possible potential for alcohol to disrupt both activation and monitoring processes has opposing consequences for false memory levels. Impaired activation is thought to decrease false memories (Thapar & McDermott 2001), whilst impaired monitoring is thought to increase false memories (Benjamin 2001). One can argue that if alcohol were to affect both activation and monitoring mechanism, their opposing effects on false memory levels would not serve to cancel each other out: in accordance with argument relating to the inverted U-shaped relationship between repetition and false memory levels, one can derive the conclusion that, effects on activation processes must prevail. Only when a threshold of activation is reached within critical items can their successful monitoring be executed. Thus, the primary prediction is for alcohol to impair false memories through decreased activation. A tentative second hypothesis can also be formed that, with increased learning, monitoring processes may be disrupted under the effect of alcohol. The discussion will therefore first centre on alcohol's propensity to disrupt semantic processing and consequent semantic activation – leading to a potential decrease in false memories. Secondly, reasons to expect that alcohol may impair monitoring will be addressed and there will be a discussion of the potential implications of this for false memories.

1.4.2.2.1. The effect of alcohol on semantic activation

As previously mentioned, there are two hypothesised routes for the activation of the critical item under the AMF (Roediger *et al.* 2001). The first is by conscious thought of the critical item at encoding, the likelihood of which is increased though encoding techniques which employ organisational and elaborative processing strategies. The second is the automatic spread of activation within semantic networks. In order to hypothesise how alcohol may effect the semantic activation of critical items, the way in which alcohol might affect these two possible routes of activation must be considered.

Conscious route

Parker *et al.* (1974) hypothesised that "the more demanding the task the greater the impairment from alcohol" [pg. 826]. Johnson (1977) qualified this claim by defining 'demanding' as being the extent to which a task necessitates the "finding or generating [of] associations, interrelationships or structures"(pg. 46). These processes can be viewed as analogous to those implicated in the elaborative semantic processing of DRM lists. As elaborative strategies are shown to increase false memory levels (Libby & Neisser, 2001), an impairment induced by intoxication could serve to reduce false memories under an alcohol challenge. Likewise, the *attention-allocation model* (AAM) proposed by Steel and Josephs (1988) argued that alcohol has two central detrimental effects on attentional processing. Firstly, alcohol impairs the capacity for controlled and effortful processing, and secondly alcohol narrows attention to the most salient internal and external cues. It is these dual effects, as argued by Steel and Josephs, which are thought to give rise to an *alcohol myopia,* which results in the processing of "fewer cues, and because of the impairment of one's ability to engage in control processing, the cues that one perceives are poorly understood and difficult to relate to existing knowledge". This model is thus in accordance with the theorising of Johnson (1977), and provides a theoretical basis for the reduction in conscious elaborative processing under alcohol, which could result in a reduction of false memories. Work done by Parker *et al.* (1974) empirically investigated the potential for alcohol to disrupt cognitive processes. It was demonstrated that a high dose of alcohol served to impair category clustering in free recall. They took this to mean that higher-order conceptual processes were impeded during intoxication. In addition, Parker *et al.* (1976) found that a high dose of alcohol (1.0ml/kg [0.8g/kg], which leads to a typical peak BAC of 0.7g/l) impaired paired associative learning. The authors hypothesised that this effect could possibly be attributed to the inefficient utilisation of associative strategies under intoxication. The impairment of such processes has implications for the forming of conscious associations between veridical items, a process which is thought to be a potential route to increasing false memories (Roediger *et al.* 2001).

Automatic Route

Levels of Processing

In 1977 Craik published an article that made comparisons between the effects of aging and alcoholic intoxication on memory performance, and used the levels of processing (LOP) framework to account for these similarities. According to his argument, alcohol serves to reduce the depth at which items are processed, with depth being defined as "a continuum of processing running from shallow sensory analyses requiring little attention to deeper semantic processes through which the stimulus is identified, interpreted and enriched by associations with stored knowledge" (pg. 10). Since studies which have increased depth of processing found a resultant increase in false memory levels (Toglia *et al.* 1999; Rhodes & Anastasi 2000; Thapar & McDermott 2001), the effect of alcohol on LOP has implications for the way in which alcohol may affect false memory.

The amnesic effects of alcohol consumed prior to encoding are well documented, with studies consistently demonstrating an impairment of free recall (Birnbaum *et al.* 1978) and cued recall (e.g. Duka *et al.* 2001) relative to a placebo control group. Craik (1977) argues that such a pattern of impaired memory parallels the findings of experiments which manipulate encoding level, with impaired retention for shallowly processed items relative to memory levels for items deeply processed (e.g. Craik 1975). This leaves open the possibility that a reduction in processing depth is the mechanism by which retention is impaired in intoxicated participants.

Craik and Tulving (1975) argued that retention is enhanced as a result of deeper processing by greater degrees of elaboration of traces, with elaboration being defined as the richness and complexity of operations performed on stimuli at encoding (Craik 1977). As alcohol has been shown to reduce attentional and processing resources (e.g. Schweizer, Vogel-Sprott, Dixon, & Jolicoeur, 2005), it can be hypothesised that the performance of complex elaboration processing under alcohol is likely to be impaired.

In addition, Craik and Tulving (1975) suggest that elaboration is enhanced when integration occurs between the remembered item and its encoding context, resulting in the formation of a coherent unit. The selective impairment of 'remember' responses under alcohol, with the preservation of know responses (Duka *et al.* 2001) has been taken as evidence for the severing of item and context in memory under alcohol. This, combined with the speculations of Craik and Tulving (1975) could account for one of the mechanisms by which alcohol impairs memory.

Priming

One of the ways in which the effect of alcohol on the depth of processing can be assessed is though examination of the empirical literature surrounding the effect of alcohol on semantic priming, as semantic priming is found to increase with depth of processing (Bentin, Kutas & Hillyard, 1993). The effect of alcohol on semantic priming has implications for how an alcohol challenge will affect the generation of false memories using the DRM paradigm. As the AMF theorises that the key mechanism which elicits false memories is activation within semantic networks, it follows that if alcohol disrupts semantic processing, as demonstrated by semantic priming, then this may serve as a possible route through which alcohol may lower levels of false memories.

At present, the literature surrounding the effect of alcohol on semantic priming is somewhat contradictory. Lister *et al.* (1991) found that an alcohol challenge of 0.6g/kg did not affect semantic priming as determined by backwards reading of words which were associated to previously studied words (semantically related pair presented immediately before, N = 9). This apparent preservation of semantic priming under alcohol was supported by a recent study by Ray *et al.* (2004), who investigated the effect of alcohol on an implicit semantic priming task. Semantic priming was assessed using a lexical decision task for semantically related words, and alcohol was found not to impair reaction times, relative to a control condition. However, a study performed by Sayette *et al.* (2001) used a mediated semantic priming task, and found that an alcohol challenge disrupted semantic priming. When trying to reconcile this apparent discrepancy in the way in which alcohol affects semantic priming, it can be argued that these studies differed in the strength of semantic activation required in order to detect a priming effect. Lister *et al.* (2001) minimised the retention interval between the target word and the semantic prime, and Ray *et al.* (2004) employed a encoding technique for the studied words which maximised semantic priming (Craik & Lockhart 1972), as it required participants to make liking ratings. Since activation within semantic networks increases with depth of processing (e.g. Thapar & McDermott 2001), such an encoding technique would increase the likelihood of semantic activation, and thus the probability of obtaining semantic priming. This could serve to mask any impairment caused by alcohol, and it remains a possibility that the 'spontaneous' spread of semantic activation when processing is passive/not controlled may be impaired under alcohol. Sayette *et al.* (2001), who found that alcohol impaired semantic priming, used a mediated semantic priming task. In this task, processing of an initial word took place (e.g. *lion*), but priming for its direct semantic associate was not assessed (e.g. *tiger*). Rather, semantic priming for a semantic associate of this (e.g. *stripes*) was assessed. As this task used second order semantic priming as its measure, and alcohol was found to impair this process, it can be suggested that alcohol has the potential to disrupt semantic priming, but whether this effect is detected or not depends on the sensitivity of the priming test used. This poses a problem in regard to making definite predictions about whether alcohol will affect semantic priming, and if so, whether this effect will extrapolate into a reduction in false memory.

Semantic Processing and Associations

It has been hypothesised that the consumption of alcohol acts to block semantic processing (Craik, 1977). A variety of different empirical studies have demonstrated the different ways in which alcohol has the potential to affect the forming of associations. Research done by Birnbaum *et al.* (1980) demonstrated that alcohol at encoding served to disrupt the production of semantic context required to encode the meaning from information being processed. Similarly, research by Rosen and Lee (1976) demonstrated that alcohol acted to inhibit the implementation of semantic processing required to organise recall strategies. More recent research conducted by Weissenborn and Duka (2000) found that alcohol at encoding eliminated the benefit afforded by the presentation of high associations as a contextual cue for retrieval. Participants studied pairs of related words that were either high or low semantic associates. It was found that the group which consumed alcohol at both encoding and at retrieval recalled significantly fewer words than the placebo group, but this was true only for words from the high association and not the low association pairs. As false memories have been shown to decrease with an encoding strategy that is not semantically focused (Libby & Neisser 2001), alcohol could thus be hypothesised to reduce false memories.

1.4.2.2.2. The effect of alcohol on monitoring

Johnson (1977) makes the proposition that drinking alcohol might impair a persons' ability to distinguish fact from fantasy, a type of source monitoring termed 'reality monitoring'. Johnson mentions that this hypothesis would mean that even in the event of similar processing at encoding, such impairment will manifest itself at the time of retrieval. As the process of reality monitoring is dependent on ones' ability to differentiate between items presented and items not presented, it can be argued that the potential for successful reality monitoring is dependent upon the detail inherent within memories. Consequently the extent to which recollective experience is affected by alcohol has implications for monitoring ability, and must therefore be addressed.

Curran and Hildebrandt (1999) conducted a study to investigate the dissociative effects of alcohol on recollective experience. They found that alcohol selectively impaired remember responses, but left know responses relatively intact. Curran and Hildebrandt (1999) point out that, remember responses require not only memory for the item in question, but actual conscious recollection of prior exposure to the item, and thus the processing of context is integral to the remember response. This lead to the argument that alcohol may disrupt the ability to encode contextual information, or to associate the encoding context with the study items, which could account for the selective reduction in remember memories under alcohol. Curran and Hildebrandt

(1999) cite Steele and Joseph's (1990) model of "alcohol induced myopia" as a possible theoretical framework that could account for such an effect. The model proposes that alcohol reduces attentional capacity by virtue of a 'myopia' whereby intoxicated participants focus only on the most salient cues. Consequently, the range of cues attended to are reduced under alcohol, resulting in the possible impairment of peripheral cues, such as context.

This effect could have implications for false memories under alcohol. The activation monitoring framework postulates the necessity for context enriched memories as a means to differentiate between words that were presented, and critical words that appear familiar by virtue of their association to presented words. In addition, Schacter and colleagues proposed a 'distinctiveness account' of false memories, arguing that as material learnt becomes increasingly distinctive, a corresponding drop in false memories is observed (Dodson & Schacter 2001; Israel & Schacter 1997; Schacter *et al.* 1999). This is because, at retrieval, participants are able to use this distinctive information to differentiate between which items where presented and which items were not, aiding the monitoring process. Thus, if alcohol reduces the encoding of contextual information and enriched item-specific information, then it follows that participants will be impaired in their ability to source monitor, leading to a possible rise in false memories under alcohol at encoding. Such a hypothesis is substantiated by Milani and Curran (2000), who cite work done by Gardiner *et al.* (1998) which discusses the mechanisms that may underlie false remember responses and suggest that such mistakes can either occur when recollected details are mistakenly attributed to the study context, or if details from the study context are retrieved, but wrongly attributed a non-presented item. Consequently, Milani and Curran propose that enhanced remember responses to critical items under alcohol "may reflect source misattribution induced by alcohol" (pg. 401). This conclusion is consistent with the 'myopia'-induced disruption of context encoding under alcohol. since correct source attribution can be viewed as dependent upon the encoding of context.

A final perspective regarding a possible increase in false memory under alcohol is made by Milani and Curran (2000), who put forward the proposition that the effect of alcohol on false memory may resemble that of aging, as a greater susceptibility to illusory memory has been found in the elderly. Research in the elderly suggests that they have a greater susceptibility to false memories due to a deficit in source monitoring (e.g. Dehon & Bredart 2004), an effect which has been attributed to a relative impairment in recollective as opposed to familiarity based processes within the elderly (Benjamin 2001).

1.4.2.3. Alcohol, false memories and repetition.

To summarise, it has been argued that alcohol will lead to a decrease in false memories relative to a placebo control group resulting from decreased semantic activation when intoxicated. In addition, the potential for alcohol to impair monitoring processes has also been raised as a possibility. As monitoring processes operate once a threshold in learning has been surpassed (Seamon *et al.* 2002), only then could any potential impairment in monitoring under alcohol be observed. As previously discussed, repetition serves as a variable with which to increase learning. Consequently, repetition acts as a useful manipulation to use in conjunction with alcohol. Based on previous research, it can be expected that, once lists are sufficiently well learnt, repetition will lead to a decline in false memories (Seamon *et al.* 2002; Benjamin 2001). It can be predicted that this decline should be more readily obtained in the placebo group relative to the alcohol group, because of two different hypothesised mechanisms. Firstly, due to impaired learning in the alcohol group, baseline false memory levels will be initially lower in the alcohol group than the placebo group. Consequently, the rise in activation levels as a function of repetition is likely be greater in the alcohol group than the placebo group, and this could translate into greater increases in false memories with repetition. Alternatively, due to the potential impairment in monitoring ability, intoxicated participants may be less able to differentiate between veridical and critical items. Research has shown that intact recollection is required in order to be able to reject false memory items with the increased repetition of study lists (Jones 2005). As recollective memory is selectively impaired under alcohol, participants may not be able to reject false memories with increased repetitions.

1.5. Aims and summary of experiments

Understanding the effect of alcohol on false memories was a primary aim of this thesis. Study list repetition was employed to explore the potentially complex ways in which alcohol may affect the dual mechanisms underlying false memories, as specified by the AMF. Observation of the way in which repetition and alcohol modulated false memory levels was used to gain insight into the mechanisms underlying false memories.

All experiments used repetition as a manipulation. Initial experiments [Experiments 1 and 2] investigated the way in which the retrograde facilitative effects and anterograde impairment effects of alcohol affected false memories. Due to the differential effect of alcohol on implicit and explicit memories, both memory measures were taken. Based on the complexity of the findings from the first two experiments, subsequent studies did not pursue an investigation of the facilitative effects of alcohol on false memories.

Experiment 3 focused on the anterograde effects of alcohol on false memories. Explicit memory was assessed using free recall. Implicit memory was also assessed and awareness measures were taken.

Experiments 4, 5, 6, 7 and 8 were a series of cognitive experiments designed to elicit the inverted U-shaped relationship between false memories and repetition. A number of manipulations were made to elicit this relationship; reduced retention interval, a warning about the nature of the false memory paradigm and a source monitoring paradigm were all employed.

Experiment 9 investigated how alcohol modulated the inverted U-shaped relationship between false memories and repetition. Words were presented with pictures and a source monitoring procedure was administered at test. This experiment provided insight into how alcohol shifted the inverted U.

Chapter 2. Materials and methods

2.1. Rational

This chapter is concerned with common methodologies and stimuli that are used within this thesis. Firstly, the type of alcohol and placebo drinks administered remained constant throughout experiments which employed drink as a between subjects factor (Chapters 3, 4, & 6). Section 2.2. provides details of a pilot study designed to test the extent the alcohol and placebo beverages could be discriminated. Section 2.3. deals with the stimuli presented at encoding. The DRM (Deese 1959; Roediger & McDermott 1995) paradigm was used as the task throughout the thesis to elicit false memories. Whilst this paradigm remained constant, the actual stimuli used varied dependent on the specific task demands. DRM lists taken from the Stadler *et al.* (1999) norms were used in Chapters 3-6. In addition, in experiments where implicit stem completion tests were used (Chapters 3 & 4), these lists were modified and additional ones were created to ensure they fit the criteria for stem completion, as specified by McKone and Murphy, (2000) (see section 2.3.). Section 2.4. deals with a series of pilot studies run to determine whether newly created lists differed from those in the Stadler *et al.* (1999) norms in terms of key features, specifically BAS, baseline stem completion rates and probability of eliciting a false memory. Methodological details concerning presentation rates of stimuli, amounts of repetitions used, retention interval and type of test employed varied between experiments. Specific details can be found in the individual experimental chapters (Chapters 3 - 6). Lastly, section 2.5. deals with issues around consent and common questionnaires and tasks.

2.2. Drinks

2.2.1. Pilot 1: Drinks

Pilot study 1 was designed to determine the extent to which the alcohol and placebo beverages could be discriminated when angostura bitters was the masking agent.

Method

Participants

10 participants, all of whom were postgraduate students at the University of Sussex.

Materials and procedure

The methodology employed by Duka *et al.* (1999) was followed, and the alcohol beverage consisted of 0.2g/kg participants' body weight alcohol, diluted with tonic water plus making agent. The placebo drink was identical to this, but alcohol was excluded.

Participants were in one of four conditions, and were provided with either two alcohol beverages, two placebo beverages, alcohol followed by placebo, or placebo followed by alcohol. The beverages were provided consecutively and, for each drink, participants were required to state whether they thought it was alcohol or placebo and provide liking ratings on a ten-point scale.

Results

Discriminatory ability

Beverage 1				**Beverage 2**			
Alcohol		Placebo		Alcohol		Placebo	
Correct	Incorrect	Correct	Incorrect	Correct	Incorrect	Correct	Incorrect
2 (50%)	2 (50%)	3 (50%)	3 (50%)	3 (50%)	3 (50%)	2 (50%)	2 (50%)

Table 2.1. **Identification of drink consumed**

Table 2.1. shows that participants were at chance when determining whether a drink was either alcohol or placebo, and that they remained at chance for their second beverage. As subjects consistently performed at chance, there was no difference between participants' ability to recognise whether a drink was placebo or alcohol. The expectancy that one has consumed alcohol has been shown to increase false memory levels (Assefi & Garry 2003). Consequently, by making the alcohol and placebo drink indistinguishable, the expectancy effects induced by the taste of the drink would have been minimised.

Liking Ratings

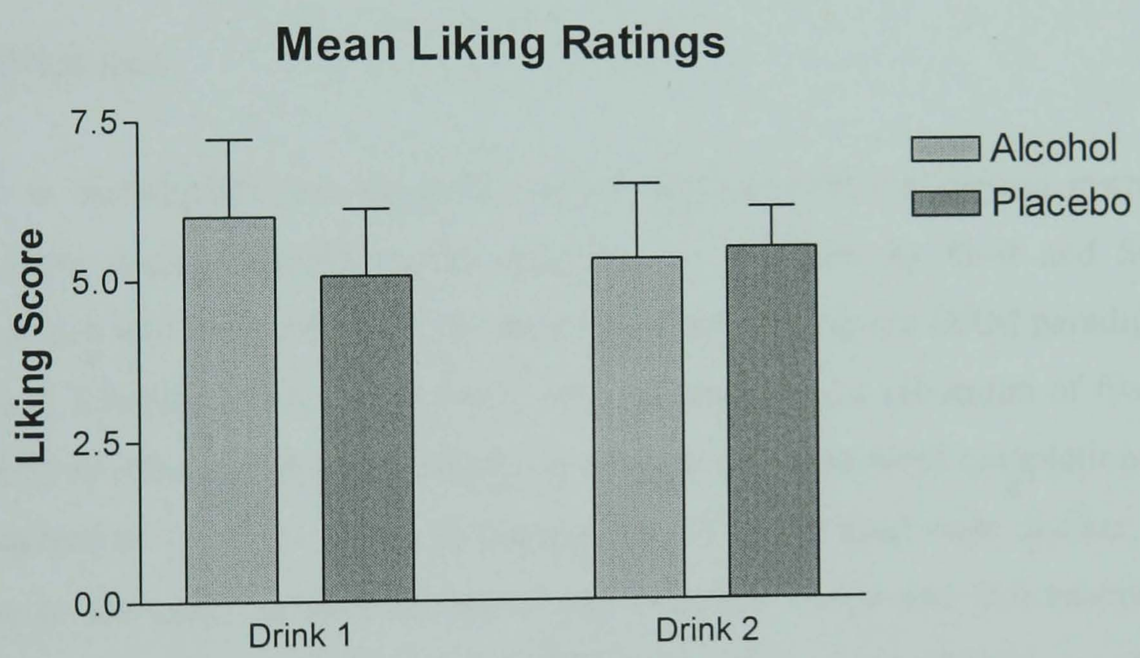

Figure 2.1. **Graph to show mean liking ratings for alcohol and placebo beverages.**

Inspection of figure 2.1. demonstrates that mean liking ratings for placebo and alcohol beverages were comparable, and did not change for the second drink consumed. Ensuring that the beverage is pleasant, and that this liking rating does not sufficiently differ between alcohol and placebo beverages is necessary in memory research. Pharmacological agents which manipulate mood have been shown to affect memory performance. Agents which enhance cheerfulness (e.g. the herbal anxiolytic kava-kava) enhance cognitive functioning (Munte *et al.* 1993). In addition, a recent study has demonstrated that the manipulation of mood prior to encoding activates different brain circuitry in the encoding and recognition of neutral items dependent on mood induced (Erk *et al.* 2005). Mood at encoding also has implications for memory performance according to semantic network approaches (Bower 2003). It has been hypothesised that mood influences the nature of the activation within semantic networks, since mood (at either encoding or retrieval) will affect which pathways and nodes become activated and the likelihood that their activation will be above threshold (Lewis & Critchley 2003). Since the Activation Monitoring Framework (AMF) uses semantic network theory to account for the activation of false memory items, any factors which may lead to different patterns of activation within semantic networks should be equivalent for the alcohol and placebo groups.

2.3. DRM lists

In order to investigate false memories under implicit stem completion instructions, critical items had to adhere to the specifications outlined by Graf and Schacter, (1985), which had been followed by other researchers using the DRM paradigm (e.g. McKone & Murphy 2000). These were: critical items were a minimum of five letters long, all three letter stems had a minimum of eight different word completions, stems were required to not form words in themselves, all stems used were distinct and not the same as the opening three letters of any veridical words and that baseline stem completion rates were not higher than a 50% probability of completion, as a means to avoid ceiling effects on priming scores. (McKone & Murphy 2000).

Only 12 lists included with Stadler *et al.*'s (1999) norms fulfilled the above criteria. As the experiments in Chapters 3 and 4 used a maximum of 24 lists, a total of 12 new lists were created with the aid of the Edinburgh Associative Thesaurus (EAT: http://www.eat.rl.ac.uk/). The EAT is a set of word association norms, displaying the counts of word association elicited in association to target words, as collected empirically from participants following the methodology employed by Kiss *et al.* 1973). Following the procedure used by Roediger and McDermott (1995), lists were formed of the top veridical associates of 12 new critical words. (see Appendix 1).

2.3.1 Pilot studies: DRM stimuli

A series of pilot studies were performed to ensure that the newly created lists did not differ from the established DRM lists in terms of backwards associative strength from the veridical items to the critical items, baseline stem completion rates and probability that the critical item would be erroneously recalled.

2.3.1.1. Pilot 2: Backwards associative strength

Backward associative strength (BAS) is an "index of strength of associative connections from the study words to the critical item", (Roediger *et al.* 2001, 389). In a multiple regression analysis which determined the factors that contributed to false recall of critical items, BAS was identified as the largest predictor (Roediger *et al.* 2001).

To determine that old and newly created lists did not significantly differ in their mean backwards associative strength, the procedure originally used by Nelson *et al.* (1999) and later adopted by Roediger *et al.* (2001) was employed. This gauged the probability that the various veridical items would elicit the critical item.

Method

Participants

The ten participants were students at the University of Sussex.

Materials

The 12 lists taken from Stadler *et al.* (1999) which fulfilled the criteria for implicit stem completion (McKone & Murphy 2000) served as the old lists. These 15-word lists were reduced to 10-word lists by choosing the ten veridical items most closely associated to their respective critical item. The new lists were the 12 ten-word lists created using the specifications outlined by McKone and Murphy (as described in section 2.3).

Procedure

All ten words on each list were given to participants on sheets of paper. Each list was presented as a single block of words in decreasing associative strength to the critical item. The order of lists (old vs. new) was randomly intermixed. Participants were instructed to read each word in turn and next to it write the first word that came to mind evoked by the word in question. If they thought of a word they had already used, participants were instructed to use that word again[1]. Participants worked at their own pace until they had provided an associate for every list item.

Results

The dependent variable was the average number of critical free associates generated for each list. This dependent variable was collapsed across the 12 new lists and the 12 old lists for each participant. It was found that the average number of critical free associates for old and new lists did not significantly differ [$t(9) = -1.507$, $p = .166$].

[1] This procedure was adopted as it was the one used by other researchers when constructing DRM lists (e.g. Nelson *et al.* 1999), however it is acknowledged that it could have served to overestimate BAS due to repetition priming.

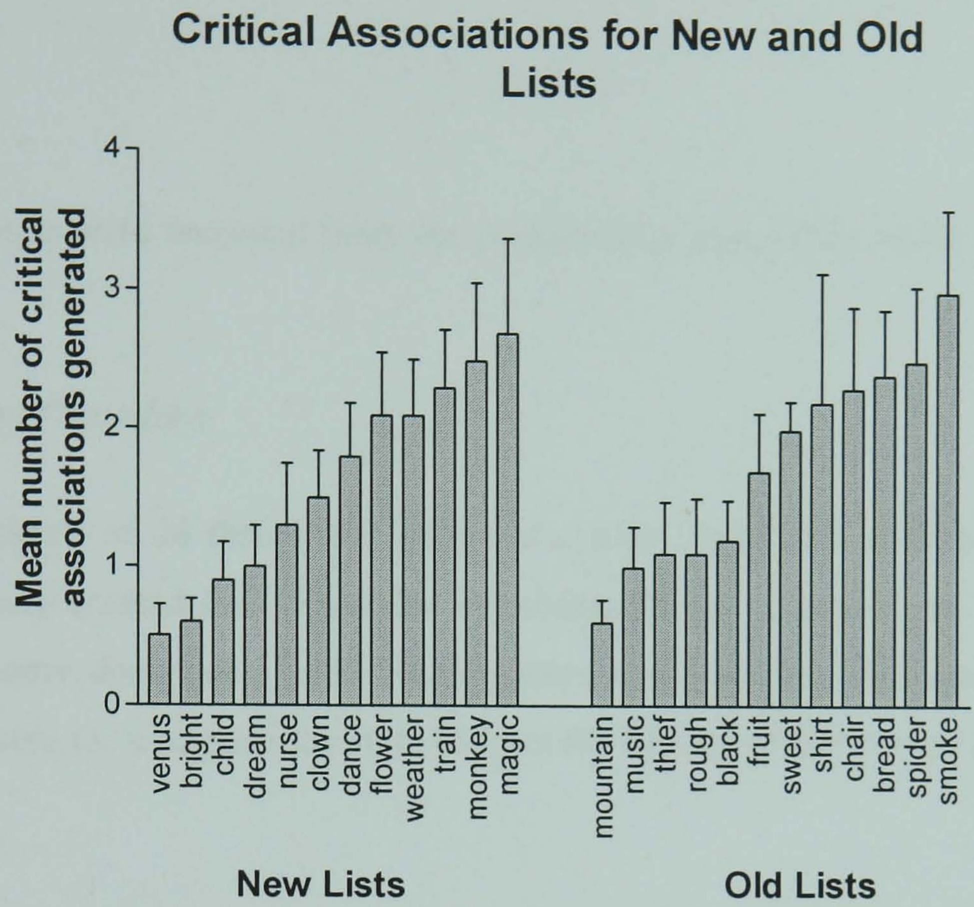

Figure 2.2. **Graph to show mean critical associates generated in response to veridical words for both new and old lists (see Appendix 7a).**

2.3.1.2. Pilot 3: Probability of baseline stem completion

Previous empirical research investigating implicit false memories, have used stem completion as a mode of assessment (e.g. McDermott 1997). In order to ensure the possibility of obtaining a priming effect, McKone and Murphy (2000) argued that baseline stem completion rates should not exceed 50 percent. Pilot 3 was designed specifically to assess baseline stem completion rates for the critical items. This would ensure that they were all below 50 percent, and that old and new lists did not significantly differ in terms of baseline stem completion rates.

Method

Participants

Ten participants were recruited from the postgraduate population at the University of Sussex.

Materials and Procedure

Stimuli consisted of 24 three-letter stems of critical items: 12 of these stems were from the newly created lists whilst the remaining 12 stems were from Stadler *et al.* (1999) and were designated 'old'. Participants were provided with instructions that stated they were to "complete the stem to form the first word that comes to mind".

Results

The dependent variable was the probability that a stem would be completed to form a critical item. This dependent variable was collapsed across the 12 new lists and the 12 old lists for each participant. It was found that the average number of critical baseline stem completion rates for old and new lists did not significantly differ $t(9) = .387$, $p = .708$.

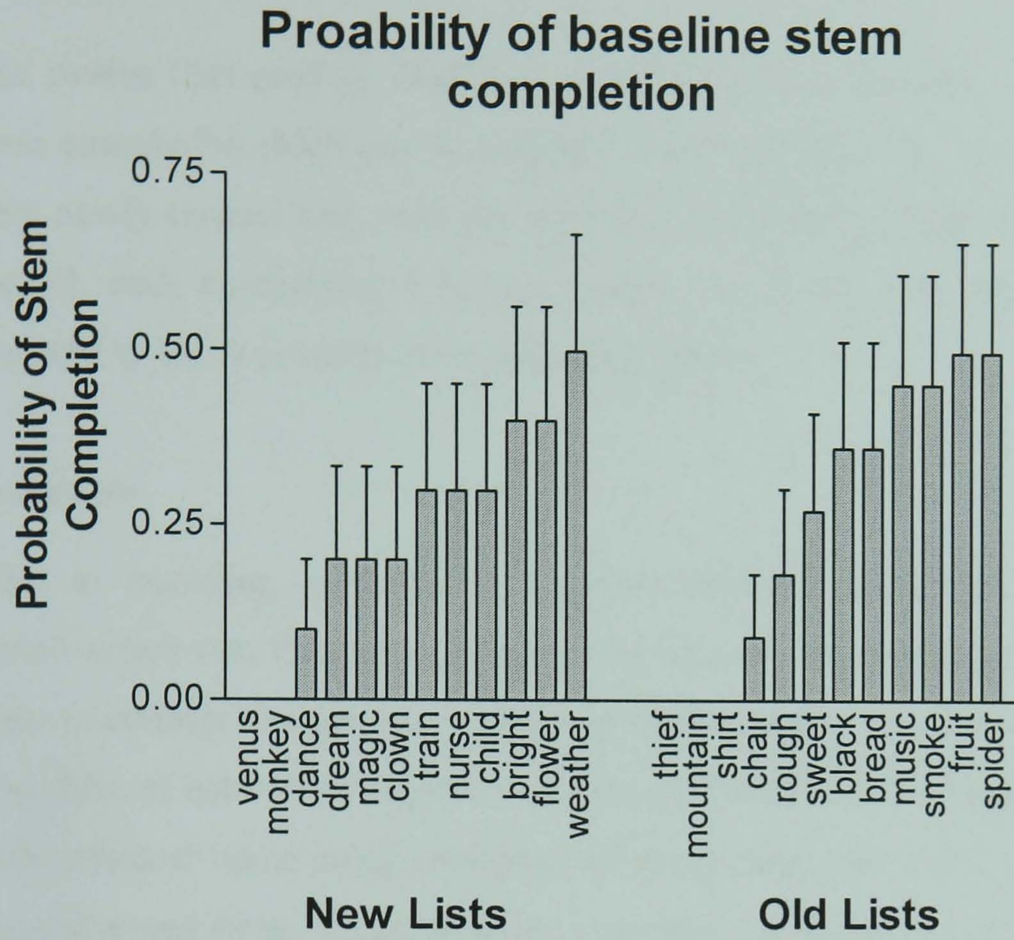

Figure 2.3. **Probability of stem completion for critical items from new and old lists (see Appendix 7b).**

2.3.1.3. Pilot 4: Probability of eliciting a false memory

A pilot study was conducted in order to determine whether old and new lists differed in their ability to induce a false memory.

<u>Method</u>

Participants

32 participants undergraduates at the University of Sussex were given a cash payment for participating in the experiment.

Materials

The twelve lists used by Stadler *et al.* (1999) which fulfilled the criteria for implicit stem completion (McKone & Murphy 2000) served as the old lists. The twelve ten-item newly created lists were the new lists. Two sets of lists were created (list A and list B), each comprising 6 newly created and 6 old lists. Participants were either exposed to list A or list B in the encoding phase.

Procedure

Prior to encoding, participants received standard intentional learning instructions which stated that they were about to be shown twelve lists of words and that they were to attempt to learn these words as their memory for them would later be tested. The order of lists was completely randomised. Each list was shown in blocked format, with veridical items being presented by decreasing associative strength to the critical non-presented item. Veridical items remained on the screen for 3-seconds, with a 1-second interval between words. A 5-second 'New List' warning preceded each list. This mode of presentation was identical to that employed by Benjamin (2001) and was used in Experiments 1, 2 & 3.

Participants returned to the lab 24 hours later for the memory test. They received standard free recall instructions stating that they were to write down all the words they recalled from the previous days encoding phase.

Results

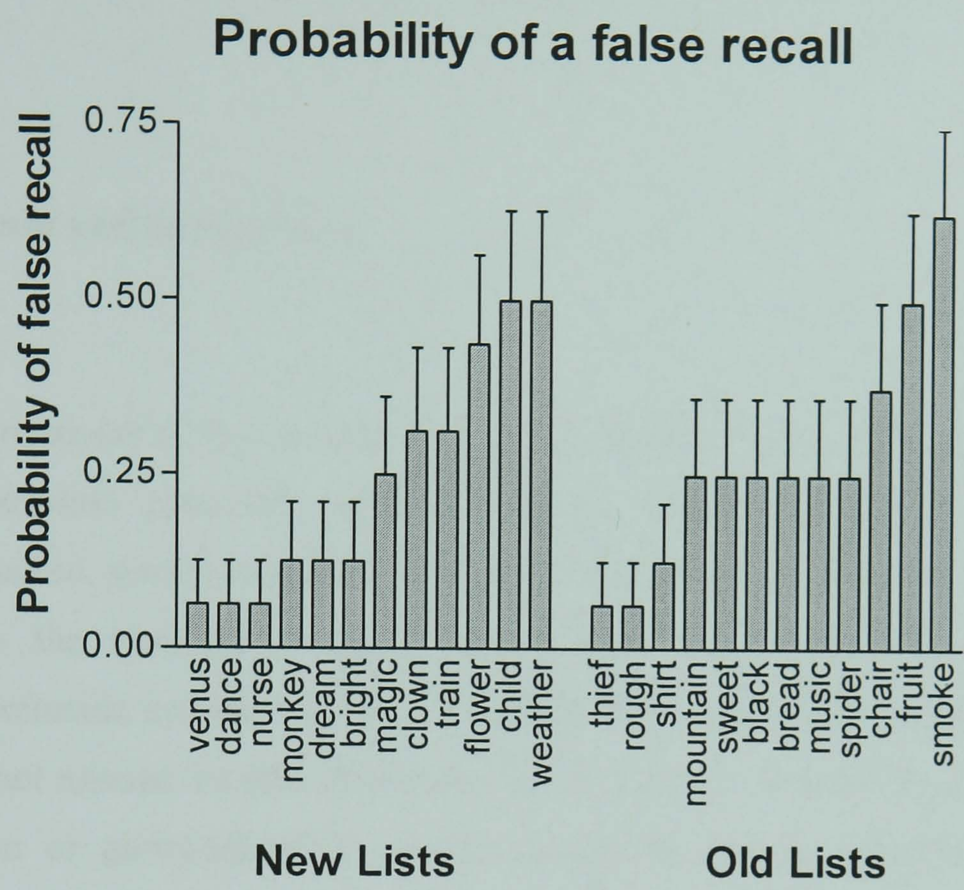

Figure 2.4. **The probability that a critical item would be erroneously recalled, divided into old and new lists (see Appendix 7c).**

The dependent variable was the probability that a critical item would be erroneously recalled. This dependent variable was collapsed across the 12 new lists and the 12 old lists for each participant. The average number of critical words recalled was not found to significantly differ between old and new lists [$t(15) = 1.192$, $p = .252$].

Discussion

BAS, baseline stem completion rates and probability of eliciting a false memory, were not found to significantly differ between old and new lists. Inspection of Figures 2.2, 2.3. and 2.4. reveal the extent to which lists varied from each other in terms of these measures. Establishing quantitative values for different lists in terms of these measures will assist with the balancing of stimuli in future studies. Lists were found to vary in the extent to which they induced a false memory, consistent with the Stadler *et al.* (1999) norms. Having lists which vary in their ability to induce a false memory is particularly necessary when dealing with factors which either increase or decrease false memories to ensure that both floor and ceiling effects are avoided.

2.5. Consent and prohibitions

The ethics committee of the University of Sussex approved all experiments within this thesis. Participants provided informed consent (Appendix 2). For the studies providing alcohol, participants were only permitted to take part on the basis of their responses to the Nuffield Medical Questionnaire (Appendix 3) and a medical interview. Exclusion criteria included: a history of severe mental illness, a history of drug or alcohol misuse, an altered metabolism of alcohol (as determined by impaired liver function or gastroenteritis), anyone displaying current symptoms of mental illness or neurological disease. For studies involving alcohol, participants were asked to abstain from illicit recreational drugs for a minimum of 7 days, from sleeping tablets or hayfever medication for 48 hours, and from drinking tea or coffee immediately prior to the commencement of the experiment and were required to have a low fat breakfast the morning of the experiment. In addition, participants were told to abstain from drinking for 24 hours prior to the beginning experimental session, and were breathalysed on entering the lab as a means to determine whether they had complied with this requirement.

2.5. Materials and measures

2.5.1. Blood Alcohol Concentrations (BAC)

A standard breathalyser with a detection limit equivalent to 0.01g/l of alcohol in the bloodstream was used to measure BAC levels (Alcolmeter S-D3M. Loborservice

GmbH, Bonn, Germany). The dependent variable measured was BAC measured in g/l.

2.5.2. Alcohol Use Questionnaire (AUQ)

Participants' weekly alcohol consumption was assessed using the AUQ (Mehrabian & Russell 1978, Appendix 4). The AUQ consists of 12 questions designed to evaluate consumption of beer/cider, wine and spirits in terms of frequency and quantity. Due to the recent changes in drinking trends, an updated version was used which incorporated questions about the consumption of alcopops (Knowles & Duka 2004). The dependent variables produced by the AUQ are: 8g UK units of alcohol units drunk each week and an overall AUQ score which represents speed and frequency of drinking and intoxication. In addition, a separate binge drinking score based just on speed of drinking and frequency of intoxication developed by Townshend and Duka (2002) was also determined. The questionnaire was administered to ensure that participants met the specifications for participating – that they were a social drinker who consumed on average between 5 to 50 units a week. In addition, group analyses could ensure that the alcohol and placebo participants were matched in terms of units consumed per week, AUQ score and binge drinking score alcohol.

2.5.3. Visual Analogue Scales

To assess mood, both in terms of baseline measures and the acute effects of alcohol on mood, participants were asked to complete a set of 100mm VASs (Duka *et al.* 1998). These provided measures of how participants were feeling at that particular moment. Dependent variables were 0-100 scores for the following adjectives: contented, light-headed, relaxed and irritable (see Appendix 5).

2.5.4. Assessment of baseline memory

Baseline memory was assessed to ensure that no differences existed between alcohol and placebo groups. 15-member word lists – lists A and B from the Rey Auditory-Verbal Learning Test Word Lists which were validated for frequency and complexity by Lezak (1983) were administered prior to drink consumption. The dependent variable was the mean number of words recalled from the two lists (five minutes after presentation) (see Appendix 6).

Chapter 3. Exploring the anterograde impairment and retrograde facilitation effects of alcohol on false and veridical memories

3.1. Introduction

A number of different studies have demonstrated that alcohol can both impair (e.g. Parker *et al.* 1976) and facilitate memory (e.g. Parker *et al.* 1974) relative to a placebo control group. The nature of the effect – whether it is deleterious or facilitative - is dependent upon the temporal relationship between the encoding of stimuli, alcohol consumption and the testing of memory (Birnbaum & Parker 1977; Knowles & Duka 2004). Memory for information encoded prior to an alcoholic drink is facilitated relative to a placebo control as assessed using free recall (Parker *et al.* 1980) and recognition (Parker *et al.* 1981). These facilitative effects are not uniform for all types of memory. Instead, a selective enhancement for emotional memory versus neutral memory, relative to a placebo control group, has been found (Knowles & Duka 2004). Regarding the anterograde impairments of alcohol, alcohol has a deleterious effect for memory when information is encoded post consumption of alcohol as assessed using explicit tests of memory. In contrast, when implicit tests are used, memory remains intact (Lister *et al.* 2001; Duka *et al.* 2001).

The presence of two encoding phases (pre and post ingestion) has the advantage of being naturalistic (Knowles & Duka 2004). That is to say, because learning does not take place in isolation, including a pre and post drink encoding phase more accurately models how alcohol affects memory in the natural environment. In addition, inclusion of two encoding phases provides the opportunity to modulate false memory levels via both the potential facilitative and impairing effects of alcohol. Regarding the retrograde effects, to date no studies have investigated whether the retrograde facilitation effects of alcohol extend to false memories. Determining whether a retrograde facilitative effect can be observed for false memories accords with an approach undertaken by researchers who investigate whether false and veridical memories act in comparable ways. For example, recent research into retrieval induced forgetting has demonstrated that false memories are prone to inhibitory mechanisms in the same way as veridical memories (Starns & Hicks 2004) as demonstrated using a retrieval practice paradigm (Anderson *et al.* 1994).

Investigation into whether the anterograde impairment of alcohol extends to false memories is equivocal. Two studies to date have used alcohol in conjunction with the DRM paradigm. Miliani and Curran (2002) found alcohol increased false memories, whilst Mintzer and Griffiths (2001) found that alcohol impaired veridical memory whilst false memory levels remained intact relative to a placebo control group. Detailed arguments relating to the potential for alcohol to decrease false memories are outlined in Chapter 4. These centre on the propensity for alcohol to induce superficial processing (Craik 1977) resulting in decreased activation of critical items. In addition, the reduction of processing resources when intoxicated (Steele & Josephs 1988) could reduce the amount of elaborative processing. These dual effects of alcohol would, under the principles of the AMF, result in decreased false memories (Gallo & Roediger 2002).

Repetition of study list material will be manipulated at encoding. Repetition has been shown to increase false memories (Seamon *et al.* 2002), decrease false memories (Benjamin 2001), have no effect on false memories (Tussing & Greene 1999), and affect memories in an inverted U-shaped function by initially increasing them then subsequently decreasing them (Seamon *et al.* 2002). Repetition is thought to increase false memories via increased activation of the critical items (Benjamin 2001). In addition, repetition provides an opportunity for increased learning of veridical items which can aid source monitoring decisions, leading to a decrease in false memories (Benjamin 2001). Consequently, it can be argued that the way in which repetition affects false memory levels can provide insight into whether repetition is differentially affecting activation or monitoring processes, and which processes are prevailing in memory judgements. As both recollective processes (Duka *et al.* 2001), and semantic activation (Craik 1977) are thought to be impaired under alcohol, repetition may have a differential effect on false memory levels in intoxicated participants relative to a placebo control group.

The primary aim of Experiments 1 and 2 is to assess the anterograde and retrograde effects of alcohol on false and veridical memory. A consequence of the two encoding phases also enable investigation of potential proactive, retroactive and negative transfer interference effects (Anderson 1999)[1]. Repetition has been shown to increase false memories in information which is less well learnt (Seamon *et al.* 2002). Presumably this arises from a threshold of learning needing to be attained before effective monitoring can operate. Consequently, repetition may differentially affect false memory levels dependent on the extent to which interference effects generated by the two encoding phases impedes learning.

As a means to assess false and veridical memory levels, measures of implicit and explicit memory were taken at test. McKone and Murphy (2000) propose that using implicit as well as explicit tests serves as an additional means to assess the similarities and differences between false and veridical memories. McDermott (1997) demonstrated a priming effect for false memory items, as assessed using stem completion and word fragment completion[2]. McKone and Murphy (2000) also obtained a significant priming effect for false memory items using the DRM paradigm specially modified for the purpose of stem completion instructions. It was found that the priming effect for false memory items mirrored veridical memory in that the effect was modality specific; a shift from auditory encoding to a visual test eliminated the priming effect for both types of items. As alcohol has been demonstrated to differentially affect implicit and explicit memory (Lister *et al.* 1991), it would be interesting to explore whether the false memory tested under implicit instructions are preserved to the same extent as veridical memories in intoxicated subjects.

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[1] Proactive interference refers to the phenomenon whereby the material initially learnt can accelerate the forgetting of later learnt material. Retroactive interference is when later learnt material accelerates the forgetting of initially learnt material. Negative transfer is when the learning of subsequent material is impeded by material previously learnt (Anderson 1999).

[2] Stem completion refers to the completion of a 3-letter stem (e.g. sle…). Word fragment completion requires the blank spaces to be filled in order to form a word (e.g. s_ e_ p).

3.2. Methods

There were two experiments: Experiment 1 assessed explicit memory, whilst Experiment 2 assessed implicit memory. Their procedures were largely identical prior to the testing phase. Consequently, their joint procedures will be described in parallel, with any variations between the two studies stated. Separate accounts will then be provided regarding their different testing procedures.

Twenty-four (Experiment 1) and thirty-two (Experiment 2) volunteers were recruited from the undergraduate and postgraduate population at the University of Sussex. Each experiment was composed of half male and half female participants. All subjects were native English speakers, not dyslexic and aged 18-34 years and were given a cash payment for participating.

Volunteers were screened prior to participating on the basis of their medical history and all met the criteria for inclusion (as outlined in Chapter 2, section 2.5).

Alcohol administration

Alcohol was administered at the dose of 0.6 g/kg, with 90% v/w alcohol diluted with tonic water to make up a 300 ml beverage. The drink was divided into 10 x 30 ml portions and each portion was mixed with 4 drops of Angostura bitters. The placebo beverage consisted of 300ml of tonic water and Angostura bitters only. The experimenter provided participants with the 30 ml portions at 3-mins intervals, making the total time of alcohol administration 30 minutes.

Design

The experiment was double-blind, and participants were randomly assigned to either the placebo (Exp. 1 N = 12, Exp. 2 N = 16) or alcohol (Exp. 1 N = 12, Exp. 2 N = 16) group. All participants took part in two encoding phases; one pre drink and one post drink. List repetition was a within subjects variable, with all participants viewing six lists once and six lists three times in each encoding phase. Item type (veridical and critical) was also a within subjects variable. Whilst the materials for the test remained constant, the test instructions varied between experiments. Participants in Experiment 1 had explicit cued recall instructions, whilst participants in Experiment 2 had implicit instructions (see procedure for details).

Materials

Memory task: Encoding

Word lists were in DRM format, and were selected from Stadler *et al.* (1999) provided that they conformed to the specifications deemed necessary for stem completion tests, as outlined by McEvoy *et al.* (1999) (see Chapter 2 for details). All lists contained the ten veridical words most closely related to the critical non-presented item. Nine additional lists were created, following the same specifications, to ensure a sufficient amount of lists were available. Pilot studies ensured that created lists and those used by Stadler *et al.* (1999) were balanced in terms of probability of false recall, probability of veridical recall, baseline stem completion rates and word frequency[3] (see Chapter 2). 24 lists were divided into four 6-list sets (set A, B, C, and D). These sets were divided into two groups (group 1 and group 2) each comprising three lists. The grouping of the lists determined whether lists were to be repeated or presented once. Half of participants viewed lists in group 1 once, whilst lists from group 2 were viewed three times. The other half of the participants viewed lists from group 1 three times, and group 2 lists only once. Participants saw two sets; one in the encoding phase before the drink, and one in the encoding phase after the drink. All sets and groups were fully counter balanced to ensure that any given list had an equal probability of being presented pre or post drink, as well as an equal probability of being presented once, or repeated three times. The presentation of list order was fully randomised, with the constraint that list repetitions were consecutive.

Memory task: Test

The memory task consisted of 48 3-letter word stems. Half of these stems were the first three letters of the critical items corresponding to the 24 different lists. The remaining 24

[3] familiarity and Kucera-Francis ratings were obtained using the MRC Psycholinguistic Database.

stems were the first three letters of 24 veridical words, one from each of the 24 lists. The veridical word from each list matched the critical item from that same list in terms of familiarity rating and Kucera-Francis written frequency rating and baseline stem completion rates. For each participant, six stems corresponded to veridical items viewed in the encoding phase, three of which had been repeated and three that had been presented once. Similarly, six stems corresponded to critical words semantically related to these lists, resulting in three corresponding to singularly presented list, and three corresponding to repeated lists. The remaining 24 stems corresponded to 12 veridical items from lists not viewed in the encoding phases, and their respective 12 critical items. The presence of these 12 non-studied veridical and critical items served to provide baseline stem completion rates and to reduce the chance of explicit contamination in the implicit test (McKone & Murphy 2000).

Procedure

On arrival at the lab, participants completed the AUQ and Medical questionnaire to ensure they fulfilled the inclusion criteria. They were then breathalysed to ensure no alcohol was in their system. Their height and weight was taken and their drinks were mixed for them whilst they consumed their lunch (a small roll and a glass of water). They completed the Lezak memory test to provide a measure of baseline memory.

Prior to the encoding phase participants were informed that they would be exposed to lists of words, some of which were to be presented once, whilst others were to be repeated. They were told to learn these words, as their memory for them would later be tested. Each encoding phase took 14 minutes. All lists were preceded by a 5-second 'New List' warning. Veridical items remained on the screen for 3-seconds, with a 1-second blank screen interval between each item. Repetitions of lists were blocked, and so ran consecutively, with the order of veridical items within each list remaining constant. Veridical items were ordered in each list according to decreasing associative strength to the critical non-presented item.

Once the first encoding phase was complete, participants were taken to the medical room where the drinks were administered. Drinks were divided into ten 30 ml portions (see section on alcohol administration) and participants were given one measure every three minutes. After half an hour, once all drinks had been consumed, participants were required to wait for a further ten minutes. This ensured that BAC levels peaked during encoding. Participants then completed the VAS for a first time, rinsed their mouths out with water and were breathalysed. They then underwent the second encoding phase. They then were sent to the waiting room and all participants were breathalysed at half hourly intervals. Once participants' BAC levels had dropped to below 0.23 (a quarter of the legal drink drive limit) they were admitted to the test phase. In all cases this resulted in 2 ½ hours of waiting time. Placebo participants were also kept waiting for 2 ½ hours to ensure the retention interval was matched between groups and that all participants remained blind to which drink they had consumed.

At test, 48 3-letter word stems were presented on two sheets of paper. Participants wrote their responses on the sheet. They were asked to consider each stem in turn and were requested not to go back to earlier items. Subjects in Experiment 1 were given explicit cued recall instructions. They were told to complete only those stems that could form a word viewed in either of the two encoding phases. They were also informed that not all stems could be completed to form a word viewed earlier, and thus if they could not think of one to fit a particular stem, they were to leave that stem blank. Participants in Experiment 2 did the NART before their memory was tested. The NART data was not analysed and was administered for the purpose of distracting participants from the purpose of the implicit test. They were then given implicit instructions, where they were told to complete the stem as quickly as possible to form the first word to come to mind. Once all stems were completed, participants were required to circle all words they were "aware" of having viewed in the encoding phase and then make R or K judgements for these endorsed words. No time limit was enforced in either of these two testing procedures.

Once the testing phase was over, participants completed the VAS for a second time and were then allowed to go home. Participants were informed which drink they had consumed, and those in the alcohol condition were reminded not to drive, cycle, or operate any heavy machinery for a minimum of four hours.

Statistical analysis: Rationale

The data from each encoding phase will be analysed separately, consistent with analyses followed of researchers wanting to isolate the potential facilitative and impairing effects of alcohol (Moulton *et al.* 2005). In addition, different analyses will also be performed on the veridical and critical items. This is also consistent with researchers who have used pharmacological drugs to selectively determine their effects on false and veridical memory (e.g. Hurron *et al.* 2001). As conclusions derived from the statistical analyses are not dependent upon comparing the relative levels of false and veridical memory, including these two measures within a single ANOVA was not deemed essential[4]. Instead, insight into how alcohol may selectively affect false and veridical memory relative to a placebo control group is pursued, as assessed using implicit and explicit tests. In addition, insight into the way in which false and veridical memories are selectively modulated by repetition, and how this may differ as a function of drink, is also an aim, and these ends are not hampered by separate analyses in critical and veridical items. Within the cognitive memory literature, researchers have tended to perform separate analyses involving remember and know judgments due to the potential mutual dependency of these two variables (e.g. Gardiner *et al.* 1996). Analyses in the present study were performed on raw scores as opposed to percentages of remember and know judgements. Consequently, the variability induced by the memory capacity of individual participants meant that this dependency was not absolute. Thus measures of awareness (aware versus unaware), memory type (remember versus know) were incorporated within a single analysis[5]. This followed a president set by researchers within the

[4] This does not apply to the priming data, where a question of interest is the potential for a differential priming effect to be obtained in veridical and critical worlds. Consequently, analysis will include both veridical and critical words within a single ANOVA.

[5] This logic also applies to the mode of analysis adopted for source monitoring judgements (correct versus incorrect) applied in Experiments 8 and 9.

psychopharmacology literature for analyses involving both awareness measures (e.g. Duka *et al.* 2001) and memory type (e.g. Milani and Curran 2000).
The data analysis will be divided into two sections. Firstly, cued recall data will be analysed (Experiment 1). Secondly, implicit data will be analysed (Experiment 2). At the start of each section the type of statistical analysis employed will be stated. As these are the first experiments, potentially interesting trends <.09 will be discussed as a means to highlight possible effects to explore in subsequent experiments.

Researchers using the DRM paradigm sometimes correct their data for non-critical intrusion rates prior to analysis (e.g. Chan *et al.* 2005) – with intrusions being defined as words recalled or recognised which are not veridical words or critical words. Such corrections, however, are not habitually employed within the empirical literature. Indeed, at present, many researchers appear not to correct their data for intrusions (e.g. Seamon *et al.* 2003). Researchers who have used repetition as a within subjects variable have also tended not to correct their data as they do not belong to any repetition condition (Seamon *et al.* 2002). There is an incentive not to perform signal detection analyses if data incorporates a large amount of zeros and ones as the corrections employed reduce differences which may exist within the data. Nevertheless, if group differences exist in intrusion rates then clearly memory scores need to be adjusted to accommodate this. Within the present study, no corrections were administered to the data prior to analysis for intrusion rate. This was because non-critical intrusions were not found to differ between the alcohol and placebo groups, as determined using a number of different analyses. Firstly, between subjects t-tests were performed to see how the alcohol and placebo groups differed in terms of their intrusions (with an intrusion classified as a stem which was completed to form a word that was not a veridical item encountered in the encoding phase, nor its associated critical item). The first analysis determined whether the total number of intrusions recalled differed between the two groups. This was found to be non-significant [$t(22) = -.535, p = .598$]. In case levels of overall memory differed between the two groups in such a way that would render a difference in intrusions as significant, further analyses were conducted. Two new variables were devised which looked at the proportion of intrusions in terms of the total amount of veridical items recalled or the total amount critical items recalled. Neither of these respective variables reached significance [$t(22)$ - .832, p = .415; $t(22)$ = .403, p = .691]. The amount of stems corresponding to either veridical or critical words from the two encoding phases which were completed to form an intrusion were calculated. In terms of the first encoding phase, neither the amount of intrusions written by alcohol verses placebo subjects on veridical stems [$t(22)$ = .000, p = 1.000] nor critical stems [$t(22)$ = -.364, p = .719] reached significance. Nor were the amount of intrusions completed on veridical stems [$t(22)$ = -1.113, p = .278] or critical stems [$t(22)$ = .000, p = 1.000] corresponding to the second encoding phase found to significantly differ between the two groups.

3.3. Results

3.3.1. Groups

Units consumed per week, AUQ score, binge score and baseline memory scores (Lezak 1995) were separately calculated for both the placebo and alcohol groups in Experiment 1 and Experiment 2 (see table 3.1.).

	Experiment 1: Mean (SEM)		**Experiment 2: Mean (SEM)**	
	Placebo	*Alcohol*	*Placebo*	*Alcohol*
Units per week	34.59 (5.14)	23.97 (5.57)	30.90 (5.70)	31.55 (4.81)
AUQ score	65.62 (9.60)	44.81 (6.39)	55.96 (9.89)	59.15 (8.92)
Binge score	31.05 (5.90)	20.85 (2.74)	25.15 (5.23)	27.63 (6.29)
Lezak	17.64 (1.45)	18.08 (0.87)	17.63 (0.99)	16.6 (0.67)

Table 3.1. **Group qualities in the alcohol and placebo groups for Experiment 1 and Experiment 2.**

Independent t-tests revealed that the alcohol and placebo groups, in both Experiment 1 and Experiment 2, were matched in terms of units consumed per week [$t(22)$ = 1.410, p = .173; $t(30)$ = -.086, p = .932], AUQ score [$t(22)$ = 1.84, p =.09; $t(30)$ = -2.40, p = .812] and binge score [$t(22)$ = 1.614, p = .121; $t(30)$ = -.302, p = .764]. In addition, analyses of baseline memory scores (Lezak 1995) revealed that the alcohol and placebo groups were matched in both Experiment 1 [$t(22) = -.270, p = .790$] and Experiment 2 [$t(30) = .836, p = .410$].

VAS scores: Time 1 (post drink)

	Experiment 1: Mean (SEM)		Experiment 2: Mean (SEM)	
	Placebo	*Alcohol*	*Placebo*	*Alcohol*
Relaxed	5.6 (.55)	6.13 (.057)	5.82 (5.81)	6.92 (.049)
Content	5.45 (.51)	6.37 (0.37)	5.81 (.38)	6.55 (0.41)
Lightheaded	3.44 (.74)	5.9 (.72)	2.59 (.52)	4.9 (.64)

Table 3.2. **VAS scores post consumption of drink.**

VAS scores: Time 2 (post test)

	Experiment 1: Mean (SEM)		Experiment 2: Mean (SEM)	
	Placebo	*Alcohol*	*Placebo*	*Alcohol*
Relaxed	4.97 (.31)	5.58 (.32)	5.9 (.36)	5.41 (.47)
Content	6.3 (.38)	5.96 (.54)	6.02 (.39)	5.92 (.41)
Lightheaded	3.18 (.30)	3.83 (.34)	2.88 (.34)	3.06 (.35)

Table 3.3. **VAS scores post test.**

VAS scores were taken in both the alcohol and placebo groups at two separate time points. The first time was post consumption of the drinks (see table 3.2.), and the second time was post test (see Table 3.2.). Analyses of VAS scores from time 1 revealed that in both Experiment 1 and Experiment 2, there was no effect of alcohol on subjective ratings for how relaxed [$t(22) = -.669, p = .511$; $t(30)$ -1.746, $p = .091$] and content [$t(22) = -1.462, p = .158$; $t(30) = -1.335, p = .192$] participants felt. In contrast, participants in the alcohol and placebo groups differed in the their subjective ratings of lightheadedness in both Experiment 1 [$t(22) = -2.377, p = .027$] and Experiment 2 [$t(30) = -2.806, p = .009$] demonstrating a significant effect of alcohol on self-rated feelings of lightheadedness. Analyses of VAS scores in the second time point (Table 3.3.) revealed that groups were matched on all three measures in both Experiment 1 and Experiment 2 respectively: Relaxed [$t(21) = -1.340, p = .195$; $t(30) = .822, p = .418$], content [$t(21) = .506, p = .618$;

$t(30) = .176, p = .861$] and lightheadedness [$t(21) = -1.422, p = .170$; $t(30) = -.386, p = .702$].

3.4. Main analysis: Cued recall [Experiment 1]

3-way between subjects ANOVAs were performed on the amount of stems completed under explicit instructions. Analyses were separated for the pre-drink and post-drink encoding phases. In addition, separate analyses were performed in veridical and critical items, thus making four separate analyses in total: pre-drink veridical items, pre-drink critical items, post-drink veridical items, post drink critical items. Within subjects variables were repetition (presented once vs. repeated three times) and memory type (remember vs. know). Drink (alcohol vs. placebo) was the only between subjects variable. The amount of stems completed served as the dependent variable.

Phase one (pre-drink): Veridical items

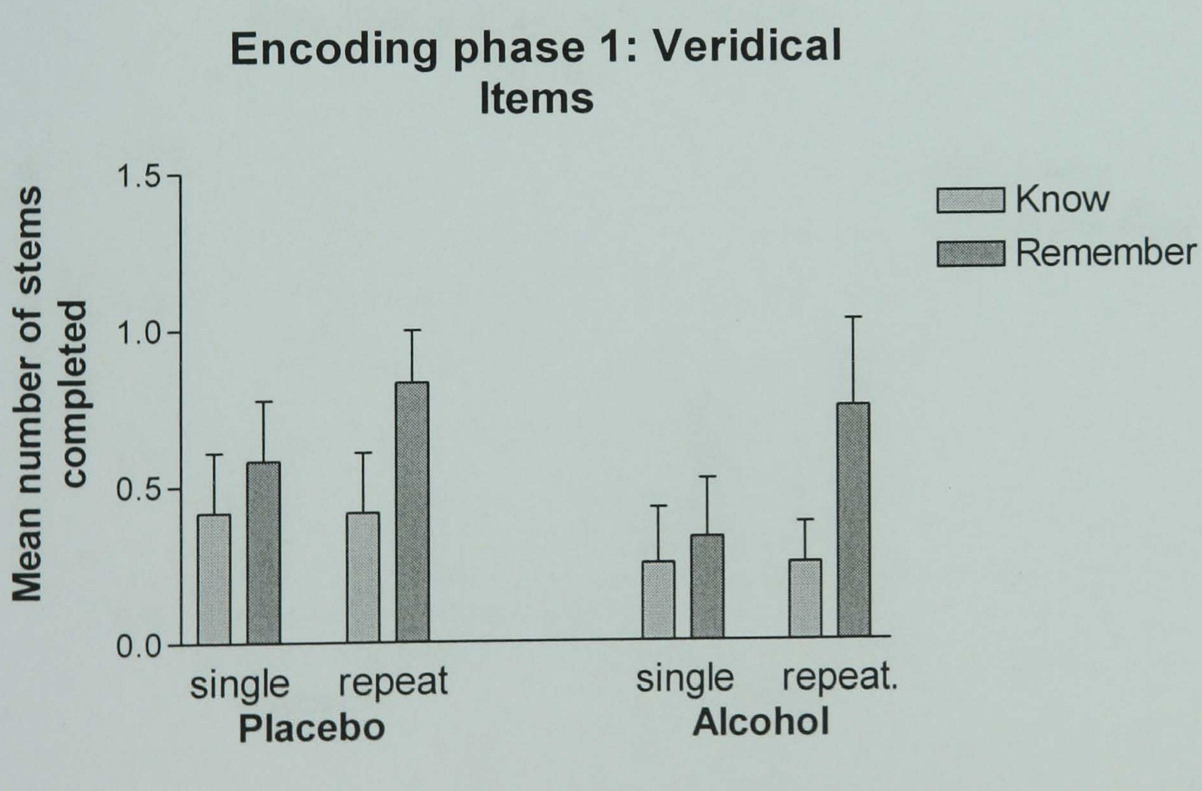


Figure 3.1. **The mean amount of stems completed by the placebo and alcohol groups to form veridical words viewed in the first encoding phase. These were divided into words viewed once, and those repeated, and whether they were ascribed a know or a remember response.**

No main effects or interactions reached significance.

A marginal main effect of memory type reflected participants' increased tendency to ascribe remember responses to memories [$F(1, 22) = 3.,446, p = .076$].

No main effect of drink was found [$F(1, 22) = 1.769, p = .197$], nor did a main effect of repetition reach significance [$F(1, 22) = 1.769, p = .197$]. Repetition was not found to interact with drink [$F(1, 22) = .111, p = .743$] or memory type [$F(1, 22) = 1.425, p = .245$], and memory type did not interact with drink [$F(1, 22) = .000, p = 1.000$]. The 3-way repetition x drink x memory type interaction also did not reach significance [$F(1, 22) = .089, p = .768$].

Phase one (pre-drink): Critical items

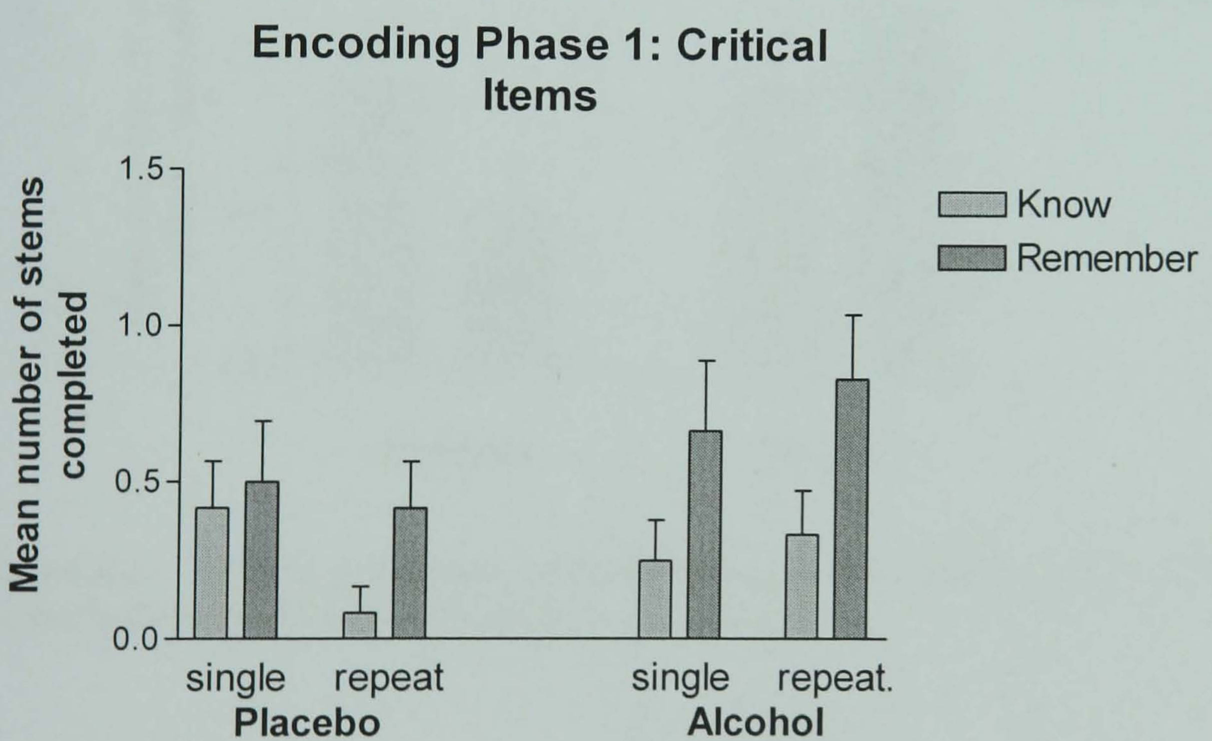


Figure 3.2. **The mean amount of stems completed by the placebo and alcohol groups to form critical words corresponding to the first encoding phase. These were divided into critical items resulting from lists viewed once, and those which were repeated, and whether they were ascribed a know or a remember response.**

A main effect of memory type [$F(1, 22) = 5.891$, $p = .024$] was found and indicated more false memories were ascribed remember than know responses. The differential effect of repetition on false memory levels dependent on drink consumed was displayed in a borderline significant repetition x drink interaction [$F(1, 22) = 3.417$, $p = .078$] (see Figure 3.3).

No main effect of either repetition [$F(1, 22) = .214$, $p = .649$] or drink were obtained [$F(1, 22) = 1.637$, $p = .214$]. Memory type was not found to interact with drink [$F(1, 22) = .828$, $p = .373$] and repetition was not found to interact with memory type [$F(1, 22) = .633$, $p = .435$].

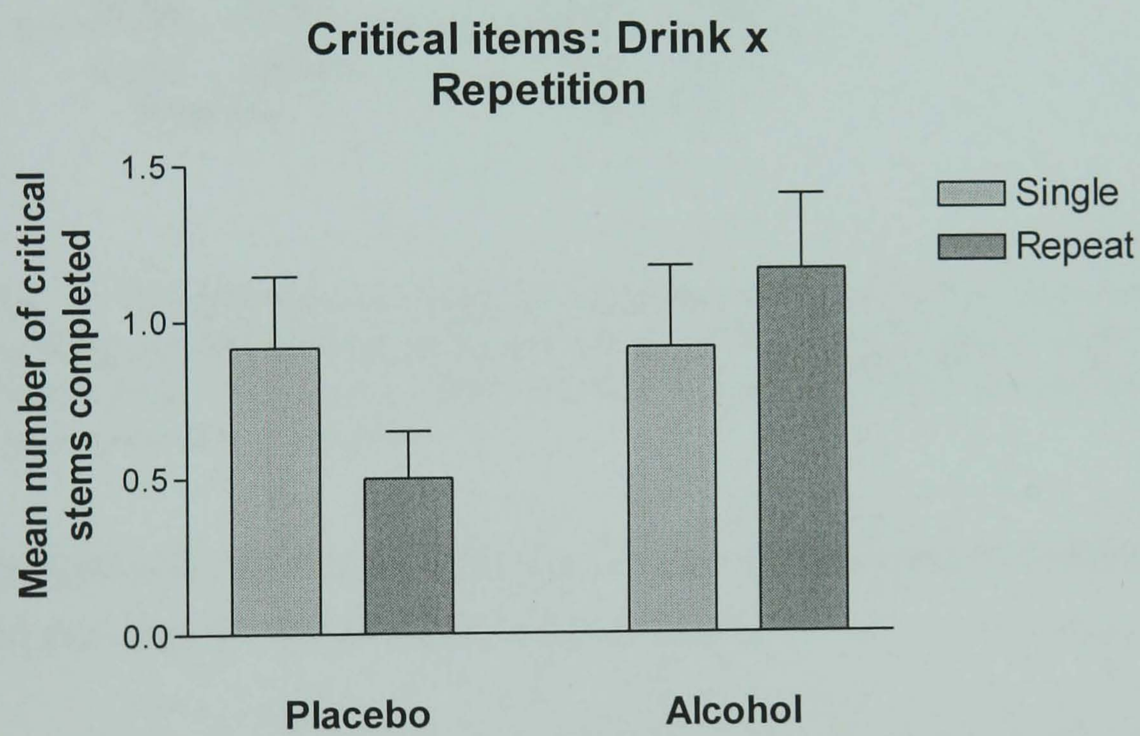


Figure 3.3. **Figure depicting a borderline significant drink x repetition interaction for critical items from the pre-drink encoding phase.**

Phase two (post-drink): Veridical items

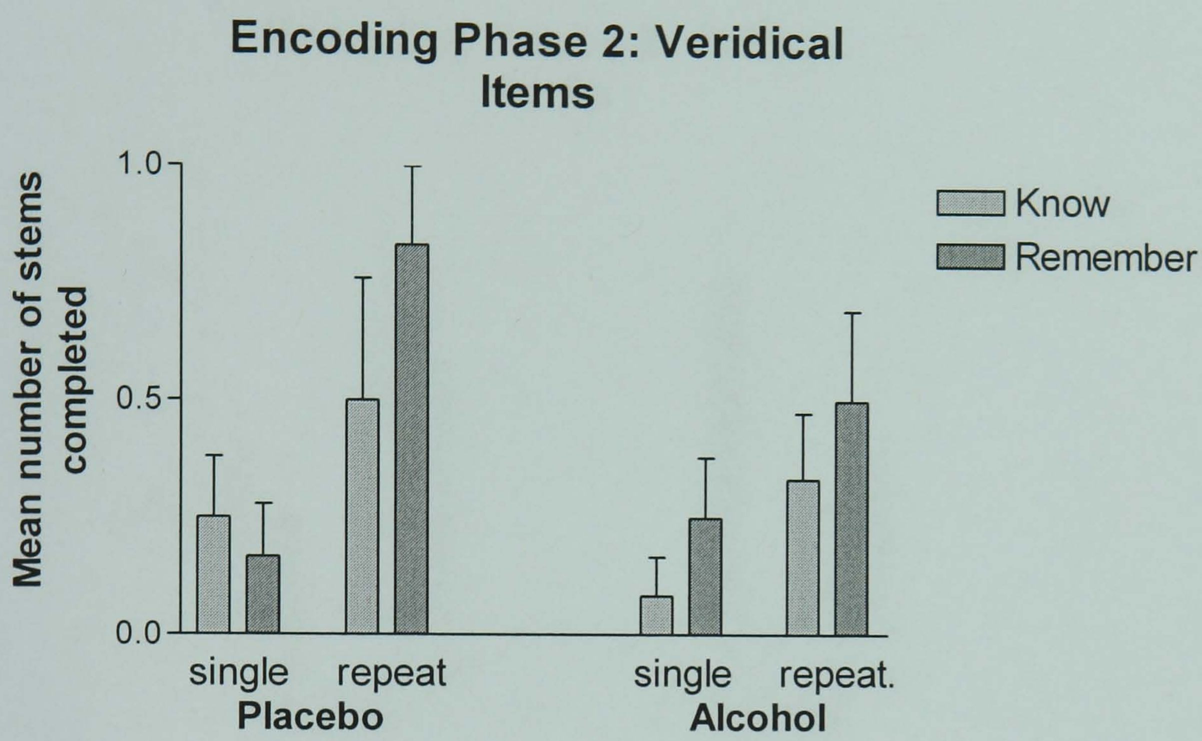


Figure 3.4. **The mean amount of stems completed by the placebo and alcohol groups to form veridical words viewed in the second encoding phase. These were divided into words viewed once, and those repeated, and whether they were ascribed a know or a remember response.**

The only significant effect was a main effect of repetition [$F(1, 22) = 12.087$, $p = .002$] signifying that repetition served to enhanced later recall.

No other main effects or interactions reached significance: main effects of memory type [$F(1, 22) = 1.365$, $p = .255$] and drink [$F(1, 22) = 1.733$, $p = .202$] were not found to be significant. Repetition was not found to interact with drink [$F(1, 22) = 1.046$, $p = .318$] nor memory type [$F(1, 22) = .793$, $p = .383$], and memory type did not interact with drink [$F(1, 22) = .028$, $p = .869$]. The 3-way repetition x word type x memory type interaction [$F(1, 22) = .793$, $p = .383$] was also not significant.

Phase two (post-drink): Critical items

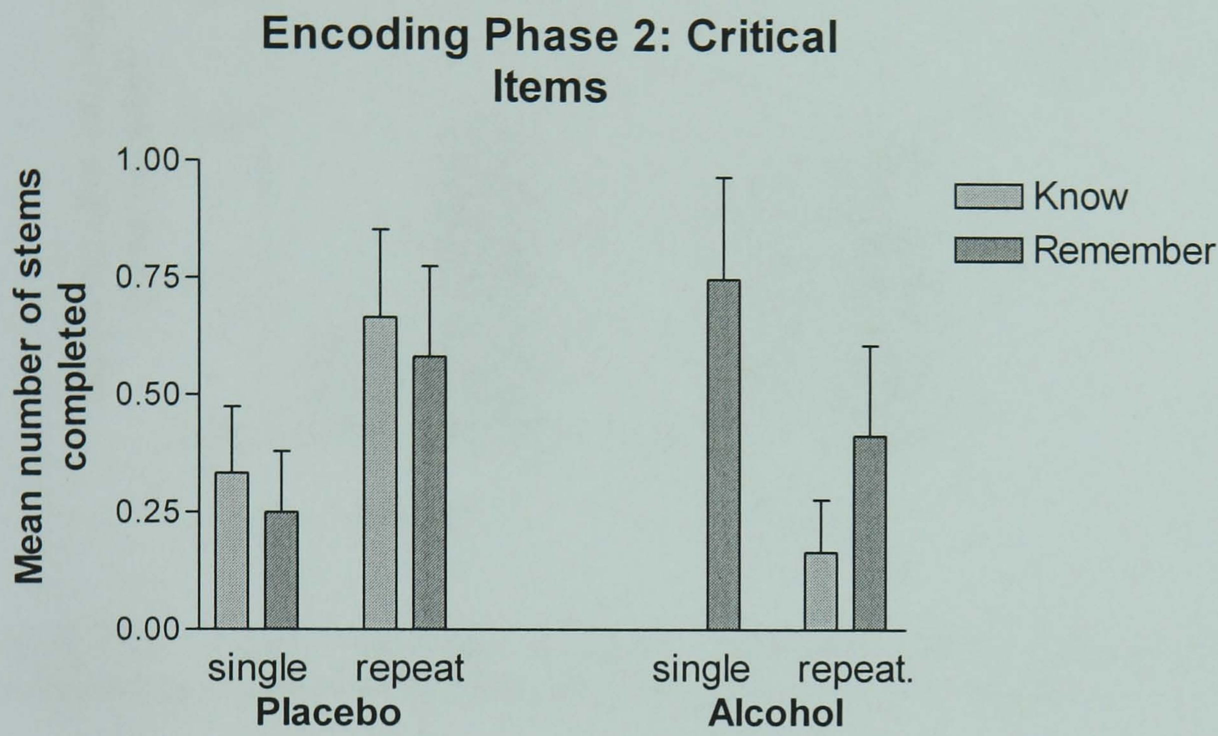


Figure 3.5. **The mean amount of stems completed by the placebo and alcohol groups to form critical words corresponding to the second encoding phase. These were divided into critical items resulting from lists viewed once, and those which were repeated, and whether they were ascribed a know or a remember response.**

Repetition significantly interacted with memory type [$F(1, 22) = 4.770$, $p = .040$], and further analysis revealed that repetition marginally increased the amount of critical items recalled and ascribed know responses [$t(23) = -1.813$, $p = .083$], whilst having no effect on remember responses [$t(23) = .000$, $p = 1.000$] (see Figure 3.6).

Repetition marginally interacted with drink, [$F(1, 22) = 3.767$, $p = .065$], as depicted in Figure 3.7.

Main effects were not obtained for repetition [$F(1, 22) = 1.356$, $p = .257$], memory type [$F(1, 22) = 2.434$, $p = .133$ nor drink [$F(1, 22) = 1.356$, $p = .257$] . The 3-way repetition x drink x memory type was also not significant [$F(1, 22) = 1.435$, $p = .244$].

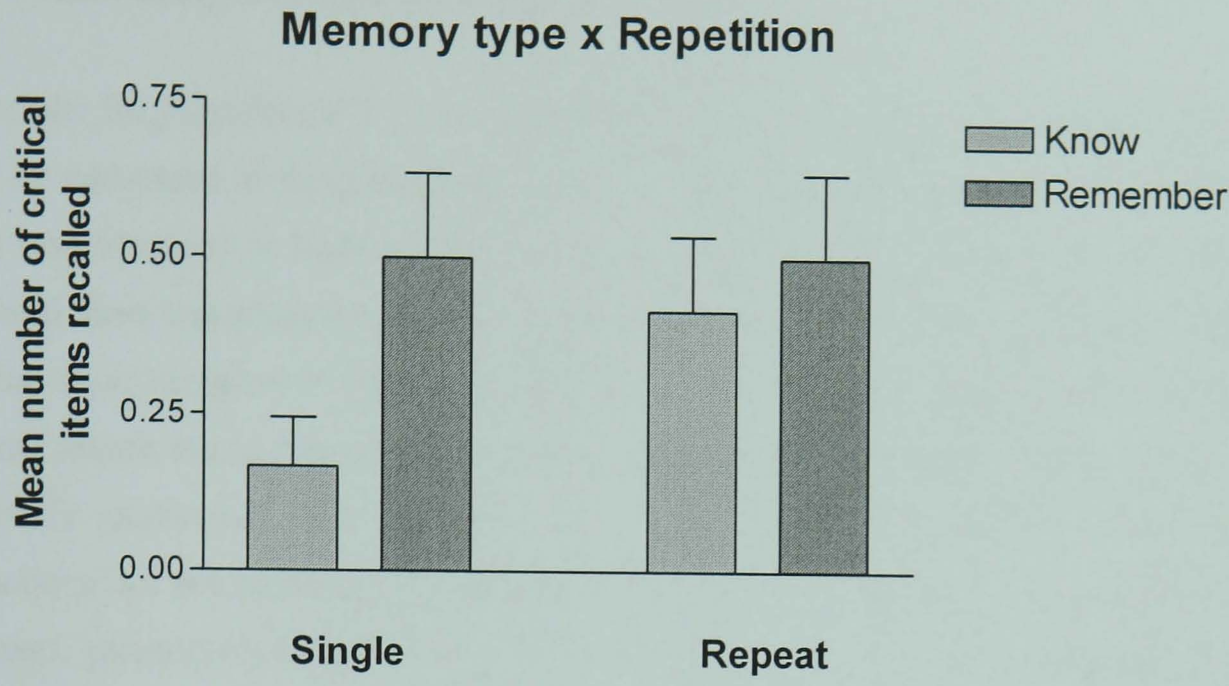


Figure 3.6. **Figure depicting marginal significant memory type x repetition interaction for critical items from the post-drink encoding phase.**

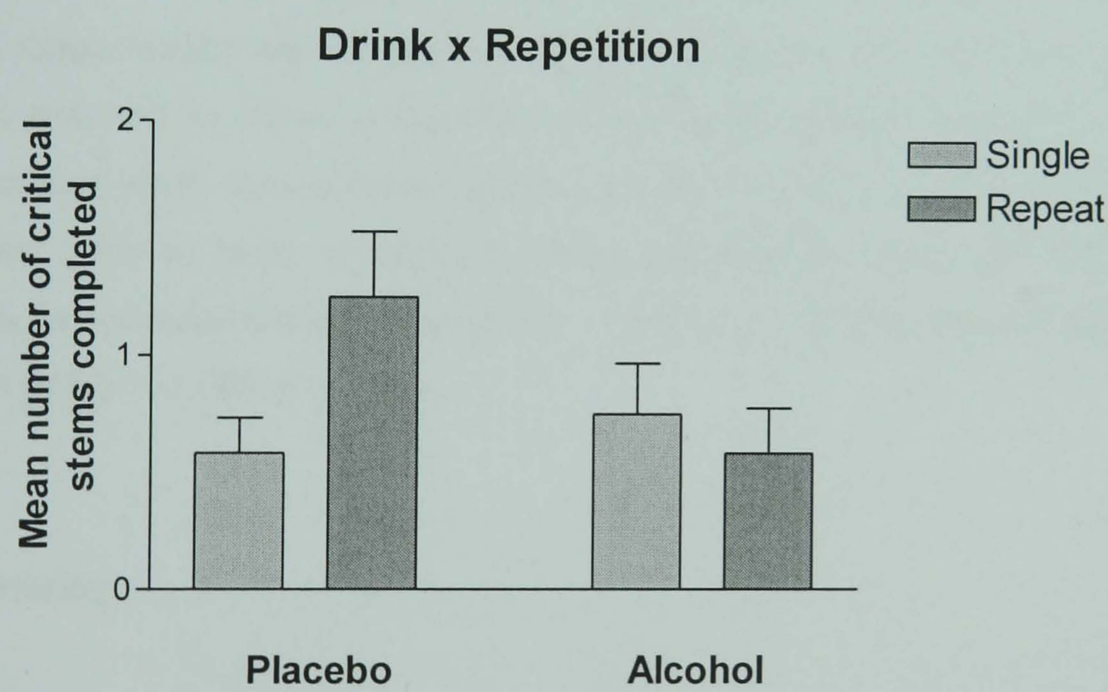


Figure 3.7. **Figure depicting a marginal significant drink x repetition interaction for critical items from the post-drink encoding phase.**

3.5. Main analysis: Implicit Results [Experiment 2]

The results for Experiment 2 - whereby memory was assessed using implicit instructions - will be addressed in three sections. Section 3.5.1 is concerned with whether a priming effect was obtained in both veridical and critical items, with priming being defined as increased stem completion to form a veridical word, or its critical associate, relative to baseline stem completion rates for those items. Section 3.5.2. deals with comparisons between aware items (those items subsequently circled and endorsed has having been previously presented) and unaware items (those items completed under implicit instructions but not endorsed as having been previously presented). Lastly, section 3.5.3. addresses phenomenological experience, as assessed using the remember / know procedure. Once again, and following an argument outlined in section 3.3., all analyses were carried out on raw data. This decision was taken following analyses which demonstrated that the alcohol and placebo groups did not differ in terms of non-critical intrusions. Similar to the analyses performed in the explicit data, analyses in the implicit data also demonstrated that the alcohol and placebo groups did not differ in terms of intrusions endorsed on either veridical stems from encoding phase one [$t(30) = .556, p = .583$] or critical stems from encoding phase one [$t(30) = .315, p = .755$]. Neither did the two groups differ in terms of intrusions either endorsed on stems of veridical words viewed in the second encoding phase [$t(30) = -.327, p = -.327$] or their semantic critical associates [$t(30) = -1.065, p = .295$].

3.5.1. Priming

An initial analysis was performed to determine whether a priming effect had been obtained for veridical and critical items. The amount of veridical and critical stems completed to correspond to studied words was compared to baseline stem completion rates. As baseline stem completion rates were not confined to a particular encoding episode (pre or post drink), the analysis assessed priming collapsed across encoding episodes. A 3-way mixed ANOVA was conducted with drink (placebo vs. alcohol) serving as a between subjects factor, and status (baseline vs. studied) and word type (veridical vs. critical) as within subjects factors. The proportion of stems completed was the dependent variable.

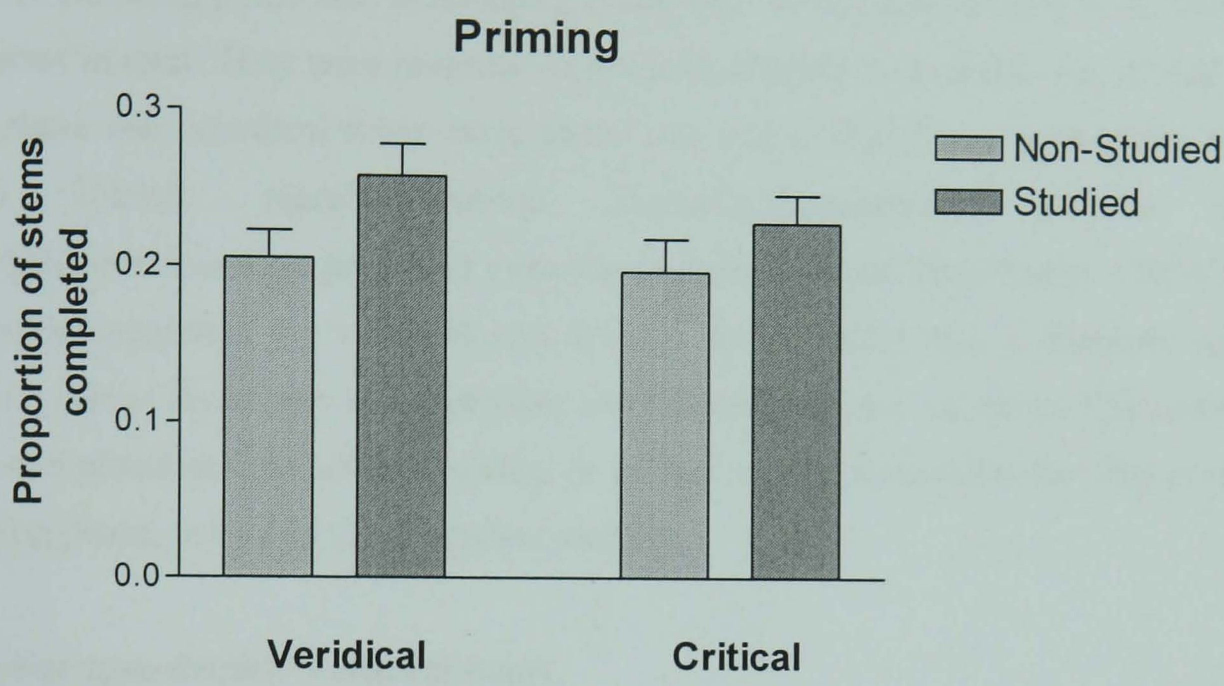


Figure 3.8. **Figure depicting the priming effect - as demonstrated by a significant main effect of studied status – for veridical and critical items.**

A main effect of status [$F(1, 30) = 4.135$, $p = .051$] indicated that a priming effect was obtained. Consequently, a stem was more likely to be completed to form a word corresponding to those encountered in the encoding phase (either veridical or critical) than baseline stem completion rates for those words.

No main effect of word type was found [$F(1, 30) = 1.146$, $p = .293$], demonstrating that a stem had an equal probability of being completed to form either a veridical or a critical word. Status was not found to interact with word type [$F(1, 30) = .308$, p .583], thus the priming effect was not differentially found in veridical and critical item. No main effect of drink was found [$F(1, 30) = .381$, $p = .541$], thus the probability of completing a stem to form a veridical or critical word did not differ as a function of drink consumed. Nor was there a status x drink interaction [$F(1, 30) = .064$, $p = .803$] or a status x word type x drink interaction [$F(1, 30) = 1.244$, $p = .274$) thus the priming effect was not found to differ as a function of drink in either veridical or critical items.

3.5.2. Comparison of aware and unaware items

Separate 3-way ANOVAs were conducted in veridical and critical items, for words learnt in either encoding phase one or encoding phase two. Four separate ANOVAs were thus conducted in total. They were performed on veridical items from phase one, critical items from phase one, veridical items from phase two and critical items from phase two. A mixed 2(drink: placebo versus alcohol)x2(awareness: unaware versus aware)x2(repetition: lists presented once verses lists repeated three times) ANOVA was performed separately on veridical and critical items. Drink was a between subjects variable, whilst awareness and repetition were within subjects variables. The amount of stems completed to form either veridical or critical words, from either the first or second encoding phase, served as the dependent variable.

Phase one (pre-drink): Veridical items

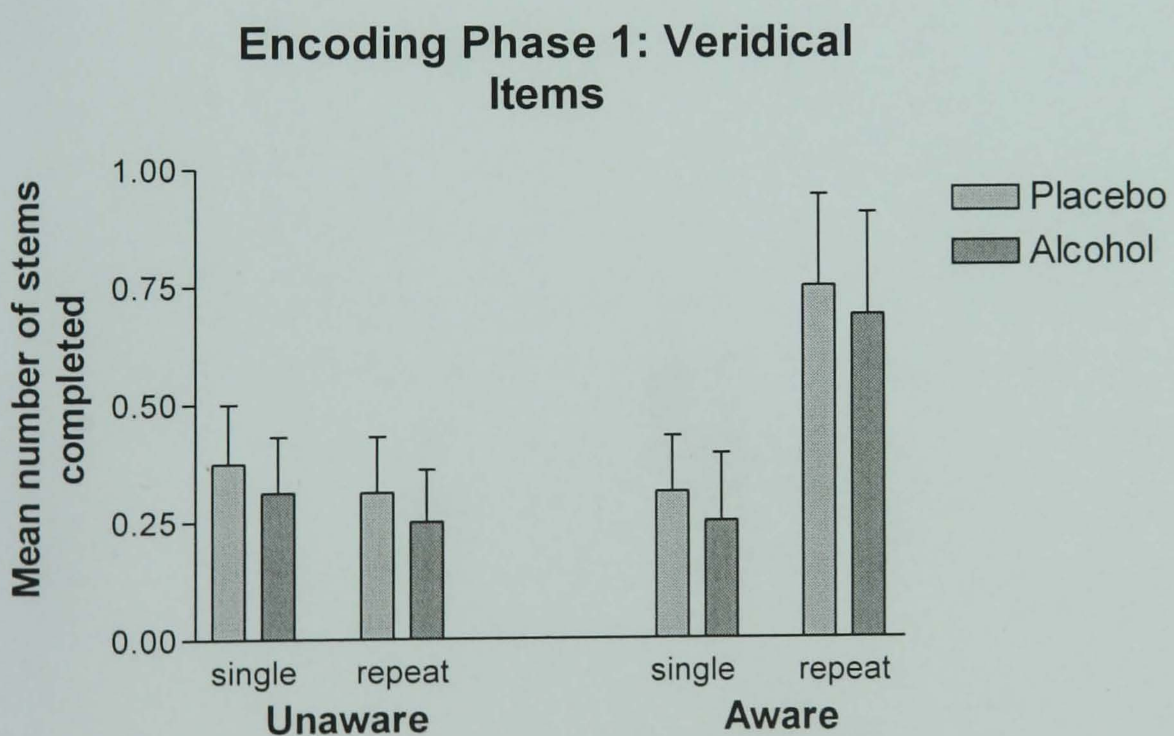


Figure 3.9. **The mean number of stems completed to form veridical words viewed in the first encoding phase which were subsequently endorsed (aware) or not endorsed (unaware) as having been previously presented. These mean values were calculated separately for veridical words from repeated and singularly presented lists.**

A significant repetition x awareness interaction [$F(1, 30) = 4.62$, $p = .040$] was further explored to indicate that repetition significantly increased the amount of aware veridical stems completed [$t(31) = -2.37$, $p = .024$] whilst having no effect on the amount of unaware veridical stems [$t(31) = .571$, $p = .572$].

A marginal main effects of awareness [$F(1, 30) = 3.10$, $p = .088$] and repetition [$F(1, 30) = 3.42$, $p = .074$] were found.

Concerning the non-significant effects, awareness status was not found to interact with drink [$F(1, 30) = .000$, $p = 1.00$], nor was drink found to interact with repetition [$F(1, 30) = .000$, $p = 1.00$]. There was also no main effect of drink [$F(1, 30) = .429$, $p = .518$], nor a significant repetition x drink x awareness interaction [$F(1, 30) = .000$, $p = 1.00$].

Phase one (pre-drink): Critical items

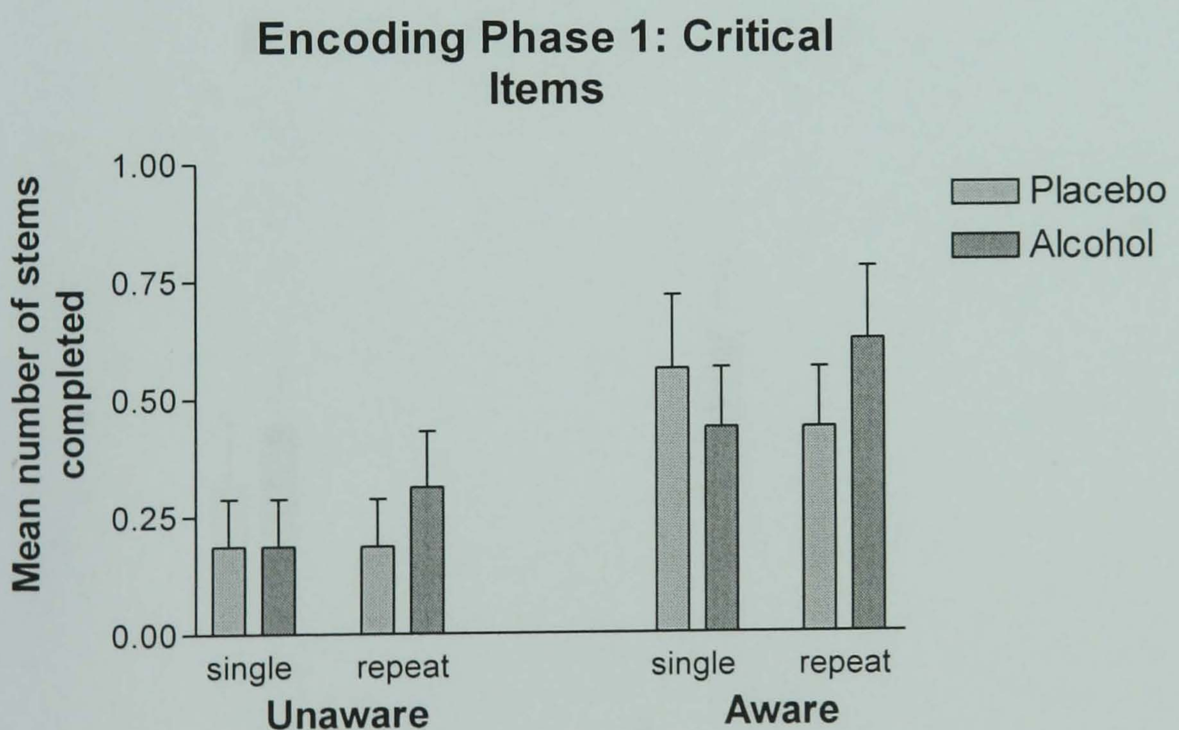


Figure 3.10 **The mean number of stems completed to form critical words corresponding to words viewed in the first encoding phase which were subsequently endorsed (aware) or not endorsed (unaware) as having been previously presented. These mean values were calculated separately for critical words corresponding to repeated and singularly presented lists.**

In critical items, a main effect of awareness [$F(1, 30) = 7.75$, $p = .009$] demonstrated that participants were more aware than unaware of the critical stems they completed.

All other main effects and interactions remained non-significant; drink was not found to affect the probability of stem completion [$F(1, 30) = .328$, $p = .571$], nor was repetition [$F(1, 30) = .491$, $p = .489$]. Awareness status did not interact with either repetition [$F(1, 30) = .027$, $p = .871$] or drink [$F(1, 30) = .021$, $p = .885$]. Inspection of Figure 3.10 reveals that repetition had a tendency to increase false memories within the alcohol group, whilst decreasing them in the placebo group, and this effect appeared to be particularly pronounced for aware false memories. This effect failed to reach significance though, as defined by a non-significant repetition x drink interaction [$F(1, 30) = 2.673$, $p = .113$], and a non-significant 3-way drink x repetition x awareness interaction [$F(1, 30) = .243$, $p = .625$].

Phase two (post-drink): Veridical items

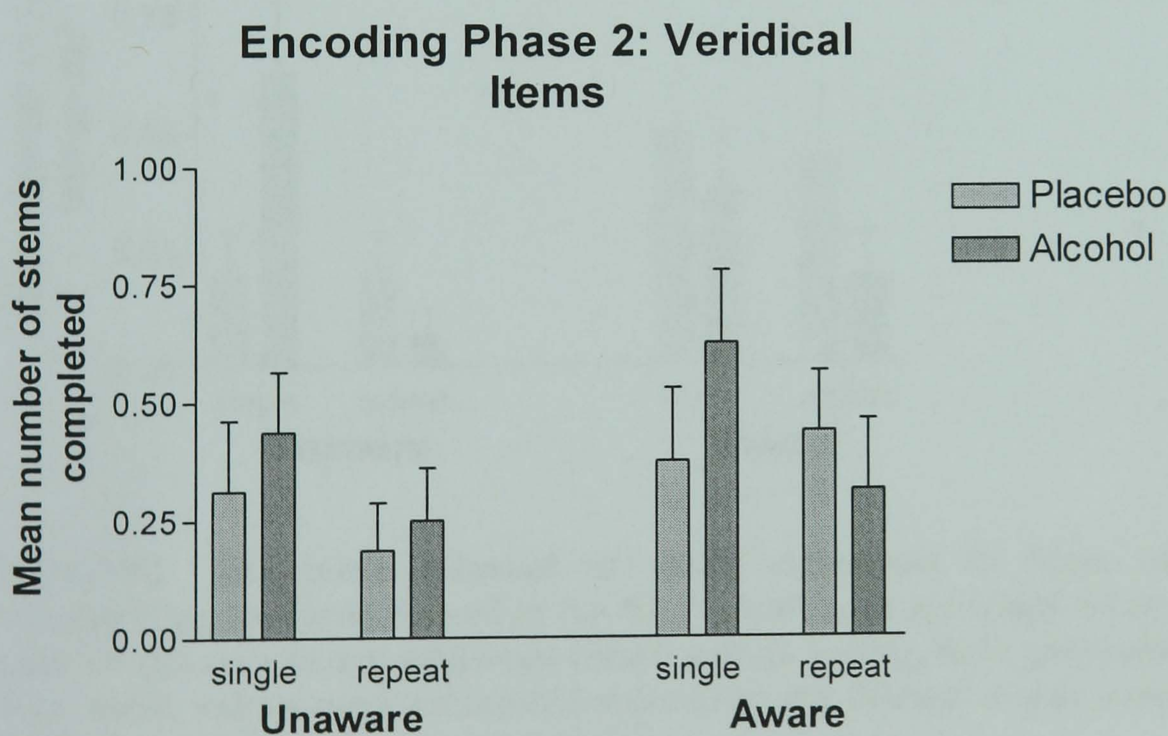


Figure 3.11. **The mean number of stems completed to form veridical words viewed in the second encoding phase which were subsequently endorsed (aware) or not endorsed (unaware) as having been previously presented. These mean values were calculated separately for veridical words from repeated and singularly presented lists.**

In veridical items, no interactions nor main effects reached significance. There was no main effect of awareness [$F(1, 30) = 2.084$, $p = .159$], repetition [$F(1, 30) = 1.950$, p .173, nor drink [$F(1, 30) = .931$, $p = .342$]. Awareness was not found to interact with either repetition [$F(1, 30) = .022$, $p = .882$] or drink [$F(1, 30) = .026$, $p = .874$]. Nor was drink found to interact with repetition [$F(1, 30) = 1.180$, $p = .286$]. The 3-way drink x repetition x awareness interaction also did not reach significance [$F(1, 30) = .556$, $p =$ .462].

Phase two (post-drink): Critical items

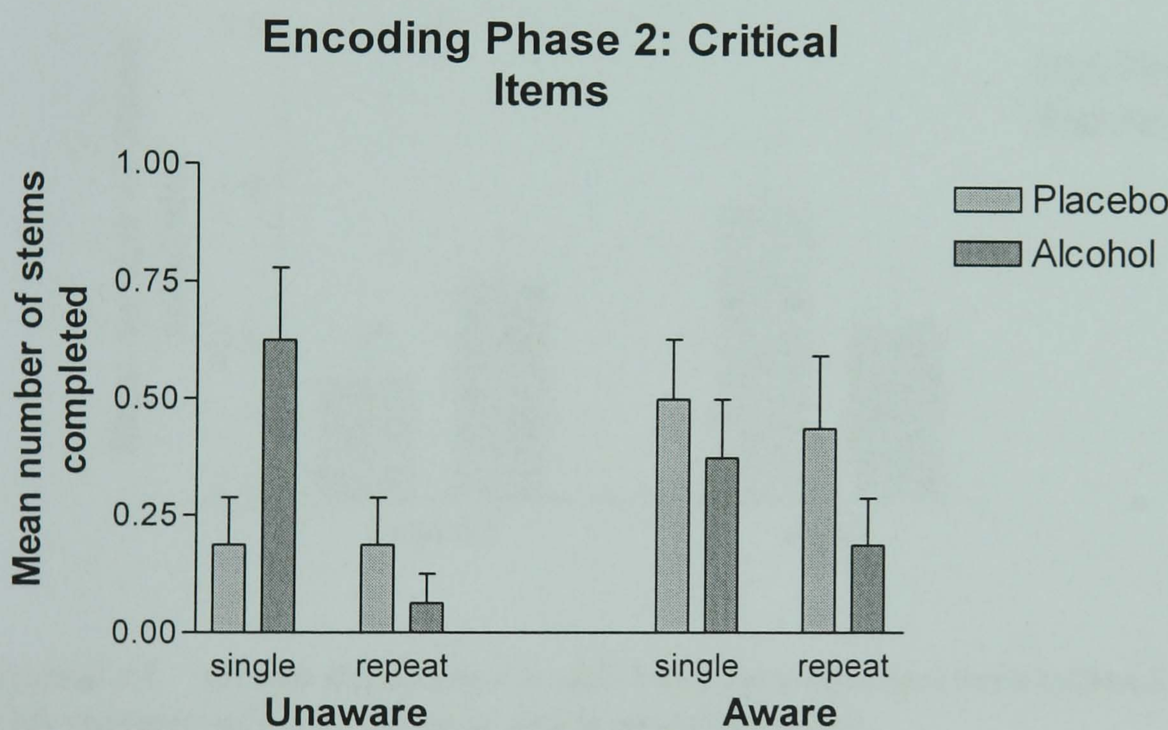


Figure 3.12. **The mean number of stems completed to form critical words corresponding to words viewed in the first encoding phase which were subsequently endorsed (aware) or not endorsed (unaware) as having been previously presented. These mean values were calculated separately for critical words corresponding to repeated and singularly presented lists.**

For critical items, a main effect of repetition was significant [$F(1, 30) = 8.83$, $p = .006$, signifying that repetition served to reduce critical items, thus making memory more accurate.

A repetition x drink interaction [$F(1, 30) = 6.32$, $p = .018$] was further analysed with within subjects t-tests. No significant difference existed between alcohol and placebo groups in the amount of stems completed to form critical items from singularly presented lists [$t(30) = 1.43$, $p = .163$]. For repeatedly presented lists, the placebo group completed more critical stems, and this value was marginally significant [$t(30) = 1.96$, $p = .059$] (see Figure 3.14).

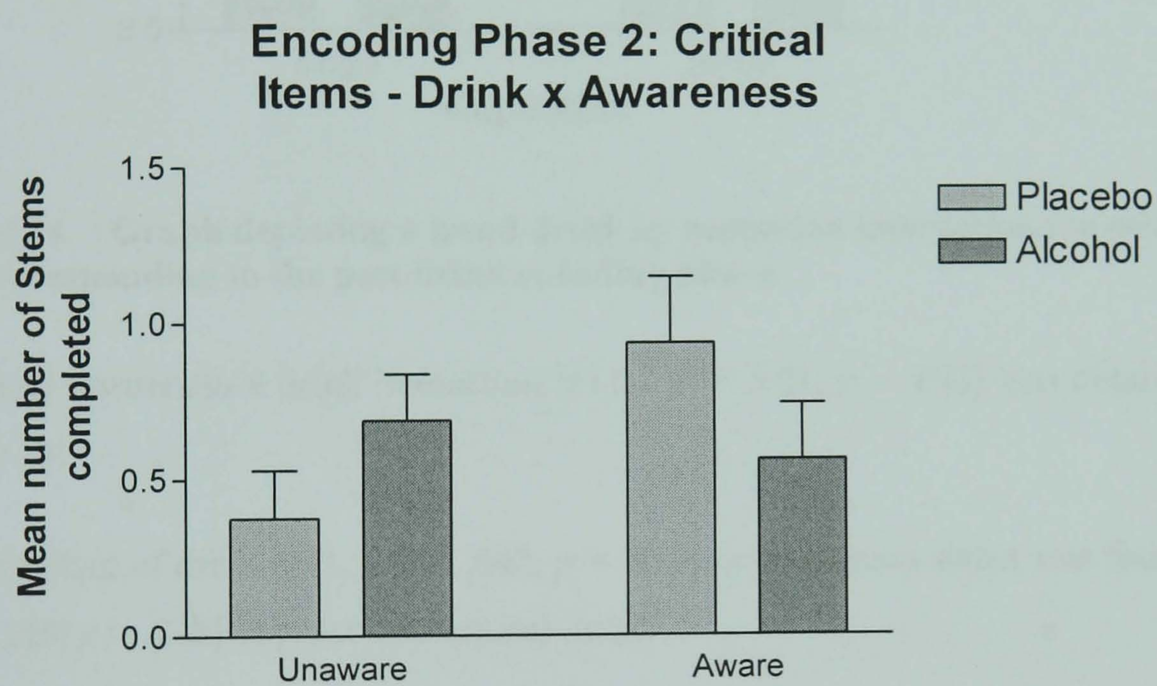


Figure 3.13. **Graph depicting a trend drink by awareness interaction for critical items corresponding to the post drink encoding phase.**

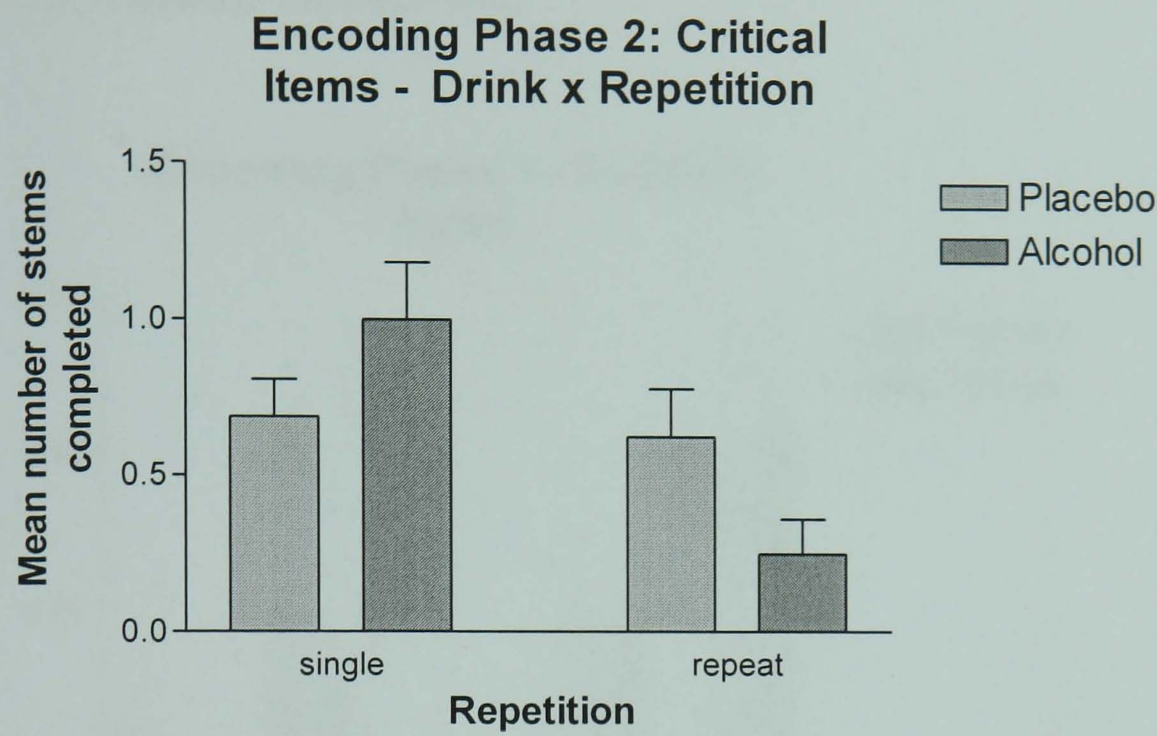


Figure 3.14. **Graph depicting a trend drink by repetition interaction for critical items corresponding to the post drink encoding phase.**

A marginal awareness x drink interaction [$F(1, 30) = 3.01$, $p = .093$] was obtained. See Figure 3.13.

No main effect of drink [$F(1, 30) = .042$, $p = .839$] or awareness status was found [$F(1, 30) = 1.219$, $p = .278$] in phase two critical items.

3.5.3. Remember / Know Analysis

Two mixed 2(drink: placebo vs. alcohol)x2(repetition: presented once vs. repeated three times)x2(memory type: know vs. remember) ANOVAs were performed separately for veridical and critical items.

Phase one (pre-drink): Veridical items

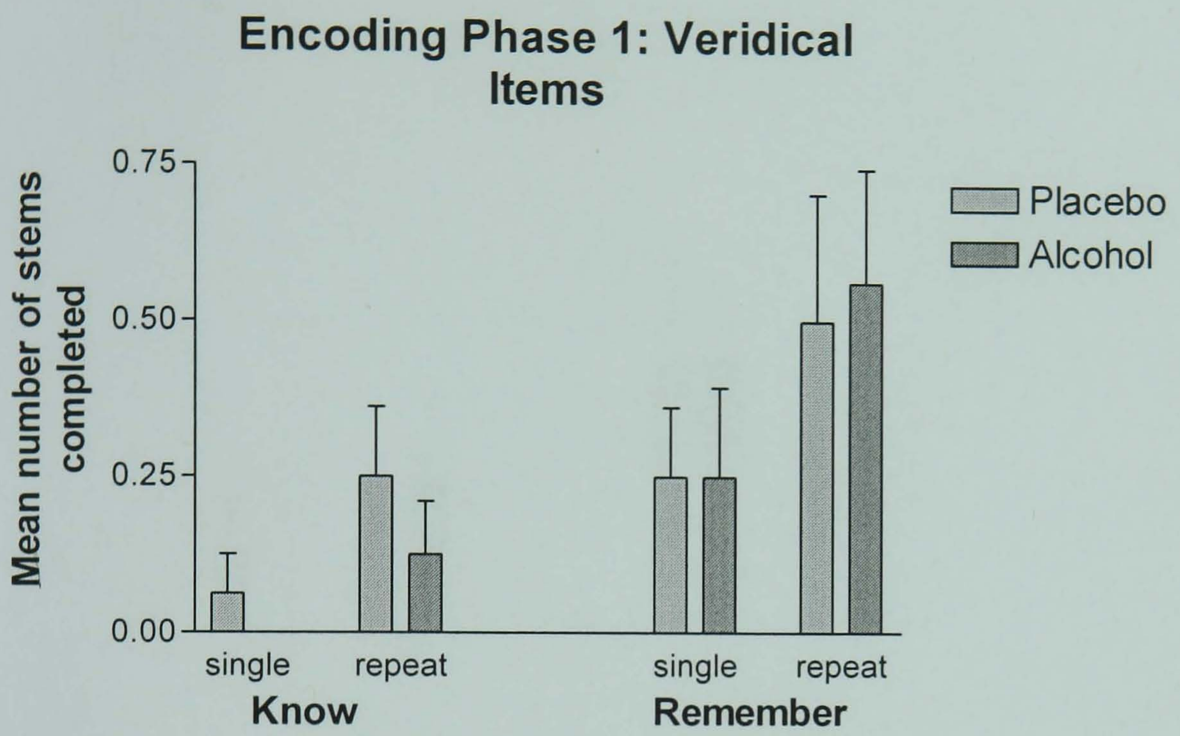


Figure 3.15. **The mean number of stems completed by the alcohol and placebo groups to form veridical words viewed in the first encoding phase, divided into those allocated know and those allocated remember responses.**

For veridical items, a main effect of memory type was found [$F(1, 30) = 8.13, p = .008$], signifying more veridical words were ascribed remember responses than know responses. In addition, a main effect of repetition [$F(1, 30) = 5.42, p = .027$] demonstrated that repetition served to increase the amount of veridical stems completed.

No main effect of drink was found [$F(1, 30) = .157, p = .695$]. Drink was not found to interact with either memory type [$F(1, 30) = .401, p = .531$, or repetition [$F(1, 30) = .000$, $p = 1.00$]. Repetition did not interact with memory type [$F(1, 30) = .478, p = .495$] and the 3-way repetition x drink x memory type interaction did not reach significance [$F(1, 30) = .120, p = .732$].

Phase one (pre-drink): Critical items

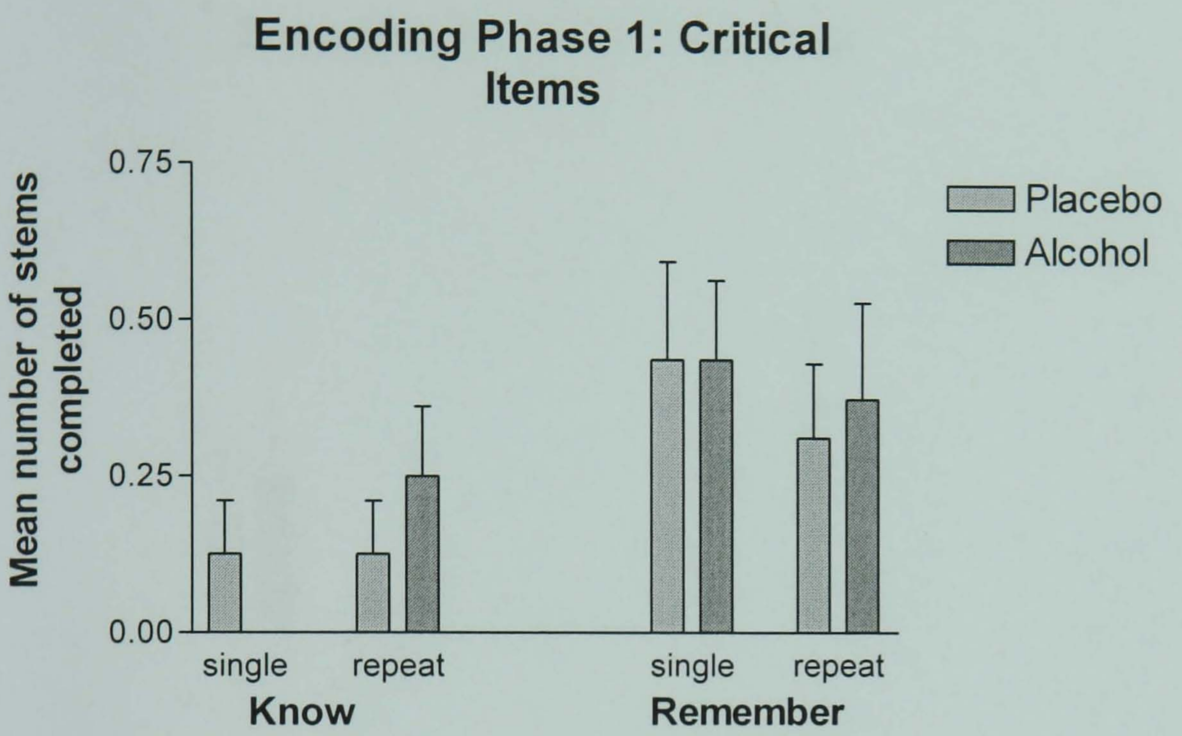


Figure 3.16. **The mean number of stems completed by the alcohol and placebo groups to form critical words corresponding to items viewed in the first encoding phase, divided into those allocated know and those allocated remember responses.**

In critical items, a main effect of memory type [$F(1, 30) = 9.05$, $p = .005$] showed that more remember than know responses were made to completed critical stems.

No main effect of repetition [$F(1, 30) = .066$, $p = .799$] nor drink [$F(1, 30) = .038$, $p = .848$] was found to be significant. Drink did not interact with either memory type [$F(1, 30) = .031$, $p = .861$] or repetition [$F(1, 30) = 1.652$, $p = .209$], and repetition did not interact with memory type [$F(1, 30) = 1.384$, $p = .249$]. The 3-way repetition x memory type x drink interaction was also not significant [$F(1, 30) = .254$, $p = .618$].

Phase two (post-drink): Veridical items

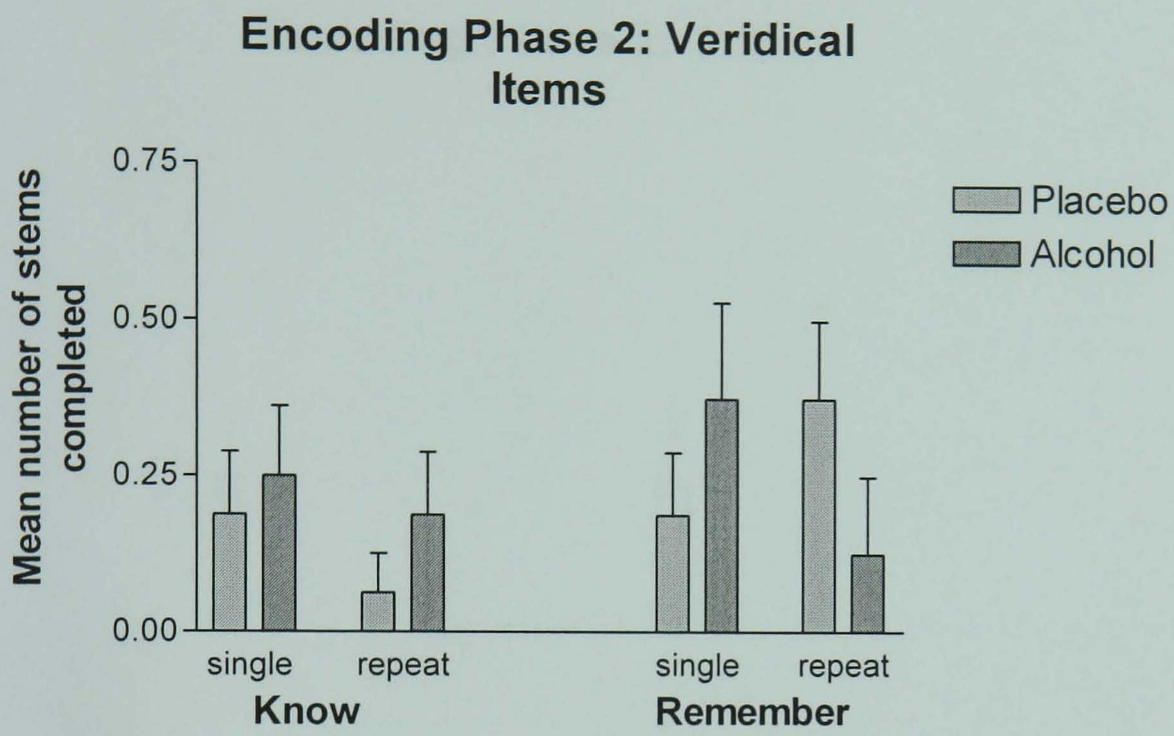


Figure 3.17. **The mean number of stems completed by the alcohol and placebo groups to form veridical words viewed in the second encoding phase, divided into those allocated know and those allocated remember responses.**

In veridical items, no main effects or interactions reached significance: main effects of memory type [$F(1, 30) = 1.189, p = .284$] repetition [$F(1, 30) = .529, p = .473$] and drink [$F(1, 30) = .280, p = .600$] were all non-significant. In addition, repetition was not found to interact with either drink [$F(1, 30) = 1.189, p$ .284] or memory type [$F(1, 30) = .135, p = .716$], nor did memory type interact with drink [$F(1, 30) = .529, p = .473$]. The 2-way repetition x drink x memory type was also not significant [$F(1, 30) = 2.152, p = .153$].

Phase two (post-drink): Critical items

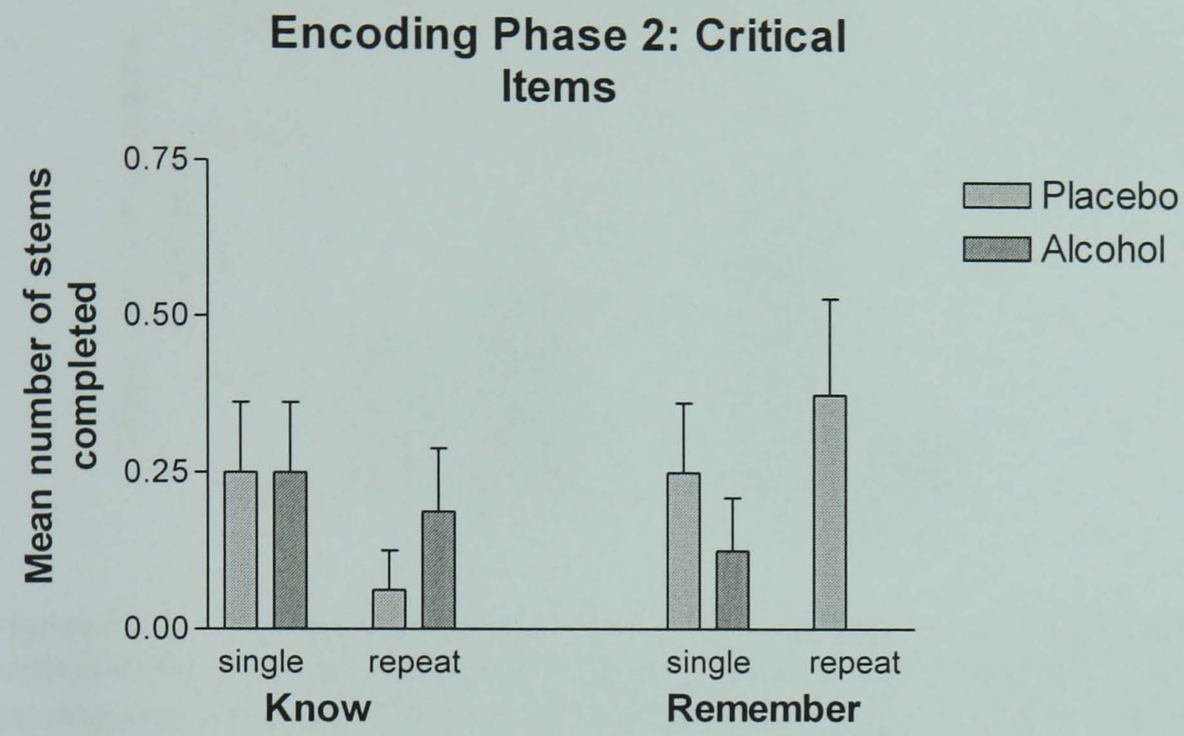


Figure 3.18. **The mean number of stems completed by the alcohol and placebo groups to form critical words corresponding to items viewed in the second encoding phase, divided into those allocated know and those allocated remember responses.**

A memory type x drink interaction was approaching significance [$F(1, 30) = 3.49$, $p = .078$] (see Figure 3.19).

In critical items, no main effects of memory type [$F(1, 30) = .000$, $p = 1.00$], repetition [$F(1, 30) = 1.121$, $p = .298$] or drink [$F(1, 30) = 1.788$, $p = .191$] were significant. In addition, repetition did not significantly interact with either drink [$F(1, 30) = .280$, $p = .600$] or memory type [$F(1, 30) = .736$, $p = .398$]. The 3-way repetition x memory type x drink interaction was not significant [$F(1, 30) = 1.656$, $p = .208$]

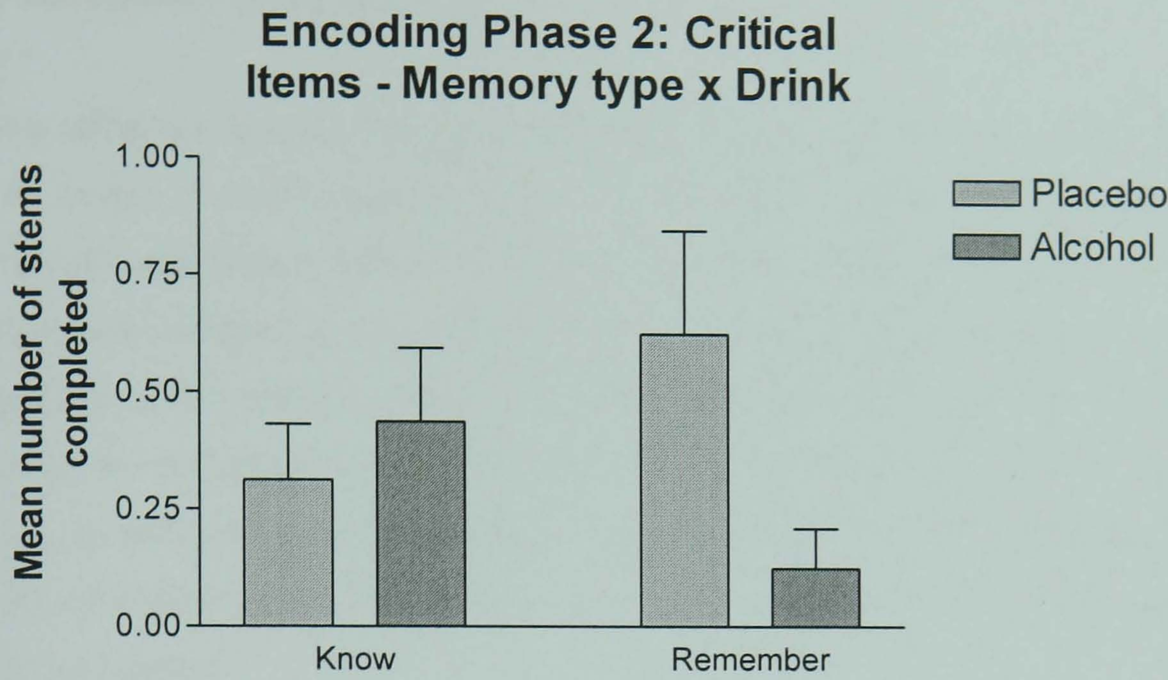


Figure 3.19. A graph depicting a trend memory type by drink interaction for critical items corresponding to lists viewed in the second encoding phase. Alcohol participants were found to have significantly less remember false memories than placebo participants, whilst no significant difference existed between the two groups in terms of false memories allocated know responses.

3.6. Discussion

3.6.1. Summary of main findings

Cued Recall [Experiment 1]

The main findings can be summarised as follows: The pre-drink encoding phase did not demonstrate a significant retrograde facilitation effect in either veridical or critical items as a function of drink. A borderline significant repetition by drink interaction was found for critical items from the first encoding phase. In terms of the post-drink encoding phase, no anterograde impairment of alcohol was found in veridical items or critical items. A repetition by drink interaction also approached significance.

Implicit instructions [Experiment 2]

Priming

A priming effect was found, indicating that if a word was viewed in the encoding phase (veridical items) or was semantically related to those viewed (critical items) the probability of completing a stem to form those words was significantly increased, relative to baseline stem completion rates. Whilst inspection of the data revealed a tendency for the magnitude of the priming effect to be larger for veridical items, this did not reach significance as indicated by a non-significant 2-way item type by studied status interaction. In addition, the priming effect was not found to interact with drink, thus the probability of completing a stem to form a veridical or critical word was not dependent upon drink consumed.

Remember / know judgements

After the awareness measures were taken for stems completed under implicit instructions, remember / know judgements were made as a means to assess phenomenological experience. Amongst these data, the only potential result of interest concerns a borderline line significant drink by memory type interaction for critical items from the second encoding phase indicating reduced remember memories under alcohol.

3.6.2. Discussion and analysis

Cued Recall

Levels of false and veridical memory as assessed using cued recall were not found to differ as a function of drink. Thus, neither a retrograde facilitation effect for material encoding pre alcohol, nor an anterograde impairment for material encoded post alcohol, was obtained. Both of these effects are well established by previous empirical literature. Studies have shown that alcohol consumed prior to encoding at a dose comparable to the present study impairs recognition (e.g. Curran & Hildebrand 1999) and cued recall (e.g. Duka *at al.* 2001). In addition, the retrograde facilitation for material learnt pre-alcohol has also been widely replicated (e.g. Lamberty *et al.* 1990; Muller *et al.* 1983; Parker *et* *al.* 1980). So how can a failure to find these two effects be accounted for? One can argue that a lack of sensitivity within the current study may have rendered these effects non-significant and the reasons for this will be addressed in turn.

Firstly, a limited number of studies have investigated the anterograde and facilitative effects of alcohol within a single experiment, a methodology chosen for its naturalistic design (Knowles & Duka 2004; Moulton *et al.* 2005). Previous studies, however, have tended to have a single encoding phase, and thus are confined to either the study of the retrograde facilitation effects (e.g. Muller *et al.* 1983; Parker *et al.* 1984), or the anterograde impairment effects of alcohol (e.g. Parker *et al.* 1974; Maylor *et al.* 1987). A simple design incorporating a single encoding phase has the methodological advantage of eliminating interference (proactive, retroactive and negative transfer) induced by the presence of the two encoding phases.[6] Moreover, two encoding phases divides the total material learnt into two. As false memories are shown to be affected by the degree of material learnt (Dodson *et al.* 2000), the present studies used similar amounts of material to previous studies (e.g. Hicks & Stans 2005), but divided this material between the two encoding phases. Consequently, a single encoding phase incorporating twice the material could serve to decrease the variability and consequently increase the sensitivity. This would increase the probability that an effect would be detected.

Secondly, whilst studies exist which incorporate two encoding phases within a single experiment and have found that both effects obtained (Knowles & Duka 2004; Moulton *et al.* 2005), these studies assessed memory using free recall as opposed to cued recall. The way in which cued recall was employed in Experiment 1 reduced the sensitivity of the experiment as it restricted the amount of material classified as valid for assessing an effect. For example, in terms of veridical items, whilst participants viewed different 30 singularly presented veridical items in each encoding phase, only 3 stems were provided. Thus only ten percent of the items viewed contributed to the assessment of memory and this could have masked the presence of a genuine effect, resulting in a type II error.

[6] As interference is thought to be the mechanism which induces the facilitation effect (e.g. Mueller 1983) this would mean having to focus on the anterograde impairments of alcohol.

A failure to find an effect of alcohol on veridical memory – either in terms of retrograde facilitation or anterograde impairment – means one must be cautious in forming judgments about the effects of alcohol on false memory based upon the results of the current study. Nevertheless, within the cued recall data, two borderline significant interactions were found in critical items. Whilst they failed to reach significance, they require attention as a means to assess whether they should be further investigated in future studies.

In the placebo group, an initial decrease in false memories with repetition is in accordance with previous studies (e.g. Benjamin 2001). This can be accounted for if the benefits of increased exposure to veridical items in terms of forming detailed episodic traces outweighed the potential for increased activations of the critical item (Benjamin 2001). Thus at test the phenomenological disparity between items presented and those not presented increased with increased learning. This could thus aid the monitoring of sources at test (e.g. Hicks & Marsh 1999), leading to a decline in false memories with repetition. Concerning the effect of repetition on false memories from the first encoding phase in the alcohol group, repetition had no significant effect.

In the second encoding phase, repetition marginally increased false memories in the placebo group. Under the principle of negative transfer[7], the memory for the initial material may impede the extent to which material from the second encoding phase was learnt. Research has demonstrated that when encoding is impoverished, as demonstrated via speeded encoding, repetition results in a monotonic increase in false memories (Seamon *et al.* 2002). When a slower rate of veridical word presentation is provided, repetition has an inverse U-shaped relationship between false memory levels and repetitions. Seamon *et al.* (2002) equated repetition with the degree of encoding, and thus argued that when material is relatively poorly learnt, limited amounts of repetitions increases false memories. In contrast, when material is learnt well, as determined by an even greater number of repetitions, a subsequent decline in false memories is observed.

[7] when the learning of initial material can impede the learning of subsequent material

This principle can be extrapolated and applied to the current experiment – when the material was well learnt (as it was the material initial viewed) repetition decreased false memories, whereas when material was not encoded sufficiently due to the speculated effects of negative transfer, repetition increased false memories.

In the alcohol group, repetition had no effect on false memories resulting from the second encoding phase. Whilst this finding is in contrast to the placebo group, one cannot conclude that this absence of an effect of repetition on false memories in intoxicated participants was a direct consequence of the alcohol. This is because the effect of the pro-active interference resulting from the first encoding phase cannot be controlled and thus accounted for. Future studies need to determine whether this effect can be replicated using a single encoding phase.

Implicit instructions

Priming

A main effect of studied status was achieved, thus viewing a word in the encoding phase increased the likelihood that stems would be completed to form that word (veridical items) or their semantic associates (critical items). Studied status was not found to significantly interact with word type (veridical versus critical). Consequently, the priming effect was not found to statistically differ between these items. This has important implications. As discussed in the introduction, other studies which obtained a priming effect for false memory words used a far shorter retention interval (e.g. McDermott 1997; McKone & Murphy 2000). It is also interesting from the perspective that stem completion tasks are traditionally viewed as perceptual tasks, whilst critical items were never physically presented, and thus are semantic by nature. Whilst the higher order ANOVA did not differentiate between the magnitude of the priming effect for veridical and critical items, inspection of Figure 3.8. indicates a numerically greater priming effect was obtained for veridical versus critical items. Indeed further analysis to investigate this potential differential priming effect reveals that a priming effect was significant only in veridical items [$t(31) = -.2.485$, $p = .019$] and not critical items [$t(31) = -.955$, $p = .347$].

Further investigation is thus needed to establish the validity of this potential long term priming effect for false memory items.

Final conclusions

Whilst this study raised some interesting points, no conclusions regarding the effect of alcohol and repetition on false memories can be drawn. The presence of the two encoding phases may have complicated the study by virtue of the potential confound of interference effects. In addition, the presence of the two encoding phases served to reduce the sensitivity of the experiment. Consequently, a single encoding phase will be pursued and the anterograde impairments of alcohol will be focused on in subsequent studies.

Chapter 4. The effect of alcohol on implicit and explicit false and veridical memories

4.1 Introduction

Experiment 3 sought to manipulate encoding quality – through study list repetition and alcohol at encoding – to determine the subsequent effects on false memory levels. Observation of the way in which repetition and alcohol modulated false memory levels was used to gain insight into the mechanisms underlying false memories.

As summarised in Chapter 1, and mentioned in Chapter 3, research on the effect of alcohol on false memories using the DRM paradigm has to date been limited, with equivocal results. A study by Milani and Curran (1999) found that alcohol (0.27 g/kg) had a tendency to increase false recognition relative to a placebo control group, whilst not affecting false recall. In addition, alcohol was found to affect the subjective phenomenological experience of false memory items by increasing false remember responses relative to the placebo control group. In contrast, Mintzer and Griffiths (2001), found no effect of a 0.27g/kg dose of alcohol on false recognition, though a larger dose (0.60g/kg) was found to reduce veridical recognition but leave levels of false memory comparable to the placebo group. In addition, and unlike the findings of Milani and Curran (1999), Mintzer and Griffiths (2001) did not find an effect of alcohol on phenomenological experience as assessed using the remember / know procedure. The proportions of remember and know responses made to false memory items were found to be equivalent in both the alcohol and placebo groups.

Methodological differences, particularly regarding the type of tests administered, may account for some of the variability in phenomenological experience obtained within the two studies (see Chapter 1 for an explanation). From a theoretical perspective, however, and following an argument outlined in Chapter 1, it can be proposed that alcohol may have the potential to both increase and decrease false memories. Using the AMF (see also

Chapter 1), a theory which postulates opponent processes underlying false memories, it can be hypothesised that by reducing both processes, alcohol could give rise to increases and decreases in false memories relative to a placebo control group (see figure 4.1). Specifically, the AMF claims that false memories get elicited by activation of the critical items. Two distinct activation routes are proposed. Firstly, via the automatic spread of activation through semantic networks, and secondly, by means of conscious elaborative processing resulting in the direct thought of the critical item (Gallo & Roediger 2002). At test, monitoring processes are thought to determine the source of this activation. For critical items, activation may be misattributed to prior presentation of the items at encoding, as opposed to internal processes such as elaborative thought at encoding. This reality monitoring error means the critical items get endorsed at test, which translates into a false memory (Roediger *et al.* 2001).

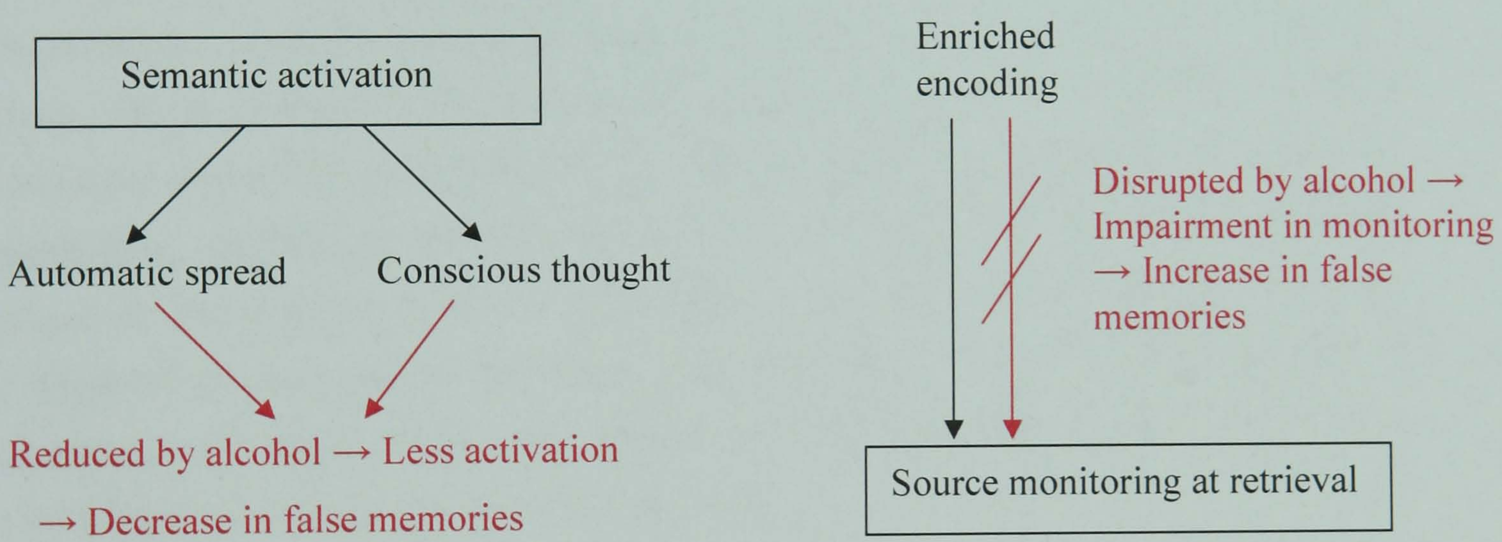


Figure 4.1. **Diagram to depict the theorised potential for alcohol to decrease false memories (via reduced activation at encoding), and increase false memories (via impairing encoding quality, leading to reduced ability to monitor at retrieval).**

Regarding activation, the speculation that alcohol will reduce false memories via reduced activation of critical items is based upon a number of findings. The potential for alcohol to disrupt attentional resources (Steele & Josephs 1988) and disrupt the production of semantic context required to encode the meaning from information being processed (Birnbaum *et al.* 1980), would indicate a decreased likelihood that the critical item will be consciously thought of under an alcohol challenge at encoding. Concerning automatic activation, proposed shallower processing under alcohol (Craik 1977), would lessen the spread of activation relative to deeper semantic processing (Thapar & McDermott 2001). This is supported by the finding that alcohol disrupts mediated semantic priming[1] (Sayette *et al.* 2001), which can be taken as a behavioural manifestation that alcohol reduces the spread of activation within semantic networks. In addition, Weissenborn and Duka (2000) found that alcohol at encoding eliminated the benefit afforded by the presentation of high associations as a contextual cue for retrieval. This thus indicates that alcohol blocks the forming of associations at encoding and thus substantiates the perspective that alcohol may reduce false memories.

The primary effect of alcohol on false memories is hypothesised to be a decrease in false memories due to decreased activation. In addition, one can argue that, under some circumstances, alcohol may lead to an increase in false memories relative to a placebo group. This hypothesis is founded upon the potential for alcohol at encoding to impair successful monitoring at retrieval. The potential for alcohol to affect false memories via monitoring mechanisms must be secondary to the effect of alcohol on activation processes. The ability to monitor – successfully or otherwise – can only take effect when a threshold of activation is surpassed. Otherwise, the ability to recollect the item in question, or the sense of familiarity felt for that item, would not be sufficiently high to enable their monitoring to occur in the first place.

Whilst no literature currently exists to support the hypothesis that alcohol may impair monitoring, it can be inferred from existing empirical research. Specifically, Curran and Hildebrandt (1999) and Duka *et al.* (2001) both demonstrated the propensity for alcohol to selectively impair remember responses, whilst leaving know responses relatively intact. Monitoring is aided by the degree to which sources can be discriminated from each other (Hicks & Marsh 1999). Consequently, enriched recollective memory would thus aid reality monitoring, relative to memories based on a sense of familiarity. If at

[1] Mediated semantic priming is when target words are preceded by primes that are either unrelated or indirectly related to the target.

retrieval items encoded under alcohol are not sufficiently distinct to make successful reality monitoring decisions, a consequent increase in false memories can be predicted.

Alcohol can thus be viewed as a tool to initially manipulate activation processes, with the potential to impair monitoring processes when learning is increased. One can thus predict that, due to impaired activation when intoxicated, participants in the alcohol group may have reduced false memories relative to the placebo group. One can also predict that false memories may increase with repetition in the alcohol group. Impaired monitoring processes could be a mechanism to account for this (Benjamin 2001). These hypotheses are in accordance with the principles of the AMF which denotes that decreased activation decreases false memories, whilst impaired monitoring can serve to increase false memories. Repetition is a study variable which can increase learning, thus allowing the potential detrimental effects of alcohol on monitoring to manifest. Repetition also has the potential to both increase and decrease false memories (e.g. Benjamin 2001). Unlike alcohol, repetition has been hypothesised to achieve this dual function through *increasing* activation and monitoring processes. Specifically, increased repetitions provide an opportunity for increased activations of the critical item, which could increase their endorsement. In addition, repeated exposures to the veridical items at encoding would heighten the potential that they will be distinctly recollected. Phenomenological disparity has been found to exist between false memory items and veridical items in terms of the degree of detail inherent within the memory and the feelings felt when 'encoding' the item (Neuschatz *et al.* 2001). Consequently, if participants are able to distinctly recollect veridical items, the disparity between true and false memories would be heightened resulting in the potential for enhanced monitoring at retrieval (Benjamin 2001; Jacoby *et al.* 1998). Thus both alcohol and repetition have the potential to increase and decrease false memories via differentially affecting the opponent processes thought to underlie false memories; alcohol through reduced activation and impaired monitoring, and repetition through increased activation and increased ability to source monitor. Repetition and alcohol thus provide two distinct ways to modulate encoding quality, using opposite mechanisms of action. One can predict that participants in the alcohol group should have decreased levels of false memories relative to the placebo group for singularly presented lists due to decreased activation. In addition, one can predict that repetition should increase false memories in the alcohol group, due to a deficit in encoding quality which may mean the activation enhancing benefits of repetition prevail relative to the placebo group.

4.2. Assessment of memory

Memory will be assessed using implicit and explicit tasks, as alcohol has been shown to differentially affect these measures of memory. The anterograde impairments of alcohol as assessed by cued recall (e.g. Weissenborn & Duka 2000) and free recall (e.g. Parker *et al.* 1974) have not been found to extend to implicit memory, as assessed using stem completion (Duka *et al.* 2001). In the present experiment, priming measures will be taken for both veridical and critical items, and subsequent awareness measures will also be taken. Previous research has investigated implicit false memories using priming measures, whereby a priming effect was obtained for both veridical and critical items (Hicks & Starns 2005; McKone & Murphy 2000). These experiments used immediate stem completion tasks as a means to assess priming levels. This study will follow previous methodologies used in the alcohol memory literature (e.g. Duka *et al.* 2001; Weissenborn & Duka 2000) and next day testing will occur. This allows for the study of how alcohol effects the encoding of false memories, since no drinks will be administered on the second day. This is significant for two reasons, firstly, neither of the two previous studies involving alcohol and the DRM paradigm (Mintzer & Griffiths 2001; Curran & Hildebrandt 1999) fully separated the encoding and retrieval phases of the experiment in terms of alcohol intoxication. The aetiology of false memories is thought to occur primarily at encoding (e.g. consequently having an experimental design which isolates an experimental manipulation at encoding allows for conclusions pertaining to the effect of encoding). Secondly, it is of interest to determine whether long-term priming will be obtained for critical items, since no study using implicit measures has previously attempted a 24 hour retention interval. Finding ways in which veridical memory operates in the same way and differs from critical memory provides insight into mechanisms underlying these two types of memory.

4.3. Materials and methods

Participants

Thirty-two volunteers (16 males and 16 females) were recruited from the undergraduate and postgraduate population at the University of Sussex. They received either a cash or course credits as payment. All participants were native English speakers, not dyslexic and aged 18-34 years.All volunteers met the criteria for inclusion specified in Chapter 2.

Alcohol administration

Same as Experiment 3.

Design

The experiment was double-blind, and participants were randomly assigned to either the placebo (n=16) or the alcohol group (n=16). The experiment took place over two consecutive days. The drink was consumed on day one, and was followed by the learning phase. Participants returned the next day to undergo 2 memory tests: an implicit test and free recall.

Memory task: Encoding

Eleven 11-word lists were taken from Stadler *et al.* (1999) when lists conformed to the specifications made by McEvoy *et al.* (1999) deemed necessary for stem completion tests (see Chapter 2). Nine lists were the newly created lists used in Experiments 1 and 2 (see Chapter 2).

The 11-word lists (including 2 non-presented critical items) were separated into two master lists consisting of 10 lists each (master list A and master list B). Each participant viewed either master list A or master list B in the encoding phase. Each master list was also divided into two sections, forming set 1 and set 2 (resulting in 5 lists in each set). The sets determined which lists were repeated; half the subjects viewed set 1 lists once, whilst lists from set 2 were consecutively repeated three times. The remaining participants saw lists from set 1 three times, and lists from set 2 once, thus ensuring list repetition was counterbalanced. The presentation order of lists was fully randomised, with the constraint that repetitions were consecutive. Lists in each set were matched for word frequency, stem completion rate and whether the critical items were nouns or adverbs.

Memory task: Test

The implicit test consisted of 80 stems: 2 critical items and 2 veridical items from each list. 20 studied veridical and 20 non-studied critical items corresponded to lists viewed in encoding. 10 of these veridical items came from lists presented once, whilst the remaining 10 were from repeated lists. Similarly, 10 critical items were from repeated lists, whilst 10 were from singularly presented lists. The remaining 40 stems were from the master list not viewed in the encoding session, and served as baseline measures. These baseline stems comprised 20 veridical items not viewed in the encoding session, and their associated 20 critical items.

Following the implicit test, a free recall test was introduced. Participants were given instructions to write down all the words they remembered from the previous days encoding phase.

Subjective self-ratings

Participants completed a series of 100mm VASs (Duka *et al.* 1998; See Chapter 2).

Alcohol Use Questionnaire and Nuffield Medical Questionnaire

See Chapter 2.

Procedure

Participants were tested individually. On entering the lab participants signed a consent form, and read a brief description about the experiment, which stated that the effect of alcohol on learning was to be tested. They were thus not informed that the experiment was concerned with false memory.

Participants filled out a medical questionnaire to ensure they were medically fit to take part, and the AUQ to ensure they were moderate social drinkers (that they consumed between 5-50 units per week).

All participants were breathalysed to ensure their baseline breath alcohol concentrations (BACs) were 0.

Participants height and weight was taken, they consumed their lunch (a small roll and a glass of water) and completed the AUQ (Alcohol Use Questionnaire) and a verbal memory task (Lezak), as a means to obtain baseline memory scores. They were then taken to a medical room in order to consume their drinks. Their BAC level was measured 10 min after the final drink was provided (40 min after the initiation of drinking) and they completed a series of visual analogue scales. They were subsequently breathalysed at half hourly intervals thereafter. Participants were then taken to the testing rooms where they underwent the encoding phase. The encoding phase lasted for 15 minutes.

Participants completed the VAS for a second time, and then retired to the waiting room. Once BACs had fallen to below 0.4 g/l, participants gave consent that they would not drink, ride a bike or operate any kind of machinery for 4 h and were released from the laboratory.

On day 2, participants completed the implicit test with implicit instructions, followed by free recall. They then returned to the words they had generated under implicit test instructions. They were instructed to circle all the words they were 'aware' of having viewed in the encoding phase. They then completed the VAS.

Statistical analyses

In accordance with an argument outlined in Chapter 3, and following a mode of analysis employed by previous researchers using pharmacological manipulations in conjunction with the DRM paradigm (Hurron *et al.* 2001), all analyses were performed separately in veridical and critical items. This would allow an assessment of how repetition and alcohol selectively modulated false and veridical memory levels. In addition, and following a procedure employed in Chapter 3, all analyses were performed on raw data scores due to equivalent intrusion rates within the alcohol and placebo groups, as described in section 3.4.1. The main analysis is divided into three sections. Firstly, the free recall data is addressed. The data generated under implicit instructions is dealt with in regard to priming, followed by an analysis which is concerned with aware verses unaware items. Details of individual ANOVAs preformed precede each analysis.

4.4. Results

4.4.1. Groups

	Mean (SEM)	
	Placebo	*Alcohol*
Units per week	37.11 (5.40)	26.96 (3.32)
AUQ score	54.09 (5.85)	51.57 (7.92)
Binge score	21.46 (2.91)	24.61 (5.65)
Lezak	17.56 (1.08)	17.19 (1.09)

Table 4.1. **Group qualities in the alcohol and placebo groups for Experiment 3.**

Analyses of the alcohol and placebo groups revealed that participants were matched for units consumed per week [$t(30) = 1.602, p = .120$], AUQ score [$t(30) = .257, p = .799$], binge drinking score [$t(30) = -.459$, $p = .625$] and baseline memory measures ($t(30) = .293$, $p = .772$) (see table 4.1.).

VAS scores

	Day 1: Mean (SEM)		Day 2: Mean (SEM)	
	Placebo	*Alcohol*	*Placebo*	*Alcohol*
Relaxed	5.51 (.46)	6.1 (.47)	5.32 (.41)	4.77 (.52)
Content	5.65 (.39)	6.27 (.37)	5.65 (.39)	5.69 (.51)
Lightheaded	1.83 (.56)	5.96 (.52)	0.53 (.09)	0.53 (.09)

Table 4.2. **VAS scores on day 1 and day 2.**

The alcohol and placebo groups did not differ on subjective ratings of relaxedness on either day 1 [$t(30) = -.885$, $p = .383$] nor day 2 [$t(30) = -.833$, $p = .412$]. Nor did they differ on ratings of contentedness on either day 1 [$t(30) = -1.116$, $p = .261$] nor day 2 [$t(30) = -.068$, $p = .946$]. In contrast, on day 1 post consumption of the drink, the alcohol group rated themselves as significantly more lightheaded than the placebo group [$t(30) = -5.392$, $p < .001$]. On day 2 when no alcohol was administered, no significant difference existed in lightheadedness ratings between the two groups [$t(30) = -.000$, $p = 1.000$] (see table 4.2).

To determine whether it was necessary to correct memory scores for the recall of intrusions[2], between subjects t-tests were administered to determine the extent to which intrusion rates differed between the alcohol and placebo groups. The amount of non-critical intrusions recalled between the two groups was approaching significance [$t(30) = 1.862$, $p = .072$], however the mean value of non-critical intrusions recalled was higher in the placebo group (4.81) than the alcohol group (2.81). As placebo participants recalled more veridical and critical items than the alcohol group, two new variables were formed which looked at the ratio of non-critical intrusions to total veridical memory and total critical memory recalled. As placebo participants recalled more veridical and critical words than alcohol participants (see analyses below), these new variables resulted in non-

[2] Defined as the recall of non-presented items which were not critical items

significant differences in intrusions as a function of total veridical memory recalled [$t(30) = .037$, $p = .91$] and total critical memory recalled [$t(30) = .952$, $p = .349$]. Consequently, no corrections were administered prior to analyses and thus results were analysed using raw data only.

4.4.2. Free Recall

Veridical items

In order to explore the effect of alcohol on veridical items, a mixed 2(drink: alcohol vs. placebo)x2(repetition: lists presented once vs. lists presented three times) ANOVA was performed on the percentage of veridical words recalled, with drink serving as a between subjects variable, and repetition as a within subjects variable.

A main effect of repetition was found [$F(1, 30) = 67.143$, $p < .001$] demonstrating that repetition of lists resulted in a greater probability of later recall. The repetition x drink interaction was not found to be significant [$F(1, 30) = 1.190$, $p = .284$], nor was a main effect of drink obtained [$F(1, 30) = 1.775$, $p = .193$]. Due to a homogeneity of variance problem, separate between subjects t-tests between alcohol and placebo groups were run in single and repeated conditions. It was found that participants in the alcohol group recalled significantly less than placebo participants for singularly presented lists [$t(30) = 2.953$, $p = .006$]. No difference existed between the two groups for repeated lists [$t(30) = .418$, $p = .679$].

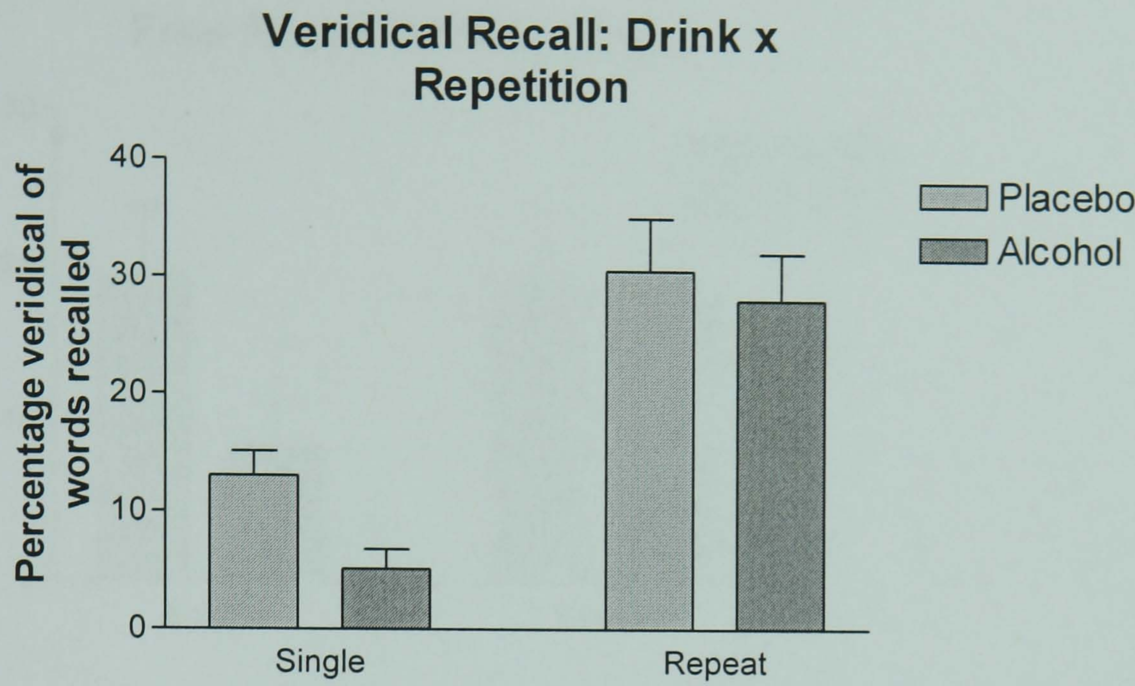
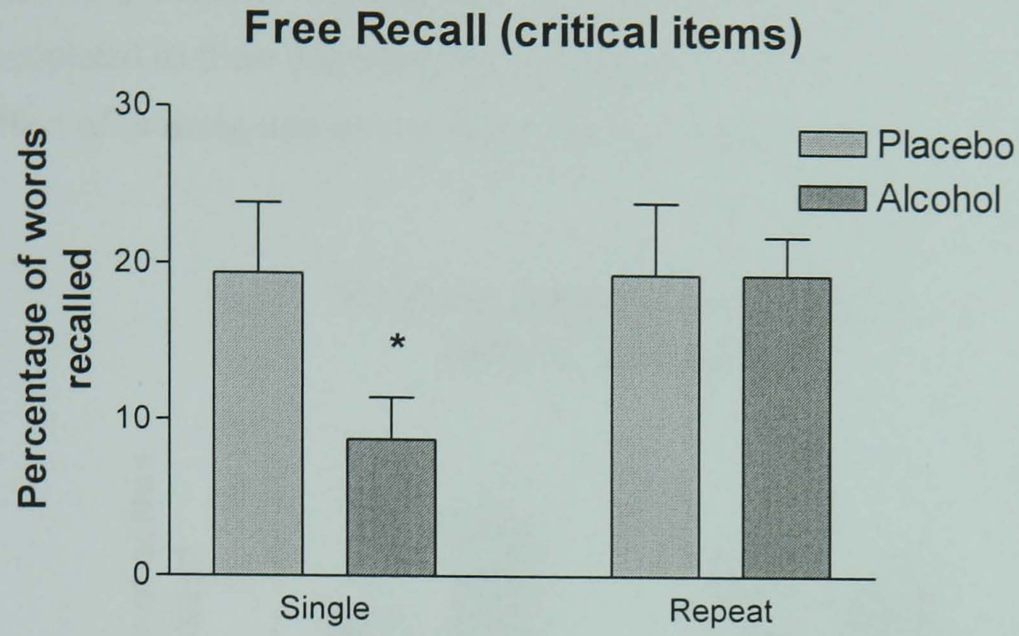


Figure 4.2 **The percentage of veridical items recalled in singularly presented and repeated lists in both the alcohol and placebo groups.**

Critical items

In order to explore the effect of alcohol and repetition on critical items a mixed 2(drink: alcohol vs. placebo)x2(repetition: lists presented once vs. lists presented three times) ANOVA was performed on the percentage of critical words recalled, with repetition as a within subjects factor, and drink as a between subjects factor.

A main effect of repetition [$F(1, 30) = 3.93$, $p = .057$] was bordering on significance, indicating a tendency for repetition to increase critical recall. Whilst there was no main effect of drink [$F(1, 30) = 1.381$, $p = .249$], a repetition x drink interaction [$F(1, 30) = 3.93$, $p = .057$], was approaching significance. Further exploration revealed a non-significant effect of repetition on the percentage of critical items recalled in placebo subjects [$t(1, 15) = .00$, $p = 1.00$]. In contrast, repetition was found to significantly increased the percentage of critical items recalled in participants who had consumed alcohol [$t(15) = -2.79$, $p = .014$].



gure 4.3. **The percentage of critical items recalled in singularly presented and repeated lists in both the alcohol and placebo groups.**

4.4.3. Implicit test of memory

4.4.3.1 Priming

Before performing analyses determining memory with and without awareness for words viewed in the encoding phase, an analysis was performed to determine whether a priming effect had occurred. A mixed 2(word type: veridical vs. critical)x2(status: studied vs. non-studied)x2(drink: placebo vs. alcohol) ANOVA was performed on the percentage of words completed. Drink served as the only between subjects variable, whist word type and status were within subjects factors.

There was no overall priming effect as demonstrated by a non-significant main effect of status [$F(1, 30) = 1.085, p = .306$], and there was no status x drink interaction [$F(1, 30 = .036, p = .851$], nor a significant 3-way status x drink x word type interaction [$F(1, 30) = 1.800, p = .190$]. The only significant effect was a status x word type interaction [$F(1, 30) = 15.14, P = .001$], reflecting the finding that previously studying veridical words increased the likelihood of completing a stem to form that word [$t(31) = -3.13, p = .003$]

but that previously viewing lists did not increase the probability that a stem would be completed to form corresponding critical items [$t(31) = 1.37$, $p = .18$], thus a significant effect of priming was only obtained for the veridical items.

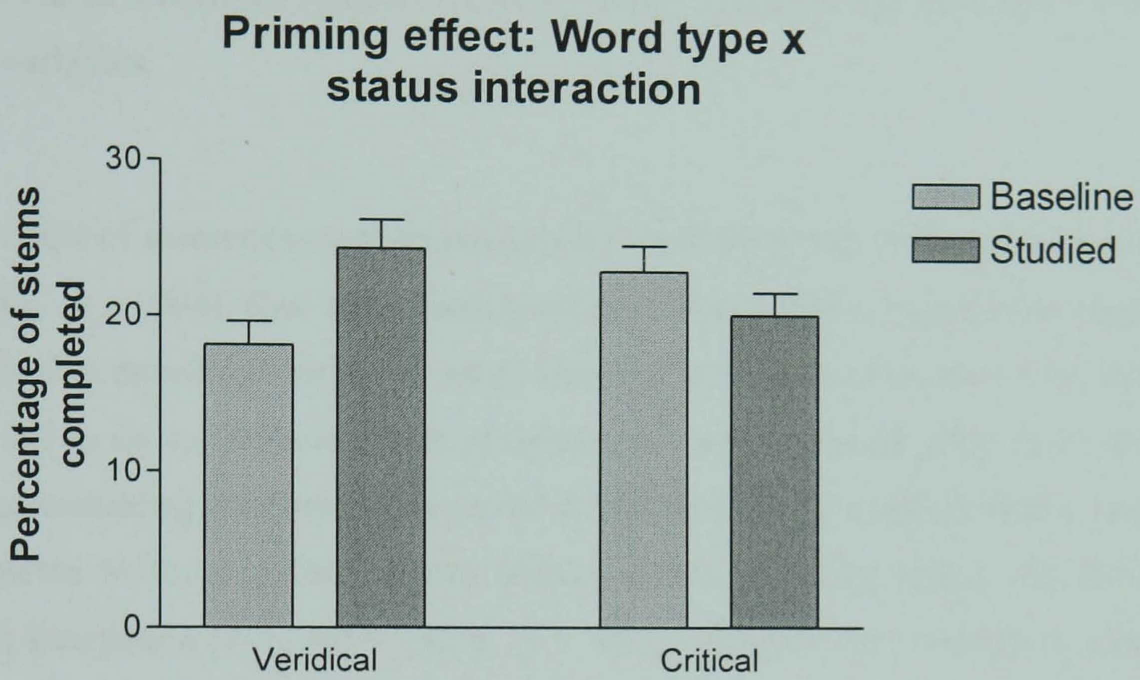


Figure 4.4. **The percentage of stems completed to form veridical or critical items corresponding to those viewed in the encoding phase (studied) versus the percentages of stems completed to form words not encountered in the encoding phase (baseline), for the alcohol and placebo groups.**

As a consequence of the non-significant priming effect in critical items, conclusions regarding implicit memory can only relate to veridical items, but the critical priming data can still be used to generate measures of aware and unaware items.

4.4.3.2. Analysis incorporating awareness measures

Analyses were performed to compare the relative rates of aware and unaware items, and how they differed as a function of alcohol and repetition

Veridical Items

A mixed 2(drink: placebo vs. alcohol)x2(awareness: aware vs. unaware)x2(repetition: presented once versus repeated three times) ANOVA was performed on the amount of stems completed to correspond to veridical items encountered in the encoding phase. Drink served as a between subjects variable, whilst repetition and awareness were within subjects variables.

A main effect of awareness was found, signifying more aware than unaware items [$F(1, 30) = 8.82$, $p = .006$], thus once participants had completed a stem to correspond to an item viewed at encoding, they were more likely to endorse it as an item they were aware of, than fail to do so. A main effect of repetition was also found [$F(1, 30) = 8.82$, $p = .006$], demonstrating that repetition served to increase the probability that a stem would be completed to form veridical items viewed in the encoding phase. An awareness x repetition interaction [$F(1, 30) = 14.26$, $p = .001$], signified that repetition significantly increased the amount of aware items [$t(31) = -3.54$, $p = .001$], but that repetition also decreased the amount of unaware items, though this effect did not reach significance [$t(31) = 1.22$, $p = .234$]. An awareness x repetition x drink interaction [$F(1, 30) = 4.71$, $p = .038$], was further explored using two-way ANOVAs separately for the alcohol and placebo groups. In the placebo group, the repetition x awareness interaction was non-significant [$F(1, 15) = 1.238$, $p = .283$]. In contrast, analysis in the alcohol group found a significant repetition x awareness interaction [$F(1, 15) = 18.483$, $p = .001$]. This interaction was further explored to reveal that repetition significantly decreased the amount of unaware veridical items [$t(15) = 2.18$, $p = .046$] but increased the amount of aware veridical items [$t(15) = -3.39$, $p = .004$] within the alcohol group.

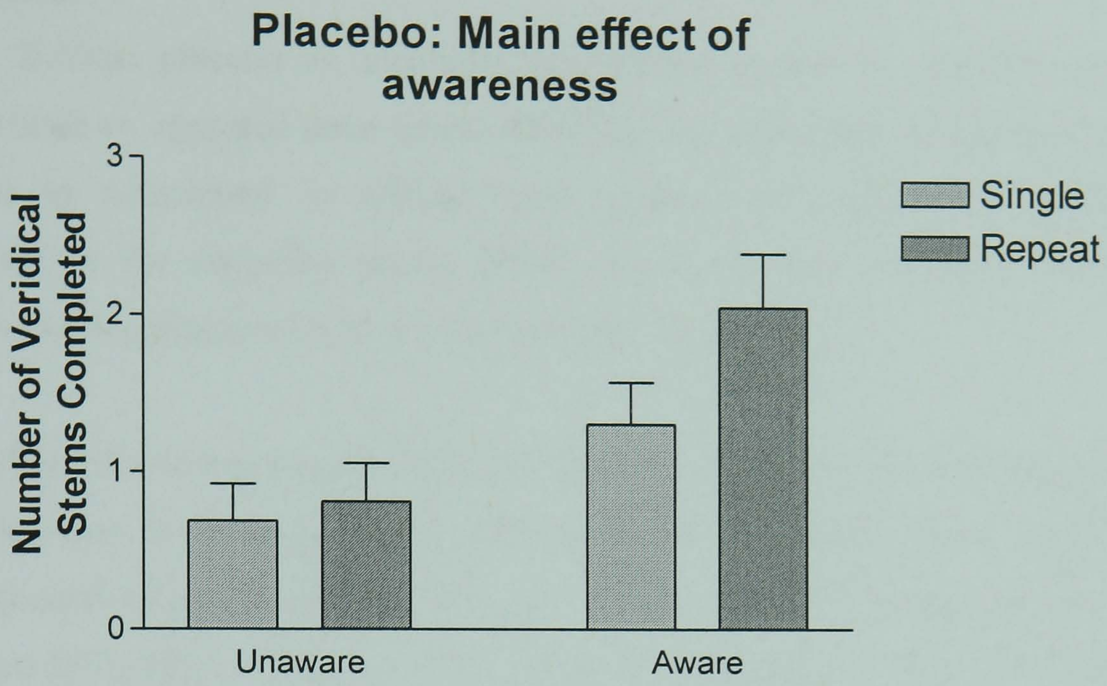


Figure 4.5. **A main effect of awareness in placebo participants, indicating that they were significantly more aware than unaware of veridical items, regardless of repetition condition.**

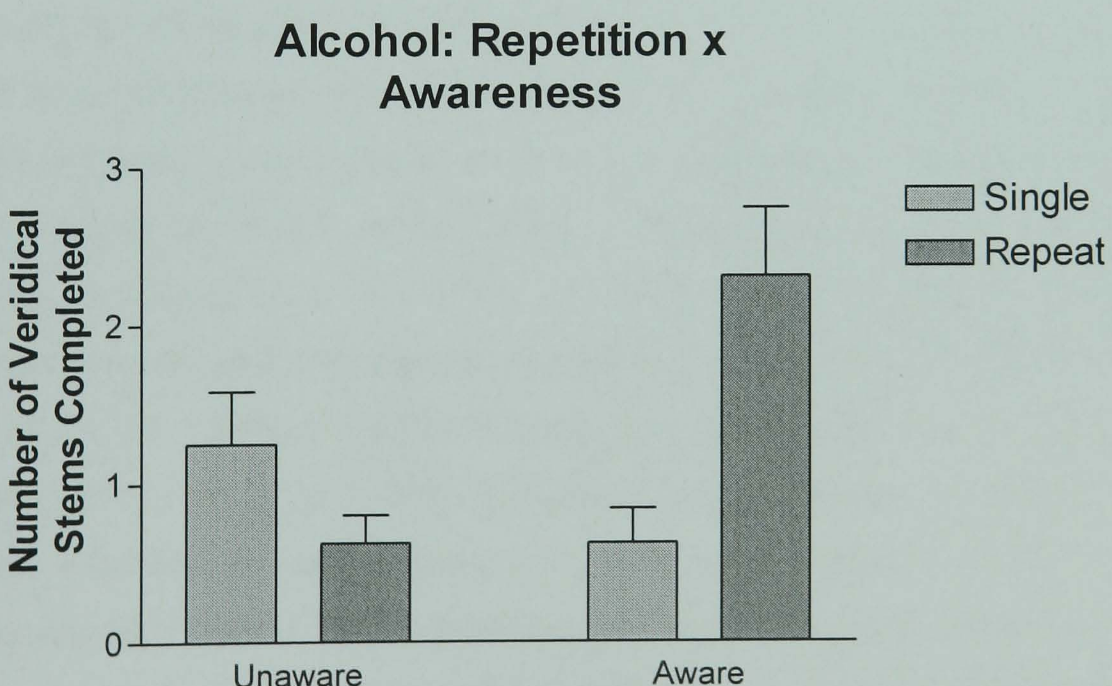


Figure 4.6. **A repetition x awareness interaction in the alcohol group indicated that participants were more unaware of single veridical items verses repeated veridical items, yet more aware of repeated veridical items relative to single veridical items.**

Critical Items

A mixed 2(drink: placebo vs. alcohol)x2(awareness: aware vs. unaware)x2(repetition: presented once vs. repeated three times) ANOVA was performed on the amount of stems completed to correspond to critical items semantically related to veridical items encountered in the encoding phase. Drink was a between subjects variable, whilst awareness and repetition were both within subjects variables.

A main effect of awareness was found [$F(1, 30) = 4.53$, $p = .042$], reflecting the finding that participants were more aware than unaware of critical items. There was no significant main effect of repetition [$F(1, 30) = .122$, $p = .729$] and neither the awareness x repetition [$F(1, 30) = .350$, $p = .558$], nor drink x repetition [$F(1, 30) = .66$, $p = .442$] interactions were found to be significant. A significant awareness x repetition x drink interaction [$F(1, 30) = 8.75$, $p = .006$] was further explored using separate two-way ANOVAs for the alcohol and placebo groups. In the placebo group, a significant repetition x awareness interaction $F(1, 15) = 5.44$, $p = .034$], was further explored to reveal that repetition increased the amount of unaware critical words [$t(15) = -2.24$, $p = .041$], but did not affect critical aware words [$t(30) = 1.31$, $p = .211$]. As being unaware of critical items constitutes accurate memory, being unaware of them thus amounts to being able to correctly reject them, and this was enhanced in the placebo group as a function of repetition. In the alcohol group, a repetition x awareness interaction was approaching significance $F(1, 15) = 4.24$, $p = .057$]. This was further explored to reveal that repetition had a borderline significant tendency to decrease the amount of unaware critical items [$t(15) = 2.09$, $p = .055$]. In contrast, repetition did not affect the amount of aware items [$t(15) = -1.37$, $p = .191$]. As depicted in the figures 4.7. and 4.8., a double dissociation was obtained, as repetition was found to have opposite effects on levels of aware and unaware critical items, dependent on drink consumed. Repetition was thus found to increase the accuracy of memory for participants in the placebo group, and decrease memory accuracy for participants in the alcohol group.

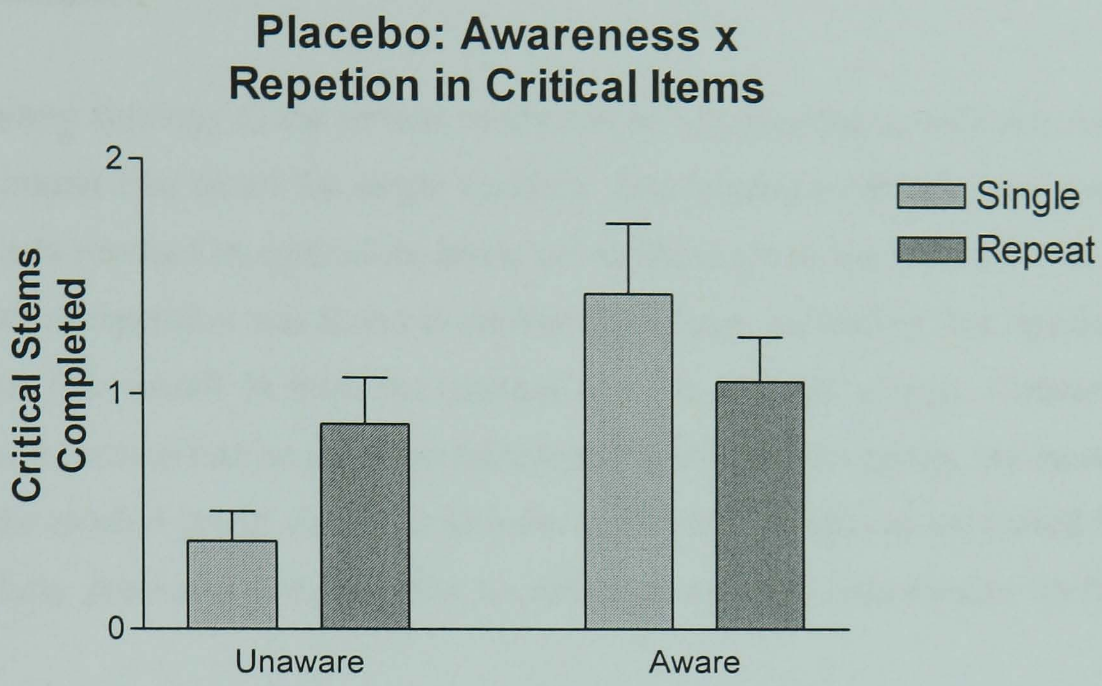


Figure 4.7. **A repetition x awareness interaction in the placebo group demonstrated that repetition increased the amount of unaware critical words and decreased the amount of aware words, though this did not reach significance.**

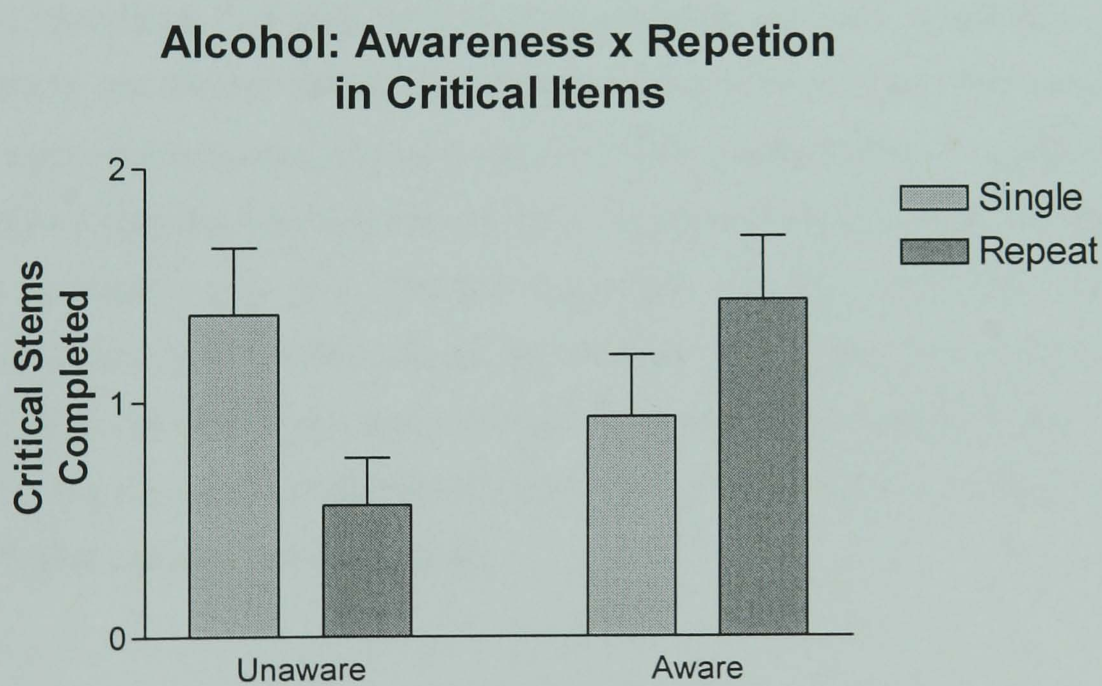


Figure 4.8. **A repetition x awareness interaction in the alcohol group demonstrated that repetition decreased the amount of unaware critical items, and increased the amount of aware critical items. Both effects were approaching significance.**

4.5. Discussion

The important findings of the present study can be summarised as follows: Alcohol was found to impair free recall for single veridical lists relative to the placebo group, whilst repeated lists resulted in equivalent levels of veridical recall between the two groups. A main effect of repetition was found in the veridical items, indicating that repetition served to increase later recall in both the alcohol and the placebo groups. Concerning false memories, repetition had no effect on false recall in the placebo group, but increased false recall in the alcohol group. Analyses also demonstrated that alcohol decreased false recall for singularly presented lists, but had no effect on repeated lists relative to the placebo group.

Implicit tests revealed a priming effect for veridical items, but not for critical items. Awareness measures demonstrated that placebo participants had a main effect of awareness, signifying that they were more aware than unaware of veridical items. For participants in the alcohol group, awareness was found to interact with repetition, such that they were more unaware of single veridical items verses repeated veridical items, yet more aware of repeated veridical items relative to single veridical items. An awareness by repetition interaction was also obtained in the false memory items, and differed as a function of drink. In the placebo group, participants were better able to not endorse (be aware of) false memory items from repeated lists, than from singularly presented lists. The reverse was found in alcohol participants, where repetition was found to increase the amount of false memory items endorsed.

4.5.1. Explicit memory

Explicit memory was assessed using free recall. The principle areas of interest were how alcohol and repetition modulated false and veridical memory levels, and whether these two distinct ways of manipulating encoding interacted. Repetition was found to effectively modulate the degree of encoding for both alcohol and placebo participants, as a main effect of repetition signified that viewing lists multiple times increased the probability of veridical recall. In addition, and in accordance with the established anterograde impairments of alcohol (e.g. Weissenborn & Duka 2000; Duka *et al.* 2001), participants in the alcohol group recalled significantly less singularly presented veridical items than placebo participants. This deleterious effect of alcohol was rendered non-significant through increased learning, as recall levels for repeated veridical items did not differ as a function of drink.

In contrast to veridical items, repetition selectively increased the probability of recall for false memory items for alcohol participants, but not placebo participants. In accordance with the AMF, if repetition is to lead to an increase in false memories, it must increase the activation of the critical item. Through increased knowledge of the study list, repetition can also result in increased monitoring ability which decreases false memories (Benjamin 2001). Consequently, the extent to which repetition increases the activation of critical items must exceed the extent to which monitoring ability is enhanced with repetition. Thus no effect of repetition on false memory levels can be interpreted as repetition increasing activation and monitoring processes to the same extent. In contrast, an increase in false memories with repetition can be taken as indicative of repetition increasing the activation of critical items to a greater extent than the enhanced potential for source monitoring at retrieval. Consequently, the finding that repetition lead to an increase in false memories in the alcohol group but not the placebo group can be attributed to: (1) repetition increasing activation processes to a greater extent in the alcohol group relative to the placebo group, or (2) repetition increasing monitoring ability to a greater extent in the placebo group than the alcohol group. Regarding activation processes, alcohol has been hypothesised to impair memory through superficial encoding (Craik 1977), leading to a decrease in activation of the critical items (Thapar & McDermott 2001). If the activation levels of critical items were thus initially lower than the placebo group, yet three repetitions resulted in equivalent activation levels between the two groups (as indexed by equivalent levels of veridical memory), then the net increase in semantic activation as a function of repetition would be greater in the alcohol group than the placebo group. Alternatively, a deficit in recollective memory under alcohol could account for the findings. Alcohol has been shown to selectively impair recollective memory (Duka *et al.* 2001). Consequently, the increase in false memories with repetition under alcohol is inline with previous research which has demonstrated that repetition selectively increases false memories in populations that have a deficit in recollective memory and hence a supposed deficit in monitoring ability. This has been demonstrated in the elderly (Benjamin 2001; Kensinger & Schacter 1999) and patients with Korsakoff amnesia (Schacter *et al.* 1998).

4.5.2. Implicit memory

The implicit instructions for the stem completion task ('complete the stems to form the first word to come to mind') resulted in a priming effect for veridical items, but not critical items. This priming by word type interaction did not differ as a function of drink. In regard to veridical items, this priming effect replicates 24 hour priming obtained by Duka *et al.* (2002), where, like the current experiment, priming was unaffected by drink consumed. It is also in accordance with empirical research that demonstrates the preservation of automatic components of memory under alcohol (e.g. Kirschner & Sayette, 2003; Tracy & Bates, 1999). In contrast, no priming effect was obtained in critical items. This appears contrary to researchers who demonstrated a significant effect of priming in critical items using stem completion (Hicks & Starns, 2005; McKone & Murphy 2000). These researchers, however, used immediate stem completion, as opposed to the 24 hour retention interval employed in the current experiment. This differential effect of priming for critical and veridical items over an extended retention interval thus provides an interesting insight into the relative durability of traces underlying true and false memory items.

Participants were required to make awareness judgements for the words they had completed under implicit instructions, following a procedure used by Duka *et al.* (2001). By circling a word, participants were endorsing it as having been presented at encoding, thus proclaiming 'awareness' for its prior presentation. Awareness of veridical words thus constituted accurate memory. The reverse was true, however, for false memory items. For, as they were never presented, proclaiming 'awareness' of their presentation was thus incorrect. As a priming effect was only achieved in veridical items, conclusions regarding the automatic influences of memory as indicated by levels of unaware items is restricted to veridical items (Duka *et al.* 2001). Whilst aware and unaware measures can still be obtained for critical items, conclusions cannot be derived from these measures in terms of automatic and controlled memory processes. This is because stem completion for critical items was at chance and consequently one cannot infer that automatic memory processes aided their completion.

For the veridical items, a main effect of repetition demonstrated that the priming effect became enhanced with repetition. This is not surprising as suprathreshold activation, leading to a priming effect, would be predicted with increased viewing (Grant & Logan 1993). This result substantiates the use of repetition as a modulator of encoding and demonstrates that it can be obtained using implicit instructions. Interestingly, a three way repetition by awareness by drink interaction revealed for participants in the alcohol group, their awareness status for veridical words differed as a function of repetition. This was not true for placebo participants. Specifically, in the alcohol group, increased repetitions served to bring veridical items into conscious awareness. For words viewed just once, they were significantly more likely to be unaware of it relative to having viewed it repeated times. This finding would thus appear to support empirical research which documents the differential impairment of alcohol on automatic and controlled memory processes (Kirschner & Sayette 2003; Tracy & Bates 1999; Lister *et al.* 2001). As priming was not affected by drink, automatic memory influences, as quantified using degree of priming for veridical items, were not found to be affected by drink consumed. Explicit awareness of these words generated under implicit instructions, however, was found to be affected by drink. In addition, explicit awareness of these veridical items was mediated by repetition in the alcohol group only, such that it would appear they benefited from increased learning to bring these words into conscious awareness. The differential effect of alcohol on implicit and explicit memory is well documented in the current literature (e.g. Lister *et al.* 2001; Duka *et al.* 2001).

In critical items, whilst a main effect of awareness indicated that participants were more aware than unaware of stems completed to form critical items, this effect was qualified by a significant three way repetition by awareness by drink interaction. It was found that repetition had opposite effects in placebo and alcohol participants. Awareness, and thus endorsement, of critical items increased with repetition in alcohol participants, whilst no such effect was present in the placebo group. Thus, regarding memory accuracy as indexed by false memory endorsement, placebo participants' memory got more accurate with repetition, whilst accuracy for participants in the alcohol group declined. This finding mirrors the results obtained in the explicit data, and is accordance with the deficit in recollective encoding under alcohol (Kirschner & Sayette 2003). It can also be taken as a possible deficit of monitoring ensuing from alcohol intoxication at encoding. Whilst the literature has yet to document such an effect, it could be argued that it would be more likely to manifest using false memories. This argument is based on the high levels of global familiarity underlying false memory items (Fazendeiro *et al.* 2005) and the propensity of participants intoxicated at encoding to rely on familiarity for memory endorsement (Lister *et al.* 2001).

Chapter 5. In pursuit of the inverted U

5.1. General introduction

Investigation into the effect of repetition at encoding on subsequent false memory levels has resulted in equivocal findings. Studies have demonstrated that repetition at encoding has the potential to increase false memories (Benjamin 2001; Jacoby 1999; Seamon 2002) decrease false memories (Benjamin 2001; Jacoby 1999), have no effect on false memories (Tussing & Greene 1997; Tussing & Greene 1999) or result in an inverted U-shaped relationship, with repetitions initially serving to increase false memories, and later acting to decrease them (Seamon *et al.* 2002).

McDermott (2001) found an inverted U-shaped relationship between the degree of learning – as manipulated by exposure duration of stimuli – and false memory levels. One can equate repetition with the degree of learning, hence accounting for the parabolic relationship between false memories and repetition obtained by Seamon *et al.* (2002). In addition, the way in which learning is affected by repetition is determined by the quality of encoding. For example, repetition when learning is impoverished has been shown to increase false memories, as shown by repetition under conditions of speeded encoding. Also repetition in the elderly, where recollection is impaired, has been shown to increase false memories relative to younger participants (Benjamin 2001).

The potential for repetition to affect explicit false memories in different ways was reflected in the findings of the previous two chapters. Chapter 4 found no effect of repetition on explicit false memories in placebo participants. In contrast, Chapter 3 found a tendency for repetition to decrease false memories prior to a placebo drink, then increase false memories after consumption of a placebo drink. This chapter is concerned with gaining a greater understanding of the complex relationship between repetition and the false memory levels. By furthering our understanding of what factors determine the way in which repetition will impact false memory levels, the previous seemingly contradictory findings can be reconciled.

With regard to explicit data from placebo participants, one can interpret the results from the previous two chapters in terms of the parabolic relationship between repetition and false memories. In Chapter 4, the non-significant effect of repetition on false memories in placebo participants may indicate that the increase in learning between the two repetition points resulted in levels of false memory which were at the peak of the curve (see figure 5.1). In the first encoding phase of Chapter 3, a tendency was found for repetition to decrease false memories. In contrast, results from the post-drink encoding phase resulted in a tendency for repetition to increase false memories. These two encoding phases could be viewed as approaching separate ends of the curve – with learning being impaired during the second learning phase as a result of proactive interference generated by the first encoding phase. This hypothesised reconciliation of the findings of the previous experiments in terms of the inverted U-shaped relationship between false memories and repetition is displayed in Figure 5.1.

The inverted U-shaped relationship between false memories and repetition: Previous experimental findings in Placebo participants.

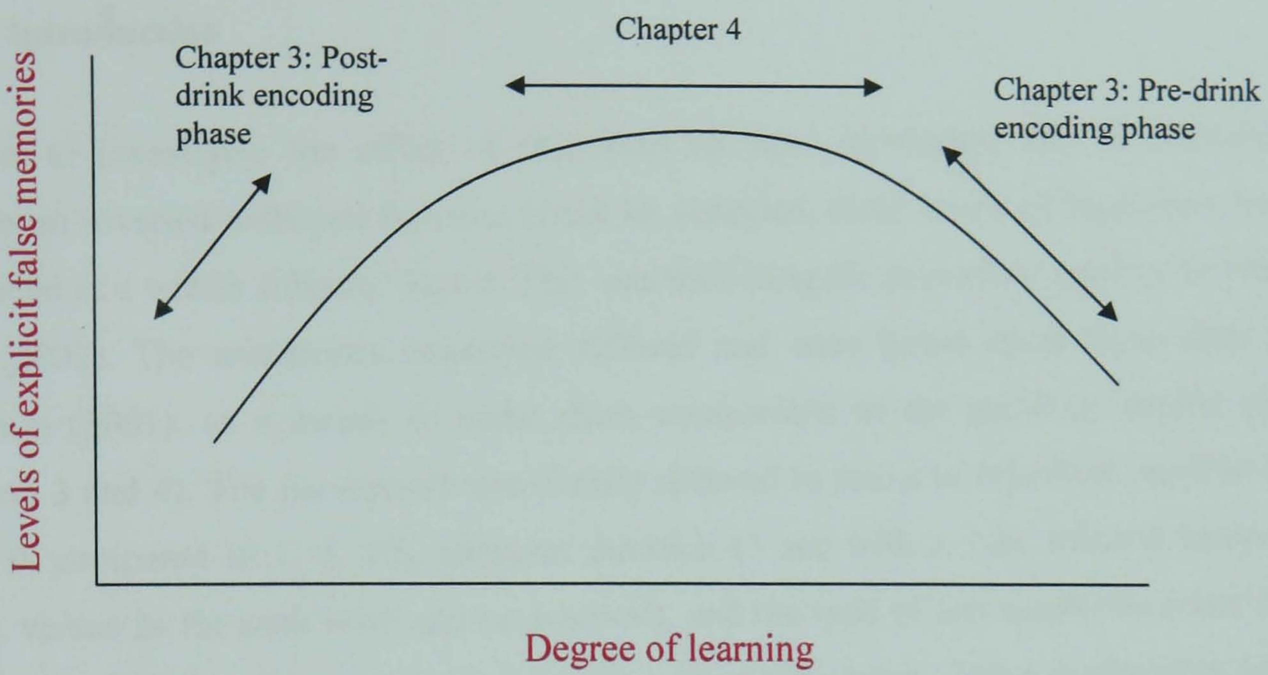


Figure 5.1. **The explicit results from placebo participants in Chapters 3 and 4 are interpreted in terms of the inverted U-shaped relationship between the degree of learning and false memory levels (Seamon *et al.* 2002; McDermott 2001)**

This chapter is an exploration of the relationship between repetition and false memories, with a view to investigating the way in which different factors serve to affect the way in which repetition modulates false memories. As the inverted U-shaped relationship between false memories and repetition has, to date, only been demonstrated once (Seamon *et al.* 2002), determining whether it can be replicated, and establishing the conditions under which it manifests, can provide insight into the mechanisms underlying false memories. By having repetition both increase and decrease false memories within a single study, a paradigm is thus established which, when used in combination with alcohol, could provide greater insight into the way in which alcohol selectively modulates these two opposing effects.

5.2. Experiment 4

5.2.1. Introduction

In order to investigate the effect of repetition on false memories, and to determine whether an inverted u-shaped function could be obtained, three levels of repetition were introduced as a within subjects' factor. This was following the procedure used by Seamon *et al.* (2002). The parameters employed differed and were based upon those used by Benjamin (2001), as a means to make them comparable to the previous studies (see Chapters 3 and 4). The parameters specifically differed in terms of repetition number (1, 3 and 9, compared to 1, 5, 10), stimulus duration (3 sec with a 1sec interval between words, versus 2s for each word and no interval), and the type of test employed (next day free recall and recognition versus immediate recognition only). These parameters have been shown to affect false memory levels in differing directions. An increase in stimulus duration post 1000ms per word has resulted in a decrease in false memories (McDermott 1996). An increase in retention interval has been shown in previous studies to have a differential effect on false and veridical memory, by decreasing veridical memories, but having either no effect on false memories (Payne *et al.* 1996; Seamon *et al.* 2002), or increasing false memories (McDermott 1996; Thapar and McDermott 2001). The adoption of different parameters provides an opportunity to investigate the potential robustness for three levels of repetition to vary false memory levels in the shape of an inverted U-shaped curve.

5.2.2. Methods

Participants

Fifteen Sussex undergraduate students, between the ages 18-30, served as paid volunteers or gained course credit for participating in the experiment. None had taken part in previous false memory research.

Materials

Encoding

Twenty four DRM format lists were divided into two sets (set A and set B). Participants saw one set of 12 lists. Eleven lists were taken from the Stadler *et al.* (1999) norms, and 13 were created for the purpose of the thesis (see chapter 2 and 3). Each list was composed of 12 veridical items. Set A and set B were each divided into 3 groups of 4 lists to form 3 repetition categories: one set of 4 lists was shown once, one set of 4 lists was repeated three times, and one set of 4 lists was repeated nine times. Each participant saw either set A or set B at encoding, and the repetition category they were in determined which lists were repeated and which were not. In order to minimise item effects, the repetition category was counterbalanced for all the lists to ensure that any one list had an equal probability of being presented once, three times or nine times. The lists contained in both sets and repetition categories were balanced, for both critical and veridical items, in terms of word frequency and probability of eliciting a false memory.

Test

The recognition test comprised 96 items: 3 veridical items from each list (serial positions 1, 5, 10), amounting to 12 singularly presented veridical items, 12 veridical items that were presented three times and 12 veridical items that were presented nine times during encoding. There were also 4 critical items from each repetition category presented in the test. The 12 critical and 36 veridical items from the set not presented at encoding served as non-related distracter stimuli. The test order was fully randomised.

Procedure

Prior to encoding, subjects were given standard intentional learning instructions stating that they were going to view lists of words and that these lists would either be shown once, or repeated multiple times, and that they should try to learn these words as their memory for them would later be tested. Although 12 different lists were viewed in total, by viewing four of these lists once, four of them three times and four lists nine times, a total of 52 lists were shown.

Veridical words in each list were presented in decreasing associative strength from the critical items. List presentation was random with the constraint that repetitions were not consecutive. Words from each list were shown sequentially for 3 seconds, with a one second interval between each word. Prior to a new list being presented, a five second 'NEW LIST' warning was displayed.

The test took place 24 hours after the encoding phase. On arrival at the lab, participants' free recall was assessed by the instruction to write down all the words they could remember from the previous day's encoding phase. Once this was over, participants then underwent a recognition test. A word was presented in the middle of the screen, and remained there until a recognition decision had been made. Participants were required to press a key, one of which was marked 'OLD', which they were instructed to press if the word had been presented in the encoding phase, the other marked 'NEW', and was to be pressed if the word had not been presented in the encoding phase. After each old/new recognition judgment, participants were required to make remember/know judgments by pressing keys labelled either r or k. It specified that remember responses were to be made if they consciously remembered the word from the study lists, whilst know responses were to be made if they were sure the word was presented, but could not remember its specific occurrence. After the test was completed, subjects were debriefed, and were asked not to discuss the details of the experiment until the project was completed.

5.2.3 Results

5.2.3.1. Free Recall

A 2(wordtype: veridical, critical)x3(repetition: presented once, three times, nine times) ANOVA was performed on the percentage of words recalled. A main effect of word type was obtained [$F(1,14) = 5.01$, $p = .042$] reflecting the finding that more veridical than critical words were recalled. A main effect of repetition was also found [$F(2,28) = 17.30$,

$p < .001$], demonstrating that increased repetitions increased free recall. In addition, word type was found to interact with repetition [$F(2,28) = 17.60$, $p <.001$]. To explore this interaction, within subjects t-tests were performed in the veridical and critical items. It was revealed that repetition served to increase veridical memory when lists were repeated three times compared to single presentations [$t(14) = -4.84$, $p <.001$] and that repetition increased veridical memory when lists were shown nine times versus three times [$t(14) = -4.04$, $p <.001$] (see Figure 5.2). In contrast, analyses of the critical items demonstrated that whilst there was a trend for false memory to increase between one and three repetitions, this effect did not reach significance [$t(14) = -1.29$, $p =.217$]. In addition, repetition had no significant effect for critical items from lists presented three and nine times [$t(14) = .250$, $p =.806$].

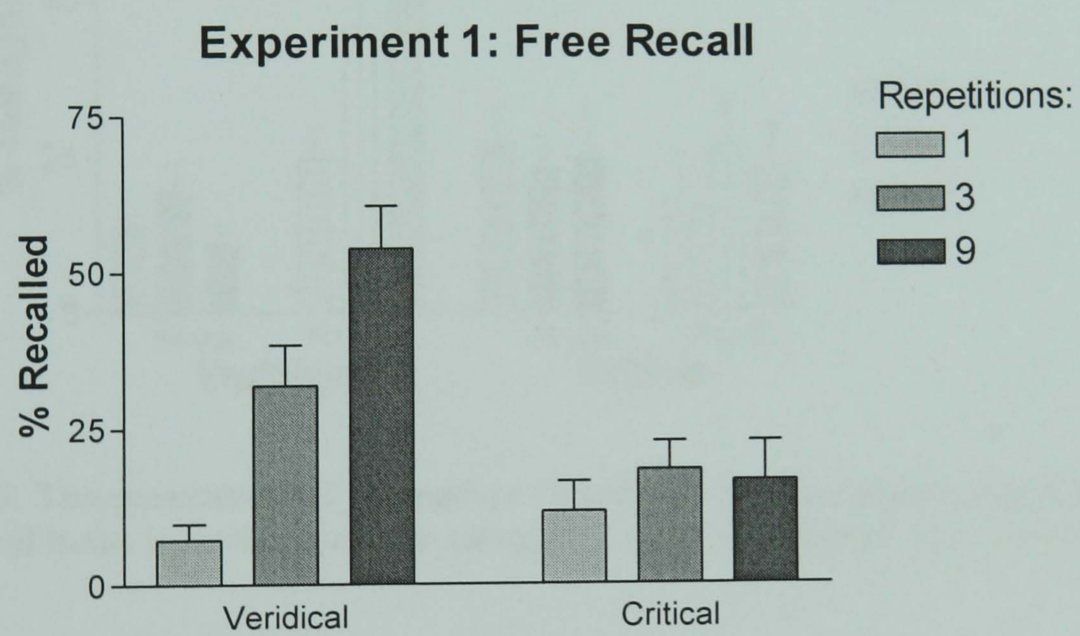


Figure 5.2. **The percentage of veridical and critical words recalled in each repetition category (once, three times and nine times).**

5.2.3.2. Recognition

A 2(wordtype: veridical, critical)x3(repetition: presented once, three times, nine times)x2(memory type: remember, know) within subjects ANOVA was performed on the percentage of words recognised. A main effect of repetition was found [$F(2, 28) = 5.29$,

p = .011], but the main effect of word type did not reach significance [$F(1, 14) = 3.26$, p = .093]. This demonstrated that repetition increased recognition, mirroring the pattern in free recall. Despite a slight tendency for more hits to be ascribed as remember responses, this was non-significant.

A significant repetition x word type interaction was obtained [$F(2,28) = 7.16$, $p = .003$], as was a repetition x word type x memory type interaction [$F(2,28) = 3.5$, $p = .044$].

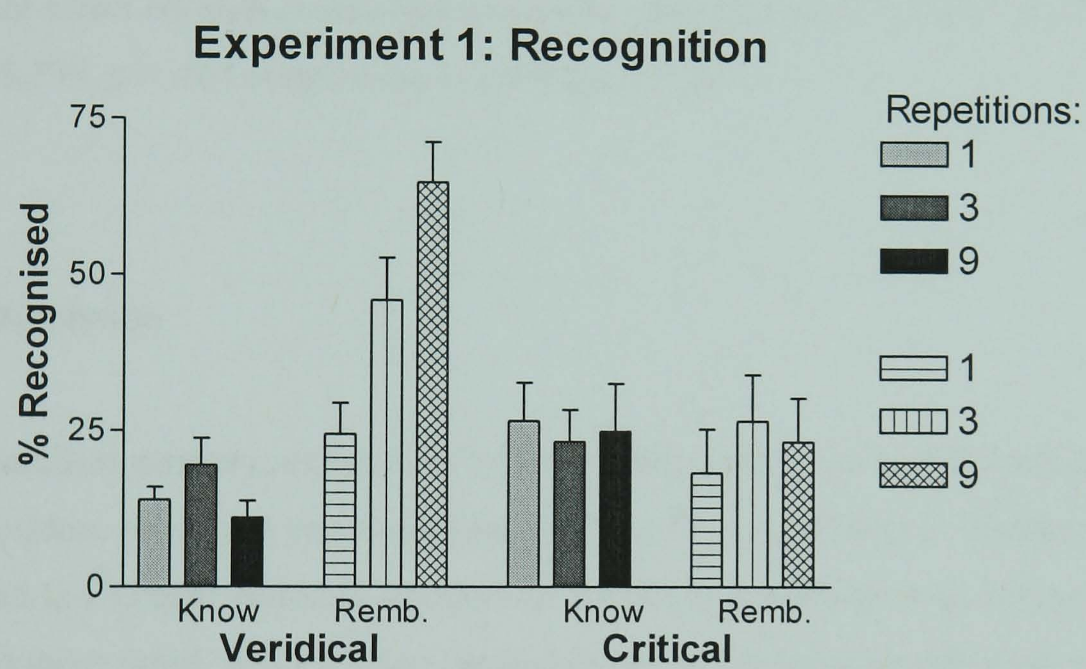


***Figure 5.3.* The percentage of remember / know recognition judgments for veridical and critical items in each repetition category (once, three times and nine times).**

Further analysis of the repetition x word type interaction revealed that repetition increased memory for veridical items [$F(2, 28) = 24.655$, $p < .001$], and this reached significance between one and three repetitions [$t(14)=-6.51$, $p < .001$], and was approaching significance between three and nine repetitions [t(14 = -1.85, p = .083]. In contrast, repetition had no effect on memory for critical items [$F(2, 28) = .129$, $p = .879$]; neither between one and three repetitions [$t(14) = -.587$, $p = .567$], nor between three and nine repetitions [$t(14) = .168$, $p = .869$].

As a means to explore the three way word type x repetition x memory type interaction, separate 2(memory type: veridical, critical)x3(repetition: presented once, three time, nine times) within subjects ANOVAs were performed on the percentage of critical and veridical items recognised. It was revealed that the memory type x repetition interaction was significant for the veridical items [$F(2, 28)= 16.54$, $p <.001$], but not the critical items [$F(2, 28)= .37$, $p = .69$]. Further analysis of veridical items revealed that repetition significantly increased the amount of remember responses in between both repetition points [$t(14) = -1.323$, $p = .207$; $t(14) = 1.936$, $p = .073$ respectively], repetition had no significant effect on know responses and either repetition point [$t(14) = -6.145$, $p < .001$; $t(14) = -3.336$, $p = .005$ respectively] (see Figure 5.3).

5.2.4 Discussion

Whilst veridical memory, as assessed by free recall, was shown to monotonically increase with repetition, repetition was not found to affect false recall levels. Similarly, repetition was found to increase veridical recognition for words presented once compared to words presented three times, and veridical remember responses between either repetition points, whilst not affecting false recognition rates.

This non-significant effect of repetition on false memory levels is in accordance with the findings of Tussing and Greene (1999) who, in four experiments out of five, demonstrated that repetition had no significant effect on false memory levels. These findings, however, appear contrary to those obtained by Seamon *et al.* (2002), as the inverted U-shaped relationship between recognition and false memories was not obtained. Confidence intervals for mean differences in the present study were from -23.277 and 13.277 for critical items between one and three repetitions, and -19.574 and 22.901 for critical items between three and five repetitions. These intervals incorporate the effect sizes obtained by Seamon *et al.* (2002), 11 and 19 for critical items at the respective repetition conditions. Consequently, the present experiment was not sufficiently sensitive to render significant an effect size comparable to Seamon *et al.* (2002).

Two key methodological parameters differed between the present study, and that of Seamon *et al.* (2002). The way in which an increased retention interval and increased exposure duration may have affected the results will be considered.

Retention interval

The retention interval used in the current experiment was 24 hours, compared to immediate recognition employed by Seamon *et al.* (2002). Retention interval has been shown to differentially affect false and veridical memory, specifically by reducing veridical memory, whilst leaving false memory intact (e.g. Payne *et al.* 1996; Seamon *et al.* 2002), or by increasing false memory, whilst decreasing veridical memory. McDermott (1996) found an increase in false memories over a 24 hour period. Whilst this effect was originally thought to have possibly been elicited through repeated testing (Roediger *et al.* 1996), a similar result was obtained by Thapar and McDermott (2001). They found that absolute levels of false recognition increased with retention interval. To date, no studies have investigated the potential for retention interval to interact with repetition in false memories. Thapar and McDermott also found that level of processing interacted with retention interval, with deeper processing leading to a greater decline in memory than superficial processing over a 24 hour retention interval for both veridical and critical memory. Whilst one needs to be careful in equating number of repetitions with level of processing manipulations, they are comparable in the sense that they affect the degree to which material is learnt. It can thus be speculated that if false memory levels increased with repetition, memory in the higher repetition conditions may also have been subjected to a disproportionate decline with the retention interval. It is thus possible that these two opposing effects may have converged and consequently rendered the net differences non-significant.

Stimulus duration

In the present experiment, the stimuli were presented for almost twice as long, compared to the duration used by Seamon *et al.* (2002). As increasing stimulus duration over 100m/s per word has been shown to decrease false memories (McDermott & Watson 2001; Seamon *et al.* 2002), this could have served to cause a decrease in false memories in the present study relative to the levels obtained by Seamon *et al.*. Indeed, false memory rates within this study remained at approximately 25 percent, substantially less than was obtained by Seamon *et al.* (54, 65 and 46 percent in the one, five and ten repetition conditions respectively). One can speculate that the decreased levels of false memory may have required a greater amount of repetitions in order for an effect to manifest itself. Indeed, in the series of experiments performed by Tussing and Greene (1999), a monotonic decrease in false memories with repetition only manifested itself when false memory levels were initially at 30%, a value almost double that of the four previous studies.

As a number of methodological parameters differed between the present study and that performed by Seamon *et al.* (2002), one can only speculate the potential ways in which they might have contributed to a difference in results and experimental sensitivity. A systematic variation in the aforementioned parameters could provide clarification on this matter. Before such systematic modulation however, a direct replication of the experiment performed by Seamon *et al.* (2002) needs to be undertaken to ensure the presence of the curve can be obtained using their exact methodology and stimuli.

5.3. Experiment 5: Direct replication of Seamon et al. (2002)

5.3.1. Introduction

The findings of Seamon *et al* (2002) are depicted in the graph below (Figure 5.4), where the inverted U-shaped curve was obtained in false memory items as a function of repetition. As this present experiment was designed to exactly replicate the materials and procedure used by Seamon *et al.* (2002) it was hoped that the results obtained would be in accordance with theirs.

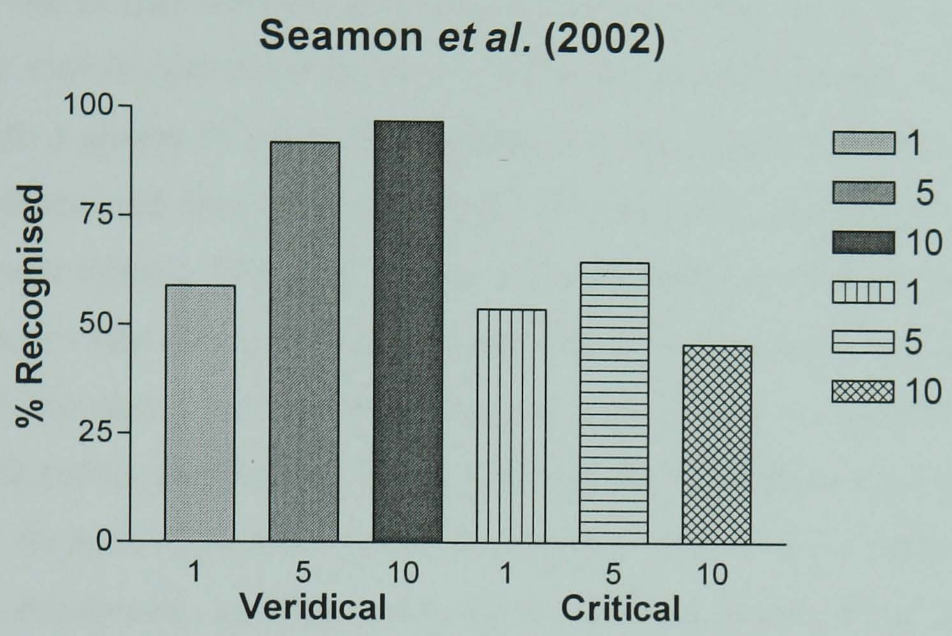


Figure 5.4. **Graph depicting the findings of Seamon *et al.* (2002), where repetition was found to monotonically increase veridical recognition, but interact with false recognition to form an inverted U-shaped function.**

5.3.2. Method

The experiment used contains many similarities with the previous experiment, but will be written in full as subsequent experiments will refer back to this exact methodology.

Participants

22 Sussex undergraduate students, between the ages 18-30, served as paid volunteers or gained course credit for participating in the experiment. None had taken part in previous false memory research.

Materials

18 DRM word lists which elicited the highest rates of false recognition were used, as demonstrated by the recognition norms provided by Stadler *et al.* (1999). Each list was

composed of 15 veridical items, all of which were converging associates of a critical non-presented item. The veridical items were arranged in hierarchical order of associative strength to the critical items, with the strongest associates occurring at the beginning of each list. Hence the order of presentation of the veridical words in each list was always constant. The 18 lists were divided into two sets of 9 lists, labelled set A and set B. Each participant viewed just either set A or set B in the encoding phase. Each set of 9 lists was divided into 3 groups of 3 lists. Participants saw one group of 3 lists once, one group of 3 lists five times, and once group of 3 lists 10 times, thus making 48 list presentations in total for each subject. The order of the lists was random, with the constraint that no list could appear twice in a row. Within each list, all words were blocked and the order of words was constant. The test was composed of 72 words; 3 veridical items from each of the 18 lists (serial positions 1, 8 and 10), and the 18 critical non-presented items from each lists. As each subject viewed one set (either set A or B) of nine lists composed of 3 repetition conditions, the test contained 9 veridical words from lists shown once, 9 veridical words from lists repeated five time and 9 veridical words form lists repeated ten times. In addition, they viewed 3 critical items corresponding to each of these three repetition conditions (x1, x5 and x10). The veridical and critical words from the set not viewed in the encoding phase but presented at test served as baseline measures for the veridical and critical words.

Procedure

Participants were tested individually and were given standard intentional learning instructions stating that they should attempt to learn all words presented as they would later undergo a recognition test. They were also informed that some lists were to be presented once, whilst other lists would be repeated. All list words were presented sequentially in the centre of the screen for 2 seconds with no gap between words. A one second warning stating ‘NEW LIST’ was presented in capitals between list presentations. The list order was random with the constraint that the same list would not appear sequentially.

After the encoding phase, participants were given a recognition test. This consisted of 72 words; 3 veridical items from each study list (serial positions 1, 8 and 10) and each non-presented critical item associated with each list. All words were presented in a random order. Each word remained on the screen until participants had made a recognition judgment. They were required to press the key labelled 'OLD' for any word presented in the encoding phase, and 'NEW' for any word not previously shown in the learning phase. If subjects pressed 'OLD' a prompt asking them to make a remember / know judgment was made by requiring them to press keys labelled 'R' (if they consciously remembered the word from the encoding phase) or 'K' (if they were sure that the word was presented, but they could not remember its specific occurrence. If subjects presented 'NEW' the remember / know judgment was not applicable and subjects were required by a prompt to press the key labelled 'N/A'. All words in the test were presented in a fully random order. After the test was completed the subjects were debriefed and requested not to discuss the nature of the experiment with anyone until the project was completed.

5.3.3. Results

A 2(wordtype: veridical vs. critical)x3(repetition: presented once vs. three times vs. nine times)x2(memory type: remember vs. know) ANOVA was performed on the percentage of words recognised. A main effect of repetition was found to be significant [$F(2,46) = 5.50, p = .007$], indicating that repetition served to increase memory when collapsed over word type and memory type. A main effect of word type was also significant [$F(1,23) = 6.71, p = .016$], demonstrating that more veridical words than critical words were recognised. A significant repetition x word type interaction [$F(2,46) = 23.08, p <.001$], was also obtained, as was a repetition x word type x memory type interaction [$F(2,46) = 6.27, p = .004$].

Further exploration of the word type x repetition interaction revealed that repetition increased veridical memory [$F(2, 46) = 39.973, p < .001$], and this reached significance between one and five repetitions [$t(23) = -6.452, p < .001$] and between five and ten repetitions [$t(23) = -2.460$, $p = .022$]. In contrast, repetition did not have a significant effect on false memory levels [$F(2, 46) = 2.241$, $p = .118$] (see Figure 5.5.).

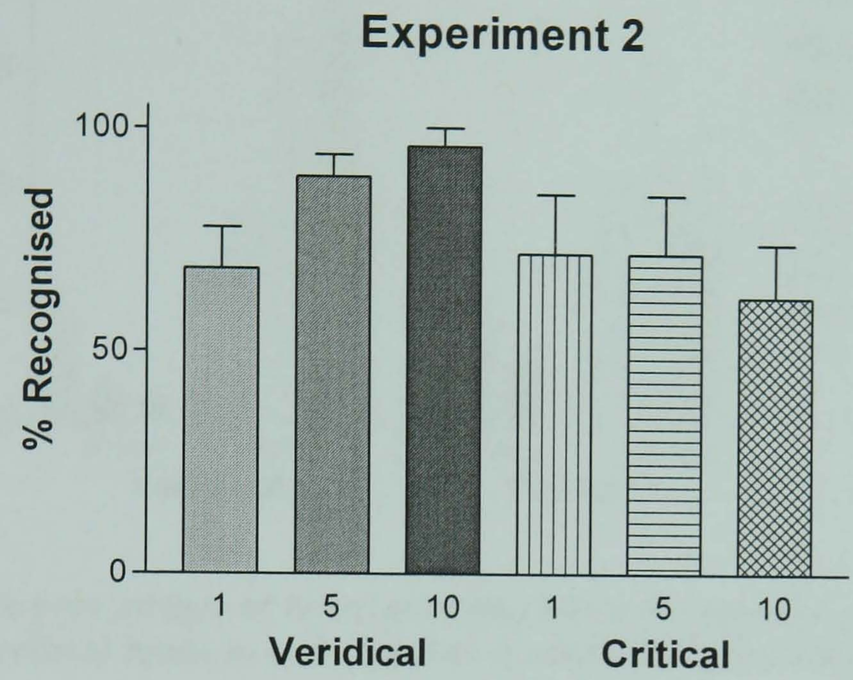


Figure 5.5. **The percentages of veridical and critical words recalled in each repetition condition (once, five and ten times).**

In addition, a breakdown of the significant repetition x word type x memory type interaction revealed that the repetition x memory type interaction was not significant for memory for critical items [$F(2, 46) = 1.286$, $p = .286$]. In contrast, a significant repetition x memory type interaction was found to be significant in veridical memory [$F(2, 46) = 32.503$, $p < .001$]. Exploration of the interaction revealed that repetition served to increase veridical remember responses [$F(2, 46) = 43.658$, $p < .001$] and this reached significance between one and five repetitions [$t(21) = -5.81$, $p <.001$] and between five and ten repetitions [$t(21) = -2.14$, $p =.045$]. In contrast, repetition decreased veridical know responses [$F(2, 46) = 13.816$, $p < .001$] and this reached significance between one and five repetitions [$t(23) = 3.773$, $p =.001$], though not between five and ten repetitions [$t(23) = 1.096$, $p = .285$], possibly due to a floor effect (see Figure 5.6).

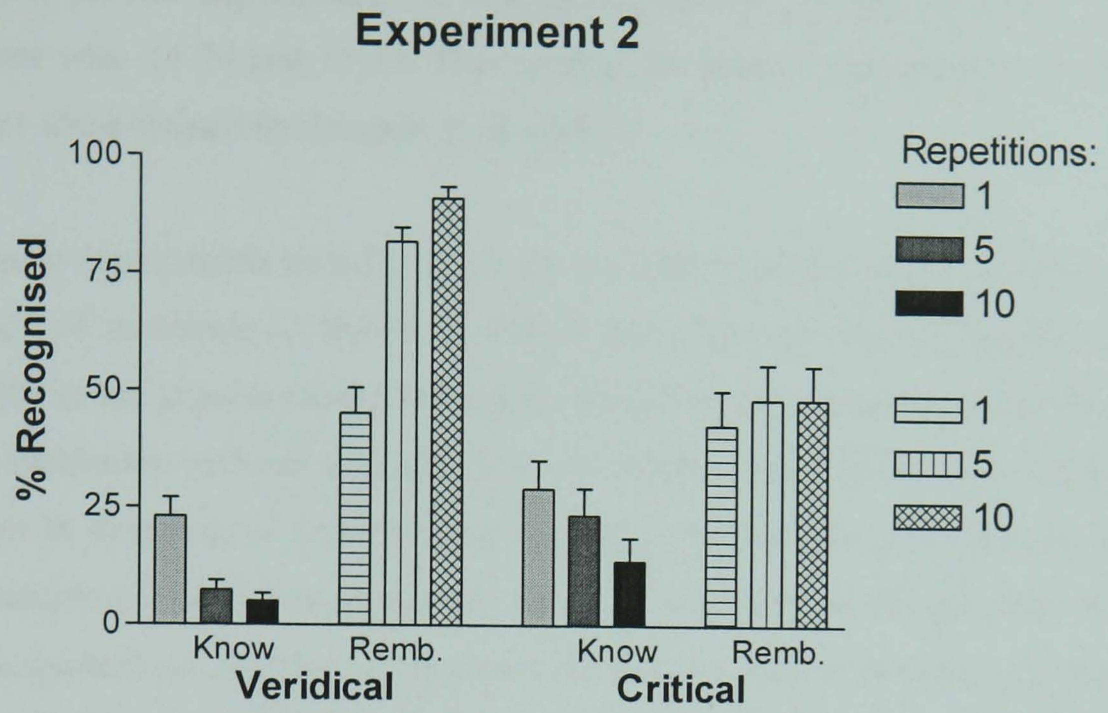


Figure 5.6. **The percentages of remember and know recognition judgements for veridical and critical items in each repetition condition (presented once, five and ten times).**

5.3.4. Discussion

Despite following the exact methodology and materials used by Seamon *et al.* (2002) the inverted U-shaped curve was not obtained in false memory items as a function of repetition.

As the methodology and stimuli were exactly the same as those used by Seamon *et al.* (2002), the difference in results cannot be attributed to methodological parameters, as previously speculated. Through an examination of the effect size obtained by Seamon *et al.* (2002), and the confidence interval within the present study, one can conclude that had effect size comparable to that obtained by Seamon *et al.* (2002) been achieved, the present experiment would not actually have been sufficiently sensitive to render an increase in false memories as significant. Specifically, Seamon *et al.* (2002) obtained a difference in percentage of 11 critical items recognised between one and five repetitions.

Within the present experiment, the confidence interval for the difference one and five repetitions was -11.74 and 11.74. This confidence interval incorporates, albeit only just, the effect size obtained by Seamon *et al.* (2002).

The present experiments failed to elicit the inverted U-shaped curve for false memory as a function of repetition. A failure to obtain this effect may be attributable to a lack of sensitivity in the present study. Reducing variability may result in a significant increase in false memories between one and five repetitions. It can be argued that manipulating repetition at encoding is somewhat analogous to manipulating the degree of rehearsal during learning, as repeated presentations of stimuli increase the potential for rehearsal. This is important as the effect of rehearsal on memory type is thought to be influenced by the type of rehearsal undertaken. Research has demonstrated that when elaborative and conceptual rehearsal is performed, a subsequent increase in remember responses is observed, whilst when perceptual processing and maintenance rehearsal are performed, an increase in know responses commonly ensues (Gardiner *et al.* 1996). It should be noted, however, that this distinction is not absolute (Rajaram, 1996; Conway *et al.*, 1996). Consequently, using repetition to manipulate the degree of encoding could be viewed as problematic if the type of rehearsal employed has a resultant impact upon the nature of their subsequent memories. In the absence of controlling the way in which information is rehearsed, it is thus left to the discretion of the participant to adopt a particular encoding strategy, which in turn can influence the nature of their memories. This could be viewed as particularly pertinent when dealing with repetition and false memories, as opposed to repetition and veridical memories, as the processes which give rise to remember and know memories can be viewed as working together to endorse veridical items, but have the potential to work in opposition to each other for the endorsement of false memory items. This supposition is based upon the work done by a number of researchers who theorise that strong recollective traces for veridical items can counteract the familiarity felt for critical items to prevent their erroneous endorsement (e.g. Hicks & Marsh, 1999). Thus a person who engages in elaborative rehearsal has the potential to strongly recollect veridical items, which could thus aid monitoring at retrieval (Hicks & Marsh, 1999). Elaborative rehearsal could reduce false memories unlike rote rehearsal which could merely increase familiarity for veridical items. The large standard error bars in the current experiment support the supposition that a high level of individual variability existed in the amount of false memory items endorsed.

In the absence of any methodological differences between the direct replication of Seamon *et al.*'s experiment and the actual methodology employed by Seamon *et al.* (2002), it thus remains a possibility that the discrepancy in results could be attributed to different encoding strategies employed by the participants. Providing instructions at encoding could serve as a way in which to limit the degree of individual variability through the use of directed encoding.

Further inspection of Seamon *et al.*'s (2002) data (see Figure 5.7.) reveals that the inverted U-shaped curve was actually confined to remember responses only, but that these effects were sufficiently large when analyses were collapsed over memory type, and thus included know responses to render the inverted U-shaped curve as still applicable. Consequently, a manipulation which directly affects recollective processes may elicit the curve more readily than other types of manipulations. In addition, both the previous experiments (see this section and Experiment 4), resulted in a trend increase in remember responses for critical items between one and five repetitions, but no decrease between five and ten repetitions. Thus, subsequent manipulations will be designed to maximise the potential for recollective processes as a means to elicit the U-shaped curve.

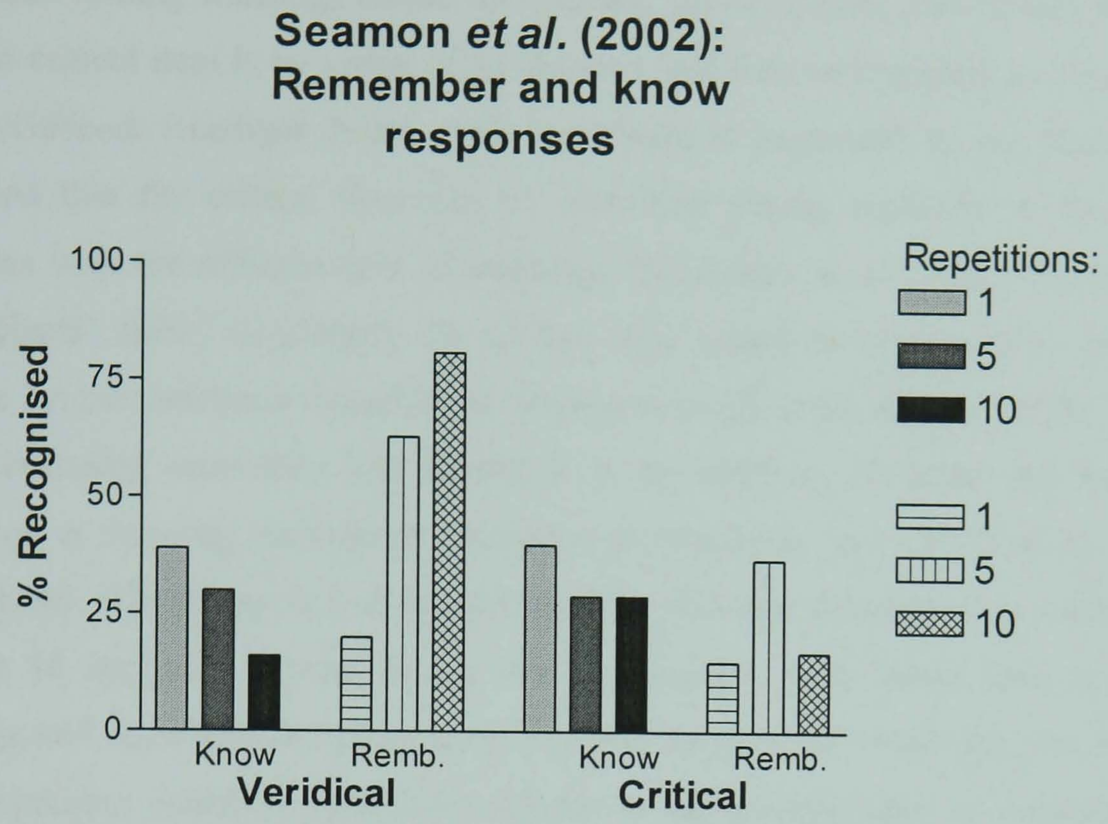


Figure 5.7. **Results from Seamon *et al.* (2002): The percentages of remember and know recognition judgements for veridical and critical items in each repetition condition (presented once, five and ten times).**

5.4. Experiment 6: Warning

5.4.1 Introduction

An introduction of a warning prior to encoding has dual functions. Firstly, research has indicated that warning participants about the nature of the DRM paradigm is to elicit false memories, and instructing them to avoid such errors, serves to affect encoding style. The now established finding that warnings reduce false memories when given prior to encoding (McCabe & Smith 2002), whilst having no little or no effect when issued post encoding but prior to test (Neuschatz *et al.* 2001; McCabe & Smith 2002) implies that the warning induced decline must be an encoding based phenomenon. Gallo *et al.* (2001)

argued that issuing warnings before the learning phase enables participants to determine what the critical item is by virtue of its absence, and then strategically avoid endorsing it at test (Gallo & Roediger 2002). This hypothesis is supported by the finding that the likelihood that the critical item can be identified during exposure to the study lists correlates with the effectiveness of warnings (Neuschatz *et al.* 2003). It can be argued that subjects' ability to identify the critical item would be enhanced by repetition, as multiple list presentations would allow subjects to confirm the absence of the critical item during encoding once they had identified it. In addition, McCabe and Smith (2002) conducted a warning experiment whereby presentation rate of veridical words was manipulated. Words were presented with a short stimulus duration (2 seconds) or a slow duration (4 seconds). It was found that participants were better able to utilise the warnings and discriminate between studied and non-studied words for slower presented lists. Repetition could be considered similar to the manipulation of presentation rates, thus supporting the prediction that the beneficial effect of warnings could be influenced by repetition.

Secondly, the mechanisms through which warnings have been hypothesised to mediate a reduction in false memories implicate a recollective emphasis, by maximising such traces at encoding, and requiring them for endorsement at retrieval. Watson *et al.* (2004) argue that issuing a warning may result in a shift in encoding focus from semantic to perceptual, as this would enable them to better discriminate between what items had been presented and those which were merely semantically related. Warnings could also reduce false memories by making the recognition criterion more stringent, forcing subjects to reject familiarity alone for an item as being diagnostic of prior presentation. Thus, in accordance with the AMF, one could hypothesise that warnings could lead to a greater emphasis being placed on monitoring the source of familiarity during recognition, to ensure that a sense of familiarity does not stem from a non-presented semantic associate. Jacoby and Whitehouse (1989) demonstrated that artificially enhanced familiarity of a to-be-recognised word increased false recognition of that word only if the source of that familiarity (immediate prior exposure through masked priming) is not appreciated[1]. Providing a warning could help subjects appreciate the origin of their sense of familiarity, allowing them to correctly attribute it to semantic relatedness to presented words, and thus rejecting them during recognition.

5.4.2. Methods

The methods were identical to those used for the direct replication of Seamon *et al.*'s study (Experiment 5), with the exception of the following variations:

Materials

- Previous research had demonstrated that the probability that participants could identify the critical item at test served as a predictor of later false memory, and that this probability varied between lists (Neuschatz *et al.* 2003). Consequently, list sets (A and B) and repetition conditions within these sets were balanced for identifiability according to the probability norms outlined by Neuschatz *et al.* (2003), whilst ensuring that word frequency and probability of eliciting a false memory remained balanced.

A warning was issued prior to encoding. The wording of the warning was based on that used by McDermott and Roediger, (1996) and was exactly the same as the warning used by Heit *et al.* (2004) in terms of font and wording with the exception of an additional sentence regarding repetition:

[1] Though see Higham and Vokey (2000) Experiment 1, where results obtained were the reverse of Jacoby and Whitehouse (1989). Possible methodolgocial reasons are provided to account for this discrepancy (pg. 578-579). In addition, the *identification heuristic* is proposed as an additional heuristic that can guide recognition decisions.

Hint to improve accuracy scores

In the study phase you will see nine lists of related words. 3 of these lists will be presented once, 3 lists well be repeated five times and 3 lists will be repeated 10 times. All the words in each list are associated to one common word, but this word is not actually presented during study. For example, you might see the following words during study:

Queen, England, crown, palace, throne, chess, subject, monarch, royal.

In this case, *king,* the word that links all the above words is not presented during study. In the test phase you are asked to decide whether the word *king* is 'old' (previously seen in the study phase) or 'new' (not seen in the study phase). In this case, the correct response to the word *king* is new, because it was not presented during study. However, previous research has shown that sometimes people mistakenly respond 'old' to these words (such as *king*) that link groups of words together even though they have not seen the word during study. **It is important that you try not to make these kind of errors.**

THANK YOU

Figure 5.8. **Instructions issued prior to encoding to warn participants about the nature of the experiment, and instructing them to avoid making false memory errors.**

5.4.3. Results

A 2(wordtype: veridical, critical)x3(repetition: presented once vs. five times vs. ten times)x2(memory type: remember vs. know) within subjects ANOVA was performed on the percentage of words recognised. A main effect of word type was found, reflecting a greater proportion of veridical items recognised relative to critical items [$F(1, 21) = 37.12$, $p <.001$]. In addition, a main effect of memory type was obtained [$F(1, 21) = 61.89$, $p <.001$], reflecting a larger proportion of remember recognition responses than know responses. No main effect of repetition was found [$F(2, 42) = .967$, $p =.39$]. A word type x repetition interaction was significant[2] [$F(1.5, 30.6) = 8.21$, $p =.003$] (see

[2] Mauchly's test of sphericity is significant (Greenhouse-Geisser adjusted)

Figure 5.9), as was a word type x repetition x memory type interaction [$F(2, 42) = 14.71$, $p < .001$] (see Figure 5.10).

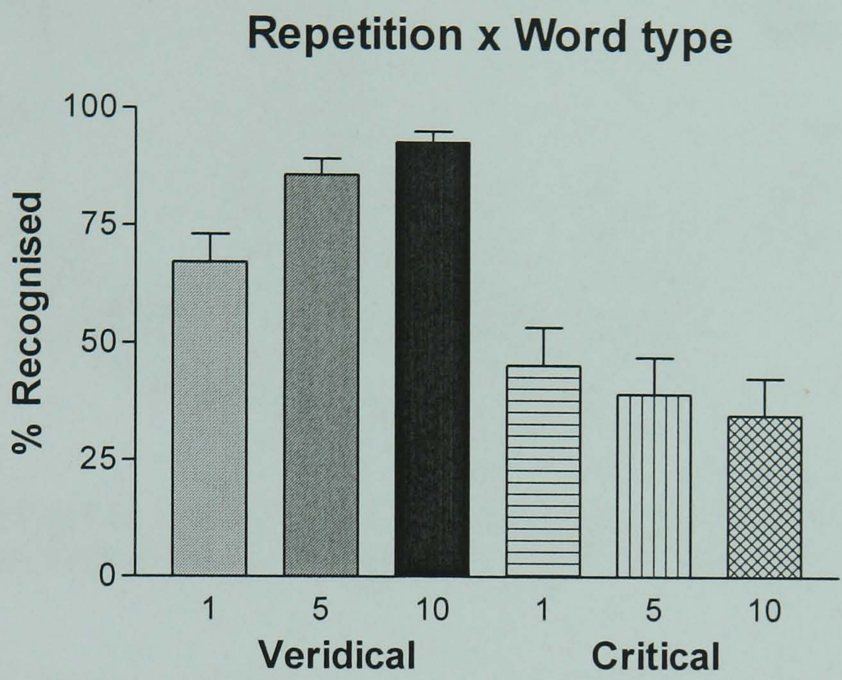


Figure 5.9. **The percentage of veridical and critical items recognised in each repetition category (one, five and ten).**

Breakdown of the repetition by word type interaction revealed that repetition served to increase veridical memories [$F(2, 42) = 15.375$, $p < .001$], and paired t-tests revealed this reached significance between both one and five repetitions [$t(21) = -3.26$. $p = .004$] and five and ten repetition, [$t(21) = -2.25$, $p = .036$]. In contrast, repetition had no effect on false memory items [$F(2, 42) = .650$, $p = .527$].

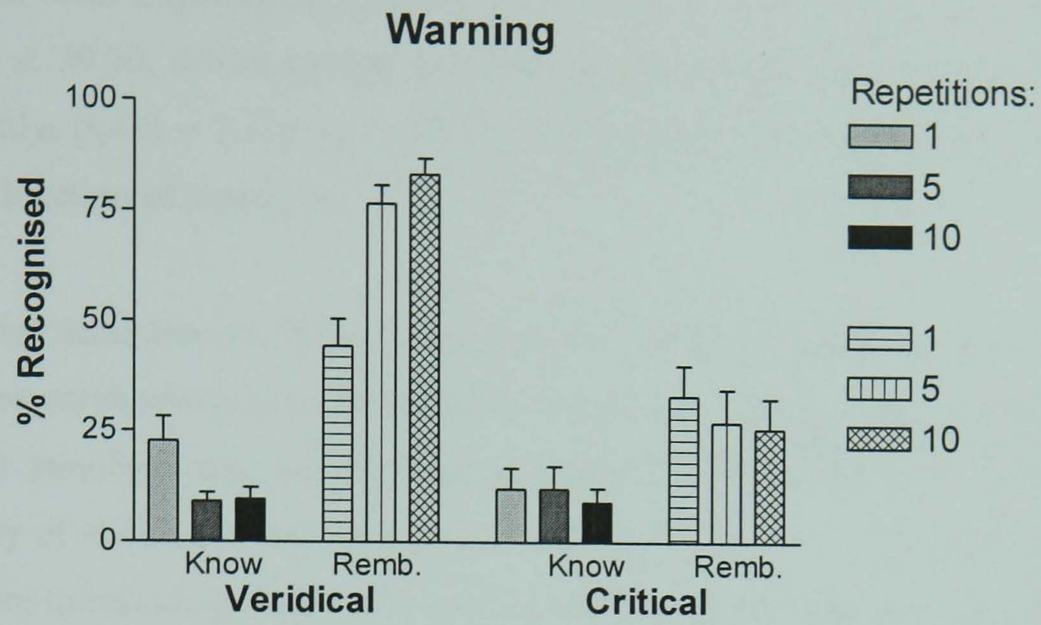


Figure 5.10. **The percentage of remember and know responses made to veridical and critical words in each of the three repetition categories (once, five and ten times).**

As a means to further explore the three way interaction, separate 2(memory type: remember vs. know) by 3(repetition: presented once vs. five vs. ten times) ANOVAs were performed in veridical items and in critical items. A memory type by repetition interaction was found to be significant in veridical items [$F(1.4, 29) = 24.199, p < .001$], but not in critical items [$F(2, 42) = .262, p = .771$]. Analysis revealed an effect of repetition in remember responses for veridical items [$F\ (1.4, 42) = 37.443$]. Repetition increased false remember responses between both repetition points, [$t(21) = -5.8, p < .001$; $t(21) = -2.14, p = .045$ respectively]. Repetition affected veridical know responses [$F(1.55) = 5.498, p = .018$]. Further analysis revealed repetition decreased know responses between one and five repetitions [$t(21) = 2.540, p = .019$], but had no effect on know responses between five and ten repetitions [$t(21) = -.196, p = .847$] (see Figure 5.1].

5.4.4. Discussion

Issuing a warning about the nature of the experiment served to reduce false memories relative to not warning participants (determined via an analysis comparing the current experiment with Experiment 2, where false memory items in the warning experiment averaged at 39.90, whilst averaging 68.98 in experiment 2, and these values differed significantly, [$t(44) = 3.495$, $p = .001$]). This reduction in false memory items did not vary as a function of repetition.

The overall reduction in false memory levels is in accordance with the findings of previous research which have shown that issuing warnings prior to the encoding phase of the DRM paradigm can reduce false memory levels. Gallo *et al.* (1997) found the probability of eliciting a false memory was reduced from .81 to .46 after a warning was issued prior to encoding. This value is comparable to that obtained in the single repetition condition of the present experiment, where the probability of a false memory was found to be .45. This thus supports previous findings which suggest warnings do not eliminate the false memory effect, but serve to reduce them.

5.5. Experiment 7: Warning and extended repetitions

5.5.1. Introduction

In the previous experiment, false memories monotonically decreased with repetition, but these effects were not found to be significant. It is possible that the presence of a warning could have resulted in a decrease in false memories with repetition, but this effect could have been rendered non-significant by the overall reduction in false memories due to the warning, thus resulting in a floor effect. This is unlikely, and the alternative possibility is that ten repetitions did not provide an adequate encoding opportunity to significantly reduce false memories. This would render the experiment as insufficiently sensitive to detect a linear trend decrease in false memories with repetition. Consequently, increasing the amount of repetitions at encoding may result in an increased likelihood that an effect will be detected. To investigate whether providing more encoding opportunities would lead to a significant decrease in false memories, an increase in repetitions was introduced.

5.5.2 Method

The methods were identical to the previous warning experiment, with the exception that lists were repeated on a between subjects basis either 1, 5, or 15 times.

5.5.3. Results

A 2(wordtype: veridical, critical)x3(repetition: presented once vs. three vs. nine times)x2(memory type: remember vs. know) within subjects ANOVA was performed on the percentage of words recognised. A main effect of word type was found [$F(1, 23) = 46.89, p < .001$], demonstrating that more veridical than critical items were recognised. A main effect of memory type [$F(1, 23) = 39.16, p < .001$] indicated that more words were ascribed remember than know responses. No main effect of repetition was obtained [$F(1.3, 30) = 1.58, p = .22$]. A significant word type x repetition interaction [$F(1.38, 31.78) = 16.46, p < .001$], and a word type x repetition x memory type interaction was also significant [$F(2, 46) = 4.21, p = .021$].

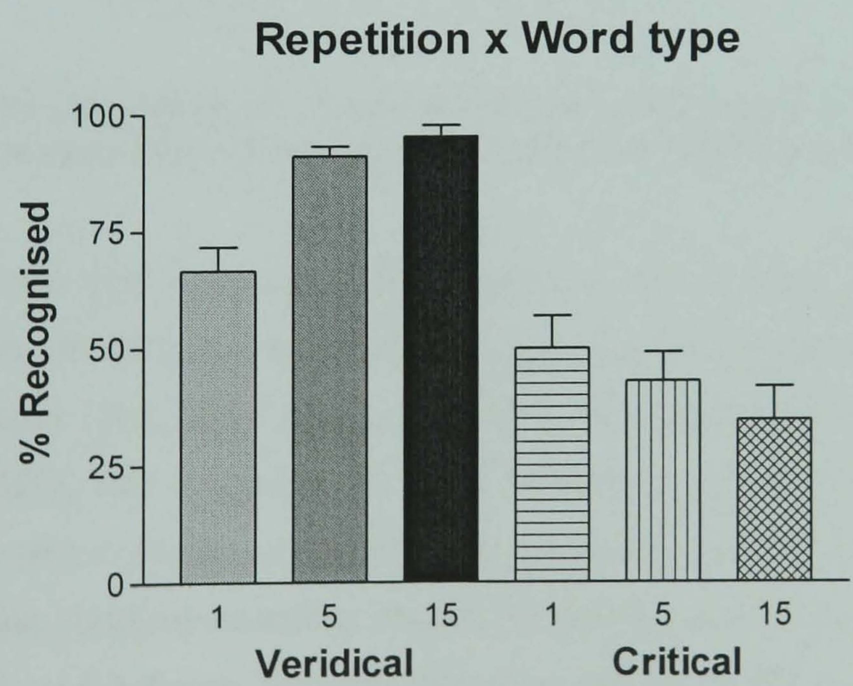


Figure 5.11. **The percentage of veridical and critical items recognised in each of the three repetition categories (one, five and fifteen).**

Further analysis of the word type x repetition interaction revealed that repetition served to increase memories for veridical items [$F(2, 46) = 30.239$, $p < .001$], and this reached significance between one and five repetitions [$t(23)= -5.19$, $p <.001$] and between five and fifteen repetitions [$t(23)= -2.10$, $p =.046$] but no effect of repetition on false memories [$F(2, 46) = 1.703$, $p = .118$] (see Figure 5.11).

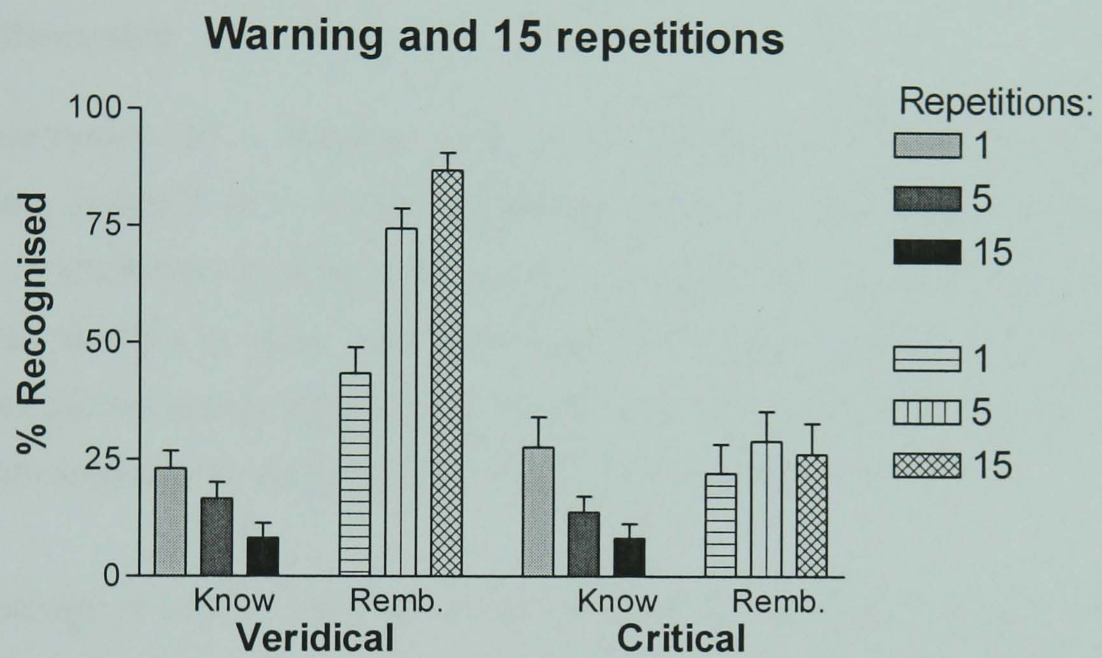


Figure 5.12. **The percentage of remember and know responses for veridical and critical items, in each of the three repetition categories (one, five and fifteen).**

Exploration of the significant repetition x memory type x word type interaction (see Figure 5.12), revealed that the repetition by memory type interaction was significant in the veridical items [$F(2, 46) = 26.80$, $p < .001$], and in addition, was marginal in the critical items [$F(2, 46) = 2.53$, $p = .091$]. Repetition increased veridical remember responses [$F(2, 46) = 41.261$, $p < .001$] and paired t-tests demonstrated that repetition served to increase veridical remember responses between one and five repetitions [$t(23) = -5.63$, $p <.001$], and between five and fifteen repetitions [$t(23) = -3.45$, $p = .002$]. In contrast, repetition decreased veridical know responses [$F(2, 46) = 6.798$, $p < .001$] though this decrease was non-significant between one and five repetitions [$t(23) = 1.66$, $p =.110$], but significant between five and fifteen repetitions [$t(23) = 2.53$, $p = .019$].

Exploration of the borderline significant repetition by memory type interaction in the critical items revealed that repetition decreased know responses [$F(2, 46) = 4.463$, $p = .017$], and this was approaching significance between one and five repetitions [$t(23) = 1.86$, $p = .076$] though was non-significant between five and fifteen repetitions [$t(23) = 1.45$, $p = .162$], possibly due to a floor effect. In contrast, repetition had no effect on remember responses made to false memory items [$F(2, 46) = .442$, $p = .646$].

5.5.4. Discussion

The introduction of a warning prior to encoding, in combination with increased repetitions, resulted in a highly significant word type by repetition interaction. In addition, a borderline repetition by memory type interaction in critical items was due to a monotonic decline in false memories in know responses only, whilst the remember responses did not systematically vary. Inspection of the graph, however, indicates a non-significant tendency for an inverted U-shaped function with repetition.

It is necessary to address the issue of why the decrease in false memories was displayed in know responses only. It could be argued that, after experiencing a warning, participants were reluctant to endorse an item as previously presented if their memory was based upon feelings of familiarity in the absence of recollection. By alerting participants to the memory illusion, the warning could have resulted in participants altering their diagnostic criteria which they deemed sufficient for the endorsement of items. This hypothesis is supported by recent research which has demonstrated that an attribution manipulation which served to make feelings of familiarity non-diagnostic for memory judgements served to eliminate false memory (Fazendeiro *et al.* 2005). Thus, with increased repetitions, the metacognitive expectation to recollect, in combination with the increased recollection of veridical items, would mean that this is an effect that could have been potentiated as a function of repetition. Such a supposition could account for a decrease in know responses with repetition, as well as being in accordance with theorists who account for the false memory effect in terms of a criterion shift adopted during retrieval (Miller & Wolford 1999). It is also supported by empirical research which has indicated that false recognition can result from the misattribution of familiarity (Jacoby and Whitehouse 1989). Instructions could have thus have helped participants to correctly attribute familiarity of critical items as deriving from semantic relatedness to presented stimuli, and not as indicative of prior presentation.

This explanation, however, should be taken with caution for three principle reasons. Firstly, in the initial warning experiment (see Experiment 6), the non-significant decrease in false memories with repetition was not selectively displayed in the know responses. Secondly, the significant decline in false memories obtained in Experiment 5 between five and ten repetitions also took place in the know responses and no warning was issued in that experiment. Thirdly, previous studies have demonstrated that warnings presented post encoding but prior to the test had little or no impact, relative to warnings presented prior to encoding (McCabe & Smith 2002). If warnings lowered false memories through a criterion shift at retrieval, then warnings provided post encoding and pre-test should be just as effective. Instead, the advantage of warnings offered pre-encoding would suggest that warnings may result in a different encoding emphasis. Similarly, Watson *et al.* (2004) argued that issuing a warning may encourage participants to direct their attention to nonsemantic and perceptual dimensions of the studied associates, such orthography and phonology, to aid source monitoring. If activation within semantic networks of critical associates gives rise to a subjective sense of familiarity which serves as the basis for know recognition judgements, then a shift to forms of encoding which lessen this activation should result in a drop in false memories ascribed know responses.

A tendency for an inverted U-shaped relationship between repetition and false memories was obtained in false remember items, but this did not reach significance. The use of warnings appeared to modulate false know memories. Warnings were abandoned as a means to elicit the curve, and an alternative manipulation was pursued which was hypothesised to affect remember false memories as a function of repetition.

5.6. Experiment 8: Distinctiveness

5.6.1. Introduction

The previous 4 experiments demonstrated that any significant modulations in false memories as a function of repetition were obtained in know responses. This, as previously pointed out, was in direct contrast to Seamon *et al.* (2002) where the inverted U-shaped curve was manifested in remember responses only. Consequently, a manipulation was sought that would make this curve more pronounced.

Previous research

A number of different studies have demonstrated that presented DRM lists in 'distinctive' format serves to reduce false memory levels. Schacter *et al.* (1999) modified the DRM lists by adding the presence of pictorial stimuli in conjunction with the DRM words at encoding. In this distinctiveness condition, each word was presented orally and was accompanied by a visual picture of that word, compared to a control group where words were presented in the absence of a picture (in both oral and visual modalities). It was found that when pictures accompanied words, a dramatic reduction in false memory levels was obtained. A number of other studies have also demonstrated that the addition of distinctive information acts to reduce false memories in adults (e.g. Israel & Schacter 1997; Read 1996; Smith & Hunt 1998; Dodson & Schacter 2002), the elderly (Dodson & Schacter 2002) and children (Ghetti *et al.* 2002), indicating the robustness of the phenomenon.

Mechanisms

Whilst the effect of distinctive information on false memory levels is well established, a contentious point surrounds the mechanism through which distinctiveness induces this reduction. Hege and Dodson (2004) argue that explanations can be divided into encoding and retrieval based theories.

Distinctiveness heuristic

The distinctiveness heuristic can be classified as a retrieval based mechanism, due to its concern with the nature of decision processes which take place at retrieval. It is a proposed metacognitive strategy, hypothesised to be employed by participants at retrieval when they are assessing whether memories contain perceptual detail sufficient to render it above a self determined threshold (Schacter *et al.* 1999; Dodson & Schacter 2001). For example, an encoding phase which presents words in conjunction with pictures, allows for the possibility for participants to utilise the presence or absence of retrieved pictorial information as means to aid recognition endorsement or rejection. That is to say, during a recognition test, a word may appear familiar, but if participants are not able to retrieve associated pictorial information participants may reject it, and assume the familiarity it elicits may derive from a source other than prior presentation (e.g. semantic relatedness to previously presented words). Consequently, presenting stimuli with associated information that can serve to enrich memories at encoding, has the potential to aid the correct rejection of non-presented items at retrieval, as the greater the opportunity for multiple memory dimensions can result in a greater potential disparity in phenomenological experience between 'memories' of presented and non-presented items.

A study by Dodson and Schacter (2002) investigated the degree of metacognitive control participants were able to exert over the use of the distinctiveness heuristic. Participants' expectations about the usefulness of the pictorial information for the test was varied. When told memory for the words and not the pictures would be assessed in the test, the presence of pictorial information at encoding did not serve to reduce false memories. In contrast, when participants were (erroneously) informed that pictorial information would also be assessed, then the presence of pictures at encoding served to reduce false memories. Dodson and Schacter (2002) thus argue that 'the distinctiveness heuristic is under metacognitive control such that it can be turned on or off depending on participants' expectations about its usefulness for reducing memory errors' (pg. 782).

Impoverished-relational encoding

Encoding based theories propose that the beneficial effects of distinctive information at reducing subsequent false memories occur at the time of encoding. Whilst there are a number of encoding based theories, Hege and Dodson (2004) argue that they share the common feature in that encoding sessions which provide distinctive information serve to direct learning to item specific aspects, and decrease memory for relational information. They therefore collectively term them impoverished relational-encoding accounts.

Hege and Dodson (2004) designed a study to compare encoding based theories concerned with impoverished relational-encoding with retrieval distinctiveness theories as a means to investigate which effect dominates. It was found that participants who studied pictures and words reported critical lures less often than participants who studied only pictures. This was true even when participants were given inclusion instructions to report related items a well as studied items. This finding is in accordance with encoding based theories as it suggests that distinctiveness results in a type of processing which is not conducive for the generation of relational items.

Distinctiveness and the Activation Monitoring Framework

It can be argued that the mechanisms through which distinctiveness reduces false memories can be accounted for using the Activation Monitoring Framework, and that retrieval based mechanisms implicate the role of monitoring, whilst encoding based theories rely on reduced activation. Concerning activation, if the presence of distinctive information results in a type of processing that limits the amount of relational processing, then the probability that the critical items will be activated is reduced. The AMF states that the critical item can become activated in one of two ways. Firstly, conscious thought of the item during encoding is thought to result in its representation within semantic networks being directly activated. Thus, focusing on the distinctive information may inhibit conscious elaboration, resulting in a decrease in the probability that the critical item will come to mind during encoding. Alternatively, the automatic spread of activation within semantic networks to associated words is also hypothesised under the AMF as a means to activate the critical item, and this can occur in the absence of conscious thought of the critical item which has been deemed unnecessary for its later endorsement (Seamon, *et al.* 2002). One can hypothesise that focusing on distinctive information would result in a shift from semantic to item specific and perceptual processing. False recall levels have been shown to increase with semantic processing, as revealed by level of processing manipulations (Thapar & McDermott 2001). Reduced false memories can be predicted if a shift from semantic to perceptual processing occurs. This line of reasoning is in accordance with the impoverished relational encoding account. Regarding monitoring, the potential for participants to engage in source monitoring would increase with the distinctiveness of veridical items, as this would increase the phenomenological disparity between veridical items and critical non-presented items. At test, participants will assess the quality of their memories, and if a memory is not sufficiently distinct, then in accordance with their metacognitive expectation that memories for words should be enriched with a source, this could lead to a rejection of the item in question.

5.6.2 Rational

The presentation of pictorial information at encoding is now an established way to reduce false memories (e.g. Israel & Schacter 1997; Read 1996; Smith & Hunt 1998; Dodson & Schacter 2002; Ghetti *et al.* 2002). In these experiments, however, distinctiveness was manipulated by the presentation of a word in conjunction with a picture of that word. Such stimuli could be considered to provide highly enriched detailed memories, by virtue of the detail inherent in the pictorial information. The resultant contrast between words presented with pictures, and non-presented critical words in terms of phenomenological appearance could be high[3]. It could be argued that the ability of subjects to use the distinctiveness information to reduce false memories could be dependent upon the ease with which it can be employed. That is to say, it could be viewed as dependent upon the nature and 'quality' of the distinctive information provided, with pictures of the words being more 'useful' than an arbitrary picture presented with the word. The latter

[3] Though it should be acknowledged that there is a potential for pictorial information to be recreated by critical items, though processes such as phantom recall (Brainerd *et al.* 2003).

manipulation, however, could be considered interesting as the resultant effects on false memory levels has not yet been firmly explored.

A final manipulation draws upon work done in relation to distinctiveness and source monitoring. When DRM lists have been previously presented in distinctive format, a modified version has been used (e.g. Schacter *et al.* 1999). In order to keep the stimuli the same across successive experiments (thus allowing for the possibility of a legitimate meta-analysis) the distinctiveness manipulation drew upon source monitoring procedures. Hicks and Marsh (1999) varied the sources of DRM lists. It was found that only when sources were sufficiently discriminable (e.g. external vs. internal) was a subsequent drop in false memories obtained. When two external sources (male vs female voice), or two internal sources (frequency judgments vs. pleasantness ratings) were used, no subsequent reduction in false memory levels ensued relative to a single source control. The present experiment sought the manipulation of distinctiveness by presenting DRM words in conjunction with one of two visual images. This manipulation was thus analogous to the external-external condition employed by Hicks and Marsh, with the exception that rather than two auditory sources, the presentation of two arbitrary pictures served to vary the visual encoding context. The use of repetition in the present study may demonstrate that increased opportunities for learning may result in the two external sources being sufficiently discriminable as to reduce false memories. One could therefore hypothesise that the effectiveness of distinctive information is likely to be enhanced with repetition, as that would provide increased opportunities for learning, especially when such information is more challenging to employ. Using sources which are not easily discriminable increases the probability that a reduction in false memories may only occur between five and ten repetitions – as in accordance with the inverted U-shaped curve.

5.6.3 Method

The method used was identical to that of experiment 2 (direct replication of Seamon *et al.* 2002), with the exception of the following changes:

- Additional instructions were issued after the standard intentional learning instructions, stating that: "Each word will be shown with an associated picture. If a word is shown multiple times, the picture will remain the same, i.e. the same word is always shown with the same picture. When you are learning the words, try to use the picture as a visual aid to remember the word."
- Each veridical word was presented with a picture - either a yellow flower or a blue fish, (see figure 5.13). The picture presented with each word remained the same throughout repeated presentations of that word.
- The word was presented in the same colour as the picture (either yellow or blue, as shown in figure 5.14).
- Each picture was presented equally often in each repetition condition and in each list. All items were counterbalanced to ensure associated words, list presentations and repetition categories were presented equally often in every combination.
- In the recognition test, instead of making 'old' or 'new' judgements for a specific word, participants were simultaneously presented with 3 squares titled A, B, or C. One of the squares had the word written in yellow with a flower, one had the word written in blue with a fish, and one square contained the words 'not presented' in green (see figure 5.13).
- At test, subjects were required to press the key which corresponded to their memory decision. The presentation of words on the test was fully random, and the order of the images displayed in squares A, B and C was fully counterbalanced.

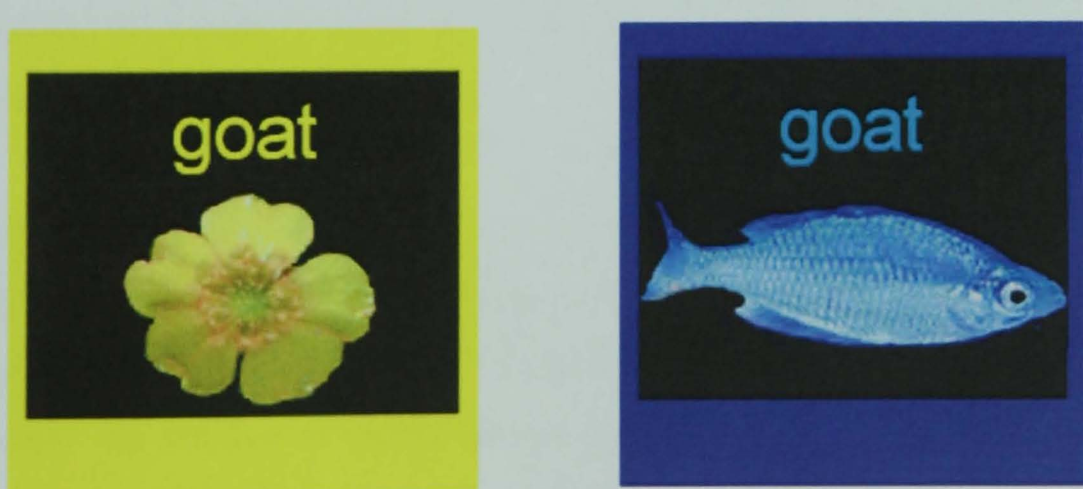


Figure 5.13. **Stimuli presented at encoding.**

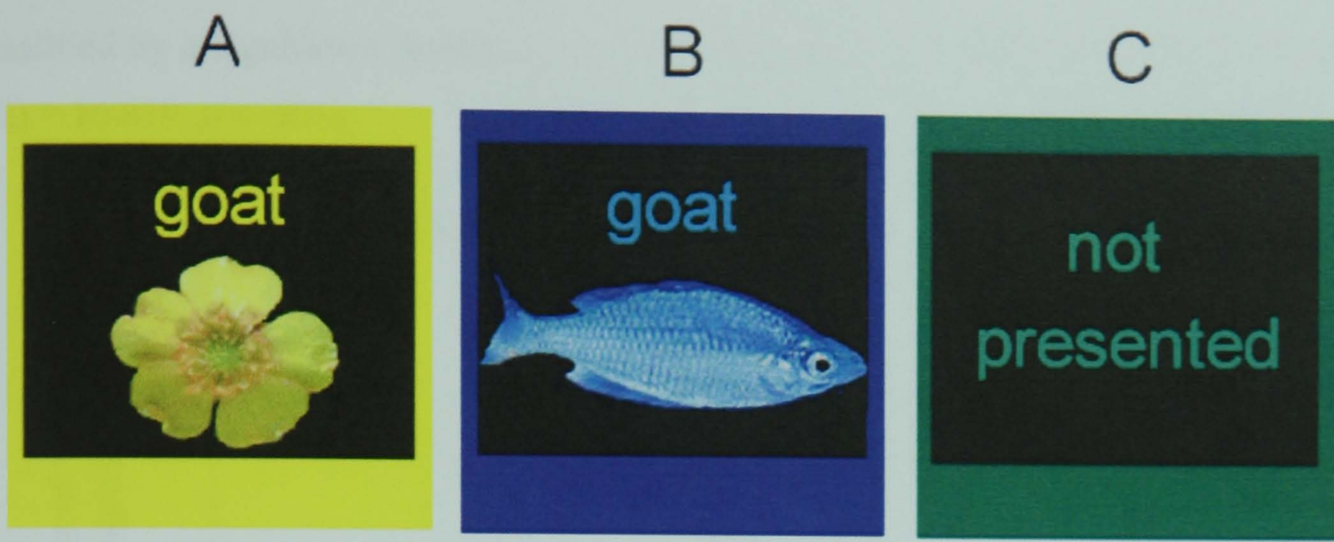


Figure 5.14. **Stimuli presented at test.**

5.6.4. Results

An initial analysis was performed to investigate participants' aptitude at source identification; to determine how this ability varied with repetitions and whether correct attributions had a tendency to be selectively ascribed know or remember response. A 3-way ANOVA was thus performed on veridical items only, as critical items were never presented and thus no correct source existed, with repetition (presented once vs. repeated five times vs. repeated ten times), memory type (remember vs. know) and attribution (correct vs. incorrect) as within subjects factors, and the percentage of veridical items recognised as the dependent variable.

A main effect of memory type [$F(1, 21) = 4.603$, $p = .044$] was indicative of a greater number of memories being ascribed remember responses compared to know responses. A main effect of repetition [$F(2, 42) = 19.585$, $p <.001$] demonstrated that repetition served to increase the number of words recognised. Memory type was found to interact with both repetition [$F(2, 42) = 18.112$, $p < .001$] and source attribution [$F(2, 42) = 5.799$, $p = .006$]. In addition, repetition was found to interact with source attribution [$F(2, 42) = 5.799$, $p = .006$]. Breakdown of these interactions will not be performed as they are qualified by a significant repetition by word type by source attribution interaction [$F(2, 42) = 10.619, p < .001$].

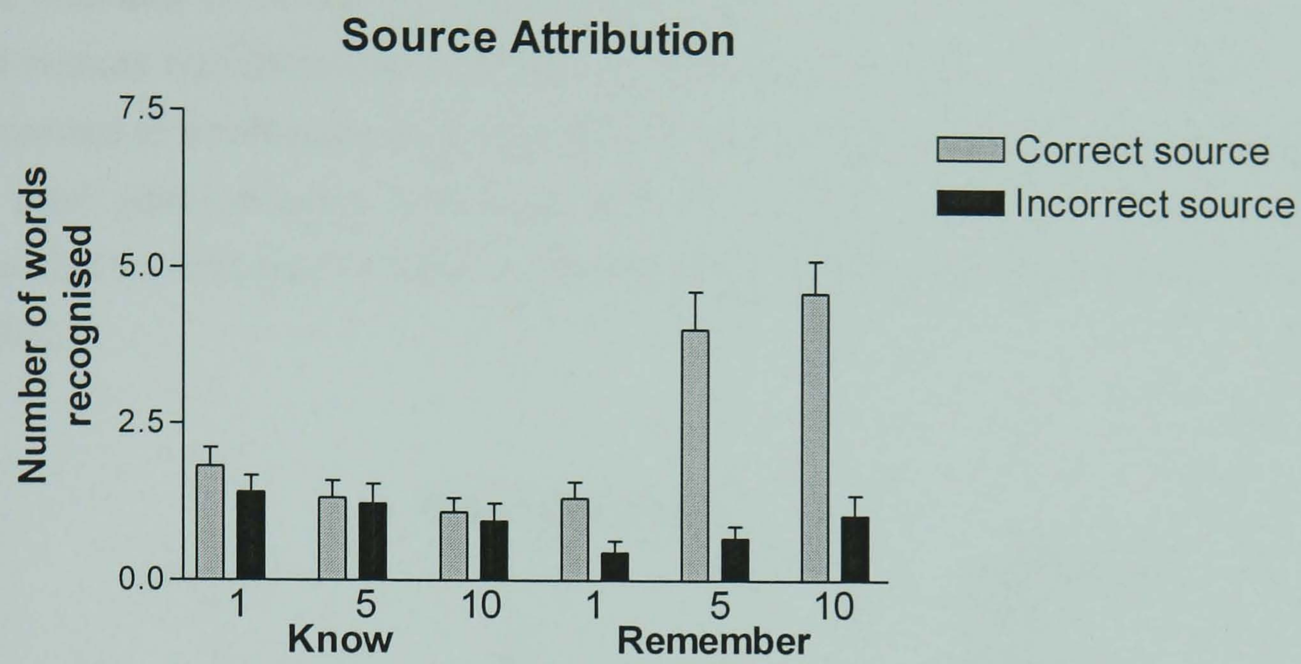


Figure 5.15. **Graph to depict how the amount of remember / know recognition judgements for veridical items change for correct and incorrect source attributions as a function of how many times the word was viewed at encoding (once, five, or ten times).**

The three-way interaction was further investigated by performing separate 2-way ANOVAs in the correct source attributions, and the incorrect source attributions using repetition and memory type as within subjects factors. This revealed that the repetition by memory type interaction was non-significant for incorrect source attributions $F(2, 42) = 2.587, p = .087$] but significant in the correct source attributions [$F(2, 42) = 21.204, p < .001$]. Additional analyses revealed that the interaction was due to repetition having a greater affect on remember responses for correct source attributions [$F(2, 42) = 23.86, p < .001$] than on know correct source attributions [$F(2, 42) = 4.48, p = .016$] (see Figure 5.15). Further break down of these two effects revealed that the effect of repetition did not reach significance at either of the respective repetition points in know correct source attributions [$t(21) = 1.834, p = .079$; $t(21) = 1.238, p = .228$]. In contrast, repetition significantly increased correct remember attributions and this reached significance between one and five repetitions [$t(21) = -4.781, p < .001$] but was non-significant between five and ten repetitions [$t(21) = -1.329, p = .198$].

In order to explore how memory changed with repetitions, a 3-way ANOVA, with word type (veridical vs. critical) and repetition (presented once vs. three times vs. ten times) and memory type (remember vs. know) as within subjects factors, was performed on the percentage of words recognised, regardless of source attribution. A significant repetition by word type interaction was found [$F(2,42) = 15.24$, $p <.001$], and a significant repetition by word type by memory type interaction was also obtained [$F(2,42) = 5.50$, $p =.008$].

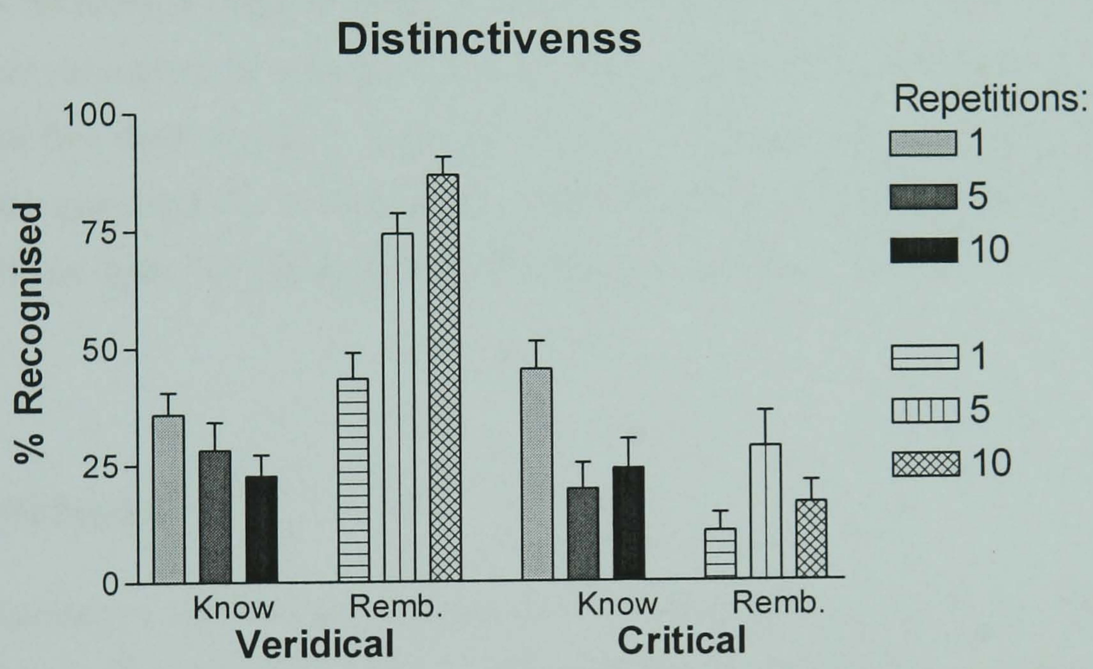


Figure 5.16. **The percentage of remember and know judgements for veridical and critical items in each repetition condition (one, five and ten).**

In order to explore the three way word type x repetition x memory type interaction separate 2(memory type: remember, know)x3(repetition: presented once, three times, ten times) ANOVAs were performed in both the veridical and critical items.

In the veridical items, a significant memory type by repetition interaction [$F(2, 42) = 18.112$, $p < .001$] was investigated to reveal that repetition increased remember responses [$F(2, 42) = 32.550$, $p < .001$] and this reached significance between both one and five repetitions [$t(21) = -4.95, p < .001$] and five and ten repetitions [$t(21) = -2.175, p = .041$]. In contrast, repetition had no effect on veridical responses [$F(2, 42) = 3.015, p = .60$].

In the critical items, a memory type by repetition interaction was also found to be significant [$F(2, 42) = 9.78, p <.001$]. Repetition served to significantly affect know responses for critical words [$F(2, 42) = 6.780, p = .003$] by significantly decreasing them between one and five repetitions [$t(21) = 3.552, p = .002$] but having no effect on them between five and ten repetitions [$t(21) = -.646, p = .525$]. Repetition was also found to significantly affect false remember responses [$F(2, 42) = 5.370, p = .008$]. Further analyses revealed, as demonstrated in Figure 5.16, that repetition significantly increased remember responses for critical words corresponding to lists presented once versus lists presented five times [$t(21) = -2.53, p = .019$]. In addition, repetition served to decrease remember responses for critical items corresponding to lists presented ten times versus critical items from lists presented five times [$t(21) = 2.01, p = .057$].

5.6.5. Discussion

When distinctive pictorial information was provided at encoding in the form of one of two arbitrary pictures, an inverted u-shaped relationship was found between repetition and false memory levels for remember responses. The effect was eliminated when collapsed over memory type. The number of veridical items endorsed and attributed to the correct source increased with repetition. This effect was found to be significant for remember responses only, though it is possible that no increase was found in know responses due to a floor effect. The key questions which need to be addressed are: what was it about the presentation of the pictures which resulted in this inverted u-shaped relationship between false memory levels and repetition, and why was it confined to remember responses only?

The decrease in false remember items between five and ten repetitions, obtained as a consequence of the distinctive stimuli, is compatible with the distinctiveness heuristic (as outlined in the introduction, Section 5.6.1.). In addition, the finding that this reduction in false memory endorsement was found solely in the remember responses can also be accounted for under the distinctiveness heuristic. By definition, remember memories require not just familiarity with the subject, but explicit memory of the context, which in this case would be the pictorial tag. Consequently, it could be argued that any recollective fuelled decline in false memories would predominantly reside in remember responses. In addition, the distinctiveness heuristic can accommodate the selective decline in false remember memories between five and ten repetitions. Metacognitive expectations about the necessity of a 'pictorial' tag to accompany memories would be at their greatest between five and ten repetitions.

This explanation regarding the distinctiveness heuristic capitalises upon source monitoring principles. It is thus in accordance with the source monitoring framework, highlighting the parallels between these two theories. It has been proposed that the distinctiveness heuristic is a distinct mechanism because of its potential to be influenced by subjective expectations regarding the quality of memories, thus making it under metacognitve control (Dodson & Schacter 2002). It can be argued, however, that its successful execution is also dependent upon source monitoring ability. Indeed, recent research done in different clinical populations supports this conclusion. Budson *et al.* (2005) demonstrated that patients with frontal lobe lesions were unable to use the distinctiveness heuristic as a means to reduce false memories, leading the authors to conclude that the distinctiveness heuristic is a metacognitive strategy dependent upon frontal lobe function. In a separate study in Alzheimer's patients, Budson *et al.* (2005) demonstrated that Alzheimer's patients were able to use the distinctiveness heuristic, but that their episodic failings rendered it as non selective, resulting in monitoring errors which lead to a reduction in both veridical and false memory. In the absence of any direct manipulation regarding metacognitive expectations to differentiate the source monitoring account from the distinctiveness heuristic, no conclusions concerning the relative role of these two explanations can be offered.

The impoverished relational encoding account, as previously stated, has been suggested as an alternative mechanism by which distinctive pictorial information serves to reduce false memories, by virtue of a shift from relational encoding to the encoding of perceptual features of stimuli (Hege & Dodson 2004). It is less clear how this theory would lead to a selective decrease in false memories between five and ten repetitions unless the additional assumption is made that perceptual information encoded is used at test to aid source monitoring.

Increase in false memory levels (remember responses).

As previous research surrounding the use of distinctive information and source monitoring has used them as manipulations to reduce false memories, the initial rise in false remember responses is not easily incorporated under the theories previously discussed. It can be argued that, initially at least, the presence of the pictures increased the memory load at encoding, which resulted in a significant reduction in remember responses in both veridical and critical items for singularly presented lists. Such an interpretation is indeed compatible with previous research as well as being reflected in the findings of the current series of experiments. Previous studies have shown that the addition of distinctive information has the potential to lead to a reduction in veridical recall, relative to a single source control group. Hicks and Marsh (1999) found veridical memory to be highest for DRM lists when a single source was used, an intermediate amount of veridical memory was obtained when two sources were used, and the lowest levels of veridical memory when participants were warned that retrieval would require the specification of source. This indicates that by increasing the memory load by requiring source learning, memory for the source could potentially be at the expense of memory for the word itself. With regard to the current experiment, this decreased learning could be considered more detrimental for singularly presented lists, as they would be viewed only once. Post-hoc inspection of the data demonstrates that veridical memory for singularly presented lists was lowest in the distinctiveness group (see graph 5.17). In addition, the distribution of remember / know responses in the singularly presented veridical items was also markedly different in the distinctiveness experiment from the previous ones (see graph 5.18). Remember responses were found to exceed know responses for all other experiments, whereas in the distinctiveness experiment the know responses exceeded the remember responses. Crucially, this was true only for the singularly presented lists; in all other repetition conditions in the distinctiveness experiment as well as all other repetition conditions in the other experiments, veridical remember memory always exceeded veridical know memory.

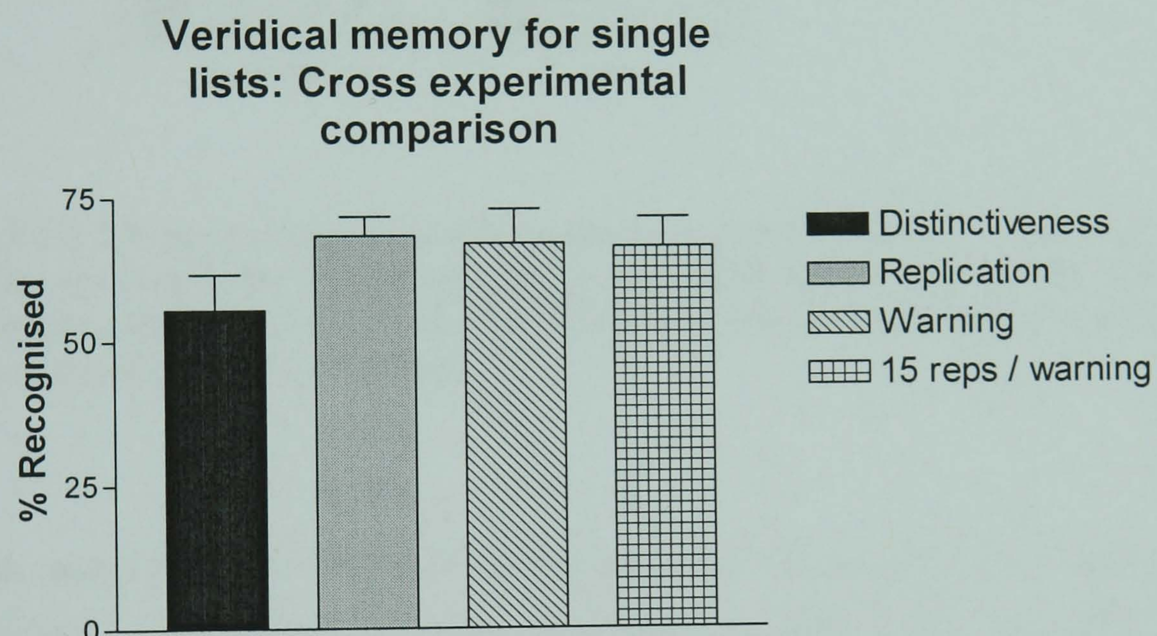


Figure 5.17. **The percentage of veridical items recognised for singularly presented lists across the latter four experiments (distinctiveness, direct replication of Seamon *et al.* 2002, warning, and extended repetitions and warning).**

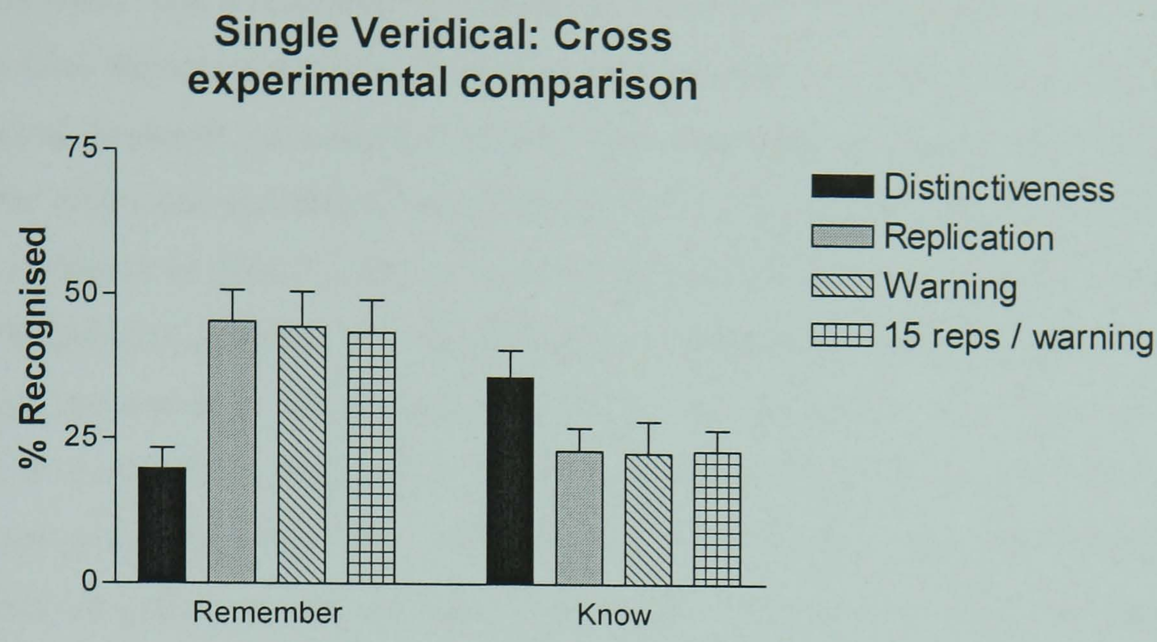


Figure 5.18. **The percentage of words recognised and classified as remember or know for veridical items from singularly presented lists, across the latter four experiments (distinctiveness, direct replication of Seamon *et al.* 2002), warning and increased repetitions and warning.**

As it has now been established that veridical memory was reduced in the lists presented once relative to the previous studies, and that remember / know distributions also differed, the implications this has for false memories must be addressed. Whilst it has been shown that false memories can exist in the absence of memory for the veridical words which elicited the false memories (Seamon *et al.* 2002), it has also been established that false memory levels are influenced by levels of veridical memory. The more is less effect, initially advocated by Tolgia (1999) and subsequently supported by Rhodes and Anastasi (2000) and Thapar and McDermott (2001) suggests that factors which serve to increase veridical memories can also serve to increase false memories. Conversely, factors which decrease veridical memory can also decrease false memory. Tolgia (1999) performed a series of experiments which demonstrated the parallel levels of false and veridical memory by manipulating factors at encoding. For example, manipulating level of processing, by shifting encoding from semantic to phonological processing, served to decrease both false and veridical memories (Tolgia 1999; Rhodes & Anastasi 2000; Thapar & McDermott, 2001). Reduced veridical learning for lists presented once, with a resultant corresponding low level of false memories, could lead to a rise in false memories due to a greater increase in veridical learning. This can not be the sole answer, however, as reduced levels of false memories were particularly confined to remember responses and thus an explanation needs to incorporate this finding. Research by Pérez-Mata *et al.* (2002) used an attention manipulation (divided vs. full) at encoding for DRM and then assessed phenomenological experience of veridical and critical items using the remember / know procedure during a recognition test. They found that 'variations in attention had similar phenomenological consequences for list items and critical non-presented words' (pg. 168). If one extrapolates this principle and applies it to the current data, the inclusion of distinctive information could have reduced memory for items for singularly presented lists, and this could have been particularly manifested in reduced remember responses. This could have translated into low levels of critical remember responses for singularly presented lists, due to the proclivity of the phenomenological experience of veridical items to mirror that of critical items. With increased repetitions, increased learning of veridical items caused remember responses to be greater than know responses, and this was mirrored in response type for critical items. With yet further repetitions (five to ten) lists were sufficiently learnt (as demonstrated by a non-significant further increase in veridical memory) for the benefits afforded by the distinctive information to manifest in a dissociation between phenomenological experience between veridical and critical items. For, as previously argued, participants' ability to recollect veridical items in conjunction with the pictorial tag was sufficiently proficient for them to utilise this knowledge as a means to 'edit out' critical intrusions. In particular, as in accordance with the distinctiveness heuristic, participants' metacognitive expectations that memories of words should be accompanied by a pictorial tag, and the lack of such a tag for critical items, meant that after ten repetitions participants endorsement of critical items with remember responses was vastly reduced. To conclude, the inverted u-shaped relationship between false memory levels and repetition may be a consequence of what could be termed 'polarisation of learning' (see figure 5.19). The presence of distinctiveness information at encoding may have resulted in reduced levels of learning at first, but ultimately allowed for heightened recollective knowledge of the study list. The presence of these extreme memory states may have consequently given rise to an inverted U-shaped memory state function of repetition

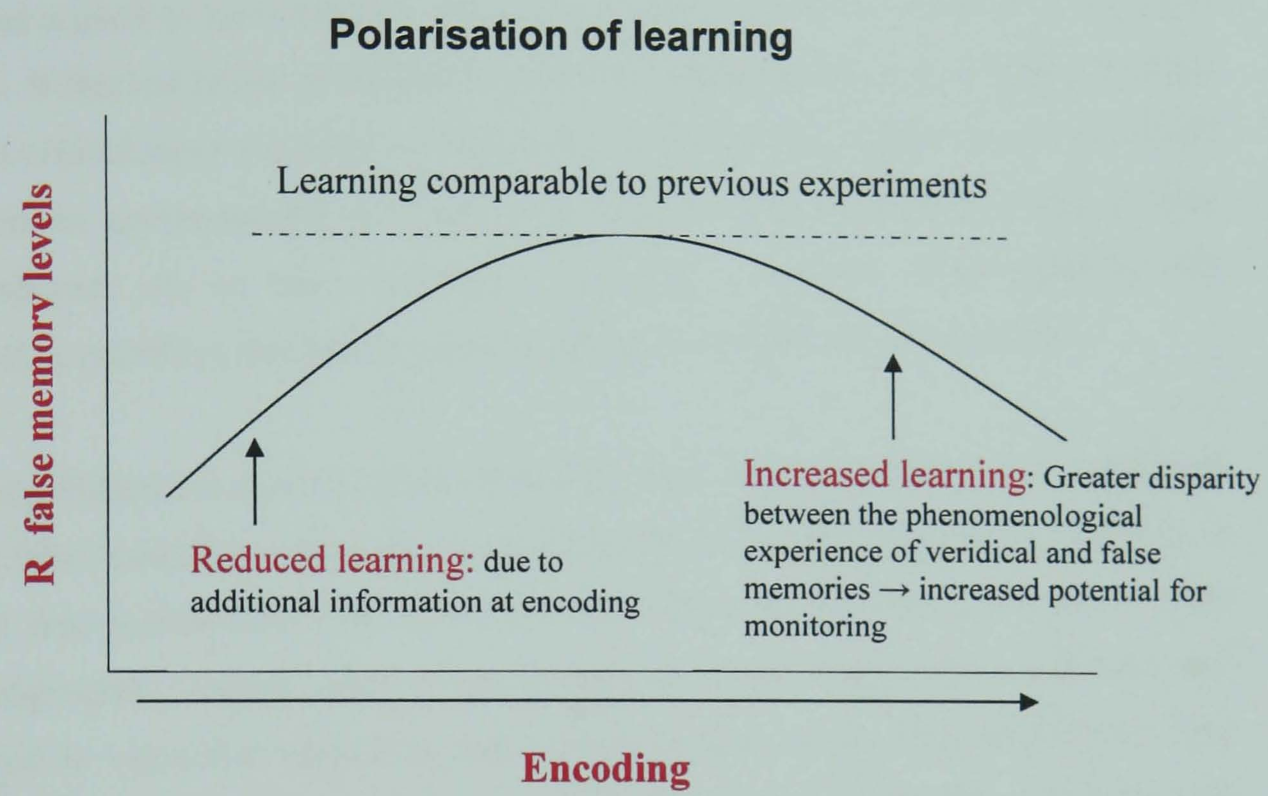


Figure 5.19. **Idealised graph to depict the theorised relationship between encoding quality and false memory levels, providing encoding is hampered at first, and that recollective encoding of veridical items is potentiated to increase encoding quality.**

5.7. General discussion

This chapter manipulated different factors as means to elicit the inverted U-shaped relationship between repetition and false memory levels. Determining which factors resulted in its inception provided insight into its underlying mechanisms. Moreover, a paradigm incorporating both an increase and decrease in false memories with repetition allows a future study to replicate it in conjunction with alcohol.

The only experiment to obtain an inverted U-shaped relationship between repetition and false memory responses was Experiment 8. This experiment found that the curve was confined to remember responses only. The inclusion of the distinctive pictorial stimuli was hypothesised to have induced this effect. The addition of extra information at encoding was argued to have initially reduced remember memories relative to the other experiments. If this reduction in remember responses translated into a net increase in the activation of critical items between one and five repetitions, the resultant increase in false memories can be accounted for. No other experiments found significant a rise in false memory responses. As no other experiment included a variable which increased the memory load at encoding, this finding is in accordance with the above argument.

Regarding significant decreases in false memories, only Experiment 8 found a significant decrease in false remember responses. As pictorial stimuli were presented at encoding, it was argued that participants were better able to utilise recollective processes in their memory judgements. Indeed, source monitoring ability increased with repetitions and was confined to remember responses only. Consequently, as no pictorial stimuli were presented with critical items, a subsequent decline in false remember responses was observed when stimuli were sufficiently well learnt. Interestingly, this effect suggests that to increase the likelihood that differences in false memory levels will manifest in remember responses, visual manipulations are required.

One other experiments obtained significant decreases in false memories. Experiment 7 - which issued a warning prior to encoding and increased the amount of repetitions - found that repetition monotonically decreased false memories. This decrease was also confined to the know responses. Interestingly, the decrease in false know responses with repetition is contrary to what one would predict based upon the AMF. One way repetition is thought to increase the activation of critical items is via the increase in opportunities for their activation within semantic networks (Benjamin 2001). One would expect this to translate into increases in know responses. In contrast, the potential to recollect veridical items increases with repetition. False and veridical memories have been found to differ phenomenologically, specifically in regard to the detail inherent in them, and the thoughts and feeling experienced when 'encountering' them at encoding (Neuschatz *et al.* 2001). With increased learning of veridical items, their increased recollection should translate into greater phenomenological disparity between veridical and critical items. One would hypothesise that this would lead to a decrease in false remember responses with repetition. Whilst theories have been proposed which can account for the phantom recollection of false memory items, such as through the binding of context with the critical items (Brainerd *et al.* 2001), such theories cannot readily account for why decreases in false memories with repetitions were found in know responses only. Further research is thus needed to determine why repetition modulated know responses in the present experiment, yet Seamon *et al.* (2002) found that effects were confined to remember responses. Using a single scale to determine whether memories are classified as know or remember results in their mutual exclusivity. Further research into the effect of the phenomenology of false memories could use a procedure which assesses them separately, such as the independent scales methodology devised by Higham and Vokey (2004). This procedure would be particularly advisable in the context of the present findings since, when the inverted U-shaped curve was obtained in false remember responses, a non-significant tendency for a U-shaped relationship between false know responses and repetition was found.

The paradigm used in Experiment 8 serves as a means to selectively increase and decrease false remember responses. Alcohol has been shown to differentially affect recollective, as opposed to familiarity based processes (Duka *et al.* 2001). As the effects were manifested in remember responses, the potential for drink to differentially effect false memories as function of repetition is increased.

Chapter 6. Activation and monitoring: Does alcohol shift the parabolic function between false remember memories and repetition?

6.1. Introduction

This chapter is concerned with the mechanisms through which study-list repetition and alcohol may serve to affect false memory levels. Building on work done in Chapter 5, three levels of repetition will be used as this provides an opportunity to assess differences in initial levels of false memory between the alcohol and placebo groups. In addition, the relative potential for alcohol and placebo to selectively modulate a rise in false memories and a subsequent decline in false memories can also be assessed. The experiment to be replicated in conjunction with alcohol is the distinctiveness design employed in Experiment 8. It was chosen for two principle reasons. Firstly it was the only design which obtained a significant inverted u-shaped relationship between repetition and false remember responses. Secondly, as words were presented in conjunction with arbitrary pictures, a source monitoring procedure administered at test can assess the propensity for alcohol to disrupt contextual memory.

6.1.1. Repetition

This thesis has previously outlined the argument that repetition has the propensity to both increase false memories – via repeated activations of the critical items – and decrease false memories – via the increased potential to learn veridical words and better differentiate between items presented and items not presented (Benjamin 2001). Consequently, whether repetition serves to decrease false memories or increase false memories can provide an insight into whether activation or monitoring processes are prevailing in memory judgements. Any differences induced by alcohol concerning the way in which repetition modulates false memory levels could hence provide an insight into the way in which alcohol affects memory processes underlying false memory endorsements.

6.1.2. Alcohol

In regard to alcohol, it is hypothesised that three distinct mechanisms could mediate alcohol's affect on false memory levels: impairment of activation, impairment of monitoring and metacognitive expectations of memories, as defined by the distinctiveness heuristic. These will be assessed in turn.

Activation

Throughout this thesis it has been strongly argued that alcohol could reduce the activation of critical semantic associates. As defined by the AMF, activation of critical items can occur through two processes. Firstly, via the automatic spread of activation within semantic networks, and secondly, by conscious elaborative processing at encoding. It has been hypothesised that alcohol has the potential to reduce activation via both mechanisms. Firstly, superficial processing at encoding under alcohol (Craik 1977) could reduce the automatic spread of activation in semantic networks. In addition, the disruption of cognitive resources when intoxicated could reduce conscious elaborative processing at study (Steele & Josephs 1988). Consequently, two distinct predictions can be made. Firstly, it can be hypothesised that alcohol may result in initially reduced false memory levels, as demonstrated by a reduction in false memories from singularly presented lists relative to the placebo control group. Secondly, activation levels of critical items should reach their maximum in placebo subjects before the activation levels of critical items peak in alcohol subjects. Consequently, extended repetitions have the potential to increase activation levels to a greater extent in alcohol subjects than placebo subjects if activation levels have reached their maximum level in the placebo group.

Monitoring

In addition, alcohol may affect the ability for participants to differentiate between false and veridical words. Consequently, an impairment in source monitoring ability in the alcohol group could serve to elevate false memories relative to the placebo group. In the previous chapter, it was found that the inverted U-shaped curve was obtained in remember responses only when words at encoding were presented in conjunction with pictures. It was thus argued that increasing the potential contextual disparity between presented and non-presented words could have aided reality monitoring decisions at test, resulting in a decline in false remember memories when sources were learnt sufficiently well (Hicks & Marsh 1999). As alcohol has been found to particularly impair recollective processes (Duka *et al.* 2001; Kirschner & Sayette 2003), and the richness of episodic traces (Curran & Hildebrandt 1999), such monitoring ability may suffer. This could consequently lead to a reduced decline in false memories with successive repetitions in the alcohol group relative to the placebo group. Whilst no effect of alcohol on source monitoring has yet been established, this tentative prediction is founded upon a number of empirical findings. In particular, Curran and Hildebrandt (1999) argued that the differential impairment of alcohol on know and remember responses was indicative of alcohol either affecting the ability to encode contextual information at study, or to associate the encoding context with studied items. Curran and Hildebrandt (1999) argue that this finding is compatible with 'alcohol myopia' (Steele & Josephs 1990) where alcohol's limitation of attentional resources (Steele & Josephs 1988) is thought to lead to only the most salient of cues being attended to. They argue that the salient stimulus could be the word itself in the absence of the context. Following this line of reasoning, it could be argued that the alcohol group may encode the word well but the pictorial tag only poorly. Administering a test which looks at participants' ability to monitor the context - and whether this ability differs as a function of alcohol - could serve to investigate the validity of this speculation.

Distinctiveness Heuristic

As discussed in Chapter 5, the distinctiveness heuristic states that pictorial information at encoding can reduce false memories if, at retrieval, participants have a metacognitive expectation that the presence of a pictorial tag is diagnostic of prior presentation (Schacter *et al.* 1999). Alcohol could serve to alter this metacognitive expectation, as participants may attribute the lack of distinctive memories to alcohol induced impairment of encoding, as opposed to it being indicative of whether the item was presented or not. This speculation is in accordance with an experiment where the mere suggestion that participants had consumed alcohol resulted in an increase in false memories (Assefi & Garry 2003). Two predictions can be made utilising the principles advocated by the distinctiveness heuristic regarding the effect of alcohol on false memory levels. Firstly, perceived level of drunkenness may increase the amount of false memories endorsed. Secondly, extended repetitions may not reduce false memory levels if participants believe they are drunk, since participants may be less inclined to override the familiarity felt for critical items from repeatedly presented lists. Whilst perceived levels of drunkenness were not experimentally manipulated within this study, subjective reports of lightheadedness were taken post consumption of the drink and prior to encoding. These provide levels of perceived subjective drunkenness which are distinct from pharmacological levels of drunkenness, as assessed by BAC levels. Consequently, under principles of the distinctiveness heuristic, levels of self-reported lightheadedness should positively correlate with false memory endorsement to a degree with is not accounted for by BAC levels.

6.2. Method

Participants

Forty-nine volunteers were recruited from the undergraduate and postgraduate population at the University of Sussex. They received either cash or course credits as payment. All participants were native English speakers, not dyslexic and aged 18-34 years.

Volunteers were screened prior to participating on the basis of their medical history, and exclusion criteria were the same as those employed in Chapter 3. Participants were instructed to abstain from the use of illicit recreational drinks for at least 1 week prior to the experiment, from the use of sleeping tablets or hayfever medication for at least 48 hours, and from the use of alcohol for at least 12 hours prior to the experiment.

Alcohol administration

See Chapter 3.

Design

The experiment was double-blind. Participants were randomly allocated to either the placebo group (N = 26, 12 males and 14 females), or alcohol group (N = 23, 11 males and 12 females).

Procedure

The experiment took place over two consecutive days. On arrival at the lab, participants completed the AUQ whilst the drink was prepared. Consumption of the drink (over a half an hour period, see Chapter 3 for details), was followed by a ten minute break in order to ensure encoding coincided with peak BAC. Participants then completed the VAS and were breathalysed.

Participants then underwent an encoding session and recognition test identical to those in Experiment 8.

On completion of the test, participants did the VAS for a second time, and then were breathalysed. Participants were only allowed to leave the lab when their breath alcohol concentration (BAC) had fallen to 0.02%.

Participants returned on the following day, 24 hours after the duration of their initial encoding session. They were breathalysed to ensure no alcohol was in their system and then completed the VAS for a third time. They then took a free recall test, where they were instructed to 'Please write down all the words you can recall from the learning session yesterday'. There was no time limit; participants were given as long as they required to complete this task.

6.3. Results

6.3.1. Group analysis

Group VAS ratings at the three time points

	Experiment 9: Mean (SEM)					
	Placebo			Alcohol		
	1st	2nd	3rd	1st	2nd	3rd
Content	5.78 (.29)	5.55 (.32)	5.80 (.39)	6.46 (.33)	5.76 (.31)	5.64 (.43)
Relaxed	5.70 (.36)	5.55 (.36)	5.07 (.37)	6.55 (.41)	5.47 (.39)	4.91 (.43)
Lightheaded	1.75 (.40)	1.73 (.38)	0.47 (.07)	6.24 (.42)	5.71 (.58)	0.49 (.08)

Table 6.1. VAS scores in the alcohol and placebo groups for time 1 (post drink consumption) time 2 (post recognition test) and time 3 (post recall test).

Independent t-tests of VAS scores revealed that the alcohol and placebo groups did not differ in terms of self ratings of contentedness, at time point 1 (post drink consumption) [$t(47) = -1.528, p = .133$] time point 2 (post recognition test) [$t(47) = -.469, p = .641$] nor time point 3 (next day: post recall test) [$t(47) = .278, p = .782$]. Similarly, self ratings of relaxedness also did not differ between the two groups at the three respective time points [$t(47) = -1.538, p = .131$; $t(47) = -.154, p = .878$; $t(47) = -.267, p = .790$]. In contrast, alcohol was shown to have a significant effect on ratings of lightheadedness, and this was true for time point 1 [$t(47) = -7.778, p < .001$] and time point 2 [$t(47) = -5.863, p < .001$], though, as would be expected, no significant difference existed the next day, at time point 3 [$t(47) = -.154, p = .879$].

6.3.2. Recognition: Immediate testing

An initial analysis was performed to investigate how alcohol at encoding affected veridical recognition levels, in combination with participants' aptitude at source identification for the veridical items in question. Of interest were whether differences might exist between the alcohol and placebo groups, in regard to how this ability varied with repetition and whether correct attributions had a tendency to be ascribed know or remember response in the two groups. A 4-way mixed ANOVA was thus performed on veridical items only, as critical items were never presented and thus no correct source existed. Repetition (presented once vs. repeated five times vs. repeated ten times), memory type (remember vs. know) and context (correct vs. incorrect) were within subjects factors, and drink (alcohol vs. placebo) was a between subjects factor. The number of veridical items recognised was the dependent variable.

Main effects were found in all within and between subjects' variables: a main effect of memory type demonstrated more remember than know responses were made [$F(1, 47) = 10.932$, $p = .002$], a main effect of context indicated that more correct than incorrect contexts were remembered [$F(1, 47) = 97.216$, $p < .001$], a main effect of repetition [$F(2, 94) = 91.380$] indicated that recognition of veridical items increased with repetition, and this reached significance for one compared to five repetitions [$t(48) = -10.271$, $p < .001$], and approached significance for five compared to ten repetitions [$t(48) = -1.639$, $p = .108$]. Lastly, a main effect of alcohol [$F(1, 47) = 10.315$, $p = .002$] demonstrated a greater number of veridical words were recognised by the placebo group versus the alcohol group. Further analysis of a memory type x context interaction [$F(1, 47 = 31.587$, $p < .001$] indicated that more remember responses were ascribed to correct contexts than know responses [$t(48) = 4.897$, $p <.001$], whereas no difference existed between the amount of remember and know responses for incorrect contexts [$t(48) = -.772$, $p = .474$. A context x repetition interaction [$F(2, 94) = 16.012$, $p < .001$] was further explored to reveal that there was no effect of repetition on the amount of incorrect contexts [$F(2, 96) = 1.804$, $p = .170$], but a significant effect of repetition on the amount of correct contexts [$F(2\ 96) = 55.248$, $p < .001$]. These were found to significantly increase between both one and five repetitions [$t(48) = -8.525$, $p < .001$] and five and ten repetitions [$t(48) = -2.131$, $p = .038$]. Memory type was not found to interact with drink [$F(1, 47) = .576$, $p = .452$], nor was participants ability to correctly remember context dependent on drink consumed, as displayed by a non-significant drink x context interaction [$F(1, 47) = .620$,

$p = .435$]. In addition, the memory type x context x drink interaction [$F(1, 47) = .955$, $p = .333$], memory type x repetition x drink [$F(2, 94) = .522$, p .595] and memory type x context x repetition x drink [$F(2, 94) = .291$, $p = .748$] interactions were all found to be non-significant.

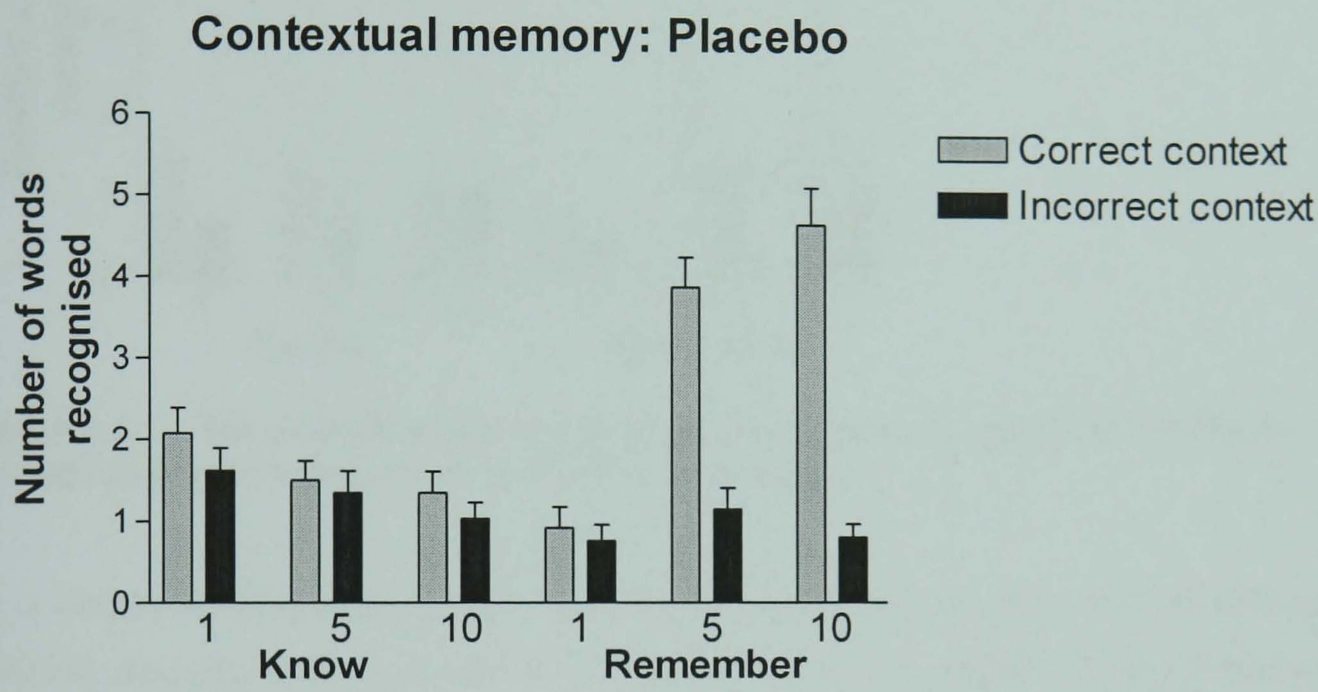


Figure 6.1. **The amount of know and remember responses made for veridical contexts (correct vs. incorrect) in placebo participants.**

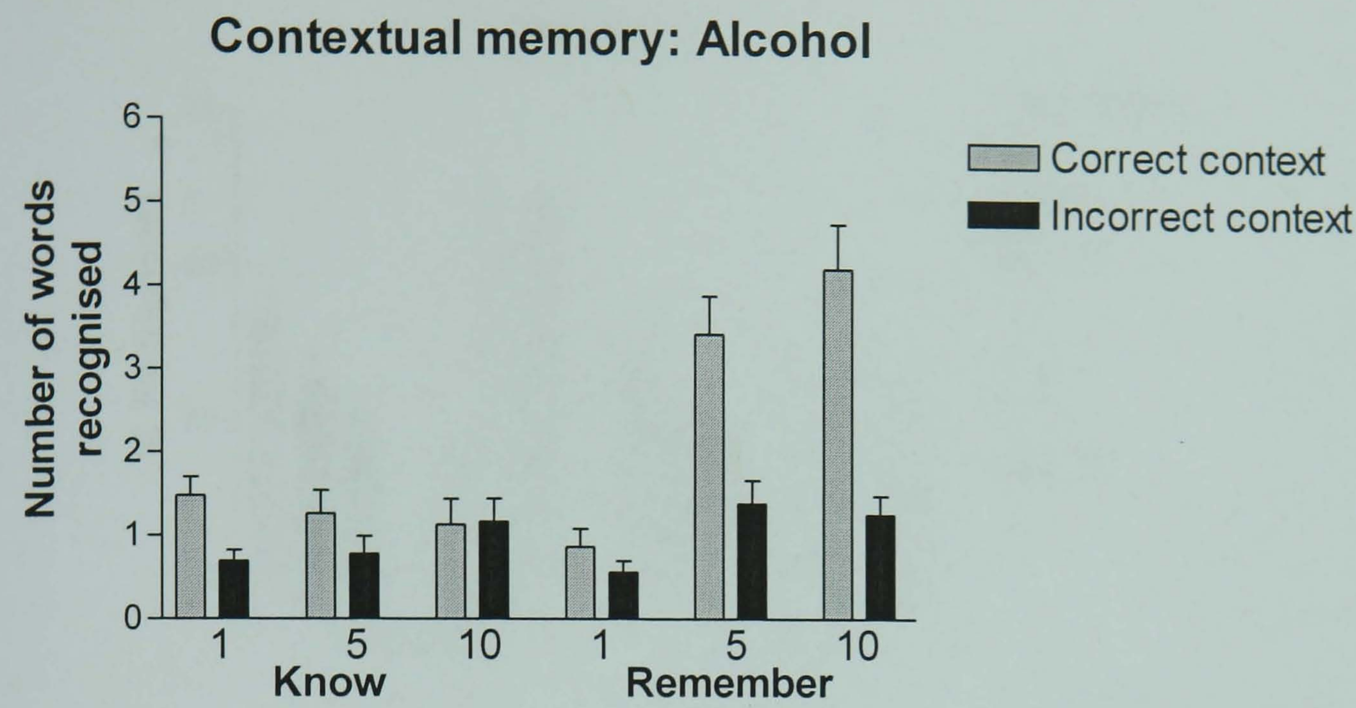


Figure 6.2. **The amount of know and remember responses made for veridical contexts (correct vs. incorrect) in alcohol participants.**

As a means to determine the way in which alcohol and placebo affected false and veridical memory levels, a 4-way ANOVA was performed. Repetition (presented once vs. repeated five times vs. repeated ten times), memory type (remember vs. know) and word type (veridical vs. critical) were within subjects' variables, whilst drink (placebo vs. alcohol) was a between subjects' factor. The number of items recognised served as the dependent variable.

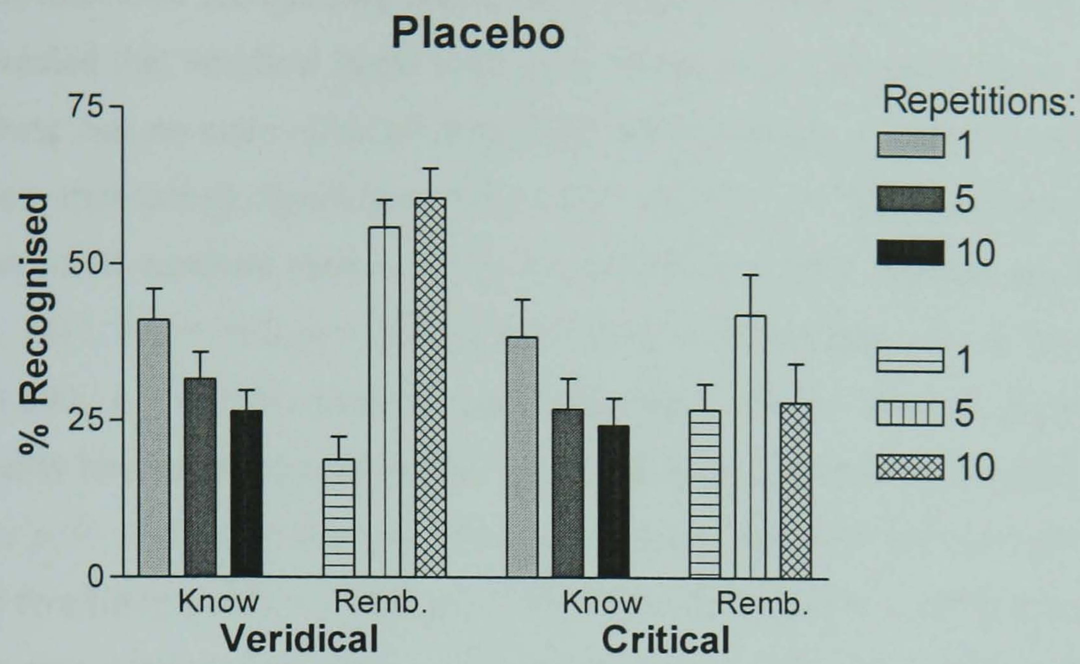


Figure 6.3.

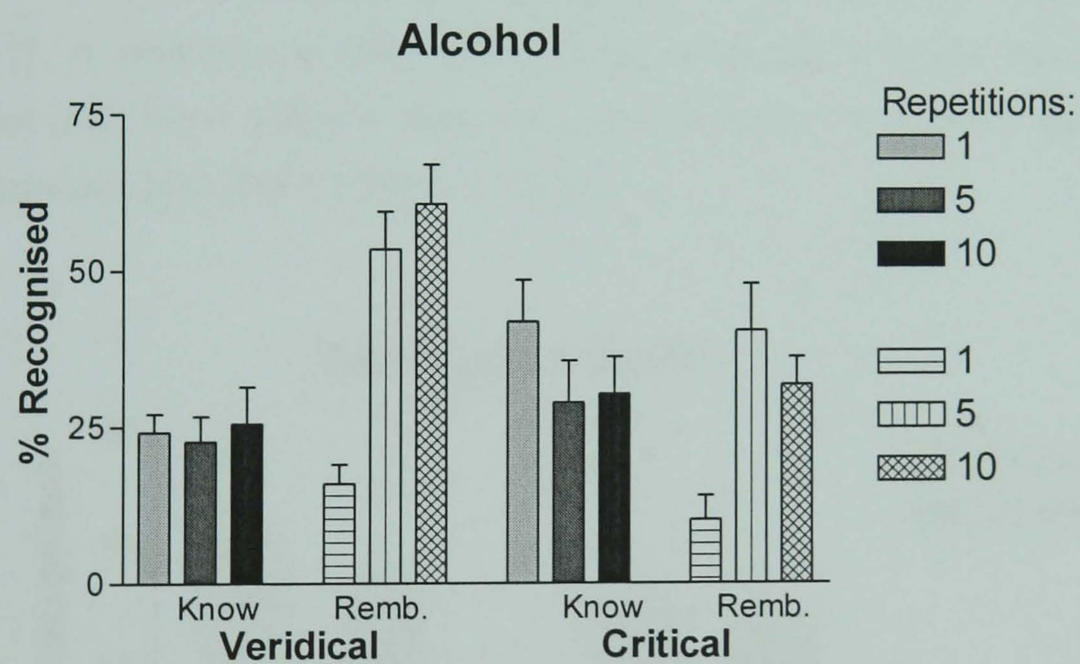


Figure 6.4.

The percentage of veridical and critical items allocated remember and know attributions as a function of repetition (presented once, five times or ten times) in the placebo group (Figure 6.3.) and the alcohol group (Figure 6.4.).

A borderline significant main effect of memory type [$F(1, 47) = 3.103$, $p = .085$] indicated a tendency for memories to be ascribed remember responses relative to know responses. A main effect of repetition [$F(2, 94) = 23.124$, $p < .001$] demonstrated that repetition increased recognition, and a main effect of word type [$F(1, 47) = 17.150$, < .001] revealed that veridical items were more likely to be recognised than critical items. Whilst there was no main effect of drink [$F(1, 47) = 2.204$, $p = .144$] a word type x drink interaction approached significance [$F(1, 47) = 3.193$, $p = .080$] and demonstrated that alcohol reduced veridical memory [$F(1, 47) = 10.315$, p .002], but had no effect on false memory [$F(1, 47) = .032$, $p = .859$]. Exploration of a repetition x drink interaction [$F(2, 94) = 4.890$, $p = .010$] revealed that participants in the alcohol group recognised significantly less items from singularly presented lists relative to the placebo group [$t(47) = 2.562$, $p = .014$], but that no difference existed between the two groups for lists repeated five times [$t(47) = 1.178$, $p = .254$] or ten times [$t(47) = -.854$, $p = .398$]. Drink, however, was not found to interact with memory type [$F(1, 47) = .001$, $p = .918$], and a memory type x repetition x drink interaction also did not reach significance [$F(2, 94) = .073$, $p = .930$, nor did a word type x memory type x drink interaction [$F(1, 47) = 2.639$, $p = .111$]. A repetition x word type x drink interaction was also not found to be significant [$F(2, 94) = .108$, $p = .898$], nor was a repetition x word type x memory type x drink interaction [$F(2, 94) = 1.395$, $p = .263$].

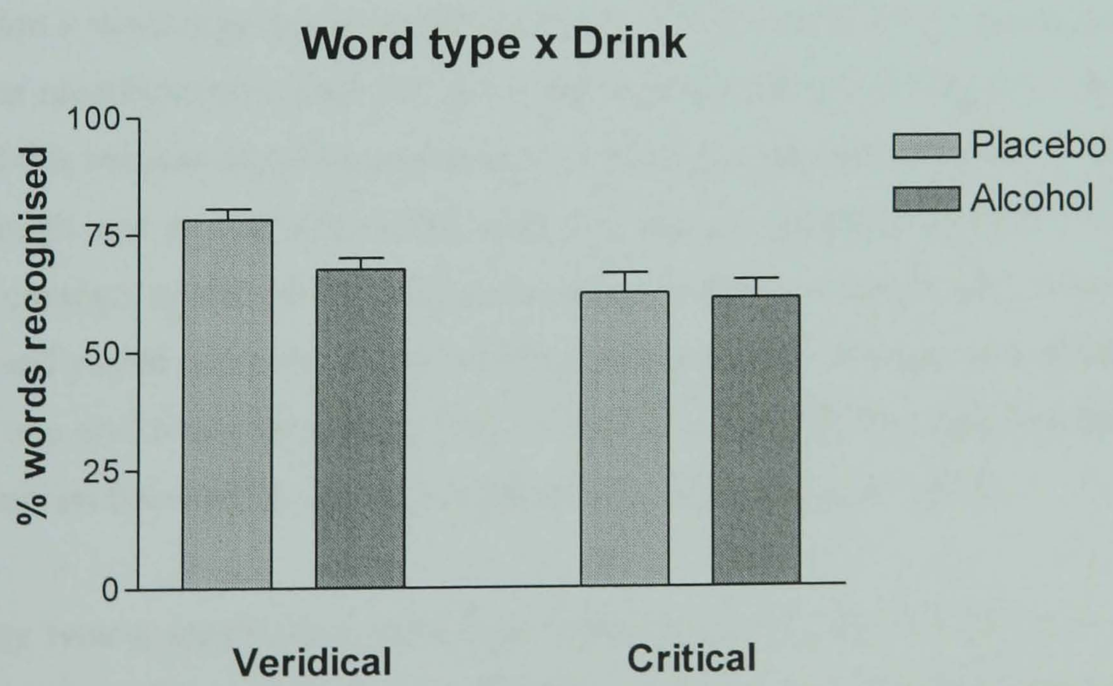


Figure 6.5. **A word type x drink interaction demonstrated that, when collapsed across the three repetition conditions, participants in the placebo group recognised significantly more veridical items than the alcohol group. No such difference existed between the two groups for critical items.**

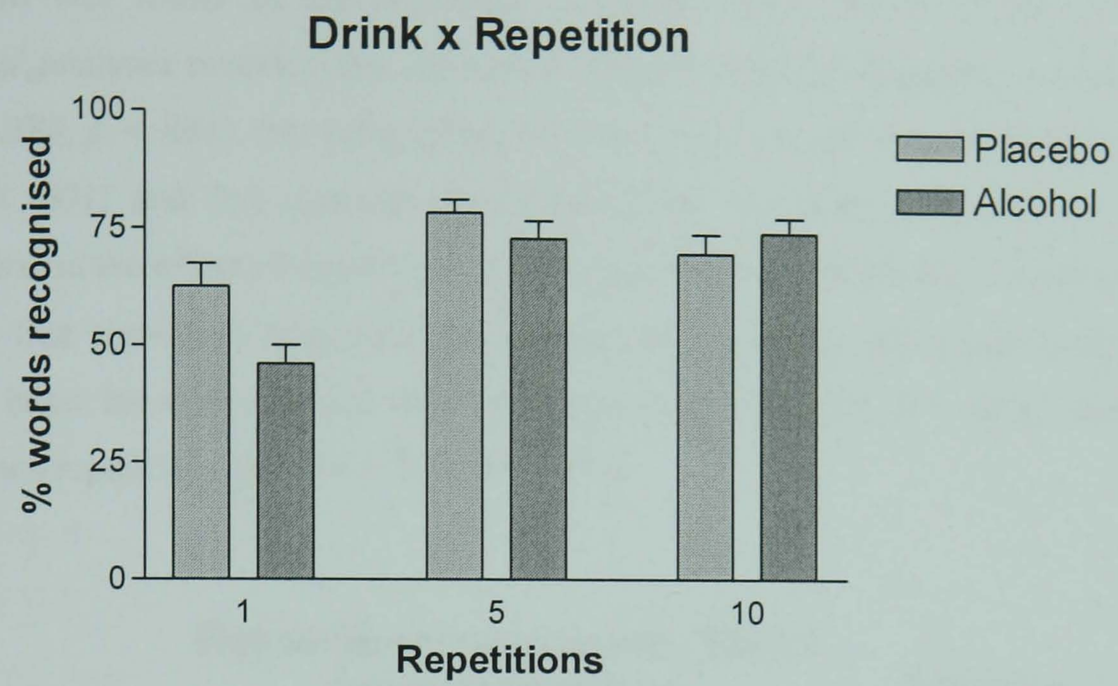


Figure 6.6. **A drink x repetition interaction demonstrated that, when collapsed across word type (veridical and critical items), participants in the placebo group recognised significantly more items from singularly presented list than those recognised in the alcohol group. No such different existed between the two groups for items corresponding to lists presented five times or ten times.**

A repetition x word type interaction [$F(2, 94) = 22.155, p < .001$] was further explored to reveal that repetition monotonically increased veridical memory [$F(2, 94) = 82.205, p < .001$] and this reached significance between one and five repetitions [$t(48) = -10.271, p < .001$], though was non-significant between five and ten repetitions [$t(48) = -1.639, p = .108$]. In contrast, repetition had a marginal effect on false memories [$F(2, 94) = 2.831, p = .064$], and paired t-tests revealed that repetition served to increase false memory items between one and five repetitions [$t(48) = -2.013, p = .050$], but significantly decrease false memories between five and ten repetitions [$t(48) = 2.588, p = .013$].

A memory type x repetition x word type interaction [$F(2, 94) = 3.557, p = .032$] was further explored with separate 2-way ANOVAs in remember and know memories, with repetition (presented once vs. repeated five times vs. repeated times) and word type (veridical vs. critical) as within subjects factors, and the amount of words recognised as the independent variable. No repetition x word type interaction was found for know responses [$F(2, 96) = .855$, $p = .429$], whilst a significant repetition x word type interaction was found in the remember memories [$F(2, 96) = 15.386$, $p < .001$]. Additional analyses revealed that repetition affected veridical remember responses [$F(2, 96) = 92.385$, $p < .001$], increasing them between both one and five repetitions [$t(48) = -10.644 < .001$] and five and ten repetitions [$t(48) = -1.906$, $p = .063$]. In contrast, breakdown on the effect of repetition on false memory items [$F(2, 96) = 9.963$, $p = .000$], revealed that repetition increased the amount of remember responses made to false memory items between one and five repetitions [$t(48) = -4.335$, $p < .001$], and between five and ten repetitions [$t(48) = 2.354$, $p = .023$].

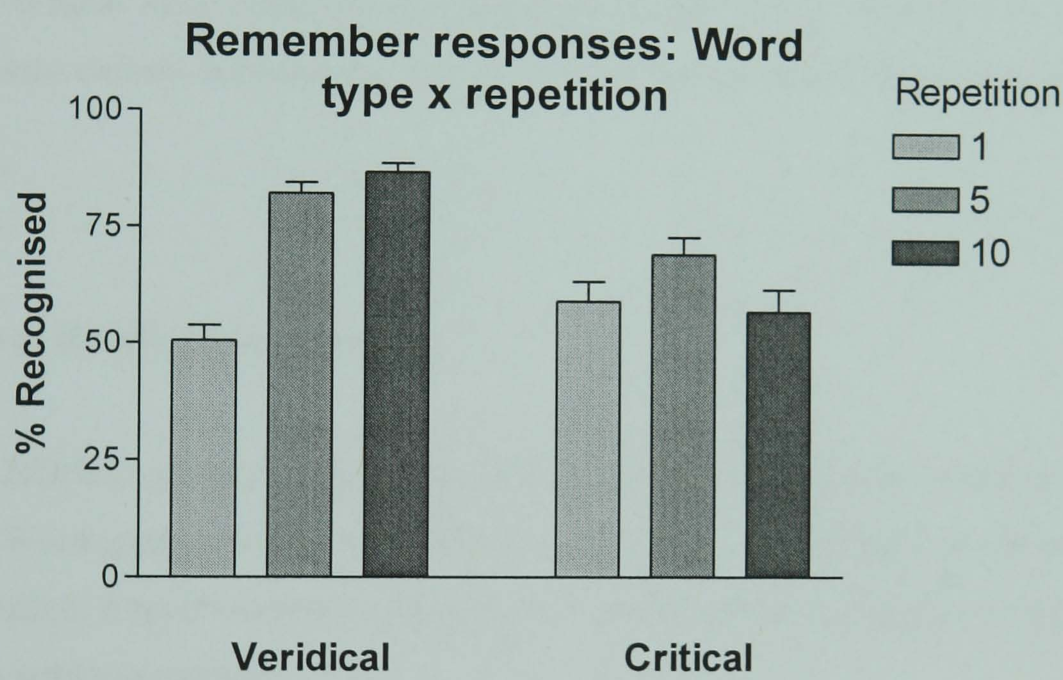


Figure 6.7. **A significant word type x repetition interaction in remember responses only signified that repetition monotonically increased veridical remember responses, but served to initially increase false remember responses, and then subsequently decrease them.**

A memory type x repetition interaction [$F(2, 94) = 36.195$, $p < .001$] was broken down to reveal that repetition did not significantly increase memory in know responses [$F(2, 94) = 2.168$, $p = .120$], but did significantly increase remember responses [$F(2, 94) = 93.285$, $p < .001$] and this reached significance between one and five repetitions [$t(48) = -10.644$, $p < .001$] and was approaching significance between five and ten repetitions [$t(48) = -1.906$, $p = .063$).

Planned comparisons in regard to how alcohol may shift the curve in false remember responses revealed that, in the placebo group, repetition increased false remember responses between one and five repetitions [$t(25) = -2.287$, $p = .031$] and significantly decreased false memories between five and ten repetitions [$t(25) = 2.3917$, $p = .025$]. For participants in the alcohol group, repetition increased false remember responses between one and five repetitions [$t(22) = -3.892$, $p = .001$]. False remember responses failed to decline within the alcohol group between five and ten repetitions [$t(22) = 1.064$, $p = .299$]. Regarding how false memory levels differed between the two groups, participants in the alcohol group had significantly less false remember memories than the placebo group for critical items from singularly presented lists [$t(47) = 2.932)$ $p = .005$], though no difference existed between the two groups for lists presented ten times [$t(47) = -.465$, $p = .644$]

6.3.3. Free Recall: Delayed testing

A mixed 2(Drink: alcohol vs. placebo)x3(Repetition: lists presented once vs. five vs. ten times)x2(Word type: veridical vs. critical) ANOVA was performed on the percentage of words recalled. Repetition and word type were within subjects variables, whilst drink was a between subjects variable.

A main effect of repetition [$F(2, 94) = 26.303$, $p<.001$] was found, indicating that repetition affected recall, increasing it between both one and five repetitions [$t(48) = -4.391$, $p< .001$] and five and ten repetitions [$t(48) = -3.376 =$]. A main effect of word type [$F(1,47) = 9.561$, $p = .003$] signified that more critical than veridical words were recalled. There was also a main effect of drink [$F(1, 47) = 7.307$, $p = .010$], demonstrating significantly reduced recall in the alcohol group. No significant word type x drink interaction was found [$F(1, 47) = .318$, $p = .576$] nor was repetition found to interact with word type [$F(2, 94) = .666$, $p = .516$]. There was, however, a borderline significant repetition x drink interaction [$F(2, 94) = 2.674$, $p = .074$).

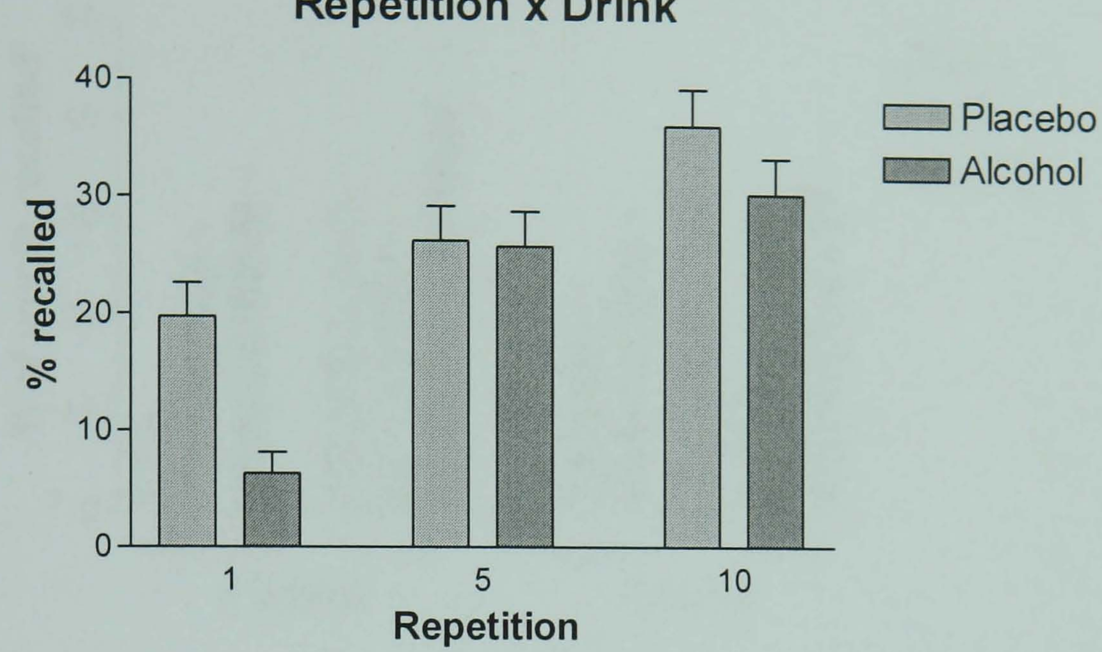


Figure 6.8. **A significant repetition x drink interaction in free recall data mirrored the recognition data, and indicated that a significant difference existed between the alcohol and placebo groups for the amount of words recalled corresponding to singularly presented lists (collapsed across word type), but that not such difference existed for repeated lists.**

Further analysis revealed that the amount of words recalled in the five and ten repetition conditions did not differ between the alcohol and placebo groups [$t(47) = .106$, $p = .916$ and $t(47) = 1.313$, $p = .196$ respectively], but that the placebo group recalled significantly more words corresponding to singularly presented lists [$t(47) = 3.834$, $p < .001$].

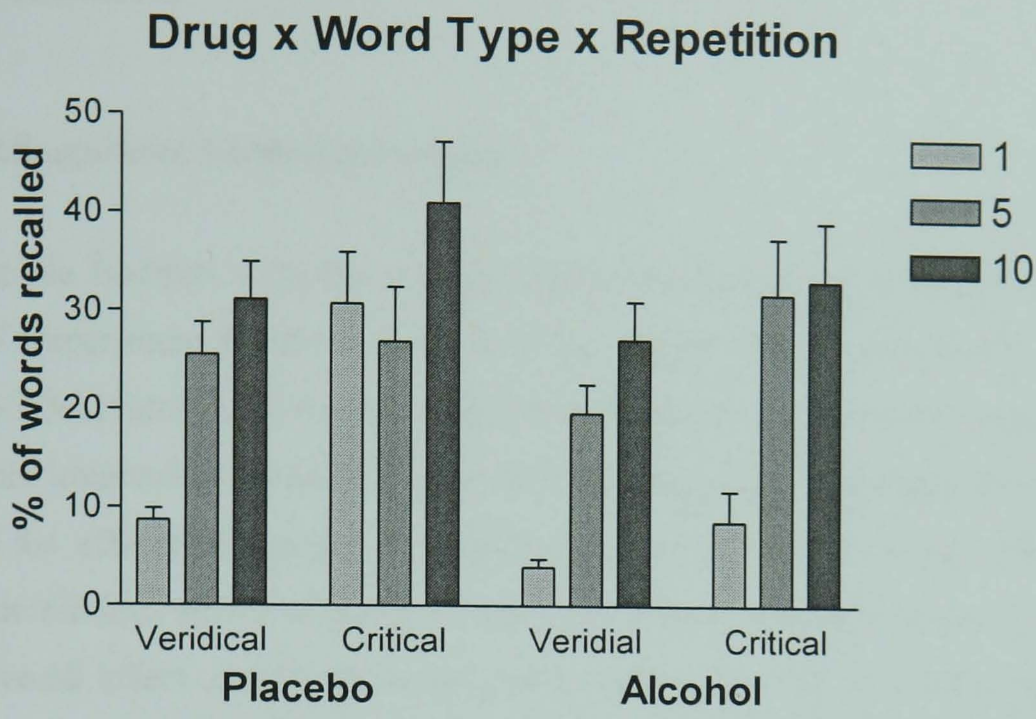


Figure 6.9. **The percentage of veridical and critical words recalled for the groups who consumed alcohol or a placebo prior to encoding.**

A borderline significant repetition x word type x drug interaction [$F(2, 94) = 2.641$, $p = .077$] was further investigated using separate 2-way ANOVAs in the veridical and critical items. Repetition (presented once vs. five times vs. ten times) was the only within subjects variable, and drink (placebo vs. alcohol) served as the only between subjects variable. The percentage of words recalled was the dependent variable. No repetition x drink interaction was found within veridical items [$F(2, 94) = .095$, $p = .910$]. Analysis of the critical items revealed a significant repetition x drink interaction [$F(2, 94) = 3.067$, $p = .051$] which was broken down to reveal that whilst repetition did not have a significant effect on false memory items in the placebo group [$F(2, 50) = 2.141$, $p = .128$], repetition affected false memories in the alcohol group [$F(2, 44) = 6.148$, $p = .004$], increasing false memories between one and five repetitions [$t(48) = 3.425$, $p = .002$], though not between five and ten repetitions [$t(48) = -.196$, $p = .847$].

6.4. Conclusions

6.4.1. Recognition: Immediate testing

The principle findings from the present experiment can be summarised as follows: The results of Experiment 8 were replicated in the current study - specifically, repetition was shown to affect false memories by initially increasing them, then subsequently decreasing them. This inverted U-shaped function was manifested in remember responses only. In terms of the effects of alcohol; a repetition by drink interaction demonstrated that the general deleterious effect of alcohol was confined to veridical memory, whilst alcohol had no overall effect on false memory levels. In regard to the inverted U-shaped function in false remember responses, and in line with the predictions outlined in the introduction, alcohol had dual effects. Firstly, it was shown through an initial reduction in false remember memories relative to the placebo group. Secondly, false remember memories significantly declined between five and ten repetitions in the placebo group, but this decline was not significant in the alcohol group. Contrary to speculations, alcohol was not shown to affect contextual source monitoring ability, as no differences were found between the alcohol and placebo groups in terms of ability to remember the context of veridical words. The main issues which thus need to be addressed are the propensity for alcohol to differentially affect veridical and critical items, and the mechanisms which may underlie this. In addition, an account needs to be provided regarding the shifted inverted U-shaped function in false memory levels, and the mechanisms which may underlie these opposing effects. The non-significant decrease in false remember responses between five and ten repetitions in the alcohol group needs to be accounted for particularly in regard to alcohol's non-significant effect on source monitoring levels within veridical items. In addition, differing effects of repetition on false memory endorsement was also obtained for same and next day testing. When memory was assessed the next day, repetition was no longer found to affect false memory levels in an inverted U-shaped function. Instead, a main effect of repetition for critical items demonstrated a propensity for repetition to enhance false memories.

The first major finding was a word type by repetition interaction which demonstrated that, when memory was collapsed across all repetition conditions, the deleterious effect of alcohol was more pronounced for veridical items than for critical items. Why does alcohol appear to differentially affect veridical and false memory levels? An argument can be made that certain properties of false memories are compatible with the processes which get selectively preserved under alcohol, namely, automatic processing (Tracy & Bates 1999) and familiarity based processing (Duka *et al.* 2001). Firstly, research has shown that the false memory effect can be founded purely upon feelings of familiarity (Fazendeiro *et al.* 2005). Secondly, research has revealed that, when encoding is severely impaired, memory for false memory items can exceed memory for veridical items. Seamon *et al.* (1998) manipulated encoding with rapid rates of stimulus presentation (20 ms per word), which, it was argued, would minimise conscious processing of study items. At test, it was found that memory discrimination for list items were poor (13 %), and significantly less than memory discrimination for critical items (23 %). Whilst a debate currently exists about the extent to which this finding, and other similar ones, can be taken as evidence for false memories resulting from nonconscious processing (Gallo & Seamon 2004; Zeelenberg *et al.* 2003; Raaijmakers & Zeelenberg, 2004), it can still be argued that this effect is indicative of the potential automaticity of the false memory effect. Other research has demonstrated that factors which impair encoding can selectively impair false memories. For example, divided attention at encoding, caused a resultant impairment in veridical memory whilst leaving levels of false memory intact relative to a full attention control condition (Seamon *et al.* 2003). Despite finding that alcohol differentially affects veridical and false memory when memory levels were collapsed over all three repetition conditions, this assertion needs to be qualified for the effect of alcohol on false memory levels is actually more complex.

Initial reduction in false remember responses under alcohol

As outlined in the introduction, and in accordance with arguments posed in chapters 3 and 4, initial decreases in false memories in the alcohol group can be accounted for by reduced activation of critical items. Not only is this argument compatible with the AMF, it is also in accordance with the established effects of alcohol. Specifically, the AMF hypothesises that activation of the critical item can occur through two routes – an automatic route, via the spread of activation within semantic networks, and a conscious route, via elaborative semantic encoding. Alcohol has the potential to reduce activation via both routes, which could account for the initial decrease in false memories under alcohol. Firstly, it has been theorised that reduced levels of processing serves as the mechanism through which veridical memory is impaired under alcohol (Craik, 1977). The reduced levels of processing could reduce the degree of activation within semantic networks, leading to reduced false memories under the AMF (Rhodes & Anastasi, 2000; Thapar & McDermott, 2001). Secondly, the impairment of attentional resources under alcohol (Steele & Josephs 1988) could also reduce the degree of elaborative processing under alcohol, which may reduce the probability of the critical item being thought of at encoding. This process could reduce the quality of the representation of the critical item (Gallo & Roediger 2002). In an experiment where participants were required to verbalise semantic elaborations at encoding, a path analyses demonstrated that verbalising the critical item at encoding predicted subsequent levels of false recall (Goodwin *et al.* 2001). Thus decreased levels of semantic activation under alcohol as a consequence of shallow encoding and reduced semantic elaborations at encoding could account for the reduced levels of false memory relative to the placebo group.

Non-significant decline in remember false memories under alcohol

The role of activation

Planned comparisons revealed that in the placebo group, a significant decline in false remember memories were found between five and ten repetitions. In contrast, the difference in false remember memories between five and ten repetitions was not found to be significant in the alcohol group. Conclusions derived in chapter 5 (Experiment 8) centred upon the pictures aiding source monitoring, which in turn better abled participants to differentiate between items presented and items not presented – leading to a decrease in false memories. Crucially, however, monitoring ability was not found to be impaired in the alcohol group, as assessed using a contextual monitoring procedure on veridical items. Yet if alcohol was not found to affect monitoring judgments, how can the failure for extended repetitions to reduced remember false memories in the alcohol group be accounted for? Under the AMF, it can be argued that a lack of a decline in false memories with repetition must occur through a dominance of activation based processes over monitoring ones being enhanced by successive repetitions. This could occur through an impairment of monitoring or a strengthening of activation with repetition. In light of the non-significant effect of alcohol on contextual monitoring, it is thus possible to account for the finding in terms of differential activation levels in the placebo and alcohol groups.

Figure 6.10 depicts the hypothesised relationship between activation and repetition for the alcohol and placebo groups. It has been strongly argued that alcohol serves to initially 'block' activation, resulting in decreased levels of false memory for singularly presented lists. If the alcohol group is thus operating from reduced baseline levels of activation, and if the additional assumption is made that with the activation enhancing effects of repetition (Benjamin 2001) the alcohol and placebo groups can be brought up to equal levels of activation with ten repetitions, a relationship such as that displayed in Figure 6.10. could exist. This clearly indicates that as baseline differences in activation exist, a smaller number of repetitions are needed for the asymptote to be reached for activation peak levels in the placebo group. Consequently, differential gradients exist between the alcohol and placebo groups between five and ten repetitions. As the gradient represents increase in activation, a greater increase occurs within the alcohol group between these two repetition points. Thus, even if monitoring ability were the same between the placebo and alcohol groups, a greater increase in familiarity for false memory items within the alcohol group would result in smaller decline in false memory levels relative to the placebo group.

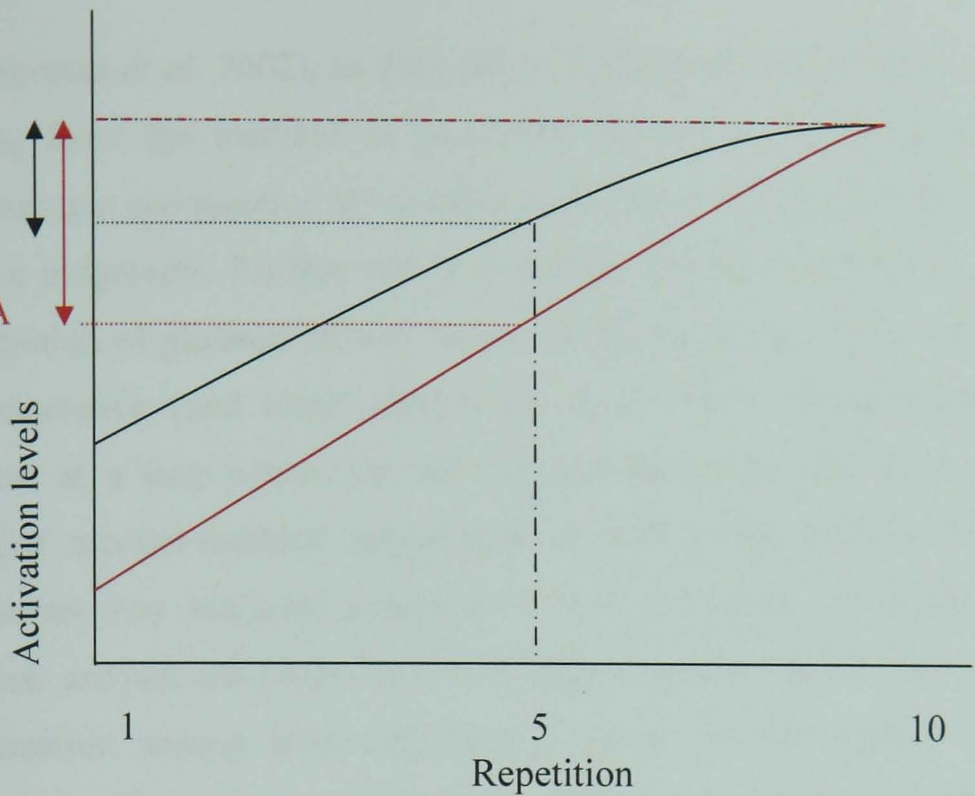


Figure 6.10. **Red line demonstrating the activation levels of the alcohol group, black levels representing the activation levels of the placebo group and how they change with repetition. The arrows indicated the magnitude of increased activation between five and ten repetitions, with a greater increase hypothesised to be present in the alcohol group (red arrow) verses the placebo group (black arrow).**

The role of monitoring

The simplest explanation for the effect of alcohol on false memories is reduced activation under alcohol – as this can account for both the initial reduced and the subsequent delayed decline. There are, however, reasons to be cautious in disregarding an impairment in monitoring under alcohol. Firstly, it is too simplistic to equate correct veridical contextual monitoring with the monitoring of false versus veridical items. Correct contextual monitoring of veridical items is not in fact synonymous with the reality monitoring decisions needed to differentiate between veridical and critical items. In the current study, source monitoring was assessed by recognition, and, as argued by Yonelinas (1999), familiarity can be the basis of correct contextual source judgements. Yonelinas (1999) challenges the traditional assumption that source monitoring decisions rely exclusively on recollection; they may be based on perceptual fluency (Kelley *et al.* 1989). Fluency is enhanced when the study and test match each other in modality

(Westerman *et al.* 2002), as they did in the present experiment. The sense of familiarity arising from the increase in perceptual fluency from the specific word and picture combination encountered at encoding could have thus guided correct veridical contextual source judgments. Further recent empirical research has shown that alcohol can keep recognition of pictorial stimuli intact, whilst impairing other measures of memory, such as associative cued recall (Söderlund *et al.* 2005). Consequently, assessing veridical context in a way which was reliant upon perceptual familiarity may have potentially masked alcohol-induced impairment in monitoring ability. In addition, recollective memories may integrate information from a number of different sources. Perceptual features are just one aspect of a recollective memory. In addition, other processes such as information arising from reflective processes at the time of encoding can also be retrieved. These include thoughts, evaluations, inferences, intentions and imagination (Henkel, Franklin & Johnson 2000). The present experiment only used a perceptual measure of monitoring and thus one can not conclude that monitoring ability in its entirety is equivalent in the alcohol and placebo groups. For example, the two groups may differ in terms of the monitoring of reflective processes. Indeed, such monitoring on internal versus external sources is especially important for reality monitoring. In future, a variety of source monitoring procedures could be administered. For example, participants could be asked to recall rather than recognise the word and the picture. In addition, using a monitoring procedure that directly targeted reality monitoring would mean one was not implicitly equating contextual monitoring of veridical items with monitoring veridical versus critical items.

The role of the distinctiveness heuristic

As discussed in the introduction, the distinctiveness heuristic could influence levels of false memories. As argued by Schacter and colleagues, the use of distinctive information to reject false memories is mediated by a metacognitive expectation that the presence of distinctive information is diagnostic of prior presentation. Alcohol may affect the metacognitive expectation that memories require a 'pictorial' tag to indicate their reality. Smith *et al.* (2001) argue that 'although the presence of appropriate source knowledge during recollection may be diagnostic of an item's list membership...the lack of appropriate source information may not prove that an items did not belong to a memorised list' (pg. 364). Due to encoding impairments under alcohol, participants in the alcohol group may have had a reduced expectation that they would have effectively encoded pictures and thus may have been reluctant to reject the familiarity elicited for false memory words with a lack of an accompanying pictorial tag. If the distinctiveness heuristic was mediating false memory levels, one would expect to find a correlation between subjective levels of perceived drunkenness and levels of false memory. This correlation should still hold regardless of whether participants had consumed alcohol or placebo. Pearson's correlation analyses demonstrated that subjective ratings of lightheadedness[1] were found to significantly correlate with the mean amount of false remember responses in the alcohol group [$r = .584$, $p = .004$], but not in the placebo group [$r = -.242$, $p = .254$]. Interestingly, no other types of memories (false know, veridical remember and veridical know) memories were found to correlate with lightheadedness in either the alcohol or placebo groups.

As lightheadedness was not found to correlate with false remember responses in the placebo group, it would appear that subjective feelings of drunkenness were not sufficient to increase the likelihood of having a false memory. This possibly suggests that in fact it was the pharmacological effects of alcohol, as indicated by lightheadedness, that was predictive of false memory levels. There are two reasons to suppose this is not the case. Firstly, variance in lightheadedness ratings was 1.61 in the placebo group, and 4.00 in the alcohol group. Indeed, with the exception of one outlier (5.90), all placebo participants had a lightheadedness rating between 0 and 3.2, with a mean value of 1.44. In contrast, the alcohol group had a range of .90 to 8.90 with a mean rating of 6.35. This lack of spread in lightheadedness ratings in the placebo group could account for why the correlation was rendered significant in the alcohol group and not the placebo group. Secondly, a pharmacological index of drunkenness, as indexed by BAC levels, were not correlated with false remember responses in the alcohol group [$r = -.086$, $p = .704$]. BAC

[1] Lightheadedness ratings were used from time point 1, though the same pattern of results was obtained

levels, were, however, found to be significantly related to lightheadedness [r = .584, p = .004]. A dissociation thus exists between participant's pharmacological index of drunkenness and their subjective index of drunkenness in their ability to predict false memories. This is compatible with the hypothesis that lightheadedness affects false memory levels via expectations, as per the distinctiveness heuristic.

As discussed, ratings of lightheadedness appear to influence the overall amount of false remember memories in the alcohol group. What is of principle interest though is the mechanism mediating the significant decline in false remember memories between five and ten repetitions in the placebo group, but not in the alcohol group. Is it possible that a lack of a significant decline in the alcohol group was also mediated by lightheadedness? In line with the principles of the distinctiveness heuristic, people with lower levels of lightheadedness may have an increased expectancy that repeatedly viewing lists should give rise to more detailed memories. Consequently, low levels of lightheadedness should be correlated with a decrease in false memories between five and ten repetitions. Conversely, people with higher levels of lightheadedness may not have the same expectancy that increased repetitions should give rise to detailed memories. Thus, people with higher levels of lightheadedness could have a more liberal endorsement criterion and consequently be less likely to reject a highly familiar critical item from repeated lists. To specifically investigate whether subjective feelings of lightheadedness within the alcohol group was responsible for the decline in false remember responses being non-significant, a new variable was created. This new variable was the difference between the amount of false remember responses from lists repeated five versus ten times. This variable did not correlate with lightheadedness in either the placebo group [r = .066, p = .764] or the alcohol group [r = .130, p = .555]. In sum, perceived levels of drunkenness, as measured by subjective ratings of lightheadedness, influenced overall levels of false remember memories in the alcohol group. In contrast, lightheadedness was not related to whether a decrease in remember false memories was obtained between five and ten repetitions. Whilst the distinctiveness heuristic – as mediated by perceived levels of drunkenness –

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with lightheadedness ratings from time point 2.

can influence false remember memory levels, it does not appear to be the mechanism responsible for the decrease in false remember responses with extended repetitions in intoxicated participants.

Shifted Curve

As discussed, participants in the alcohol group recalled significantly less false remember memories from singularly presented lists relative to placebo participants. In addition, a significant decline in false remember memories was obtained between five and ten repetitions in the placebo group but not the alcohol group. Despite a repetition by drink interaction failing to reach significance in false remember memories, can one infer that alcohol may have 'shifted' the inverted U-shaped curve, as depicted in Figure 6.11.

Alcohol and the shifted inverted U-shaped curve

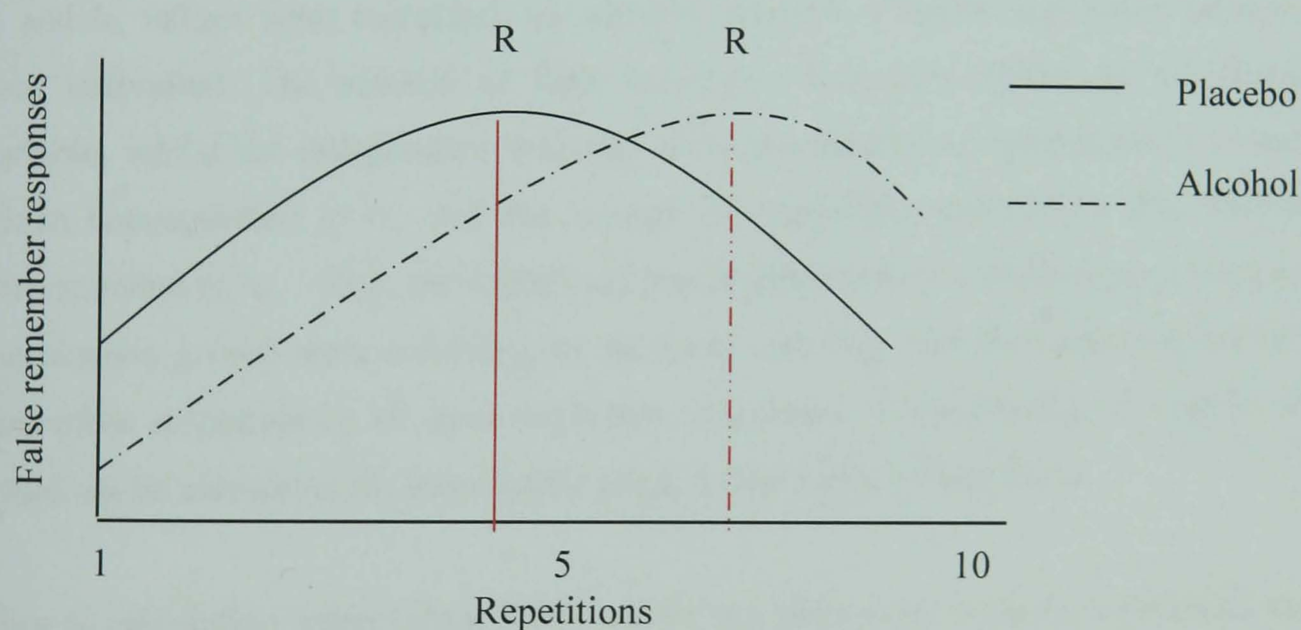

Figure 6.11. **The speculated 'shifted curve' in false remember responses under alcohol, with R marking the peak of the curve.**

To investigate whether the curve was indeed 'shifted' under alcohol, an analysis was conducted to investigate whether the point at which the curve peaked was different in the alcohol and placebo groups. This would reveal whether the mean amount of repetitions needed to induce a peak level of false memories differed as a function of drink.

The value of false memories at any given point, where R is the amount of repetitions is:

False remember memories = $a + b_1R + b_2 R^2$

Differentiating the equation to determine when the gradient equals zero:

$dfm/dR = b_1 + 2b_2 R = 0$

Rearranging the equation to determine R, when R is the value of repetitions at the point were the gradient of the curve equals zero

$R = - b_1/2\ b_2$.

b_1 and b_2 values were calculated by running separate multiple regression analyses for each individual. The amount of false remember responses served as the dependent variable, whilst the independent variables were the amount of repetitions (1, 5 and 10) which corresponded to b_1, and the amount of repetitions squared (1, 25, 100) which corresponded to b_2. Nine participants (5 participants from the alcohol group and 4 from the placebo group) were excluded on the basis that they had the same amount of false remember responses in all three repetition categories. Consequently, b_1 and b_2 values could not be calculated for these participants on the basis of their data.

Prior to calculating mean values for b_1 and b_2, box plots were made as a means to exclude all outliers. When calculating b_1, three outliers were removed from the placebo group, and five placebo participants were removed when calculating b_2. Their removal did not change the absolute patterns in the data. The value of R did not significantly differ between the two groups [$t(34) = .284, p = .778$]. The mean values for b_2 were comparable between the two groups, yet the mean b_1 value in the alcohol group was approximately double that of the placebo group. Any differences in R resulting from drink would stem from b_1 values only. In an attempt to heighten the sensitivity of the analysis, a within subjects t-test was run on b_1 values only to determine whether they differed as a function of drink. A one-tailed test revealed a marginally significant [$t(26.2)$-1.631, p = .0574] difference. The borderline significant difference in b_1 values between the alcohol and placebo groups could indicate that the inverted U-shaped curve may have shifted. Future studies are needed as a means to investigate whether indeed the inverted U-shaped curve is shifted under alcohol.

6.4.2. Free Recall: Delayed testing

Regarding the free recall data, a main effect of repetition was obtained, indicating that repetition monotonically increased both false and veridical memory. Unlike the recognition data, no repetition by word type interaction was found. Thus, immediate recognition showed that increased repetitions decreased false memories, whilst delayed recall showed a tendency to increase false memories with extended repetitions. As immediate testing employed a source monitoring procedure to assess false and veridical recognition, whilst delayed testing employed free recall only, it is thus possible that different testing procedures could account for these contrasting findings. Alternatively, it can be argued that these opposite effects of repetition can be accounted for in terms of the extended retention interval and by using the AMF. It could be argued that as retention interval increases, the phenomenological disparity between veridical and false memories is reduced. As recollection becomes less defined with time, participants would hence be less able to distinguish between which items were presented and which were not. Because critical items from repeated lists could give rise to a greater sense of familiarity due to the potential for multiple activations, a shift to familiarity based endorsement criterion could account for the increase in false memories with repetition.

6.2.1. Summary of conclusions

Repetition was found to affect false remember responses in an inverted u-shaped function; by initially increasing false memory levels, then by subsequently decreasing them. This replicated the finding from Experiment 8. Alcohol initially decreased levels of false remember memories relative to the placebo group, and rendered their decline between five and ten repetitions as non-significant. The potential for alcohol to have 'shifted' this curve is thus raised as a possibility.

It has been argued that alcohol affects false memories through an impairment of activation within semantic networks. As the degree of semantic activation has been found to correlate with false memory levels (e.g. Thapar & McDermott 2001), this could account for why initial levels of false remember memories were lower in the alcohol group than in the placebo group. In addition, an argument has been proposed to account for how reduced levels of semantic activation in intoxicated participants could account for the propensity for extended repetitions to significantly decrease false memories in the placebo group but not in the alcohol group. A consequence of lower initial activation in the alcohol group relative to the placebo group may have meant the increase in activation between five and ten repetitions was higher in the alcohol group if activation levels had reached their maximum in the placebo group.

A failure to find a correlation between the degree to which extended repetitions decreased false memories and subjective ratings of lightheadedness indicated that it is unlikely that the distinctiveness heuristic mediated the non-significant decline in false memories with repetition. Specifically, perceived levels of drunkenness did not interact with repetition to influence participants' expectations about the quality of their memories. In contrast, lightheadedness, but not BAC levels, were significantly and positively correlated to overall levels of false remember responses in the alcohol group. This indicated that the more drunk participants perceived themselves to be, the more likely they were to endorse a critical item and ascribe it a remember response. This is in accordance with the distinctiveness heuristic as it indicates that participants could have been more liberal with their response criterion if they perceived themselves as drunk as they may have had a reduced expectation about the detail needed in a memory in order for it to be ascribed a remember response.

In regard to source monitoring, alcohol was not found to affect the monitoring of veridical items, as memory for veridical context was found to be equivalent between the two groups. In previous empirical research, an inability for repetition to decrease false memory levels has been attributed to a deficit in monitoring ability (e.g. Benjamin 2001). The finding that alcohol did not impair the monitoring of veridical context would appear to indicate that monitoring ability was equivalent between the two groups, and thus differential monitoring ability cannot be the mechanism through which increased repetitions failed to significantly decrease false remember responses in the alcohol group. It was also acknowledged that contextual monitoring was assessed by recognition and not recall and this would have increased the likelihood that no group differences would have been found in monitoring ability. Because the ability to remember veridical context could be aided by perceptual fluency (Kelley *et al.* 1989), and as familiarity and perceptual processing are thought to be selectively preserved under alcohol at encoding (Kirchner & Sayette 2003), this mode of assessment could have potentially masked any differences that may have existed between the two groups in terms of monitoring ability. In addition, it was argued that contextual veridical memory is not equivalent to reality monitoring, and thus future studies need to administer a reality monitoring procedure as a means to directly assess whether reality monitoring ability is affected by alcohol.

Lastly, the free recall test performed 24 hours after encoding demonstrated that extended repetitions no longer decreased false memories, instead a marginal increase was observed. Lists which were repeated would have repeatedly activated the critical item, and thus have made them more familiar. Because of the decline in recollection over an extended retention interval, it is argued that participants were less able to differentiate between which items were presented and which were not. Consequently, the increased familiarity felt for critical items from repeated lists could have resulted in an increased tendency that they would be recalled relative to false memory items corresponding to lists viewed only once.

Chapter 7. General discussion

7.1. Introduction

This thesis investigated the way in which alcohol affected false memory levels. The AMF was chosen as the principle framework, as predictions about the effect of alcohol on false memories could be made using the opponent processes it incorporates. It was hypothesised that alcohol would reduce false memories via reduced activation within semantic networks. A secondary speculation was that alcohol may impair monitoring processes and that this could give rise to an increase in false memories when intoxicated. Repetition was chosen as an additional manipulation to explore whether these opposite effects of alcohol on false memory levels could be elicited. Study list repetition has been shown to increase both activation and monitoring processes (Benjamin 2001). According to the AMF, any variable which increases false memories can be interpreted as having a net increase on activation based processes relative to monitoring based processes. It was hypothesised that repetition could increase false memories in intoxicated participants through two routes. Firstly, initially decreased activation levels in critical items for intoxicated participants may result in a greater net increase in semantic activation with repetition. In addition, if monitoring processes were impaired under alcohol, this could lead to an increase in false memories with repetition when intoxicated. In contrast, placebo participants may be better able to counteract the increased activations of critical items that occur with repetition with an intact ability to source monitor. Thus, impaired activation when intoxicated would be manifested in initially reduced levels of false memories relative to the placebo group. Differential effects of repetition on false memory levels in the alcohol and placebo group would allow any potential increases in false memories in the alcohol group relative to the placebo group to manifest.

Conclusions regarding the affect of alcohol on false memories, and an account of the mechanisms underlying these effects, were initially hampered by the complex relationship between repetition and false memories. The results of Experiment 1, 2 & 3 did not find a consistent effect of repetition on false memories in the placebo group. Repetition displayed a tendency to increase false memories (Experiment 1, encoding phase 2), decrease false memories (Experiment 1 encoding phase 1, Experiment 2 encoding phase 1) have no effect on false memories (Experiment 3 explicit data) and reduce false memories (Experiment 3 implicit data). To reconcile these seemingly equivocal results, Chapter 5 sought to obtain the inverted U-shaped relationship between false memories and repetition within a signal paradigm. The provision of a stable paradigm displaying both an increase and decrease in false memories, when combined with alcohol, would offer the best insight into how alcohol affects false memories as a function of repetition. The inverted U-shaped curve was only reliably obtained when the potential for recollective monitoring – through the use of pictorial stimuli – was facilitated. It was found that this parabolic relationship was confined to false remember responses only. This paradigm was then used in conjunction with alcohol where results were consistent with alcohol 'shifting' the curve.

The way in which alcohol affects false memories will be discussed in section 7.2. Section 7.3. accounts for the findings from all experiments in terms of an U-relationship between the nature of learning and subsequent false memory levels. Finally, section 7.4. accounts for this inverted U-shaped relationship between learning and false memory levels in terms of underlying activation and monitoring processes.

7.2. The effect of alcohol on false memories

Conclusions regarding the effect of alcohol on false memories could not be definitely derived from Experiments 1 and 2 because of the confounding interference effects. Experiments 3 and 9 investigated the anterograde effect of alcohol on false memories. In Experiment 3, it was found that, for material viewed once in the encoding phase, participants recalled significantly fewer false memory items than the placebo group. This result was consistent with Experiment 9, where, relative to the placebo group, alcohol reduced false recognition for false remember items corresponding to material viewed once in the encoding phase. Under the AMF, this can be accounted for by decreased activation of critical items. Craik (1977) hypothesised that the mechanism through which alcohol impairs veridical memories is a reduction in encoding depth. Superficial encoding is known to reduce false memories (e.g. Thapar & McDermott 2001). Experiments 3 and 9 support this hypothesis, and their findings in line with research which has demonstrated that alcohol impairs associative veridical memory (e.g. Duka *et al.* 2001), and extends this impairment to semantic false memories.

Experiment 3 found that alcohol increased false recall with repetition. In contrast, repetition was not found to effect false memory levels in the placebo group. Experiment 3 also explored implicit memories and took awareness measures. Results obtained support the free recall data. Repetition increased the 'awareness' of critical items, thus also demonstrating an increase in false memories with repetition. The increase in false memories under alcohol could also be accounted for by a greater net increase in activation of critical items relative to the placebo group. Chapter 6 explores the possibility that, via initially reduced activation levels when intoxicated, repetition could induce greater net increases in activation of critical items. Thus, even if monitoring processes were not impaired under alcohol, such an effect could lead to a rise in false memories with repetition. Indeed, Experiment 9 would suggest that reduced monitoring ability was not the mechanism responsible for the increase in false memories with repetition. This finding is interesting as, in the DRM literature, increases in false memories with repetition have been found in populations with impaired recollective ability (Benjamin 2001; Jacoby 1999). Consequently, alcohol's propensity to increase false memories is compatible with an impairment of monitoring induced by alcohol's selective detrimental effect on recollective memory (Duka *et al.* 2001; Curran & Hildebrandt 1999). Although this was the initial hypothesis, this mechanism was not substantiated by empirical findings within this thesis. Experiment 9 demonstrated that alcohol did not affect contextual monitoring in veridical items, leading to the conclusion that monitoring ability remains intact when intoxicated. Chapter 6, however, discusses the reasons for caution in arriving at this conclusion. Specifically, one cannot equate veridical contextual monitoring, as assessed using recognition, with reality monitoring decisions. In addition, it should also be noted that the degree to which alcohol impairs recollective processes is affected by state dependency. It has been demonstrated that recollective processes are most affected when encoding and retrieval take place in different states (Duka *et al.* 2001). Consequently, the design of Experiment 9, where contextual monitoring was assessed when participants were in the same drug state, would have minimised the potential for demonstrating an alcohol induced impairment. Future research could use a full state dependent design – splitting up encoding and retrieval and administering a drink before each. This would result in four separate conditions (alcohol-alcohol, placebo-placebo, alcohol-placebo, placebo-alcohol). This would have the benefit of maximising the detrimental effect of alcohol on recollective processing, thus increasing the potential for alcohol at encoding to *increase* false memories due to an impairment in monitoring. In addition, alcohol could be used as a tool to selectively investigate how mechanisms at encoding and retrieval selectively contribute to false memory levels. Such a design requires a minimum 24 hour retention interval to ensure that participants sober up in time. A state dependent design was not employed in the present experiments because of the way in which repetition also interacts with retention interval. Chapter 6 demonstrated that false memories increase with repetition when next day testing occurs.

7.3. Summary of main findings: How they accord with the inverted U

The directional effect of repetition on false memories has been shown to be affected by the nature of learning. In all experiments, repetition enhanced veridical learning, whilst alcohol impaired learning[1]. The nature of learning was also affected by a number of other factors, and consequently, these manipulations also affected false memory levels. These included interference effects [Experiments 1 & 2], instructions warning about the false memory effect [Experiments 6 & 7], the retention interval [indicated in Experiment 3 and verified in Experiment 9] and the addition of distinctive pictorial information [Experiment 8]. All experiments were compatible

[1] As assessed using explicit tests of memory, with the exception of Experiment 1 which assessed the impairing and facilitative effects of alcohol.

with the parabolic relationship between the nature of learning and false memory levels. To demonstrate this, the experiments will be summarised and interpreted in terms of this inverted U-shaped curve.

In the placebo group from Experiment 1, repetition had a tendency to decrease false memories for material learnt in the initial encoding phase, and a tendency to increase false memories for material in the second encoding phase. This marginal effect was accounted for using the principle of interference and negative transfer. It was agued that information from the initial encoding phase was learnt well, as demonstrated by repetition decreasing false memories. This information was hypothesised to have impeded learning of material from the second encoding phase, leading repetition to marginally increase false memories. Consequently, results from the two encoding phases can be conceived as extreme ends of the curve – with results from encoding phase 1 corresponding to the descending limb. Impaired learning in the second encoding phase suggest that the results from encoding phase 2 represent the ascending limb (see Figure 7.1). Within these two experiments, accounting for how alcohol affected false memories in terms of the inverted U-shaped curve was problematic. It was argued that the complex design of the study meant that definitive conclusions were hard to derive due to the confound of interference effects. Henceforth additional studies concentrated on the anterograde impairments of alcohol. Further research could investigate the way in which interference impedes learning, and the way in which this interacts with repetition and alcohol as additional modulators of learning.

The hypothesised relationship between interference, repetition and false memory levels

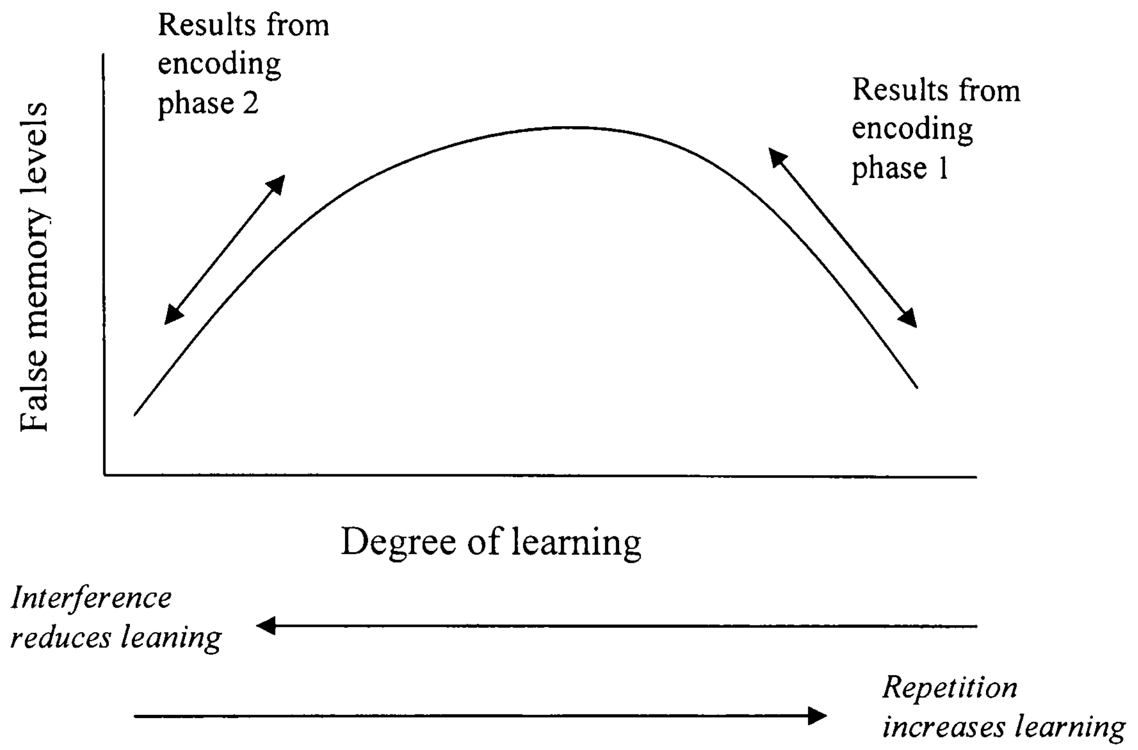

Figure 7.1. The hypothesised relationship between interference, repetition and false memory levels inferred from Chapter 1 (Experiment 1), based on the placebo group only.

In Chapter 4, no effect of repetition was found on explicit false memory levels in the placebo group. In contrast, repetition increased false memories in the alcohol group. These findings can also be accounted for in terms of the curve – with learning between the two repetition points in the placebo group representing the top of the curve. The impeded learning under alcohol would have resulted in a left shift, thus accounting for the rise in false memories with repetition when intoxicated. In addition, one can speculate that the result in the placebo group is also compatible with Experiment 1. The increased retention interval (24 hours versus 4 hours) would have decreased the accuracy of memory (McDermott 1996; Thapar 2001) and thus a left shift in the curve would be expected relative to the first encoding phase of Experiment 1.

The results from experiments in Chapter 5 can also be interpreted in terms of the inverted U-shaped relationship between false memories and repetition. Whilst two experiments decreased false memories between five and ten repetitions (Experiment 2 and Experiment 4), only Experiment 5 found an inverted U-shaped relationship between false memories and repetition. This experiment presented words with arbitrary pictures as a means to employ a contextual source monitoring paradigm. It was argued that the presence of this additional visual information initially impeded learning, which would cause a shift in the curve. This could account for why false memories increased between one and five repetitions. In addition, it was argued that, with increased learning, participants were between able to 'edit' out false memories. This was reflected in a significant decrease in false remember memories between five and ten repetitions.

Lastly, Experiment 9 investigated the propensity for alcohol to shift the curve. Results obtained did not prove that alcohol shifts the curve, though they were compatible with this perspective. Firstly, participants in the alcohol group had significantly less false remember memories than the placebo group for critical items from singularly presented lists. In addition, the placebo group were able to significantly decrease their amount of false remember responses between five and ten repetitions; this decrease did not reach significance in the alcohol group. Lastly, an analysis which was designed to compare the number of repetitions required to bring about a peak in false remember responses indicated a tendency for this value to be greater in the alcohol group than the placebo group.

7.4. The mechanisms underlying the effect of alcohol and repetition on false memories.

The AMF has been used as the principle theoretical framework to make predictions and account for results. It can be argued that the inverted U-shaped relationship between false memories and the nature of learning is actually a manifestation of how the learning employed influences activation and monitoring processes. Benjamin (2001) argued that the effects of repetition on memory processes were twofold.

Firstly, repetition provides an opportunity for increased activations of the critical items, leading to their enhanced familiarity. In addition, repetition can increase recollection for items presented, and thus familiarity felt for critical items could be counteracted with an absence of their comparable recollection[2]. The parabolic relationship between false memories and repetition suggests, however, that these two processes do not operate simultaneously. The curve would instead suggest that activation processes initially prevail as a consequence of repetition, followed by a domination of monitoring processes. Thus, an argument has been made that only when a threshold of activation has been attained can monitoring processes operate. This could account for how repetition initially serves to increase false memories: the repeated activations of critical items increase their endorsement as this is not counteracted by an increased ability to source monitoring. Once a threshold of activation has been ascertained, participants are able to use the increased exposure to 'edit' out false memories through an increased phenomenological disparity between false and veridical 'memories'. The role of monitoring in affecting false memory levels was demonstrated in a number of experiments. Firstly, presentation of a warning prior to encoding served to decrease false memory levels (Experiments 6 & 7). A decrease in false remember responses in Experiments 8 and 9 between five and ten repetitions was found when pictorial stimuli were presented. This would indicate that participants were able to use the increased phenomenological disparity between the 'memories' of veridical and critical items to better monitor at test. Lastly, Experiment 6 found a monotonic increase in false memories with repetition when memory was assessed 24 hours after encoding. This was in contrast to the inverted U-shaped relationship obtained with immediate testing. This would indicate that monitoring was impaired with an increase in retention interval, due to a reduction in phenomenological disparity between true and false memories with time.

Future research could also use a different way of assessing recollective and familiarity based memories. The present studies employed the remember / know procedure which is currently the method most frequently employed in the DRM literature. The general

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[2] As previously stated, although not acknowledged by Benjamin (2001), mechanisms have been proposed to account for the erroneous recollection of false memory items (e.g. phantom recollection, Brainerd 2003). Many connectionist models would also naturally produce occasional erroneous recollections, as such models are essentially reconstructive.

discussion in Chapter 5 addressed the failings of such an approach. Specifically, the mutual exclusivity of this mode of assessment instils an arithmetic dependency between the two. Higham and Vokey (2004) propose the use of independent scales to separately assess levels of familiarity and recollection for items. As argued by Higham and Vokey (2004), the separate assessment of recollection and familiarity would provide insight into the way in which repetition selectively affects activation and monitoring processes for critical items.

Future research could assess the confidence associated with memory decisions. Research has shown that the confidence ascribed to false memories tends to be lower than for veridical memories (Jou *et al.* 2004). The mere suggestion that people have consumed alcohol – in the absence of drinking - has been shown to increase the confidence of erroneous events (Assefi & Garry 2003). Determining whether the consumption of alcohol increases the confidence of false memories thus warrants investigation. Investigating the conditions which elicit a false memory, and the confidence associated with that memory, has important implications for the legal system, especially in regard to eyewitness testimony. It should also be noted that the false memories investigated within this thesis were based upon semantic relatedness to veridical material. Consequently, one cannot generalise the findings to all types of false memories. Research on how alcohol may distort memories of events is highly limited (e.g. Read *et al.* 1992) and this area warrant further investigation.

Manipulating factors which selectively affect different memory processes furthers our understanding of which mechanisms underlie our true and false memories. Knowledge of the factors which elicit erroneous memories thus provides insight into the workings of our memory system. Increasing our knowledge of the conditions which elicit false memories allows for a more accurate assessment of when our memories are a faithful representation of the past.

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Appendix 1

Old Lists (Stadler *et al.* 1999)

Black	**Fruit**	**Smoke**	**Spider**	**Music**	**Shirt**
white	apple	cigarette	web	note	blouse
dark	vegetable	puff	insect	sound	trousers
cat	orange	billows	bug	piano	tie
night	kiwi	pollution	fright	sing	button
funeral	citrus	ashes	fly	radio	shorts
colour	ripe	cigar	arachnid	band	iron
grief	pear	fire	crawl	melody	polo
blue	cocktail	tobacco	tarantula	horn	cotton
death	bowl	pipe	poison	rhythm	vest
gray	basket	lungs	creepy	concert	waistcoat

Sweet	**Rough**	**Mountain**	**Thief**	**Chair**	**Bread**
sour	bumpy	hill	steal	table	butter
sugar	road	valley	robber	sit	food
bitter	tough	climb	crook	legs	eat
good	sandpaper	summit	burglar	seat	sandwich
taste	jagged	top	cop	couch	rye
tooth	coarse	peak	bad	desk	jam
nice	uneven	plain	rob	sofa	milk
honey	gravel	glacier	jail	wood	dough
chocolate	ground	goat	villain	bench	crust
heart	sand	bike	crime	rocking	slice

New Lists

Clown	**Venus**	**Monkey**	**Dance**	**Weather**	**Child**
circus	love	ape	jive	rain	adult
funny	planet	baboon	ball	forcast	baby
nose	Mars	primate	steps	bad	young
fool	goddess	animal	move	wet	small
coco	beauty	nuts	band	hot	infant
jester	statue	business	twist	fine	kid
hat	Saturn	puzzle	disco	meteorology	play
around	star	banana	clap	report	parent
joke	sun	rhesus	hall	climate	toy
tumble	woman	climb		centre	innocent

Magic	**Dream**	**Bright**	**Flower**	**Nurse**	**Train**
wand	sleep	light	rose	doctor	engine
spell	nightmare	dull	pot	patient	station
trick	day	sun	garden	uniform	railway
circle	night	dark	petal	kind	fast
roundabout	ideal	early	plant	matron	journey
conjurer	Freud	star	power	sister	steam
lantern	bed	day	pretty	ward	carriage
wizard	rest	sparkle	bloom	aid	coach
carpet	erotic	dim	daffodil	help	bus
enchantment	wish	golden	stem	clinic	wheels

Appendix 2.

Subject Information

The effect of alcohol on learning

Conducted in the laboratory of Experimental Psychology, University of Sussex, by Sarah Garfinkel and Theodora Duka

The aims of the study

This study seeks to investigate the effects of alcohol on an individual's ability to learn information.

Outline of the experiment

You will be asked to attend the laboratories in the Faculty of Experimental Psychology on two separate occasions on consecutive days. The first session will last for a maximum of 4 hours. The second session will last for a maximum of an hour.

On the initial day of the experiment you should be prepared to be breathalysed on one or more occasions. You will be given a drink, alcohol or placebo, and will be required to complete a number of different questionnaires about your drinking and mood. You will be shown lists of words on a computer screen, each list will either be presented once, or more than once. On the second day no alcohol will be administered. You will be required to complete a series of word paradigms and questionnaires on your mood state. Your memory for the material you learnt the previous day will be tested.

The amounts of alcohol you may be asked to drink

When you decide to participate in this experiment you should be prepared to consume an amount of alcohol that is equivalent to 5 units (i.e. about 2 pints of typical lager or bitter at 4.5% ABV). You will be given the drink in small portions over a period of 30 minutes. You will not be able to participate in the test phase of the experiment until your breath alcohol concentration (BAC) has fallen to a quarter of the legal driving limit, this should take approximately 3 hours (0.02%).

Since you may still have alcohol in your system when you leave the laboratory, we also require that you **agree not to drive a car or ride a motorbike or push-bike or operate any machinery for at least four hours after the completion of the initial test session.**

What is required to participate in the study?

In order to participate in the study, you will need to meet the following criteria:

- You need to be between 18-35 years of age
- You need to complete a medical questionnaire
- You need to supply an estimate of your average weekly alcohol consumption
- You should not be a heavy smoker (under 15 cigarettes per day); you should be able to abstain from smoking throughout the two experimental sessions.
- You should not be taking any medication that may interfere with the aims of the study

What you must avoid doing before the first test session?

If you decide to participate you must avoid the following:

- Eating a high-fat breakfast or lunch before the first test session
- Drinking alcohol for at least 12 hours before the first experimental session
- Drinking alcohol in between the two experimental sessions
- Taking sleeping tablets or hay fever medication for at least 48 hours before either experimental session
- Drinking caffeine for at least 2 hours before each experimental sessions

Payment

On completion of the study you will be paid £20

Informed consent

University procedures require that you sign the consent form overleaf stating that the purposes and procedures of the study have been explained to you. **Please understand that you are free to withdraw from the study at any time.**

If you would like to participate in the study, please complete the form overleaf.

VOLUNTEER INFORMED CONSENT FORM

I have read and had explained to me the attached information sheet of which I retain a copy. The nature and purpose of the testing of the effects of alcohol on the way we remember information has been explained to me by one of the investigators. I am aware that I have the right to withdraw from the experiment at any time.

I undertake to:

a) refrain form drinking alcohol for at least 12 hours before the first experimental session;
b) refrain form drinking alcohol in between the two experimental sessions;
c) refrain form eating a high-fat breakfast or lunch before the first test session;
d) refrain form taking sleeping tablets or hay fever medication for at least 48 hours before either experimental session;
e) refrain form drinking caffeine for at least 2 hours before each experimental sessions;
f) refrain from using illicit drugs for at least one week before the test session;
g) not to drive a car, ride a motorbike or push-bike, or operate any machinery for at least four hours after the completion of the initial test session; and,
h) not to discuss the nature and detailed content of the experiment with other potential volunteers.

NAME:________________________________

DATE OF BIRTH:________________________________

ADDRESS:________________________________

____

____

E-MAIL ADDRESS:________________________________

PHONE NUMBER:________________________________

SIGNED:________________________________

DATED:________________________________

WITNESSED:________________________________

Nuffield Hospitals Medical History Questionnaire

Confidential Sub no. ....

Please complete all sections of this form unless otherwise indicated.

Medical History Questionnaire

Name (Full)..

Date of Birth................... Sex.......... Height.................... Weight....................

Please underline the appropriate answer where a **'Yes'** or **'No'** is required. If your answer is 'Yes' brief details should be given.

1. Have you suffered from any of the following?

		Details
Diabetes Mellitus	**Yes / No**	
Epilepsy	**Yes / No**	
Frequent chest, throat or nose infections/diseases	**Yes / No**	
Back injury/backache	**Yes / No**	
Joint injury	**Yes / No**	
Ear infection	**Yes / No**	
Rheumatism or Rheumatic fever	**Yes / No**	
Urinary problems or kidney disease	**Yes / No**	
Infectious diseases (Mumps, Measles, German Measles, Tuberculosis etc.)	**Yes / No**	
Hepatitis	**Yes / No**	
Heart disease	**Yes / No**	
High blood pressure, chest pain, shortage of breath	**Yes / No**	
Anxiety or Depression requiring treatment	**Yes / No**	
Nervous breakdown or debility arising from overwork	**Yes / No**	
Menstrual problems	**Yes / No**	
Haemorrhoids	**Yes / No**	
Dyspepsia or Peptic Ulcer	**Yes / No**	
Hernia	**Yes / No**	
Dysentry/Typhoid/Food poisoning	**Yes / No**	
Any other stomach disorder	**Yes / No**	
Varicose veins	**Yes / No**	
Migraines or other frequent headaches	**Yes / No**	
Hay fever, eczema or other allergies	**Yes / No**	
Skin disorders	**Yes / No**	
Fainting or giddiness	**Yes / No**	
Poor eyesight (even when wearing		

glasses/contact lenses) **Yes / No**

Please give date when eyesight was last tested (approx.) **Yes / No**

Impaired hearing **Yes / No**

---

2. Are you a registered disabled person? **Yes / No** If '**Yes**' what is you registration number and expiry date?

---

3. a) Have you been an in-patient in hospital or consulted your GP during the last five years? **Yes / No** If '**Yes**' please give details:

b) How many days of sickness have you had in the last 12 months? What were the main causes?

c) Are you taking any pills, tablets or having injections, receiving any medical or psychiatric treatment or advice or awaiting surgery? **Yes / No** If '**Yes**' please give details:

---

4. How often do you visit your dentist? When was your last visit?

---

5. What was the date of your last immunisation against the following: (approx.)

Tetanus

Tuberculosis

Polio

Rubella (German Measles)
(Anti-D Gammaglobulin)

Hepatitis B

---

6. Date of last x-ray Reason for x-ray

---

7. General state of health; please comment on any aspects not covered above (i.e. accidents, injuries, disorders not mentioned).

8. What is your average consumption of a) alcohol units* per week (* A unit- single measure of spirit one glass of wine/ half a pint of beer)

b) tobacco per day

9. Is there any additional information regarding your health not covered in the above questions?

I declare that the answers given to the above questions are true to the best of my knowledge and I have not withheld any material facts which may have any bearing as to the state of my health.

Signature Date

Alcohol Use Questionnaire

Subject Number______
Age______

Are you: Female / Male

The following questions ask you about your habitual use of various types of alcoholic drinks. Please consider your drinking for the last 6 months in answering the questions, and take your time to give an accurate answer to each question.

1. On how many days per week do you drink wine, or any wine-type product, eg. sherry, port, martini? ________ Please state your usual brand(s) ________________________

2. On those days you do drink wine (or similar), about how many glasses (pub measure) do you drink? ________ If unsure, please estimate the number of bottles or parts of a bottle ________

3. How many glasses (pub measure) of wine do you have in a week, in total? ________

4. On how many days per week do you drink beer or cider (at least half a pint)? ________ Please state usual brand (eg. Carling, Harvey's, Strongbow etc.) ____________________

5. On those days you do drink beer/cider, about how many pints do you typically have? ________

6. How many pints of beer/cider do you drink in a week, in total? ________

7. On how many days per week do you drink spirits (whisky, vodka, gin, rum etc.)? ________ Please state usual brand (eg. Smirnoff, Bells, Gordon's) ________________________________

8. On those days you do drink spirits, about how many shorts (pub measure) do you typically have? ________ If unsure, please estimate number of bottles or parts of a bottle ___________

9. How many drinks of spirits do you have in a week, in total? ________

10. On how many days per week do you drink alcopops? ________ Please state usual brand (eg. Hooch, Bacardi Breezer, WKD etc.) ______________________________

11. On those days you drink alcopops, about how many bottles do you typically have? _____

12. How many bottles of alcopops do you have each week, in total? _________

13. (10) When you drink, how fast do you drink? (Here, a drink is a glass of wine, a pint of beer, a shot of spirits, straight or mixed). Please circle the correct response

Drinks per hour: 7+ 6 5 4 3 2 1
1 drink in 2 hours
1 drink in 3 or more hours

14. (11) How many times have you been drunk in the last 6 months? By 'drunk' we mean loss of co-ordination, nausea, and/or inability to speak clearly ________

15. (12) What percentage of times that you drink do you get drunk? ________

16. What percentage of times that you get drunk do you suffer from hangovers? ________

17. On a scale of 1-10, how bad are your hangovers? ________

18. When do you usually drink alcohol? Please circle the correct response

most days / weekends / only on special occasions

Subject Number:____________________ **Time:**__________

Subjective mood ratings

How do you feel **NOW**? Please draw a vertical mark on each line, in the position you feel best represents your current state.

A 'normal' rating of these states would be near to the '<u>not at all</u>' mark:

Light headed

not at all ____ very much

Irritable

not at all ____ very much

A 'normal' rating of these states would be in the <u>middle</u> of the line:

Stimulated

not at all ____ very much

Alert

not at all ____ very much

Relaxed

not at all ____ very much

Contented

not at all ____ very much

PLEASE TURN OVER

Appendix 6

Assessment of baseline memory (Lezak 1983)

List A	desk
	ranger
	bird
	shoe
	stove
	mountain
	glasses
	towel
	cloud
	boat
	lamb
	gun
	pencil
	church
	fish

List B	drum
	curtain
	bell
	coffee
	school
	parent
	moon
	garden
	hat
	farmer
	nose
	turkey
	colour
	house
	river

Appendix 7a

Mean number of critical associations generated in response to veridical items for new and old lists

New Lists	Mean	SEM
Venus	0.5	0.223607
bright	0.6	0.163299
child	0.9	0.276888
dream	1	0.298142
nurse	1.3	0.448454
clown	1.5	0.341565
dance	1.8	0.38873
flower	2.1	0.458258
weather	2.1	0.406885
train	2.3	0.422953
monkey	2.5	0.562731
magic	2.7	0.683943

Old Lists	Mean	SEM
mountain	0.6	0.163299
music	1	0.298142
thief	1.1	0.378594
rough	1.1	0.406885
black	1.2	0.290593
fruit	1.7	0.422953
sweet	2	0.210819
shirt	2.2	0.940449
chair	2.3	0.597216
bread	2.4	0.476095
spider	2.5	0.542627
smoke	3	0.596285

Appendix 7b

Probability of baseline stem completion

New Lists	Mean	SEM
Venus	0	0
monkey	0	0
dance	0.1	0.1
dream	0.2	0.133333
magic	0.2	0.133333
clown	0.2	0.133333
train	0.3	0.152753
nurse	0.3	0.152753
child	0.3	0.152753
bright	0.4	0.163299
flower	0.4	0.163299
weather	0.5	0.166667

Old Lists	Mean	SEM
thief	0	0
mountain	0	0
shirt	0	0
chair	0.090909	0.090909
rough	0.181818	0.121967
sweet	0.272727	0.140836
black	0.363636	0.15212
bread	0.363636	0.15212
music	0.454546	0.157459
smoke	0.454546	0.157459
fruit	0.5	0.157459
spider	0.5	0.157459
thief	0	0

Appendix 7c

Probability of false recall

New Lists	Mean	SEM
Venus	0.0625	0.0625
dance	0.0625	0.0625
nurse	0.0625	0.0625
monkey	0.125	0.085391
dream	0.125	0.085391
bright	0.125	0.085391
magic	0.25	0.111803
clown	0.3125	0.119678
train	0.3125	0.119678
flower	0.4375	0.128087
child	0.5	0.129099
weather	0.5	0.129099

Old Lists	Mean	SEM
thief	0.0625	0.0625
rough	0.0625	0.0625
shirt	0.125	0.08539125
mountain	0.25	0.1118034
sweet	0.25	0.1118034
black	0.25	0.1118034
bread	0.25	0.1118034
music	0.25	0.1118034
spider	0.25	0.1118034
chair	0.375	0.125
fruit	0.5	0.1290994
smoke	0.625	0.125
thief	0.0625	0.0625