Influence of Negative Affect on False Memory Production

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DECLARATION

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ABSTRACT

This thesis investigates the effect of negative emotion induction on the production rate of false memories. False memories are a significant concern for situations in which the accuracy of memory is relied upon or called into question. Within the legal system eyewitness testimonies may often be the only available evidence in determining who committed a crime. In addition, in many clinical and counselling therapies memory is a central focus. In both sectors, emotion, particularly negative emotion, may affect the encoding and retrieval of false memories. Past research has previously shown that negative emotion, depending on the situation, can significantly increase, or protect against, false memory production. However, there are still many gaps in our understanding of these effects, and this thesis examines the effect of negative emotion inductions on the production of endogenous and exogenous false memories. With spontaneous endogenous false memory production, there is little known about the effect of discrete emotions, and emotion congruency. This thesis presents novel evidence of a discrete emotion congruency effect with spontaneous false memory production. This thesis also presents new perspectives on the effect of negative emotion on existing memories. Source memory errors for new false information are shown to be inflated for negative stimuli compared to neutral and positive. In addition, there is evidence that negative emotion inductions can alter the affective qualities of an already established neutral memory. The experiments presented support associative activation accounts of false memory production. The experimental evidence also demonstrates a need for future research to consider motivational aspects of emotion and investigate how goal relevance may facilitate false memory production.

ABBREVIATIONS

AAT – Associative Activation Theory

BAS – Backward Associative Strength

DRM – Deese-Roediger-McDermott, experimental paradigm

FTT – Fuzzy Trace Theory

PANAS – Positive and Negative Affect Schedule

R/K/G – Remember/Know/Guess, measures of recollective experience

SAM – Self-Assessment Manikin

"Remembrance of things past is not necessarily

the remembrance of things as they were"

Marcel Proust

Chapter 1:

Introduction and Literature Review

Memory is fallible.

As Marcel Proust succinctly put, memory is not always an accurate record of what happened. It does not work to objectively record events exactly, and retain the recordings, unchanged, over time. It is a mechanism by which experiences are interpreted, and remembered within the context of those interpretations. Memory is subject to forgetting, updating, and errors (Neath & Surprenant, 2003). Specific details of an event, or even entire events themselves, may be falsely remembered.

Memory is also subjective inasmuch as it is considered to be an adaptive mechanism for survival (Nairne, 2010), and therefore what is remembered, and how it is remembered, is dependent on the situation and the individual's appraisals of what is relevant at that time. A key factor in guiding perception and subjective interpretations is emotion. Emotion too is considered an adaptive mechanism for survival (Damasio, 2006) and can affect the production of true and false memories.

Much is known about true memory production and the effect of emotion. However, research into emotion and false memory production is much younger, and also has vastly different implications. It is a common misunderstanding that memory works like a camcorder, and this myth can cause us to rely too heavily on memories which are in fact much more fallible. This is most noteworthy within the legal system, where memory may often serve as the only evidence in determining who committed a crime.

It is important to understand how accurate an eyewitness's memory is likely to be and given the often emotional nature of the situations and events in question, it is important to understand how emotion affects the production of false memories. It is also important to understand how emotion affects memory accuracy in clinical settings. In many clinical and counselling therapies memory is the main focus and therefore it is important to understand first how reliable those memories may be, and second what effect recalling such memories in a potentially emotional state may have.

This thesis reviews the literature on false memories and emotion and presents experimental evidence of the effect of emotional experiences, and emotional stimuli, on the spontaneous production of false memories, source monitoring of new false information, and manipulations of already established memories. Theories of false memory production, and of emotion, are discussed in light of the experimental results and previous literature, and in particular, Associative Activation Theory (AAT; Howe, Wimmer, Gagnon, & Plumpton, 2009), along with appraisal theories of emotion (Moors, Ellsworth, Scherer, & Frijda, 2013; Smith & Ellsworth, 1985), is shown to be a robust account of the effects of emotion on false memories. The experimental evidence also adds to the growing false memory literature and presents novel findings of a discrete emotion-congruency effect with spontaneous false memory production.

1.1 False Memories

False memories refer to memories that we believe and experience to be real but are in fact of details of, or whole, events that we did not experience. Research into false memories took off predominantly around the 1980's and 1990's[1], driven in the most part by its practical implications, and remains a popular topic in psychology. Possibly, the most widely known example of these practical implications relates to eyewitness testimony.

[1] Wells & Olson (2002) outline much of the research being conducted at this time, and highlight the poor and questionable legal procedures that came to light, compelling researchers to investigate how reliable subsequent memory reports were

Prominent trials from the USA in the 1980's expedited false memory research with the surfacing of poor police procedures, and suggestive interview techniques (Garrett, 2011; Howe & Knott, 2015; Loftus, 1996). Statistics show that over 70% of wrongful convictions in the USA overturned through new DNA evidence were originally convicted based on a misidentification from an eyewitness (Garrett, 2011). Research into these cases has helped to inform our understanding of the development of false memories and of the procedures used when dealing with an eyewitness, and many of the advances made in this area have now been successfully integrated into the legal sectors (e.g. Fisher & Geiselman, 2010; National Research Council, 2014).

In the 1990's there was also a surge of legal cases involving hypnotic techniques to retrieve repressed memories. It was believed that painful or traumatic material could be rendered inaccessible to the conscious mind as a mechanism to protect the individual (e.g. Briere & Conte, 1993). There is, however, much debate as to whether these mechanisms really exist, how common it is, and how reliable the retrieval techniques are (Loftus, 1993; Loftus & Ketcham, 1996). Howe and Knott (2015) present some of the key cases from this period, and highlight the strong suggestive influences that led to a number of distorted memories. Although they do not claim that no memories can be retrieved using similar techniques, they caution that memories are too easily distorted.

On a lighter note, there are also many famous instances of false memories being reported for widely documented events, allowing researchers to validate or invalidate the statements made, showing quite clearly that false memories occur in a variety of situations. For example, in an interview about the 9/11 attacks George Bush spoke confidently of his vivid memory for the time leading up to and after the attacks occurred, yet in his report he included details and events that could not possibly have happened (Greenberg, 2004).

Despite these widely publicised inaccuracies and phenomenon of memory, in legal proceedings jurors and judges often have misconceptions, and naïve beliefs, about the accuracy of a reported memory (e.g., Benton, Ross, Bradshaw, Thomas, & Bradshaw, 2006; Magnussen, Melinder, Raja, & Stridbeck, 2010). Memory experts are called upon to evaluate eyewitness testimonies, and in doing so challenge many of these myths (e.g. Conway, 2013; Howe, 2013a; 2013b). Research is used to guide these judgements but, while it has come a long way, there is still much that we do not know about false memories and the factors that protect against or increase their production.

1.1.1 False Memory Research

When measuring false memory production there are two predominant branches, endogenous and exogenous false memory production. The former, endogenous, refers to an internal cause or origin of the false memory, whereas the latter, exogenous, refers to an external cause or origin. Endogenous false memories are thought to arise through naturally occurring processes in memory whereby the automatic act of encoding information produces errors that are later retrieved. Whereas, exogenous false memory production is considered to be the product of suggestive influences, memory distrust, and possible reconsolidation mechanisms, that ultimately lead to individuals adding to or changing existing memory traces, so that subsequent reports include false memories.

Endogenous False Memories

In order to measure spontaneous false memory production, the Deese/Roediger-McDermott paradigm (DRM; Deese, 1959; Roediger & McDermott, 1995) was developed. Deese (1959) pioneered this procedure by presenting participants with lists of 12 words, asking them to remember the words, and later recording their free recall. The key interest here was the intrusions in the memory test, that is, any words recalled that were not on the original lists. Deese concluded that the probability of a word being falsely recalled could be predicted by the average frequency with which that word would occur as an association to the list words presented.

Modelling their experiments on that of Deese (1959), Roediger and McDermott (1995) extended this research and created additional word lists likely to elicit memory intrusions. These DRM lists, now commonly used in false memory research (Roediger, Watson, McDermott, & Gallo, 2001), are constructed according to association norms. The words in each list (e.g., *steal, robber, crook*…) are all semantically related to one non-presented word (e.g., *thief*), known as the critical lure. The first word in each of the lists is the highest associate of the critical lure and subsequent words are arranged in descending order of associative strength. False memories are then measured as a function of the critical lures freely recalled, or recognised as old.

Exogenous False Memories

False memories can also be produced as a result of external suggestions. In order to emulate suggestive interviewing techniques used in legal and clinical settings Elizabeth Loftus developed the misinformation paradigm. There is evidence that suggestive interviewing techniques within the legal sector have led to false convictions (Loftus, 1975), and within the clinical sector similar techniques were criticised when used to help individuals retrieve repressed memories of events for which there was little to no evidence (Loftus & Ketcham, 1996).

In the classic misinformation paradigm, participants are asked to remember an event, often presented as a slideshow of images, are later given false verbal information, often in the form of leading questions or other people's accounts of the events, and in a final session are given a memory test for the original event. In the original study participants were shown a slideshow of images depicting a traffic accident and were later given misinformation regarding the presence of a stop or yield sign (Loftus, Miller, & Burns, 1978). Keeping with the practical implications for suggestive police interviewing, Loftus et al. presented the misinformation as leading questions in an interview about what participants had seen in the original slide show. Many participants in these studies then incorporate the misinformation into their memory for the original event, and subsequent research using the same paradigm has shown a fairly consistent effect with approximately a 40% hit rate (Loftus, 2005).

1.1.2 Theories of False Memory

Two theories that explain many of the effects seen with false memory production are fuzzy trace theory (FTT; Brainerd & Reyna, 2002; Brainerd & Reyna, 2001) and associative activation theory (AAT; Howe, Wimmer, Gagnon, & Plumpton, 2009; Wimmer & Howe, 2009). FTT comes from a dual-process perspective and suggests that information is encoded and stored as two different memory traces; verbatim traces, which are concerned with item-specific and surface information, and gist traces, which are concerned with more meaning-based, semantic information. Gist traces are said to decay slower than verbatim and thus false memories come from reliance at retrieval on these gist traces and a lack of verbatim memory.

AAT on the other hand, suggests that increases in true and false memories come about through automatic spreading activation of concepts. Neural representations of information presented to individuals are activated and this activation spreads along neural networks to associated concepts. Just as increased activation may account for increases in the strength of true memories, false memories are produced when spreading activation converges on a particular associate, bringing the activation of the false item to a threshold necessary for recall or recognition. Although AAT is unique in itself, it is rooted in a compelling history of associative network theories and models, such as the activation-monitoring framework (Gallo & Roediger, 2002; Roediger et al., 2001; Watson, Balota, & Roediger, 2003), and the Laws of Association developed by 19th century British empiricists (e.g., John Locke, David Hume) (Neath & Surprenant, 2003).

Moving away for a moment from the typical DRM paradigm, spontaneous false memories can also be produced when lists are compiled using phonological associates with, and in place of, semantic associates (Watson, Balota, & Roediger, 2003). Finley, Sungkhasettee, and Roediger (2017) demonstrated that adding phonological associates to semantic lists increased production rates of the critical lure. Results such as these highlight the need for theories of false memory, like AAT, that are not restricted to semantics, as with FTT.

Although originally constructed to explain spontaneous false memories, AAT can also be applied to the misinformation paradigm. Since AAT predicts that spreading activation will occur at encoding, any misinformation consistent with these patterns of activation is more likely to be accepted. Where attention may be drawn to central aspects of an image, activation of those details would result in an increase in a true memory trace as well as increased spreading activation to associated concepts. Misinformation that conflicts with the true memory trace may therefore be less easily accepted, while details that do not directly conflict may be incorporated. However, the picture here is not as clear as with spontaneous false memory production. It is important to remember that although endogenous false memory production is often measured immediately and relies on purely cognitive mechanisms, exogenous false memory production relies on other mechanisms such as social influence, and suggestibility, and is most often measured after a longer time delay.

In addition to the two theories mentioned, Activation/Monitoring Theory (AMT; Roediger III, Balota, & Watson, 2001) and source monitoring theory (Johnson, Hashtroudi, & Lindsay 1993) are also commonly used to explain false memory production. AMT is similar to AAT in that is suggests false memories arise through a spreading activation and a failure to later identify which concepts were activated by the stimuli, and which were activated internally. Unlike AAT however, AMT also posits that the false memories arise when individuals fail to monitor the source of the original activation. AAT on the other hand refers to a single trace in which source information is encoded alongside item-specific informaiton and semantic information. Spreading activations are therefore associated to this same source information and thus there is no distinction available to be monitored.

The other theory worth mentioning is source monitoring. Source memory refers to details about the when, where, and how, of an event. This information is superficial compared to the details and meaning of an event and so decays more rapidly. The theory can be related to monitoring internal and external activations, however it is most often related to misinformation (Loftus, 2005). It accounts for memory distortions whereby new mis-informaiton is associated with an original event memory, but the source of that information is not retained. The theory is limited as it cannot be easily related to an underlying or neural mechanism, and the definition of the source of information is used too interchangeable to mean a temporal or physcial source versus the source of activation.

This thesis focuses on AAT and FTT for two reasons. First, the role of spreading activations amoung assoicated concepts is easily visualised and analogous of spreading neural activations, thus AAT has clear merit for explaining cognitive processes. AMT on the other hand obfuscates this notion and thus is less effective in it's account of false memory effects. Second, AAT and FTT are distinctive in their approach to explaining false memory production as they argue for either a single or dual memory trace, respectively. This clear distinction allows for a comparison and consideration of the theories and provides different perspectives with which to consider the results of subsequent research.

1.2 Emotion and False Memories

Emotion has a significant impact on how we perceive the world and, from early memory research to more recent neuroscience techniques, there is evidence that emotion can have a significant biasing effect on the cognitive mechanisms underlying memory processes (e.g. Brown & Kulik, 2008; Talmi, 2013). Individuals can create false memories for highly emotional events. Implanted and suggested false memories have been successfully induced for being hospitalised overnight, witnessing a violent fight between your parents (Laney & Loftus, 2008), as well as invasive medical procedures (Hart & Schooler, 2006). There is also evidence that emotional false memories are easier to elicit compared to neutral (Howe, 2007; Otgaar, Candel, & Merckelbach, 2008; Porter, Spencer, & Birt, 2003), and that this enhancement is more pronounced over a delay (Howe, Candel, Otgaar, Malone, & Wimmer, 2010). Given that emotion is a prominent factor in both eyewitness testimonies and repressed memories (Bornstein & Wiener, 2010; Reisberg & Heuer, 2007), it is essential to understand the effects of emotion on the rate and content of false memory production.

1.2.1 Definition of Terms

Terms such as emotion, mood, and affect, are often used interchangeably in research but the definitions and individual interpretations of these concepts vary. It is therefore important to clarify how these terms will be used throughout the thesis and the exact nature of their meaning. The term emotion is used most often throughout this thesis as it is often used as an umbrella term. Appraisal theories of emotion predict that emotions are natural responses to changes in the environment and that they aid cognitive and behavioural changes that enable us to adapt to the changes, based on the goals and motivations of the individual (Moors, et al., 2013; Smith & Ellsworth, 1985). As such, this process is predicted to initiate changes in affect, valence, and arousal. These terms, explained in detail below, are conceptualised as underlying mechanisms of emotion that all relate to the same overarching construct. Mood on the other hand is a more general term used to refer to a much broader spectrum of feelings. A 'bad mood' for example may refer to any combination and intensity of negative emotions, such as sadness or anger.

Affect, as mentioned previously, relates specifically to the experienced qualities of an emotion. The term affect has been used to describe both the experience or feeling of emotions, as well as the expression of emotions. Reduced affect is often stated as a symptom of psychological disorders and refers to an individual expressing emotions in a more subdued manner than would be expected. In the case of the current research however, the term affect is used specifically in relation to the experience of different emotions. Negative affect therefore refers to the experience of any negative emotion. Lastly, valence and arousal are considered in terms of the circumplex model of affect (Posner, Russell, & Peterson, 2005; Russel, 1980). These are two dimensions on which all emotional experience is proposed to exist and so theoretically underlie all emotions, affective experience, and mood. Valence describes the dimension going from positive feelings to negative feelings, while arousal describes internal states of activation and readiness on a dimension from low to high. For example, feeling calm and content would be modelled as a slightly positive, low arousal, emotional experience, whereas feeling frustrated would be modelled as moderately negative, and high in arousal.

Valence and arousal dimensions can be manipulated within affective experience or within stimuli presented and, as discussed later in the chapter, affect false memory production accordingly. As mentioned however, when referring to emotions and affective experience we must also consider the effect of subjective appraisals and motivations associated with the underlying changes in valence and arousal. These motivations may bias and guide cognitive processes to relevant information and thus predicted changes related to valence and arousal would most likely be restricted to this information.

1.2.2 Emotion Induction and Measurement

In order to measure the effect of emotion on false memories we must first consider how to experimentally manipulate and measure emotion. Previous false memory research has typically used short movie clips, taken from databases such as Rottenberg, Ray, and Gross (2007a), to induce emotions (for other examples see Bartolini, 2011; Gross & Levenson, 1995; Hewig et al., 2005; Schaefer, Nils, Sanchez, & Philippot, 2010). However, these techniques are not successful for all participants. Other commonly used techniques include slideshows of images (Adam, Astor, Kramer, & Krämer, 2016), autobiographical recall (Erber & Erber, 1994), and interactive manipulations (Kučera & Haviger, 2012; Lobbestael, Arntz, & Wiers, 2008). Many comparisons of the techniques have been conducted, for example between recall and music (Jallais & Gilet, 2010), recall and films (Salas, Radovic, & Turnbull, 2012), music and films (Van der Does, 2002), and films and interactive scenarios (Lobbestael et al., 2008). In many of these comparisons only 2 techniques are compared, and in some cases the emotions induced vary according to the induction method used. It is therefore difficult to draw any conclusions regarding which techniques are the most effective or appropriate. In addition, several meta-analyses and previous literature reviews have concluded that while there are some experimental results supporting the use of one technique over another the evidence is limited and most comparisons of techniques are conducted between studies (Lench, Flores, & Bench, 2011; Martin, 1990; Phan, Wager, Taylor, & Liberzon, 2002; Westermann, Stahl, & Hesse, 1996). In addition, there are various ways in which emotion and mood can be measured. Comprehensive self-report questionnaires have been developed, such as the positive and negative affect scale (PANAS; Watson, Clark, & Tellegen, 1988) in which participants rate how well different emotion adjectives describe their current mood. In contrast, more abstract scales, such as the Self-Assessment Manikin (SAM; Bradley & Lang, 1994), measure the different dimensions of emotional experience without explicitly referencing discrete emotions.

1.2.3 Emotion and False Memory Research

Early investigations of emotion and memory focussed on general narrowing of attention as well as potential enhancement effects as a result of highly arousing emotional experiences. Brown and Kulik (2008) coined the term "flashbulb memories" to describe strong, vivid memories of events that were consequentially surprising or emotionally arousing. The authors draw on the theory "Now print!" (Livingston, 1967) which accounts for these effects by describing a step by step procedure where highly novel or distinct events are appraised for personal relevance, and in which relevant situations and all recent brain activity is permanently encoded. Although we now have a much better understanding of this process, the general idea is one which has informed much research and knowledge. Loftus's (1987) work on weapon focus effects also demonstrates a link between vividness of memory and arousal at encoding.

Research has also shown that with recall of traumatic memories there is a strong relationship between the perceived emotional intensity of the event and the confidence and clarity with which details are recalled, especially for central compared to peripheral details (Christianson & Loftus, 1990; Loftus & Ketcham, 1996). These studies provide clear insight into the relevance and implications of emotional memories. However, case studies of autobiographical memory are limited as there is no direct measure of the accuracy or false memory production. Indeed, Brown and Kulik (2008) caution that increased confidence in memory does not necessarily mean increased accuracy (see also Roediger & Desoto, 2013). However, early experimental research does reveal similar effects. High arousal increased the strength of subsequent memory traces, and in many cases this was more prominent for central than peripheral details (Berntsen, 2002; Christianson & Loftus, 1991; Heuer & Reisberg, 1990). Although there are also cases where high arousal disrupts true and false memory production (Morgan, Southwick, Steffian, & Hazlett, 2013).

Another limitation of the autobiographical evidence, is that it confounds the effects of the emotional state of the person with effects of the emotional content of the stimuli. Although there can be interaction effects between the two it is important to look at the effects of each separately, to gain a clearer understanding of the underlying mechanisms. High arousing emotional states have been shown to increase spontaneous false memory production (Corson & Verrier, 2007), while increases in false memories associated with high arousal emotional stimuli are only apparent for negative but not positive stimuli (Brainerd, Holliday, Reyna, Yang, & Toglia, 2010; Mickley Steinmetz, Addis, & Kensinger, 2010). With regard to misinformation effects, memory distortions have been shown to be more likely for negative, arousing stimuli (Gallo, Foster, & Johnson, 2009; Porter et al., 2003; Van

Damme & Smets, 2014), while a high arousal emotional state, induced after learning, reduces the endorsement of misinformation and therefore reduces false memory production (English & Nielson, 2010).

As mentioned, there is also research looking specifically at the interaction of emotional state and emotional stimuli. Knott and Thorley (2013) induced negative emotional states and showed an enhancement for valence-congruent false memories (see also Ruci, Tomes, & Zelenski, 2009). In addition, congruency effects have been shown between individuals with depression and negative, depression relevant material (Howe & Malone, 2011; Moritz, Gläscher, & Brassen, 2005; Watkins, Mathews, & Williamson, 1992). Although direct generalisations between effects of depression and effects of negative emotion cannot be made, it is worth noting the clinical implications of both branches of emotion-congruent false memory research.

Finally, distinctions should be made between the effects of different types of emotions. Research initially looked into this by investigating the difference between emotional arousal, and emotional valence, as defined by the circumplex model of affect (Posner, Russell, & Peterson, 2005; Russel, 1980). As noted previously with regard to the distinction between emotional states versus stimuli, for spontaneous false memory production emotional arousal tends to have more effect on false memory when experienced compared to when varied within the stimuli, whereas valence effects were more often seen for emotional stimuli and had little effect as emotion inductions (Brainerd et al., 2010; Corson & Verrier, 2007). For exogenous false memory production, a similar distinction between valence and arousal is seen. Memory errors and distortions are more likely for negatively valenced stimuli compared to positively valenced. Arousal effects are again mainly seen within emotion induction manipulations, however, within the stimuli increased arousal causes greater false memories for peripheral compared to central details (Hoscheidt, LaBar, Ryan, Jacobs, & Nadel, 2014; Porter et al., 2003). Neurological evidence for the effects of emotion on memory support the existence of these two distinct dimensions as it demonstrates the involvement of different neural systems for each mechanism (Colibazzi et al., 2010; Kensinger, 2004). Although there is much support for this, appraisal theories of emotion would argue that this model is limited, and that motivational aspects of emotion are key in understanding the effects on cognitive processes (Moors et al., 2013).

Within the last decade, several reviews of emotion and false memory research have endorsed the idea that inconsistencies in the valence and arousal argument can be explained by considering the motivation and goal relevance of the emotions (Harmon-Jones & Price, 2012; Kaplan, Van Damme, & Levine, 2012; Kaplan, Van Damme, Levine, & Loftus, 2016). Experimental research has also supported this idea as memory for neutral items presented during a goal conducive condition has been shown to be more resistant to decay (Montagrin, Brosch, & Sander, 2013). Distinctions between pre- and post-goal emotions have also been shown to account for differences in memory distortions, whereby pre-goal emotions narrowed attention to relevant information and therefore increased the vulnerability of irrelevant information to misinformation effects (Van Damme, Kaplan, Levine, & Loftus, 2016).

Particularly with respect to emotion congruency effects, if emotions direct cognitive processing of information relevant to the goals of the individual at the time, it stands to reason that discrete emotions differing in goal relevance and motivation would account for these effects more effectively than valence and arousal. Indeed, discrete emotion congruency between the state of the individual and the stimuli presented has been shown to account for perceptual and processing effects, whereas valence-congruence had no effect (Niedenthal & Setterlund, 1994). However, there is little research on the congruency effects of discrete emotions with false memory.

1.2.4 Theories of Emotion and False Memory

As evidenced by previous research, the effect of emotion on false memory production is not straightforward. The effects may depend on various dimensions and characteristics of emotion, and there may be different mechanisms for the effects seen with manipulations of emotional state versus those for the emotional content of the stimuli. Never-the-less there are several theoretical perspectives on the effects found, and many of these derive from more general theories of how emotion affects cognitive processes.

Bower's (1981) Network Theory of Affect states that discrete emotions are represented as nodes and that emotional states or stimuli (internal or external) can activate corresponding and associated nodes. As these associations develop during learning, each associated network of activations is specific to each individual. The theory predicts that emotion-congruency, either between the state and stimuli or between the state at encoding and the state at retrieval, will enhance memory formation. AAT leads on nicely from this theory as it predicts that increased spreading activation for emotionally congruent items will increase the chances of these items reaching an activation threshold necessary to produce false memories.

In contrast, appraisal theories of emotion highlight the motivational and goal relevant aspects of emotional experience (Smith & Ellsworth, 1985). Appraisal theories posit that emotions focus cognitive resources in favour of information congruent to the current emotional state or goals of the individual. As such, like the network theory, AAT would predict that this enhanced processing would lead to increases in false memory production. Emotion memory narrowing (Kensinger,

2009) also claims that emotions narrow focus and cognitive resources toward central aspects of a scene. However, this theory relates specifically to misinformation effects as opposed to spontaneous false memory production, as it suggests that while resources are biased toward central details, peripheral details are not encoded as well and are therefore more vulnerable to errors and later memory distortions.

Finally, an alternative account is the affect-as-information hypothesis (Clore, Gasper, & Garvin, 2001). This aligns with dual-process theories of false memory such as FTT, and relates to the emotional state of the individual. The affect-as-information hypothesis claims that valence influences the types of processing used to attend to and encode information. Negative valence is said to encourage item-specific processing while positive valence encourages more heuristic processing. Item-specific processing would increase memory for those details, thus increasing activation of the specific details, but also decreasing activation of any details less well attended. However, this account is flawed due to its reliance on negative and positive affect, as recent research has shown pre- and post-goal distinctions are more appropriate (Kaplan et al., 2012).

1.2.5 Practical Implications

This research has significant implications for legal and clinical practice. In legal situations eyewitness testimony is often relied upon and in some cases may be the only evidence available. Given the often highly emotional nature of these events it is vital to understand the likelihood of false memories being produced. There is much research on variables affecting eyewitness accuracy that can be controlled by the legal system and this has direct implications on the procedures used (see Reisberg, & Heuer, 2007). Although emotion may also affect these procedures, emotion is most often associated with variables that are out of the control of the legal system and must therefore be understood fully to determine the probability that a testimony is accurate.

Generally, the more serious a crime is the more emotional it is likely to be for the victims and witnesses to experience. As we can see from previous research, an emotional experience during an event is likely to affect the false memory production in that the more emotionally arousing the experience the more false memories will be produced (Corson & Verrier, 2007). In addition, false memories tend to be greater for information that is more negative (Brainerd, et al., 2010). As well as the encoding of the event, false memories may be produced at various stages of the eyewitness process. Much research has been conducted on false memories produced through misinformation effects during interviews and identification procedures (see Loftus, 2005) and these effects are inflated for negative stimuli (e.g. Gallo, Foster, & Johnson, 2009; Porter et al., 2003).

Similar concerns are apparent within clinical settings. False memories for emotional events may be produced spontaneously, as well as after the events have occurred during discussions and while reminiscing about events. We cannot make generalisations between everyday emotional experiences and traumatic events or clinical emotion disorders, such as depression or anxiety, however it is important to note that during any counselling sessions various emotional states may be elicited and memories of other (non-traumatic) events may be retrieved. For example, in assessing the significance of emotionally distressing memories a negative emotional state may be induced in the individual and this may affect the retrieval and reconsolidation of other memories discussed. Discussion and elaboration of memories may enhance spreading activations, increasing the chances of spontaneous false memories being produced, as well as increasing the possibility of misinformation effects occurring. Emotional elaboration has indeed been shown to significantly increase memory distortion (Drivdahl, Zaragoza, & Learned, 2009). False memory research is needed to help counsellors avoid inflating the production of negative false memories, especially when concerned about an individual's psychological well-being.

1.3 Summary and Thesis Outline

In summary, this thesis investigates the effects of negative emotion of both branches of false memory production, endogenous and exogenous, as well as looking at the most effective ways to manipulate emotion for this purpose. First, in Chapter 2 a review of the literature on emotion induction techniques is presented along with an experimental investigation of four techniques, suitable for various applications within psychology research, and assessment of the intensity and selectivity of inductions for a range of discrete emotions. In addition, two different, commonly used self-report measurement techniques are employed to provide a comparison of the two and to provide a more in-depth evaluation of the inductions. Much of the literature reviewed is shown to only focus only on a limited number of techniques and is often limited to one or two emotions. Experiment 1 therefore gives a broader, more comprehensive, investigation of the effectiveness of these techniques.

In Chapters 3 and 4 there is then a direct investigation of the effect of emotion on false memory production. In Chapter 3 there is a closer look at the valence and arousal literature and the limitations discussed so far. Experiments 2 and 3 are conducted in order to investigate the effect of discrete emotions, beyond the effects of arousal and valence, on spontaneous false memory production. Specifically looking at the congruency between the emotion induced and the stimuli presented. AAT and appraisal theories of emotion together highlight the relevance of motivation and predict that false memories should increase for information congruent to the discrete emotions and not just the valence of the emotion, as previously shown (Knott & Thorley, 2013).

In Chapter 4 a different approach is taken, and a simplified study of misinformation effects is presented using experimental manipulations of valence only. Unlike research on spontaneous false memories, the misinformation literature has already begun to look closer at effects of motivation, and pre- versus post-goal emotions. However, there is less known about the simple effects of negative emotion on source monitoring memory for new misleading information. Experiment 4 therefore investigates this effect, and discusses the role of motivation with emotion effects on misinformation. In Experiment 5, this line of investigation is extended to look at the changing affective qualities of memory instead of the explicit content. There is an investigation of distortions of the affective qualities of originally neutral memories, and a novel perspective on false memory is discussed.

The findings in each chapter are discussed in light of past research, theoretical implications, specifically for AAT and appraisal theories of emotion, and the practical implications for the legal and clinical sectors. The possible mediating role of motivation in emotions effects on cognition is also discussed throughout, and suggestions are made for future research.

Chapter 2

Emotion Induction Techniques

2.1 Overview

The focus of this thesis is to examine the effect of negative emotion inductions on the production of false memories. It is therefore necessary to first glean the most effective and appropriate induction technique. In 1924 Carney Landis faced the same question. He wanted to examine patterns of facial expressions in participants experiencing different emotions and, therefore, needed to induce these emotions in the lab. In doing so he employed methods that included placing firecrackers under participant's chairs and having them decapitate rats (Landis, 1924). Fortunately, emotion induction techniques (EITs) have advanced greatly since the early 1900's. Researchers now have access to a variety of stimuli and procedures specifically designed to induce a range of emotional states, many of which are discussed in this chapter.

The problem, however, is that with this multitude of techniques available there is still much unknown about which techniques are the most effective and reliable, which produce the most intense emotional experiences, as well as which induce the most specific emotional states. There are many areas of research that utilise emotion induction techniques (Coan & Allen, 2007) and so it is important to better understand the techniques available and be able to make informed decisions as to which to use in experimental procedures. The literature covered in this chapter examines commonly used EITs and an experimental comparison of a selection of techniques (films, pictures, news reports, and autobiographical recall) is presented. In some cases, certain techniques are much more suited to specific emotions or mood states, however, the general consensus reached is that each of the techniques tested are effective and, therefore, an appropriate technique can be chosen in line with the parameters of the research being conducted.

2.2 Introduction

Affective influences are widely researched throughout the cognitive, behavioural, and neuroscience domains. However, the literature on effective mood and emotion induction techniques has been limited, with few comparisons made, few emotions compared, and variations in the measures used to validate the inductions. Much of the original research on EITs was concerned with developing cognitive therapies for disorders such as depression and anxiety (Blackburn, Cameron, & Deary, 1990; Bouhuys, Bloem, & Groothuis, 1995; Chartier & Ranieri, 1989; Clark, 1983; Gerrards-Hesse, 1994; Velten, 1968). Whereas now, there are many instances where emotion induction is merely an experimental manipulation, and whereby its subsequent effect on another process is the main focus of the research.

Velten (1968) developed a paradigm in which self-referential statements were used to induce either feelings of elation or depression. Although widely used at the time, there were several studies published in the 1980's disputing the effectiveness of this technique and suggesting alternatives such as emotional music (Albersnagel, 1988), autobiographical recall (Brewer, Doughtie, & Lubin, 1980), and interactive achievement tasks (Chartier & Ranieri, 1989). Although there were some advantages to the Velten technique there were greater concerns that the emotional states were too short lived (Clark, 1983; Isen & Gorgoglione, 1983) and that the technique was restricted to only a small subset of emotional experiences (Jennings, McGinnis, Lovejoy, & Stirling, 2000).

Alternative techniques also being developed at the time included audio-visual stimuli (e.g. film clips, pictures, music), internally generated experiences (e.g.

imagery, autobiographical recall), and interactive manipulations (e.g. goal achievement tasks)[2]. Interactive scenarios have a great advantage in that they allow natural, ecologically valid, emotion inductions to occur. Participants may be asked to interact with another participant within an emotionally charged context (Roberts, Tsai, & Coan, 2007) or they may unwittingly be exposed to events or task outcomes designed to elicit a natural emotional reaction (Kučera & Haviger, 2012; Lobbestael et al., 2008). Either way, the emotions are induced in a natural way. One of the biggest issues with these techniques however is the ethical quandary that participants are unable to give fully informed consent. Another concern is the practical limitations. These techniques are highly involved and are likely to introduce many confounding variables if the situations are not carefully controlled. Many of these inductions would be conducted in a natural setting, and not a laboratory, and so subsequent tasks would also be conducted in this non-laboratory environment.

As an alternative, ecologically valid technique, autobiographical recall is often used. Asking participants to recall a time when they experienced a specific emotion enables researchers to tap into a genuine emotional experience. Through careful instruction these emotions can then be re-experienced in the moment (Erber & Erber, 1994). Although much easier to implement than the interactive techniques, there are considerable concerns regarding demand characteristics associated with autobiographical recall. The instructions for such a technique are explicit in giving the purpose of the recall and the desired outcome of the task. That said, alongside self-report measures of the emotions induced, there is confirmatory evidence of their effectiveness from autonomic nervous system activity (Kop et al., 2011).

[2] These are just a selection of the techniques used. For more inclusive reviews see Martin (1990), Gerrards-Hesse (1994), and Westermann, Stahl, and Hesse (1996).

The third category mentioned are techniques using audio-visual stimuli. These include playing music (Hausmann, Hodgetts, & Eerola, 2016), presenting pictures (Adam et al., 2016), and showing movie clips (Knott & Thorley, 2013). These techniques allow for more control within the experiment as the stimuli have often been normed in previous research (e.g. films: Gross & Levenson, 1995; pictures: Lang, Greenwald, Bradley, & Hamm, 1993). These EITs can also be kept consistent across participants, can be replicated between studies, and can be presented in a controlled laboratory environment. Although experimental control is increased, the biggest concerns here are the strength of the emotions experienced and the potentially artificial nature of their elicitation. It seems there is a natural trade-off with EITs that as ecological validity and strength of induction increase, experimental control and replicability decrease.

In order to increase the effectiveness of emotion inductions one possibility is to use a combination of techniques, drawing on the advantages of each. For example, combining music and imagery has been shown to induce much stronger emotional experiences compared to either technique alone (Mayer, Allen, & Beauregard, 1995). However, using these techniques together has also been shown to lead to much more complex results (Jallais & Gilet, 2010). For example, including more direct instructions may also increase the effectiveness and strength of the emotion inductions, however, this also increases confounds of demand bias and cognitive control.

So far the advantages and disadvantages of popular techniques have been discussed. However, when choosing an appropriate technique researchers also need to consider which will provide the optimal emotional response. For this purpose, the research is somewhat lacking. Previous reviews and meta-analyses of the emotion induction literature have criticised the lack of articles looking at more than one technique (Martin, 1990) and the limited range of emotions examined (Westermann et al., 1996). Salas, Radovic, and Turnbull's (2012) comparison of internally and externally generated emotions is perhaps the most informative of the literature reviewed. This review showed that films and autobiographical recall are both effective at producing a range of discrete emotions but that recall, an internally-generated technique, favours positive valence and high arousal emotions.

Previous articles have shown that music is more effective at inducing sadness than film clips (Van der Does, 2002), but that recall is more effective and reliable than music at inducing a range of different emotions (Jallais & Gilet, 2010). One possible explanation for the supremacy of recall in these studies is the element of personal relevance. Increased personal relevance of induction procedures has been shown to increase the subsequent effectiveness of the techniques (Hazlett, 2012). This is unsurprising when considering leading cognitive theories of emotion. Here, emotions are considered to be evolutionary mechanisms whose purpose is to optimise appraisals of our environment and guide subsequent cognitive and behavioural responses (Moors et al., 2013).

With regard to the more interactive manipulations mentioned earlier, Kučera and Haviger (2012) presented findings that interactive manipulations used to induce anger and fear were more successful than audio-visual stimuli that were used to induce joy and sadness. Although informative regarding the experience of emotions, in terms of comparing the effectiveness of two techniques, this example is substantially limited because different emotions were used with the different techniques. It is not possible to conclude whether one method was more effective or whether the high arousal of fear and anger, compared to joy and sadness, accounts for the results.

As well as variations in the emotions induced and techniques compared, the studies reviewed also utilized different self-report measures to validate the inductions. In one instance, scales measuring changes in arousal and valence were used (Jallais & Gilet, 2010) providing clear evidence of the strength of the inductions. In others, more descriptive questionnaires using emotional adjectives that are rated on how well they describe the participants current state were employed (Kučera & Haviger, 2012; Salas et al., 2012). These more descriptive measures can be used to examine the specificity of the inductions. However, the list of emotional words can also introduce confounds. Although much of the literature is informative for studies concerned directly with emotional experiences or their associated neural substrates, for the purpose of inducing a range of emotions in order to compare subsequent effects, the literature is somewhat inadequate and additional research is needed.

2.3 Experiment 1:

Evaluating Emotion Induction Techniques and Self Report Measures of Emotion

Experiment 1 was designed to examine four different emotion induction techniques: films, pictures, news reports, and autobiographical recall. Film clips are a popular technique to use, and specifically so in the false memory literature (Knott & Thorley, 2013; Ruci, Tomes, & Zelenski, 2009). Collections of normed film clips make this technique particularly useful because they provide a reliable set of stimuli from which various discrete emotions can be induced (e.g. Bartolini, 2011; Rottenberg, Ray, & Gross, 2007). Although film clips have been shown to be effective in a variety of contexts (e.g. Hagemann et al., 1999) there is a concern that people view these stimuli as entertaining and consequently detach from the events depicted, particularly if they have prior exposure (film clips are often taken from popular movies – e.g., The Shining – Stephen King). In order to evaluate the effectiveness of using real-life events, news reports were considered as an induction technique. Although there are very few instances in which this method has been used (Unz & Schwab, 2005), including it in this experiment enables an examination of a more ecologically valid and personally relevant technique.

Picture sets are also an effective means of emotion elicitation and may, in some cases, be more effective than films. This is because they allow for a range of stimuli to be presented for one emotion. For example, a clip from a horror movie may not scare everyone (leading to some failed inductions) whereas a variety of typically scary images may be more encompassing. The International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999) provides arousal and valence ratings for each image and therefore facilitates the creation of subsets of images, ones that have been successfully used to induce emotion in past research (Adam et al., 2016; Biss, Weeks, & Hasher, 2012).

Examining films, pictures, and news reports, allows a comparison between different types of audio-visual stimuli[3]. However, all of these techniques rely on externally generated emotion. Salas, Radovic, and Turnbull (2012) compared internally and externally generated discrete emotions and although both techniques were effective, they found there were slight differences in the types of emotions best induced by the different techniques. The internally-generated technique was shown to favours positive valence and high arousal emotions, and elicited greater intensity overall compared to the externally-generated induction. In addition, personal relevance has been shown to greatly enhance the effectiveness of emotion inductions (Ellard, Farchione, & Barlow, 2012; Hazlett, 2012). Therefore, by including autobiographical recall as an induction technique in this experiment, it will

[3] Music was not chosen as a technique due to methodological issues with the discrepancy between the length of music clips and the length of the film clips (Hausmann et al., 2016) as well as the potential ambiguity in the target emotions associated with the music clips.

allow an examination of both of these factors, and as with the other chosen techniques, has been used in a variety of experiments as an EIT (e.g. Erber & Erber, 1994; Kop et al., 2011).

A further consideration when manipulating emotion is the measure used to validate any inductions. Different measures are often used in different studies. For example, inductions using the IAPS are typically measured using the self-assessment manikin (SAM; Bradley & Lang, 1994; Gupta et al., 2007), whereas Kučera and Haviger (2012) and Jallais and Gilet (2010) used more detailed, explicit, emotion questionnaires. The key difference between these measures is the nature in which emotional experiences are identified. The SAM is a pictorial representation of dimensions thought to underlie emotional experience. Participants rate how positive/negative their current mood state is and how high/low the corresponding arousal levels are. The abstract nature of this scale allows for a measure of emotion to be taken without explicitly drawing participant's attention to discrete emotions. This is particularly useful in memory studies of emotional stimuli as it prevents confounding the memory data by presenting emotional adjectives. An alternative that does use emotional adjectives is the Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988). This is a popular measure that presents multiple emotion adjectives and asks participants to rate to what extent each describes their current mood state. The PANAS allows for a much more concrete measure of discrete emotions. However, it also presents an increased risk of demand characteristics compared to the SAM. The effectiveness of the emotion inductions in Experiment 1 are therefore measured using both the SAM and an adaptation of the PANAS scale.

In summary, Experiment 1 assesses the effectiveness of film clips, affective pictures, news reports, and autobiographical recall at inducing anger, fear, sadness, and happiness, along with a neutral induction. The analysis is separated into *specificity*, whether the induction is specific to the target emotion or elicits a cluster of emotions, and *intensity*, the strength of the subjective experience of the emotion experienced.

2.3.1 Method

Participants

For an 80% chance of finding a medium effect size with an alpha of .05 we need 112 participants. The purpose however of this study is to pilot possible techniques to be used throughout the thesis and so a total of 71 participants (23 male) were recruited through local advertisements in the areas surrounding City, University of London, with the age range being 18-35 (M = 25.33, SD = 5.41). Participants were fully informed as to the procedure of the experiment but were not told directly that the purpose was to evaluate to the effectiveness of the different inductions in order to avoid demand characteristics. Participants were given an £8 inconvenience allowance. There were 4 conditions for the between group variable (films, pictures, recall, and news) and participants were split randomly into each group with the sample sizes being 17, 18, 19, and 17 respectively[4].

Design

A 4 (Technique: film, picture, recall, news) x 5 (Emotion: anger, fear, sad, happy, neutral) mixed design was used, where the between-participants variable was Technique and the within-participant variable Emotion. Randomising the order of the emotion presentation eliminated order effects and participants were randomly allocated to each of the technique groups.

[4] These sample sizes are small for a design of this complexity; however, the purpose of this experiment was to inform the selection of a reasonable emotion induction technique to be used throughout the false memory research in this thesis. As such, a more comprehensive evaluation was deemed unnecessary.

Materials

Films. Five film clips were selected from Rottenberg, Ray, and Gross (2007) and Bartolini (2011), each lasting approximately 3-4 minutes. The film chosen for neutral inductions was a clip from "The President's Men" in which a reporter is asking questions while a court trial appears to be commencing in the background. For inductions of fear a clip was taken from "Halloween" and shows a woman entering a house at night and being pursued by an attacker. A clip from the film "My Bodyguard" depicting a scene in which a young boy is being bullied was used to induce anger. Sadness was induced using a clip from "The Champ" in which a young boy witnesses his injured father die, and happiness was induced using a clip of a football teams triumphant win taken from "Remember the Titans".

Pictures. For the picture inductions a slideshow of 50 images was created (see Figure 2.1) for each emotion, with images presented for 5 seconds each. Images were selected from the IAPS database (Lang, Bradley, & Cuthbert, 1999) using the corresponding arousal and valence ratings for the desired emotions and subjectively checking the content for the most appropriate images for each emotion (for a full list of images refer to Appendix A). Valence and arousal scores for fear and anger images were similar and for each scale were between 1 and 4, and 5 and 8 respectively. For sad images valence scores were between 1.5 and 4.5, and arousal scores between 3 and 6. Valence scores for happy images were between 6 and 9, and arousal scores were between 3 and 7. Finally neutral images were chosen with valence scores between 4 and 6, and arousal scores between 1.5 and 4.5 (see Table 2.1 below for descriptive statistics).

Anger

[redacted] [redacted]

Fear

[redacted] [redacted]

Sad

[redacted] [redacted]

Happy

[redacted] [redacted]

Neutral

[redacted] [redacted]

Figure 2.1: ***Example images used for each of the emotion inductions***

Table 2.1: ***Arousal and valence ratings for images chosen for each emotion***

	Arousal		**Valence**	
	M	***SD***	***M***	***SD***
Anger	5.72	2.27	2.60	1.61
Fear	6.28	2.13	2.77	1.62
Sad	4.65	2.13	3.10	1.58
Happy	5.31	2.33	7.60	1.50
Neutral	3.06	1.93	4.78	1.16

News Reports. A pilot study with 30 participants was conducted online to gather ratings for anger, fear, sadness, and happiness for a selection of news articles. The results of the pilot can be found in Appendix B. The articles chosen were between 800 and 1100 words in length with 1 or 2 accompanying photos. The neutral article described the different "cultural meals" provided by McDonalds stores in different countries; the anger article described a vicious homophobic attack in London; the fear article described a non-fatal shark attack in a highly-populated "low-risk" area; the sadness article described an accident in which two toddlers were killed at their home while playing; and finally the happiness article described a D-Day veteran who attended anniversary commemorations in Normandy and returned saying his trip "meant the world" to him. Participants were asked to spend 3-5 minutes reading over each of the articles and to imagine the events were happening to them or someone close to them.

Autobiographical Recall. Participants in the recall condition were not presented with any stimuli but were instead asked "to think back to a time in your life when you felt really [angry/scared/sad/happy]". For the neutral induction, the instructions were to "think back to a typical day at school or college". Participants were asked to spend 3-4 minutes imagining the event and trying to recall as many details as possible. Further instructions to help participants remember the event clearly were adapted from Erber and Erber (1994). Participants were asked to remember the events "vividly", to "see all the details", to picture the events "as they happened", to "experience the events" and to let themselves "react as if the event was happening now". Finally, to increase the strength and richness of the recall participants were asked to write down details about the event and answer questions about each event. Details and answers about sensitive topics were not shared with the researcher and were only a tool to enhance recall.

Measurement scales. Emotion was measured using two different questionnaires. The first was the SAM, a pictorial scale from 1-9 measuring arousal and valence. The second was an adaptation of the PANAS, for which participants were presented with four adjectives related to each of the four emotions (anger, fear, sad, happy) giving sixteen adjectives in total, and asked to rate to what extent each word described their current mood on a scale from 1 to 7 (1 being not at all, 7 being extremely).

Procedure

All aspects of the experiment were run on a computer. To begin participants were asked to complete an adaptation of the PANAS followed by the SAM measuring arousal and valence. This was followed by the first emotion induction. Depending on the assigned group, participants were either shown a video clip, a slide show of images, a newspaper article, or instructions to recall a period in their life pertaining to one of the five emotions. Immediately following the emotion induction, the SAM and then PANAS were presented followed by a distractor task. For those participants in the autobiographical recall group only, there were additional questions regarding the recency, intensity, and personal relevance of the memory recalled, as well as any emotion regulation strategies employed whilst recalling the memory. The distractor task consisted of 4 simple math questions: counting backward in 3's, a simple equation, completing a number sequence, calculating a proportion of a large number. The distractor task was not timed nor was progression restricted by answering correctly. However, any participants' whose responses later indicated they had not attended to the distractor task were removed from the analysis[5]. Finally, a second SAM questionnaire was given after the distractor task to validate the intended return to a neutral mood.

This procedure was repeated for each of the 5 different emotions. Participants were debriefed at the end of the experiment before being given one final mood check to ensure everyone left the experiment in a neutral/positive mood. The entire session lasted approximately 45 minutes. All induction techniques lasted between 3 and 5 minutes and this was comparative across emotion conditions.

2.3.2 Results

Data was recorded for 71 participants; 2 were removed due to missing data and a further 3 were removed due to lacking or incorrect data on the distractor tasks. Of the remaining 66 participants, 18 were male, the ages ranged from 18 to 35 (M = 25.33, SD = 5.37), and there were 17 participants in the film, picture, and (autobiographical) recall groups, and 15 in the news group. Scores from the adapted PANAS scale were averaged for each of the response sub-scales (Anger, Fear, Sadness, and Happiness), for each of the emotion conditions (Anger, Fear, Sad, Happy, and Neutral), and changes in arousal and valence were calculated by subtracting the responses given immediately before from the responses given immediately after each induction. Given that these changes are dependent on direction the changes in arousal scores for sad and neutral and the changes in

[5] Participants were deemed to have not engaged with the distractor task if 2 or more of the 4 questions were left blank or if 3 or more answers were incorrect.

valence scores for anger, fear, and sad were reverse coded in order to account for the expected directions and allow comparison between the different emotions induced. The analyses are then organised according to each of the research questions. The *intensity* analysis examined how strong the emotional responses were for each of the inductions and the *specificity* analysis examined the responses to target emotions when compared to non-target emotions (for descriptive statistics see Table 2.2 for SAM scores, and Table 2.3 for PANAS scores).

Intensity Analysis

Arousal and Valence. Two 4 (Technique: film, picture, recall, news) x 5 (Emotion: anger, fear, sad, happy, neutral) mixed ANOVAs were run for changes in arousal and valence separately, with Bonferroni corrected post-hoc tests. In such cases where the assumption of sphericity was violated, the Greenhouse-Geisser correction is reported (see Figure 2.2 and 2.3).

For the changes in arousal there was a significant main effect of Emotion, $F(4, 248) = 2.43$, $p < .05$, $\eta_p^2 = .04$, a significant main effect of Technique, $F(3, 62) = 4.18$, $p < .01$, $\eta_p^2 = .17$, but no significant interaction effect of Emotion x Technique, $F(12, 248) = 1.10$, $p = .36$, $\eta_p^2 = .05$. Pairwise comparisons for Technique show films elicit significantly greater changes in arousal compared to news, $p < .01$; however, no other differences were significant (all *p's* > .1). For Emotion, the changes in arousal were significantly higher for neutral inductions compared to sad, $p < .05$; but again, no other differences were significant (all *p's* > .1).

For the changes in valence scores there was a significant main effect of Emotion, $F(4, 248) = 9.11$, $p < .01$, $\eta_p^2 = .13$, no significant main effect of Technique, $F(3, 62) = 2.00$, $p =.12$, $\eta_p^2 = .09$, and no significant interaction effect of Emotion x Technique, $F(4, 248) = 1.55$, $p = .11$, $\eta_p^2 = .07$. Pairwise comparisons for Emotion reveal that the changes in valence were significantly greater for happiness and sadness compared to anger, fear, and neutral (all *p's* < .05); all other differences were not significant (*p's* = 1.00).

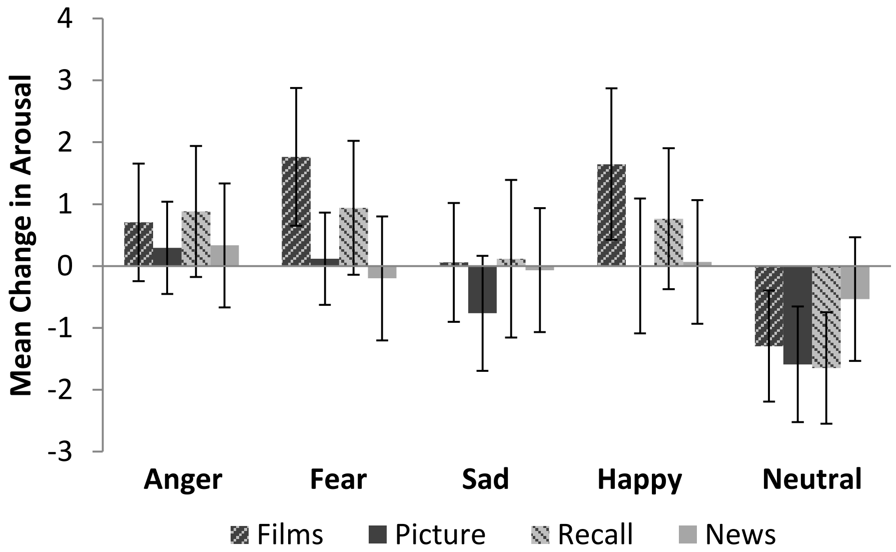


Figure 2.2: ***Mean changes in arousal scores as a function of target emotion and induction technique (error bars represent standard deviation)***

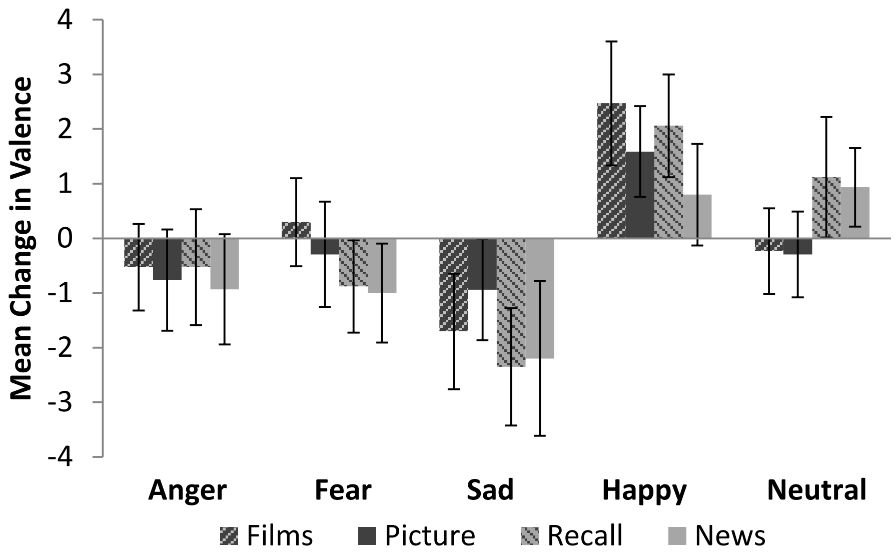


Figure 2.3: ***Mean changes in valence scores as a function of target emotion and induction technique (error bars represent standard deviation).***

Table 2.2. ***Change in responses for the SAM scale following each emotion induction***

	Films				Pictures				Recall				News			
			95% CI				95% CI				95% CI				95% CI	
	M	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*
Arousal																
Anger	.71	.46	-.27	1.68	.29	.36	-.47	1.06	.88	.51	-.21	1.97	.33	.47	-.68	1.35
Fear	1.76	.54	.62	2.91	.12	.36	-.65	.89	.94	.52	-.17	2.05	-.20	.47	-1.21	.81
Sad	.06	.47	-.93	1.05	-.76	.45	-1.72	.19	.12	.62	-1.19	1.43	-.07	.53	-1.2	1.07
Happy	1.65	.59	.39	2.91	.00	.53	-1.12	1.12	.76	.55	-.41	1.94	.07	.48	-.97	1.10
Neutral	-1.29	.44	-2.22	-.37	-1.59	.45	-2.55	-.63	-1.65	.44	-2.57	-.72	-.53	.45	-1.49	.42
Valence																
Anger	-.53	.38	-1.34	.29	-.76	.45	-1.72	.19	-.53	.52	-1.62	.56	-.93	.52	-2.05	.18
Fear	.29	.39	-.53	1.12	-.29	.47	-1.29	.70	-.88	.41	-1.75	-.01	-1.00	.47	-2.00	.00
Sad	-1.71	.51	-2.79	-.62	-.94	.45	-1.89	.01	-2.35	.52	-3.46	-1.25	-2.2	.73	-3.77	-.63
Happy	2.47	.55	1.31	3.64	1.59	.40	.73	2.44	2.06	.46	1.09	3.03	.80	.48	-.23	1.83
Neutral	-.24	.38	-1.04	.57	-.29	.38	-1.1	.51	1.12	.53	-.02	2.25	.93	.37	.14	1.73

Table 2.3. ***PANAS ratings for each emotion sub-group following each emotion induction***

	Films				Pictures				Recall				News			
			95% CI				95% CI				95% CI				95% CI	
	M	SE	LL	UL	M	SE	LL	UL	M	SE	LL	UL	M	SE	LL	UL
Anger																
Anger	3.9	0.38	3.09	4.7	2.62	0.31	1.96	3.27	3.71	0.44	2.78	4.63	3.45	0.43	2.53	4.37
Fear	1.65	0.2	1.22	2.08	1.66	0.24	1.15	2.17	1.91	0.24	1.41	2.42	2.4	0.44	1.46	3.34
Sad	3.32	0.24	2.82	3.83	2.76	0.3	2.12	3.41	2.66	0.38	1.85	3.48	3.33	0.34	2.6	4.07
Happy	1.99	0.18	1.6	2.37	1.9	0.27	1.32	2.47	2.62	0.29	2.01	3.23	1.92	0.2	1.5	2.34
Fear																
Anger	1.65	0.23	1.16	2.14	1.71	0.19	1.29	2.12	2.74	0.45	1.78	3.69	1.93	0.27	1.36	2.51
Fear	3.69	0.39	2.87	4.51	1.82	0.24	1.31	2.33	3.35	0.38	2.54	4.17	2.92	0.39	2.07	3.76
Sad	2.12	0.25	1.58	2.65	2.12	0.23	1.63	2.61	3.53	0.45	2.59	4.47	2.43	0.28	1.84	3.02
Happy	2.51	0.3	1.88	3.15	1.94	0.29	1.32	2.56	2.31	0.28	1.72	2.9	2.25	0.24	1.73	2.77

Sadness																
Anger	1.78	0.21	1.33	2.23	1.99	0.15	1.66	2.31	2.28	0.43	1.36	3.2	2.17	0.32	1.47	2.86
Fear	1.68	0.21	1.24	2.11	1.62	0.25	1.09	2.15	2.5	0.42	1.61	3.39	2	0.28	1.4	2.6
Sad	3.82	0.3	3.19	4.46	2.75	0.32	2.07	3.43	4.07	0.42	3.18	4.97	3.3	0.36	2.53	4.07
Happy	1.85	0.19	1.45	2.26	1.93	0.24	1.42	2.43	1.82	0.21	1.38	2.27	2.17	0.28	1.56	2.78
Happiness																
Anger	1.28	0.16	0.94	1.62	1.16	0.07	1.02	1.31	1.34	0.2	0.92	1.75	1.38	0.22	0.91	1.85
Fear	1.26	0.13	1	1.53	1.26	0.22	0.8	1.73	1.5	0.23	1.02	1.98	1.57	0.27	0.99	2.14
Sad	1.28	0.12	1.03	1.53	1.24	0.12	0.98	1.49	1.41	0.18	1.03	1.8	1.38	0.14	1.08	1.68
Happy	4.01	0.32	3.34	4.68	3.21	0.38	2.4	4.01	4.47	0.24	3.96	4.98	3.43	0.46	2.46	4.41
Neutral																
Anger	1.65	0.25	1.11	2.18	1.43	0.18	1.05	1.8	1.32	0.14	1.02	1.63	1.18	0.09	1	1.37
Fear	1.28	0.12	1.03	1.53	1.13	0.1	0.91	1.35	1.34	0.18	0.95	1.72	1.35	0.16	1.01	1.69
Sad	1.66	0.17	1.3	2.03	1.62	0.14	1.32	1.92	1.56	0.24	1.06	2.06	1.35	0.13	1.06	1.64
Happy	2.29	0.26	1.75	2.84	2.07	0.37	1.28	2.87	3.31	0.25	2.78	3.83	3.22	0.31	2.54	3.89

PANAS ratings. A 4 (Technique; Film, Picture, Recall, News) x 4 (Emotion; Anger, Fear, Sad, Happy) repeated measures ANOVA was run for each of the five target emotions induced (Anger, Fear, Sad, Happy, Neutral), with Bonferroni corrected post-hoc tests (see Figure 2.4).

***Anger Induction*.** For the anger emotion induction there was a significant main effect of Emotion, $F(2.17, 134.34) = 25.14$, $p < .01$, $\eta_p^2 = .29$, no significant main effect of Technique, $F(3, 62) = 1.79$, $p = .16$, $\eta_p^2 = .08$, and no significant interaction effect of Emotion x Technique, $F(6.50, 134.34) = 1.74$, $p = .11$, $\eta_p^2 = .08$. Pairwise comparisons for Emotion show the responses for "anger" were significantly higher than for "fear", $p < .01$, and "happy", $p < .01$, and the responses for "sad" were significantly higher than for "fear", $p < .01$, and "happy", $p < .01$ (no other differences were significant, *p's* > .05).

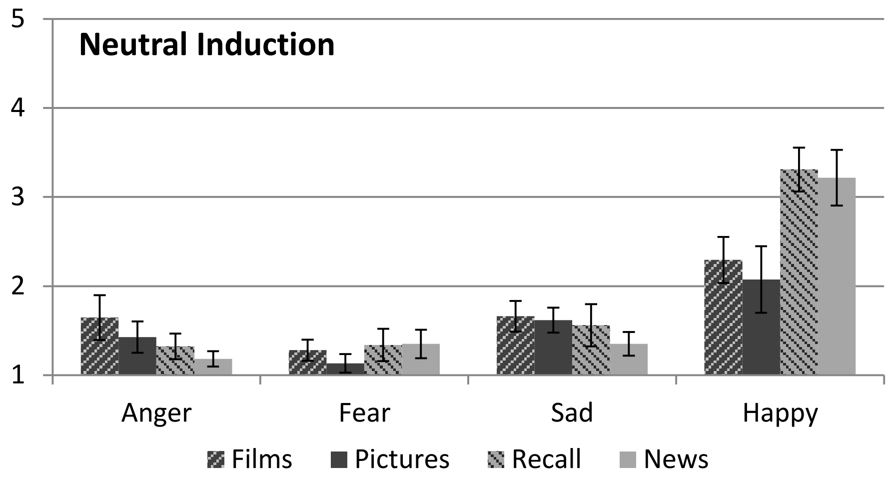
***Fear Induction*.** For the fear emotion induction there was a significant main effect of Emotion, $F(2.33, 144.23) = 8.00$, $p < .01$, $\eta_p^2 = .11$, a significant interaction effect of Emotion x Technique, $F(6.98, 14.23) = 2.63$, $p < .05$, $\eta_p^2 = .11$, and a significant main effect of Technique, $F(3, 62) = 5.37$, $p < .01$, $\eta_p^2 = .21$. Pairwise comparisons for Technique show recall elicited significantly higher responses compared to pictures, $p < .01$, but no other differences were significant (all *p's* > .1). Pairwise comparisons for Emotion show significantly higher responses to the sub-scale "fear" compared to the subscales "anger", $p < .01$, and "happy", $p < .05$, but not "sad", $p = .1$. Responses to the sub-scale "sad" were also significantly greater compared to "anger", $p < .01$ (no other differences were significant, *p's* > .05). Post-hoc analyses of the interaction effect revealed that films (*M* = 3.69, *SD* = 1.60) and recall (*M* = 3.35, *SD* = 1.59) induced significantly greater responses to the target sub-scale, fear, compared to pictures (*M* = 1.82, *SD* = .99), *p's* < .05. Films (*M* = 2.11, *SD*

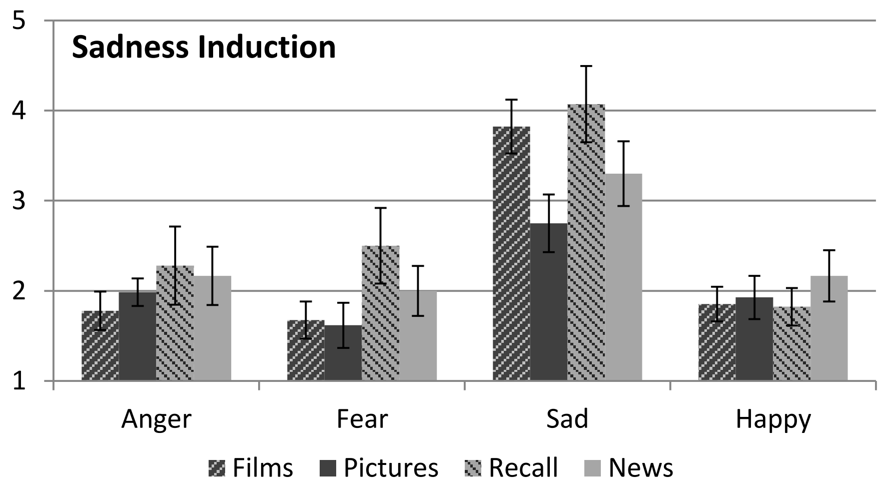
= 1.04) and pictures (*M* = 2.11, *SD* = .96) induced significantly lower responses to the non-target subscale sad compared to recall (*M* = 3.53, *SD* = 1.84), *p's* < .05.

***Sad Induction*.** For the sad emotion Induction there was a significant main effect of Emotion, $F(2.18, 135.37) = 30.47$, $p < .01$, $\eta_p^2 = .33$, no significant main effect of Technique, $F(3, 62) = 1.90$, $p = .14$, $\eta_p^2 = .08$, and no significant interaction effect of Emotion x Technique, $F(6.55, 135.37) = 1.34$, $p = .26$, $\eta_p^2 = .06$. Pairwise comparisons for Emotion show the only significant differences were found for the sub-scale "sad" whereby responses to all other emotion sub-scales were significantly lower (all *p's* < .001).

***Happy Induction*.** For the happy emotion Induction there was a significant main effect of Emotion, $F(1.50, 92.76) = 106.60$, $p < .01$, $\eta_p^2 = .63$, a significant main effect of Technique, $F(3, 62) = 2.98$, $p < .05$, $\eta_p^2 = .13$, but no significant interaction effect of Emotion x Technique, $F(4.49, 92.76) = 1.34$, $p = .26$, $\eta_p^2 = .06$. Pairwise comparisons show overall responses in the Recall group were significantly higher than those in the Pictures group, $p < .05$, no other differences for Technique were significant (all *p's* > .1). For Emotion responses the only significant differences were found for the sub-scale "happy" whereby responses to all other emotion sub-scales were significantly lower (all *p's* < .001).

Neutral Induction. For the neutral emotion Induction there was a significant main effect of Emotion, $F(1.82, 112.60) = 44.65$, $p < .01$, $\eta_p^2 = .42$, a significant interaction effect of Emotion x Technique, $F(5.45, 112.60) = 3.28$, $p < .01$, $\eta_p^2 = .14$, but no significant main effect of Technique, $F(3, 62) = 1.30$, $p = .28$, $\eta_p^2 = .06$. Pairwise comparisons for Emotion show responses were significantly greater for the sub-scale "happy" compared to all other emotion sub-scales (all *p's* < .001), and responses for "sad" were significantly greater compared to "fear", $p < .05$, however the mean difference in this case was .27 (*95% CI* [.02, .53]) meaning that participants responses were within half a point on the Likert scale. No other differences were significant (all *p’s* > .05). Post-hoc analyses of the interaction effect revealed that for the sub-scale happy, recall induced significantly greater responses compared to pictures, $p < .05$.





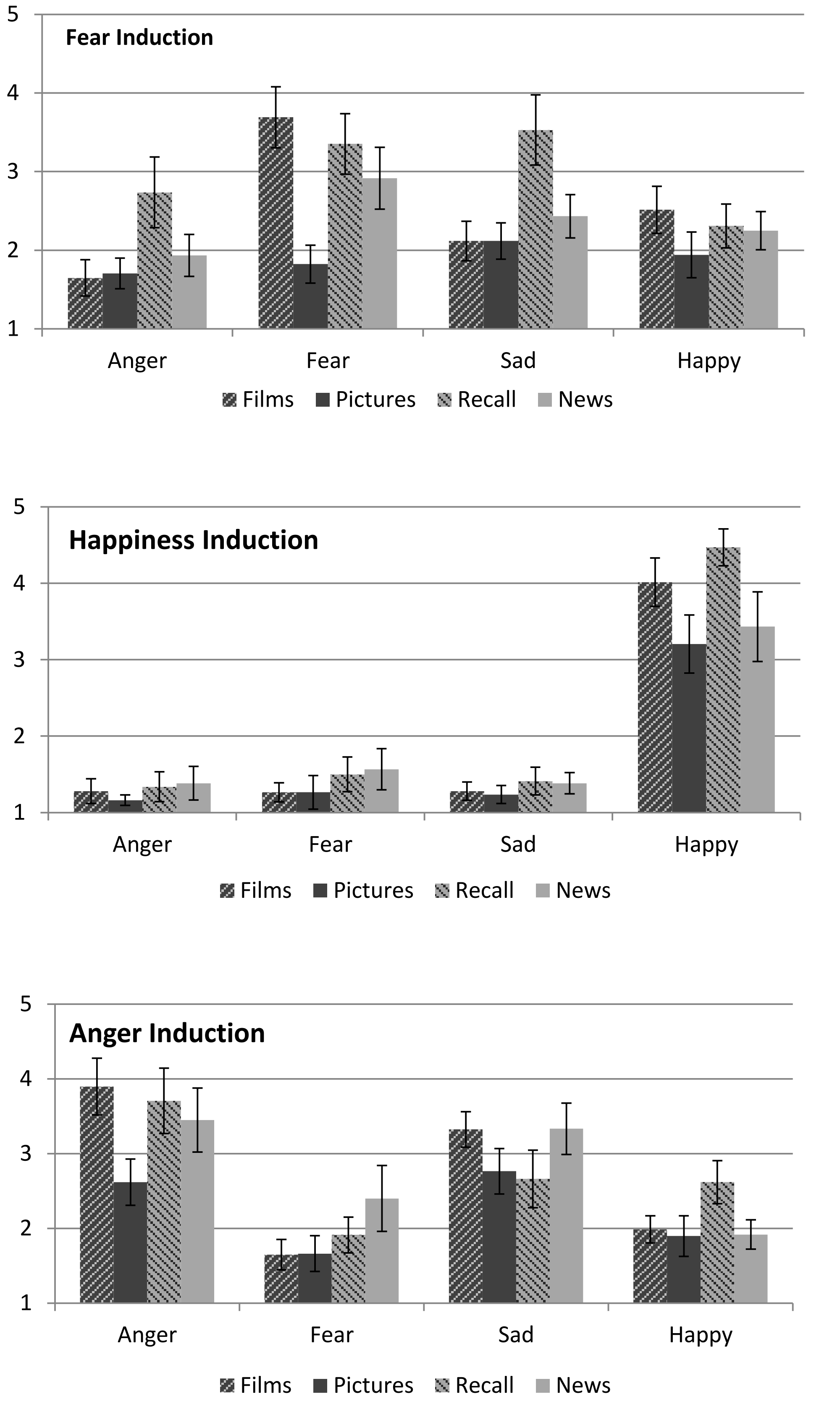


Figure 2.4. ***Mean responses to emotion sub-scales as a function of technique used, for each of the emotions induced (error bars represent standard deviation; response scale ranged from 1 to 7).***

Specificity Analysis

In order to examine whether target emotions were induced independently of the non-target emotions, simple contrasts were run with the target emotions as the reference point. For the neutral induction the reference emotion used was happiness. For the anger inductions simple contrasts showed that overall responses to the target emotion were significantly higher than all non-target emotions (all *p's* $< .05$), and there was a significant interaction effect of Emotion x Technique for the contrast between the target anger and non-target sadness ($p < .05$) but not with fear ($p = .05$) or happy ($p = .42$). Post-hoc analyses show that this difference between anger and sad items was only present in the recall group ($p < .01$).

Within the fear inductions overall responses to the target emotion were significantly higher than all non-target emotions (all *p's* $< .05$). There was also a significant interaction effect of Emotion x Technique for the contrast between the target fear and non-targets anger ($p < .01$) and sadness ($p < .01$) but not happy ($p = .23$). Post-hoc analyses show that the target emotion responses were significantly higher than responses to anger items within the film group ($p < .01$) and news group ($p < .05$), and compared to the responses for sad items within the film group ($p < .01$).

For the sad inductions, again all contrasts with the target emotion and non-targets were significant (all *p's* $< .01$), and there was a significant interaction effect of Emotion x Technique between the target sad and non-target anger ($p < .05$), but no significant interaction for contrasts with fear ($p = .11$) and happy ($p = .15$). Post-hoc analyses show that this difference between responses for the target sad and non-target anger was significant in all technique groups (all *p's* $< .01$).

For the happy inductions, all contrasts with the target emotion were significant (all *p's* $< .01$) but there were no significant interaction effects (all *p's* >

.10). With the neutral inductions overall responses to the happy sub-scale were significantly higher than all other emotion sub-scales (all *p's* $< .05$). There was also a significant interaction effect of Emotion x Technique for the contrast between happy and anger ($p < .01$) and happy and sadness ($p < .05$) but not fear ($p = .07$). This difference between responses to happy and anger sub-scales were only significant in the recall ($p < .01$) and news groups ($p < .01$), and responses to happy were greater than sad sub-scales only in the recall ($p < .01$) and news groups ($p < .01$).

Self-Report Measures

In order to examine the relationship between the two different self-report measures used in the study we ran bivariate correlations with the reported changes in valence and arousal and the reported experiences of each discrete emotion. Because the direction of the changes in arousal and valence is important in this instance we have used the original data, not the reverse coded data necessary for the means comparisons. The results of the Pearson's correlations are shown in Table 2.4.

For the arousal scale there was a significant positive relationship between expected changes in arousal and reported experiences in target-emotions for fear $r = .34$, $p < .05$, and anger $r = .30$, $p < .05$, however for sad and happy inductions no relationships between changes in arousal and target-emotion ratings were significant. Also, no correlations between changes in arousal and non-target emotion ratings were significant. For the measurement of valence, the results show significant positive relationships between expected changes in valence and reported experiences of the target emotions for anger $r = .25$, $p < .05$, sad $r = .47$, $p < .01$, and happy $r = .31$, $p < .05$, inductions. However, for the fear induction there was no significant relationship between expected changes in valence and reported experiences of fear.

There were a number of significant correlations between expected changes in valence and reported experiences of non-target emotions. For the anger induction expected changes in valence were positively correlated with reported experiences of sadness $r = .28$, $p < .05$, and negatively correlated with reported experiences of happiness $r = -.31$, $p < .05$. With the sadness induction expected changes in valence were positively correlated with reported experiences of anger $r = .27$, $p < .05$, and fear $r = .28$, $p < .05$. For the happiness inductions, expected changes in valence were negatively correlated with reported experiences of anger $r = -.29$, $p < .05$, and sadness $r = -.31$, $p < .05$. For the neutral emotion inductions there was a negative relationship between expected changes in valence and reported experiences of sadness $r = -.25$, $p < .05$. No other correlations with the changes in valence were significant.

Table 2.4. ***Pearson's correlation between target emotion responses for the PANAS scale and corresponding SAM responses (sig in parentheses)***

	Arousal Changes for Emotion Induced				**Valence Changes for Emotion Induced**			
Target Emotion:	**Anger**	**Fear**	**Sad**	**Happy**	**Anger**	**Fear**	**Sad**	**Happy**
Anger	.30*	.15	-.09	-.06	-.25*	.08	-.28*	-.31*
	(.02)	(.22)	(.46)	(.61)	(.04)	(.52)	(.03)	(.01)
Fear	.17	.34*	-.18	-.14	-.12	-.10	-.22	-.04
	(.18)	(.01)	(.15)	(.27)	(.34)	(.40)	(.08)	(.72)
Sadness	-.08	-.06	.02	.19	-.27	-.28*	-.47**	-.16
	(.54)	(.65)	(.86)	(.12)	(.03)	(.02)	(.00)	(.20)
Happiness	-.20	.08	-.01	.10	.29	.06	.31*	.31*
	(.12)	(.51)	(.94)	(.43)	(.02)	(.65)	(.01)	(.01)
Neutral	.07	.19	-.15	.14	.11	.03	.25*	.12
	(.59)	(.13)	(.22)	(.28)	(.38)	(.81)	(.05)	(.35)

* $p < .05$ ** $p < .01$

2.3.3 Summary

This experiment is one of very few to directly compare multiple different emotion- and mood-induction techniques across a range of discrete emotions (see Martin, 1990; Salas et al., 2012; Westermann et al., 1996). The results are broken down into the intensity of the emotion induced, and the specificity of the induction. Overall films and autobiographical recall appear to be the most effective techniques, compared to pictures and news reports.

Comparing the magnitude of changes in valence there were no significant differences between the techniques used. However, the magnitude of changes in arousal was greater when film clips were used, compared to news reports. For inductions of fear, films and recall induced greater responses to the congruent PANAS sub-scale suggesting a more intense experience compared to pictures, and for inductions of happiness, recall induced greater responses to the congruent sub-scale compared to pictures. Films and recall also came out as the most effective techniques with regards to the specificity of the emotions induced. For inductions of fear, film clips and news reports produced the greatest distinction between the experience of the target and non-target emotions, whereas for inductions of anger recall produced the greatest distinction. It should be noted that these results should not be used to discredit any of the techniques used, but rather are useful to inform researchers looking specifically for a technique that will create the largest changes in emotional state, and the most specific inductions.

Although the specificity analysis shows responses to the target emotion for fear inductions were significantly greater than all other responses, within the intensity analysis there is evidence that within these same fear inductions the responses to the sad sub-scale were significantly greater than to the anger sub-scale. Further analysis reveals these responses to the sad sub-scale were greater in the recall group compared to films and pictures. Although recall was shown to produce some of the greatest intensity levels for target emotions the fact that it also produces some quite high experiences of non-target emotions brings into question whether it is in fact a reliable technique. Autobiographical recall techniques allow participants to tap into real experiences of emotion and re-experience them in the moment, however this also means there is little control over what events are used to elicit the emotion and thus it is likely other emotional experiences will also be re-established.

Comparing the techniques was the primary goal of this experiment however there are also interesting comparisons to be made between the inductions of the emotions themselves. On average, inductions of happiness and sadness were much more successful at inducing the specific emotion without also inducing non-target emotions. Although the specificity analysis shows responses to the congruent sub-scales for inductions of fear and anger were significantly greater than responses to non-target sub-scales, the intensity analysis showed that response to the non-target sub-scale sad were, in both cases, also significantly greater than other sub-scales. In addition, the changes in valence for happy and sad inductions were significantly greater than anger and sad, suggesting more intense experiences of these emotions.

As a comparison group many studies use a neutral induction in their design (e.g. Knott & Thorley, 2013) however the results of this study highlight the need for clarity when opting for this induction. Changes in arousal and valence for the neutral induction were expected to be minimal however for arousal the changes were greater for the neutral inductions compared to the sad inductions. In addition, ratings on the emotion sub-scales were significantly higher for the happy scale compared to all other scales, and significantly greater for the sad scale compared to fear. Further analysis of the happiness ratings showed they were greater in the recall group compared to the pictures group. These results highlight the ambiguity that comes with a neutral condition. The term neutral may be used to describe a range of emotion and mood states simulating happiness, contentment, and boredom (to name just a few). Thus, when employing a neutral condition researchers should be wary to clarify its exact nature.

An additional purpose of this experiment was to use two very different but effective measurement scales in order to aid comparisons between studies. As a result of this manipulation the relationship between the scales could be evaluated. All correlations were in the expected direction showing no immediate concerns with either scale. The changes in valence corresponded well to the target emotion responses for the PANAS scales, with the exception of the fear induction. There is a lot of variability within the intensity of the PANAS scores for fear between the different techniques. This alongside the fairly small changes in valence may account for the lack of an overall correlation. In addition, there was no significant relationship between the changes in arousal and the reported experiences of sadness and happiness. Given that noticeable changes in arousal for the sad inductions are not likely this may contribute to a non-significant relationship with subjective experiences of the emotion, however the same cannot be said for happy inductions. The most likely explanation amounts to the definition of happy. Like with the neutral inductions, the term can be used to describe a range of positive emotions. The variation in arousal among these possible emotional states may have created additional noise in the data.

It is also necessary to take caution when evaluating the SAM results since the variation within participants was quite high, and calculating changes in valence and arousal does not account for the possibility that participants' emotional states may have been similar to the target emotion prior to the induction. Researchers may benefit from using the raw responses from SAM scales, especially when comparing between participants, since these nevertheless indicate the current emotional state of the participant.

2.4 Conclusions

This research examined in this chapter focusses on the use of various emotion induction techniques and experimental evidence is presented supporting the use of the different methods, whilst also highlighting important considerations. Emotion inductions are used frequently in psychology research (Coan & Allen, 2007) and yet it is difficult to know which techniques will give the best results. The study presented in this chapter expanded on previous research (e.g. Ellard et al., 2012; Kučera & Haviger, 2012; Salas et al., 2012) by examining a range of discrete emotions along with a range of induction techniques.

In the introduction EITs were considered in three categories: audio-visual stimuli, internally generated experiences, and interactive manipulations. Although interactive manipulations have been shown to be highly effective at inducing ecologically valid and intense emotional experiences (Kučera & Haviger, 2012; Lobbestael et al., 2008; Roberts et al., 2007) the ethical and practical limitations of such methods reduce their suitability for many experiments, and as such Experiment 1 focused only on comparing different presentations of audio-visual stimuli and autobiographical recall.

Autobiographical recall was shown to be one of the better techniques reviewed. The key advantages to this technique being the ecological validity of the emotions experienced. The emotions elicited are based on real-life experiences of the participant, levels of personal relevance are therefore very high which increases the strength of emotional experiences (Ellard et al., 2012). However, there is limited experimental control over what specific experiences are recalled, and with everyday emotional events there is often a cocktail of emotions induced thus compromising the specificity of the target emotion.

In terms of audio-visual stimuli it appears film clips may be the most effective technique. From a practical standpoint there are various normed film sets available to choose from, covering a wide range of emotions (Bartolini, 2011; Gross & Levenson, 1995; Johnathan Rottenberg, Ray, & Gross, 2007; Schaefer et al., 2010). These film clips (all spoken in English) have even been shown to be effective with non-native English speakers (e.g. Hagemann et al., 1999). Experiment 1 also suggests that film clips are a more effective technique than pictures. The intensity and specificity of emotions induced appears to be greater for film clips, possibly due to their more immersive nature, and the variations within the picture slideshows. It was hypothesized that the diversity gained though using multiple images would increase the generalizability of the inductions and therefore increase the overall effectiveness, however, this was not supported. News reports as an induction technique shows potential however further work developing the stimuli is needed. In Experiment 1 news reports, as with all the techniques used, elicited the expected responses in each emotion induction, however the intensities were relatively low. To increase the effectiveness of this method the reports would need to be tailored more to the target emotions. It may also be worth using video clips in place of written reports, however this limits the researcher's future ability to edit and tailor the information included.

As well as the varying efficiency of the techniques there are also differences in the ease at which certain emotions can be induced. Experiment 1 revealed much more effective inductions of sadness and happiness compared to fear and anger. Sadness and happiness, although distinctively negative and positive, can be used to describe many more variations in emotional state than fear and anger. This generalisation may increase the likelihood of participants reporting experiencing them. It may also be that within a controlled experimental environment these emotions are easier to elicit.

Coppin and Sander (2016) reviewed theoretical approaches to emotion and consider the view that emotions are a multicomponent phenomenon, composed of expression, action tendency, bodily reaction, feeling, and cognitive appraisals. Several of these components relate to a response motivated by the emotion however, if the responses in a laboratory are inhibited or suppressed, the subjective experience of the emotion may also be reduced. Fear, and sometimes anger, is predominantly associated with immediate behavioral responses to a threat, whereas happiness and sadness are associated with more measured, long-term motivations, by which associated information cumulates to guide future behaviour. In a laboratory environment, inductions of fear and anger have no real purpose, no action to guide, and therefore the subjective experience may be automatically down-regulated.

Chapter 3

Emotion-Congruent Spontaneous False Memories

3.1 Overview

Research into the effects of emotion on spontaneous false memory production has so far been limited to generic moods. Often this generalisation comes about by focussing emotion manipulations on changes in arousal and valence. Arousal and valence are important dimensions of emotions and can account for many of the effects emotion has on cognitive functions. However, they are not all encompassing as there is more to emotional experiences than these two dimensions. Emotions are led by appraisals and as such the distinct motivations associated with discrete emotions also affect cognitive resources, such as attention and memory. In this chapter, literature on emotion and spontaneous false memories is reviewed, and two experiments are presented, in which the effect of discrete negative emotions on false memory production is examined. First, by manipulating and comparing sadness and fear, two discrete negative emotions with similar valence levels but different arousal levels, and second with anger and fear, two discrete negative emotions with similar levels of both valence and arousal. The subsequent results provide evidence for discrete emotion-congruent spontaneous false memories, irrespective of arousal and valence.

3.2 Introduction

Spontaneous false memory production is enhanced for mood-congruent stimuli. Ruci, Tomes, and Zelenski (2009) investigated the effect of positive and negative valence on spontaneous false memory production for positive, negative, and neutral stimuli. The authors predicted that manipulating both the mood of participants and the emotion of the material would induce a mood congruence effect in memory. The recognition results supported this prediction. False memory production was enhanced for emotional material that matched the emotional state of the participant at encoding. This finding was replicated by Knott and Thorley (2013) who in addition, showed that mood-congruent false memories persisted over a one week delay, while incongruent and neutral false memories did not.

The focus of these studies was on differences in valence, whereas other research has shown that the level of arousal associated with emotions is another important factor to consider. In fact, valence and arousal have been shown to have very different effects on false memories. For example, Brainerd, Holliday, Reyna, Yang, and Toglia (2010) measured the effects of arousal and valence when varied orthogonally across materials. False memory rates were found to be higher for low valence and high arousal, however the effects of arousal were only present for negatively valenced material (Steinmetz, Addis, & Kensinger, 2010). In contrast, Corson and Verrier (2007) examined the effects of arousal and valence on false memory by inducing a range of discrete emotional states. A temporary mood induction technique was used to induce happiness, serenity, anger, and sadness; chosen to give distinctions between high and low arousal, and positive and negative valence. False memories were measured for neutral stimuli and the results revealed that high arousal led to more false memories, but there was no effect for valence. The authors concluded that higher arousal increased confidence leading to an increase in the number of false memories being reported. Although this research goes to furthering our understanding of how arousal and valence affect false memory production, it fails to address any other dimensions of emotion that may also have an effect on false memory production.

In a review of the emotion and memory research literature, Levine and Pizarro (2004) argued that it made little sense to limit research to the effects of emotional arousal on memory, stating that people may feel elated, terrified, despairing, or furious – but they are never just “aroused”. Many cognitive theories of emotion stress the importance of appraisals. Emotions help people evaluate their environment based on their specific goals and guide appropriate action (Frijda, 1988; Moors et al., 2013). This aspect of emotion cannot be explained in terms of arousal and valence and thus for a complete understanding of the effects of emotion we need to look beyond these effects.

Lench, Flores, and Bench (2011) conducted a meta-analysis of studies using discrete emotions as the independent variable and evaluated the range of results according to different models of emotion; specifically models of the effect emotion has on cognition, behaviour. The effects of each of the discrete emotions reviewed gave conflicting evidence for dimensional models, such as valence and arousal. Although the results of the meta-analysis are restricted by the selection criteria, the authors present evidence in favour of evaluating discrete emotions rather than focusing on dimensional differences.

Research has recently shown how important specific emotional states may be in false memory. Although caution is appropriate when generalising from psychopathology to everyday emotional experiences, Howe and Malone (2011) showed specific emotion congruent effects for false memories in individuals diagnosed with a major depressive disorder (Moritz et al., 2005). Howe and Malone (2011) warned clinical practitioners, during discussions in therapy, not only to be aware of the presence of false memories, but also of the possibility of inducing new false memories. This paper raises an interesting question of whether this congruency effect is also present within typical everyday emotional experiences, and highlights the importance of understanding what effect discrete emotional states have on memory production.

In addition, the effect of emotion on false memory production has practical implications for scenarios in which memory accuracy is questioned. In many legal trials memory serves as the only source of evidence. If an eyewitness' memory is biased towards information deemed most appropriate according to their emotional state then it is important to understand to what extent this effect occurs and, more so, to what extent this biasing effects the production of false memories. The aim of this chapter is therefore to expand on the work of Ruci et al. (2009) and Knott and Thorley (2013), by manipulating and comparing distinct negative emotions, to investigate whether there is a discrete emotion-congruency effect with spontaneous false memories.

3.2.1 Theoretical considerations

According to theories of spreading activation such as associative activation theory (AAT; Howe et al., 2009) and Bower's Network Theory of Affect (Bower, 1981) we would expect to see an increase in the production of false memories for material that is emotionally congruent to that of the participant. AAT hypothesizes that knowledge is stored in a semantic network and when a concept is activated, this activation spreads to other neighbouring concepts. Once activation reaches a threshold the source of this activation can be misattributed to the original stimulus, subsequently producing a false memory. Bower's Network Theory of Affect similarly suggests that emotion concepts and memories are interconnected and so when an emotion is experienced there is an automatic activation of events in memory related to that emotion (and vice versa). Consequently, as discrete emotions activate associated concepts and related emotional experiences we would expect to see an increase in false memories produced as the thresholds are more likely to be reached. These theories are also consistent with appraisal theories of emotions. Cognitive processing is enhanced for information relevant to a person's emotional state (Oatley & Johnson-Laird, 2014) therefore relevant information is more readily activated and related false memories are more likely to be produced.

Fuzzy-trace theory (FTT; Bookbinder & Brainerd, 2016) would also predict these effects. FTT states that at encoding both verbatim and gist memory traces are stored, and that as verbatim traces deteriorate gist traces are more readily available and therefore lead to the retrieval of false memories. These gist traces contain semantic information associated with the remembered stimuli as well as the emotional state and therefore would lead to an increase in false recognition of emotionally congruent information.

3.2.2. Experimental Paradigm

As with many of the experiments mentioned in this chapter, the following experiments measured false memories using the Deese/Roediger-McDermott paradigm (DRM; Deese, 1959; Roediger & McDermott, 1995). The DRM paradigm (explained in full in Chapter 1) is a popular procedure used to study the spontaneous creation of false memories. DRM word lists are typically 10-15 words in length, and are arranged in descending order of associative strength to one non-presented word, known as the critical lure.

The presence of these critical lures in memory is measured via a recognition test, following a distractor task. In order to further validate the false memories reported the following experiments also measure recollective experience. Specifically, upon reporting that they recognise a word as being presented in the original lists, participants are asked to give a remember-know-guess judgement; where ‘remember’ measures the presence of a distinctive recollective experience, ‘know’ measures a sense of familiarity, and ‘guess’ measures a level of uncertainty.

In order to experimentally induce the discrete emotions prior to encoding the participants are shown short film clips, taken from Rottenberg et al. (2007).

Previous emotion-congruent false memory studies have successfully used this technique (Knott & Thorley, 2013; Ruci et al., 2009). In Chapter 2 it was argued that autobiographical recall would produce stronger emotional experiences. However, for the following experiments, the use of this technique would confound the memory results for the emotion list words, thus film clips are used to induce the desired emotions. The same can be said for the more descriptive self-report scales, for example the Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988), therefore the self-assessment manikin (SAM; Bradley & Lang, 1994) is used to get self-report measures of arousal and valence throughout the experiments.

Finally, as a comparison group to the experimental negative-emotion groups the experiments employ a control group where no emotion manipulation is used. Typically, control groups display quite a positive affective state (Diener & Diener, 1996), and as such there are advantages to controlling the emotional state by presenting a neutral emotion induction. However, there is also much controversy over what constitutes a neutral emotion. In Chapter 2 the issues with defining neutral emotion were discussed, and the possible variations from boredom-like to happy-like emotional states were highlighted as a key consideration. In addition, the intent is to conduct comparisons between the experimental negative emotion groups and a true control group, therefore no emotion induction is used.

3.3. Experiment 2:

Emotion Congruent DRM False Memories with Fear and Sadness

Experiment 2 was designed to investigate the emotion congruency effect, which is well established in false memory literature with generic emotional inductions (e.g., negative). Rather than use a non-specific negative mood induction, two negative emotions, fear and sadness, were manipulated. It was predicted that the emotion congruency effect would extend to these specific negative emotions.

3.3.1. Method

Participants

A total of 74 University students (31 male) participated voluntarily in the experiment and were awarded course credits for their time. All participants were between the ages of 18 and 35 (M = 24.30, SD = 4.89) and were enrolled on either an undergraduate or postgraduate course at City, University of London.

Design

A 3 (Emotion: sad, fear, control) x 3 (List: sad, fear, neutral) mixed design was used with a standard DRM paradigm, and a recognition memory test as the dependent variable. Emotion group was the between group variable for which participants were randomly assigned, and List was the within group variable. Recognition responses were taken for target words, filler items, and critical lures. A post-hoc measure of recollective experience was taken whereby participants were asked if 'old' responses were based on either *remember*, *know*, or *guess* judgements; where 'remember' measures the presence of a distinctive recollective experience, 'know' measures a sense of familiarity, and 'guess' measures a level of uncertainty. Instructions were based on those from (Rajaram, 1993).

Materials

For the emotion inductions short film clips were taken from Rottenberg et al. (2007), and the control group underwent no induction procedure. The film clips were chosen because they have been normed previously and elicited the highest levels of the desired emotion, as well as being specific to that emotion. The clip for the sad induction was from "The Champ" in which a boy cries out as he watches his father die. The clip for the fear induction was from "Silence of the Lambs" in which a woman is pursuing a killer through a dark basement.

Since only the effects of emotion at encoding were of interest in this study, prior to retrieval all participants watched a short clip from a nature documentary. This ensured that all participants were in a comparable, somewhat neutral, emotional state at retrieval. To monitor emotional states throughout the experiment the SAM was used to get self-report measures of arousal and valence. As noted, this questionnaire uses pictorial representations of arousal and valence alongside a 9-point scale thus enabling us to get a measure of these two dimensions without confounding the memory results by introducing emotion words; we especially wanted to avoid using the critical lures.

For the to-be-remembered stimuli, nine 12-item DRM lists were created from the University of South Florida free association norms (Nelson, McEvoy, & Schreiber, 2004; Roediger & McDermott, 1995). Of these lists, three were associated with sadness, three with fear, and three were neutral (i.e. not related to an emotion). The critical lures for the lists were *sad, upset, sorrow, fear, scared, danger, needle, cup,* and *slow* (full lists in Appendix C). The list presentation order was randomised, average backward associative strength (BAS)[6] was matched between the negative lists but was slightly higher for neutral lists, and arousal and valence scores were taken for the list words in each list[7] (see Table 3.1).

[6] BAS is taken from the University of South Florida free association norms website (Nelson et al., 2004) and represents the rate at which a list word associates to the lure.
[7] Arousal and valence scores for each word is taken from the database of Affective Norms for English Words (Bradley & Lang, 1999).

Table 3.1: ***Average BAS, arousal, and valence scores for fear, sad, and neutral DRM lists.***

	BAS		Arousal		Valence	
	M	*SD*	*M*	*SD*	*M*	*SD*
List:						
Neutral	.21	.19	4.91	1.25	5.24	2.15
Fear	.10	.15	5.29	1.07	5.27	1.93
Sad	.12	.14	4.96	1.23	4.60	1.89

Procedure

After giving written and verbal consent all participants were given a SAM to complete. Comprehensive instructions were given initially to ensure full understanding of the scales, and subsequent SAMs were then accompanied with basic instructions in order to avoid too long a delay between the emotion inductions and encoding. Participants in the sad and fear emotion groups were instructed to watch the corresponding film clips, and were then given another SAM. All participants were then instructed to listen carefully to the nine DRM lists, presented in auditory form with 1 second between each spoken word, and were aware they would be tested on their memory of the words later. The neutral film clip was then presented, acting as a distractor task in addition to the emotion induction, and was followed by a final SAM. Last, instructions for the memory test were given. Here, participants were asked to decide if they recognised each word presented to them as being in the original lists by responding to the words as 'old' or 'new'. Once done for all the words, if participants recognised a word as 'old' they were then asked whether this decision was based on *remember*, *know*, or *guess* judgements (*remember* meaning they experienced a memory of the word, *know* meaning the word feels familiar but they do not have the explicit memory of it, and *guess* meaning they are just guessing that it was presented).

3.3.2. Results

Of the original 74 participants, 9 were removed due to missing data, and 3 were removed because their valence scores increased following the emotion induction procedure, leaving 21 in the control group, 23 in the sad group, and 18 in fear group. Post hoc power analyses were conducted showing that for an 80% chance of finding a medium effect size with an alpha of .05 we needed 90 participants.

Emotion Manipulation

At the beginning of the experiment no significant differences were found between the groups for arousal, $F(2, 61) = .92$, $p = .40$, or valence, $F(2, 61) = .98$, $p = .38$. Following the emotion induction the differences between groups were significant for arousal $F(2, 61) = 11.69$, $p < .01$, and valence, $F(2, 61) = 17.91$, $p < .01$. Pairwise-comparisons, with a Bonferroni adjustment, showed that arousal scores within the fear group ($M = 6.44$, $SD = 1.82$, *95% CI* [5.54, 7.35]) were significantly higher than the sad group (M=3.87, SD=1.79, *95% CI* [3.90, 4.64]) and control group (M=4.62, SD=1.53, *95% CI* [3.92, .32]); however, the difference between the sad and control groups was not significant. The valence scores were significantly lower within the sad group (M=3.21, SD=1.48, *95% CI* [2.58, 3.86]) and fear group (M=4.06, SD=1.63, *95% CI* [3.24, 4.86]) compared to the control group (M=5.95, SD=1.53, *95% CI* [5.25, 6.65]); however, the difference between the sad and fear groups was not significant. These results validate the emotion induction procedure as they confirm the expected changes in arousal and valence for the desired emotions. Fear is considered to be negative valence and high arousal emotion, whereas sadness is negative valence and low arousal. Thus, it was expected that the valence scores between the groups would not differ but the arousal would. In line with this we also expected the arousal between sad and control not to differ significantly. Following presentation of the neutral clip (at retrieval) there were again no significant differences between groups for arousal, *F*(2, 61) = .09, *p* = .91, or valence, *F*(2, 61) = .25, *p* = .78.

Recognition Responses

The proportion of correct recognition of old words, false recognition of critical lures, and false recognition of filler words were coded. Separate 3 (Emotion: fear, sad, control) x 3 (List: fear, sad, neutral) repeated measures ANOVAs were conducted for true and false recognition responses, as well as for *remember*, *know*, and *guess* responses. Where the assumption of sphericity was violated the Greenhouse-Geisser statistics are reported, and all post-hoc tests were run with a Bonferroni correction.

False recognition of critical lures. For false recognition of critical lures (see Table 3.2 for descriptive statistics) there was a significant main effect of List, *F*(1.61, 95.35) = 18.54, *p* < .01, η_p^2 = .24, but not Emotion, *F*(2, 59) = .36, *p* = .69, η_p^2 = .01, or List x Emotion interaction, *F*(3.23, 95.35) = .39, *p* = .78, η_p^2 = .01 (Figure 3.1). Pairwise comparisons for the main effect of List showed that recognition of fear related critical lures (*M* = .93, *SD* = .18) was significantly higher than sad (*M* = .85, *SD* = .18), *p* < .01, and neutral lists (*M* = .70, *SD* = .30), *p* < .01, and that recognition of sad related critical lures was significantly higher than neutral, *p* < .01. In contrast to what was hypothesised, these results show no indication of a discrete emotion-congruent effect on false memory production.

For *remember* recognition of critical lures (Figure 3.2) there was a significant main effect of List, *F*(2, 118) = 4.04, *p* < .05, η_p^2 = .06, but again no significant effect of Emotion, *F*(2, 59) = .48, *p* = .62, η_p^2 = .02, and no interaction effect of List x Emotion, *F*(4, 118) = 1.35, *p* = .26, η_p^2 = .04 (Figure 3.2). Pairwise comparisons for List showed that recognition of fear critical lures (*M* = .41, *SD* = .39) was significantly greater than sad (*M* = .27, *SD* = .31), $p < .05$. The difference between neutral critical lures (*M* = .32, *SD* = .26) and fear was not significant however, $p = .29$, nor was the difference between neutral and sad, $p = .77$.

For *know* recognition of critical lures there was a significant main effect of List, $F(2, 118) = 3.52$, $p < .05$, $\eta_p^2 = .06$, but no significant effect of Emotion, $F(2, 59) = .20$, $p = .82$, $\eta_p^2 = .01$, and no interaction effect of List x Emotion, $F(4, 118) = .96$, $p = .43$, $\eta_p^2 = .03$. Pairwise comparisons for List reveal that responses to sad critical lures (*M* = .32, *SD* = .23) were significantly greater than neutral critical lures (*M* = .20, *SD* = .24), $p < .05$, but that no other differences were significant (all *p's* > .05). For *guess* recognition of critical lures there was no significant main effect of List, $F(2, 118) = 1.16$, $p = .32$, $\eta_p^2 = .02$, no significant effect of Emotion, $F(2, 59) = 1.63$, $p = .20$, $\eta_p^2 = .05$, and no interaction effect of List x Emotion, $F(4, 118) = 1.01$, $p = .41$, $\eta_p^2 = .03$.

Table 3.2: ***False recognition responses to critical lures as a function of emotion and list***

	Fear Group				Sad Group				Control Group			
			95% CI				*95% CI*				*95% CI*	
	M	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*
Overall Recognition												
Fear lists	.94	.06	.83	1.06	.91	.04	.84	.99	.94	.03	.88	1.00
Sad lists	.83	.04	.75	.92	.84	.04	.76	.93	.87	.04	.80	.95
Neutral lists	.76	.06	.62	.90	.67	.06	.54	.80	.70	.07	.56	.84
Remember												
Fear lists	.54	.09	.34	.74	.35	.08	.19	.51	.38	.09	.20	.56
Sad lists	.24	.08	.08	.40	.35	.06	.22	.47	.21	.07	.06	.35
Neutral lists	.31	.06	.18	.45	.33	.05	.23	.44	.32	.06	.19	.45
Know												
Fear lists	.22	.06	.10	.35	.33	.07	.19	.48	.29	.06	.17	.41
Sad lists	.39	.06	.26	.52	.30	.05	.21	.40	.29	.05	.19	.39
Neutral lists	.24	.05	.13	.35	.19	.05	.08	.29	.19	.06	.07	.31
Guess												
Fear lists	.19	.07	.04	.33	.23	.06	.10	.37	.22	.07	.08	.36
Sad lists	.20	.07	.05	.36	.19	.05	.07	.30	.38	.07	.23	.53
Neutral lists	.20	.07	.06	.34	.14	.04	.07	.22	.19	.05	.09	.29

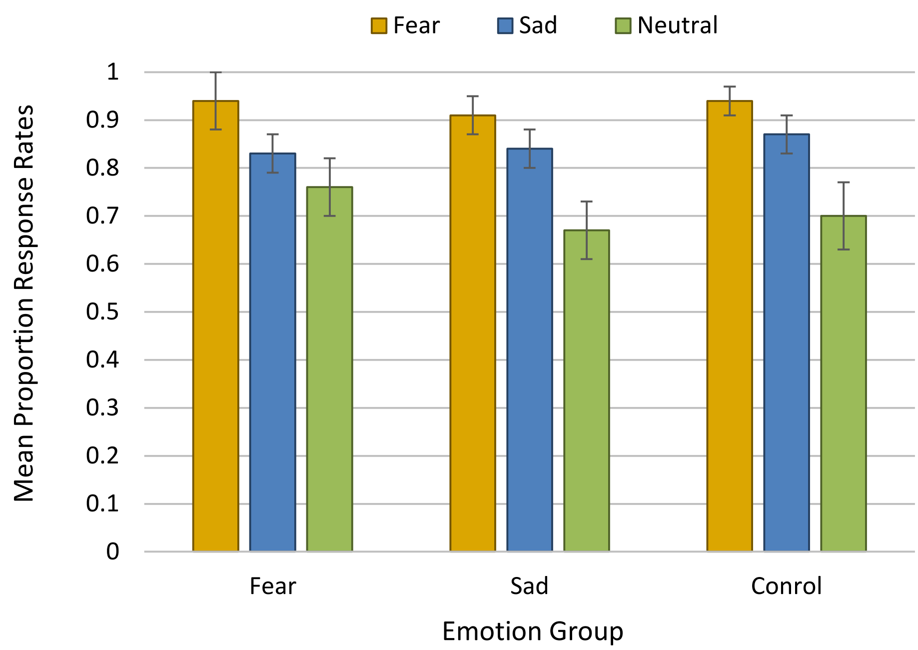


Figure 3.1. ***Proportion of 'old' responses to critical lures as a function of emotion group and list emotion (Error bars represent SE)***

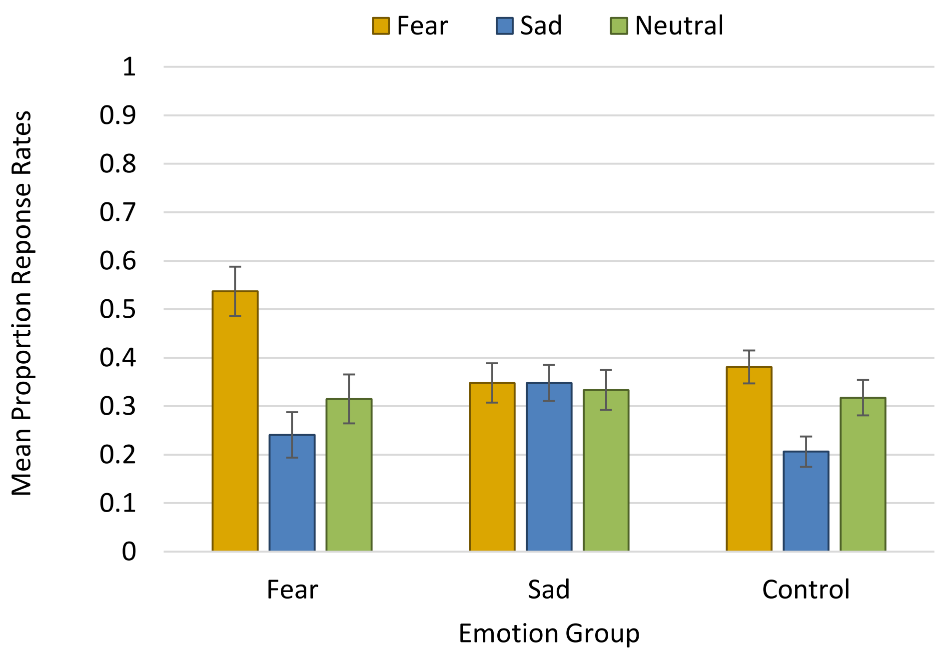


Figure 3.2. ***Proportion of 'remember' responses to critical lures as a function of emotion group and list emotion (Error bars represent SE)***

True recognition of list items. For true recognition responses (see Table 3.3 for descriptive statistics) there was a significant effect of List, $F(1.80, 106.40) = 9.615$, $p < .01$, $\eta_p^2 = .14$, but not Emotion, $F(2, 59) = 2.33$, $p = .11$, $\eta_p^2 = .07$, or List x Emotion interaction, $F(3.61, 106.40) = .32$, $p = .85$, $\eta_p^2 = .01$. Pairwise comparisons for List show recognition of fear related list items ($M = .79$, $SD = .17$) was significantly higher than neutral ($M = .68$, $SD = .21$), $p < .01$, and that recognition of sad related list items ($M = .79$, $SD = .19$) was significantly higher than neutral, $p < .01$. The difference between fear and sad was not significant, $p = 1.00$. For *remember* responses to list items there was no significant effect of List, $F(2, 118) = 1.37$, $p = .26$, $\eta_p^2 = .02$, Emotion, $F(2, 59) = 1.32$, $p = .28$, $\eta_p^2 = .04$, or List x Emotion interaction, $F(4, 118) = .11$, $p = .98$, $\eta_p^2 = .00$. Again, there is no apparent effect of the emotion manipulation.

For *know* responses to list items there was a significant effect of List, $F(1.70, 99.90) = 17.52$, $p < .01$, $\eta_p^2 = .23$, but not of Emotion, $F(2, 59) = .19$, $p = .82$, $\eta_p^2 = .01$, or List x Emotion interaction, $F(3.39, 99.90) = .37$, $p = .80$, $\eta_p^2 = .01$. Pairwise comparisons for List show that fear related list items ($M = .25$, $SD = .16$) were significantly higher than sad related list items ($M = .17$, $SD = .15$), $p < .05$, and neutral ($M = .11$, $SD = .11$), $p < .05$, and that sad related list items were significantly higher than neutral, $p < .05$. For *guess* responses to list items there was no significant effect of List, $F(2, 118) = 2.40$, $p = .10$, $\eta_p^2 = .04$, Emotion, $F(2, 59) = .05$, $p = .96$, $\eta_p^2 = .00$, or List x Emotion interaction, $F(4, 118) = .18$, $p = .95$, $\eta_p^2 = .01$.

Table 3.3: ***Recognition responses to target items as a function of emotion and list***

	Fear Group				Sad Group				Control Group			
			95% CI				*95% CI*				*95% CI*	
	M	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*
Overall Recognition												
Fear lists	.83	.04	.76	.91	.81	.04	.72	.89	.73	.04	.64	.82
Sad lists	.83	.03	.76	.90	.79	.03	.72	.86	.75	.05	.66	.85
Neutral lists	.70	.05	.60	.81	.72	.04	.63	.81	.61	.05	.51	.72
Remember												
Fear lists	.40	.06	.27	.52	.38	.05	.28	.48	.32	.05	.22	.42
Sad lists	.35	.05	.24	.45	.31	.04	.22	.40	.30	.06	.18	.42
Neutral lists	.41	.05	.30	.53	.40	.05	.29	.51	.33	.04	.25	.41
Know												
Fear lists	.17	.03	.11	.24	.19	.04	.11	.26	.16	.04	.08	.24
Sad lists	.28	.03	.21	.34	.25	.03	.18	.32	.23	.04	.15	.31
Neutral lists	.10	.02	.06	.14	.11	.02	.06	.16	.12	.03	.06	.17
Guess												
Fear lists	.27	.04	.18	.35	.24	.04	.15	.33	.25	.04	.16	.35
Sad lists	.20	.04	.11	.29	.21	.03	.15	.28	.21	.05	.10	.31
Neutral lists	.19	.03	.12	.26	.21	.04	.13	.28	.17	.04	.09	.25

It is interesting that although no emotion-congruency effects emerged in the *old* or *remember* response data there is evidence here within the *know* responses of a generic emotion-congruency effect. Participants in each of the negative emotion groups reported *knowing* that significantly more of the negative list items had been presented compared to the neutral items.

False recognition of filler items. For false recognition of negative and neutral fillers (see Table 3.4 for descriptive statistics) there was a significant effect of List, $F(1, 59) = 84.16$, $p < .01$, $\eta_p^2 = .59$, but not Emotion, $F(2, 59) = 2.03$, $p = .14$, $\eta_p^2 = .06$, or List x Emotion interaction, $F(2, 59) = 2.46$, $p = .09$, $\eta_p^2 = .08$. For *remember* responses there was a significant effect of List, $F(1, 59) = 11.13$, $p < .01$, $\eta_p^2 = .16$, but not Emotion, $F(2, 59) = 1.08$, $p = .35$, $\eta_p^2 = .04$, or List x Emotion interaction, $F(2, 59) = .30$, $p = .75$, $\eta_p^2 = .01$. For *know* responses there was a significant effect of List, $F(1, 59) = 33.24$, $p < .01$, $\eta_p^2 = .37$, Emotion, $F(2, 59) = 3.63$, $p < .05$, $\eta_p^2 = .11$, and List x Emotion interaction, $F(2, 59) = 3.69$, $p < .05$, $\eta_p^2 = .11$. For *guess* responses there was a significant effect of List, $F(1, 59) = 13.45$, $p < .05$, $\eta_p^2 = .19$, but not Emotion, $F(2, 59) = .08$, $p = .92$, $\eta_p^2 = .00$, or List x Emotion interaction, $F(2, 59) = .09$, $p = .91$, $\eta_p^2 = .03$. For all main effects of List (Table 3.5) the responses were greater for negative lists compared to neutral lists (all *p's* < .05).

Negative valence has been shown to increase response bias (Howe et al., 2010) and thus is it expected that responses to negative filler items would be higher than neutral. The increased semantic density between emotional stimuli has been shown to account for many of the effects of emotion on sensitivity and memory accuracy (Dougal & Rotello, 2007; Windmann & Kutas, 2001), and may account for the increased responding to filler items. The same, however, could also be said for responses to the critical lures, and therefore signal detection analysis was conducted.

Table 3.4: ***Recognition responses to filler items as a function of emotion and list***

	Fear Group				**Sad Group**				**Control Group**			
			95% CI				*95% CI*				*95% CI*	
	M	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*
Overall Recognition												
Negative lists	.66	.04	.58	.74	.54	.05	.43	.65	.46	.04	.38	.53
Neutral lists	.30	.06	.17	.42	.27	.05	.17	.37	.26	.05	.16	.36
Remember												
Negative lists	.15	.04	.06	.24	.13	.03	.06	.19	.08	.02	.03	.14
Neutral lists	.06	.02	.01	.11	.05	.02	.01	.10	.04	.02	-.01	.08
Know												
Negative lists	.23	.04	.15	.31	.14	.03	.08	.20	.10	.02	.04	.15
Neutral lists	.04	.02	.00	.08	.05	.02	.02	.09	.03	.01	.01	.06
Guess												
Negative lists	.28	.05	.19	.38	.28	.04	.20	.35	.28	.03	.20	.35
Neutral lists	.19	.05	.09	.29	.16	.03	.09	.24	.19	.05	.09	.29

Table 3.5: ***Main effect of List for filler recognition responses***

	Negative List		Neutral List	
	M	*SD*	*M*	*SD*
Measurement:				
Old	.55	.22	.27	.23
Remember	.12	.15	.05	.10
Know	.15	.15	.04	.07
Guess	.28	.17	.18	.19

Signal Detection Analysis

False memory data. Signal detection (*d'* and *criterion C*) analysis (Stanislaw & Todorov, 1999) for false memories was conducted by comparing responses for fear and sad related critical lures against responses to negative filler items, and for neutral related critical lures to neutral filler items. These scores were then entered into the same ANOVAs as above.

Sensitivity analysis. The *d'* scores for overall false recognition responses yielded no significant main effect of List, *F* (1.51, 89.10) = 2.78, *p* = .08, η_p^2 = .05, Emotion, *F*(2, 59) = 1.94, *p* = .15, η_p^2 = .06, or List x Emotion interaction, *F*(3.02, 89.10) = 1.59, *p* = .20, η_p^2 = .05. For *remember* responses there was a significant main effect of List, *F*(2, 118) = 4.28, *p* < .05, η_p^2 = .07, but no significant effect of Emotion, *F*(2, 59) = .08, *p* = .92, η_p^2 = .00, and no interaction effect of List x Emotion, *F*(4, 118) = 1.29, *p* = .28, η_p^2 = .04. Pairwise comparisons for List show scores for the fear lists (*M* = .77, *SD* = .34) were significantly greater than the sad lists (*M* = .65, *SD* = .23), *p* < .05, as were scores for the neutral lists (*M* = .76, *SD* = .25), *p* < .05. The difference in scores between the fear and neutral lists was not significant, *p* = 1.00. For *know* responses there was no significant main effect of List, *F*(1.77, 104.49) = .44, *p* = .62, η_p^2 = .01, Emotion, *F*(2, 59) = 1.18, *p* = .32, η_p^2 = .04, or List x Emotion interaction, *F*(2, 104.49) = .38, *p* = .80, η_p^2 = .01. For *d'* scores of *guess* responses there was also no significant main effect of List, *F*(2, 118) = .54, *p* = .58, η_p^2 = .01, Emotion, *F*(2, 59) = 1.32, *p* = .28, η_p^2 = .04, or List x Emotion interaction, *F*(4, 118) = .99, *p* = .42, η_p^2 = .03.

These analyses suggest that in most cases, sensitivity to critical lures was similar across List and between the Emotion groups. The exception to this, in the *remember* data, indicates a lower sensitivity for sad lists. The scores themselves however were moderately high and so although sensitivity is lower it is of little concern since we can conclude participants were more selective for critical lures than filler items. This difference is also expected since there were fewer responses to sad related critical lures compared to fear (see Figure 3.2) while the filler items are the same for the two negative lists.

Response bias analysis. The *criterion C* scores for overall false recognition responses showed a significant main effect of List, *F* (1.37, 80.91) = 56.24, *p* < .001 η_p^2 = .49, no significant main effect of Emotion, *F*(2, 59) = 1.28, *p* = .29, η_p^2 = .04, and no significant List x Emotion interaction, *F*(2.74, 80.91) = .08, *p* = 1.00, η_p^2 = .00. For List, pairwise comparisons show that *criterion C* was significantly higher for neutral lists (*M* = 1.00, *SD* = .15) compared to sad lists (*M* = .84, *SD* = .11), *p* < .001, and fear lists (*M* = .82, *SD* = .11), *p* < .001, and significantly higher for sad lists compared to fear lists, *p* < .05. For *remember* responses there was a significant main effect of List, *F*(2, 118) = 4.01, *p* < .05, η_p^2 = .06, but no significant effect of Emotion, *F*(2, 59) = 1.05, *p* = .37, η_p^2 = .03, and no interaction effect of List x Emotion, *F*(4, 118) = 1.29, *p* = .28, η_p^2 = .04. Pairwise comparisons for List show scores for the sad lists (*M* = 1.23, *SD* = .18) were significantly higher than fear lists (*M* = 1.17, *SD* = .17), *p* < .05, but the difference between neutral lists (*M* = 1.22, *SD* = .12) and fear lists was not significant, *p* = .07, neither was the difference between neutral and sad lists, *p* = 1.00.

For *know* responses there was a significant main effect of List, $F(2, 118) = 12.67$, $p < .001$, $\eta_p^2 = .18$, no significant main effect of Emotion, $F(2, 59) = 2.00$, $p = .15$, $\eta_p^2 = .06$, and no significant List x Emotion interaction, $F(4, 118) = .82$, $p = .51$, $\eta_p^2 = .03$. Pairwise comparisons for the main effect of List show *criterion C* scores were significantly higher for neutral lists (*M* = 1.28, *SD* = .11) compared to fear lists (*M* = 1.20, *SD* = .12), $p < .01$, and sad lists (*M* = 1.18, *SD* = .13), $p < .01$. The difference between sad and fear list was not significant, $p = .61$. For *guess* responses there was also a significant main effect of List, $F(2, 118) = 3.58$, $p < .05$, $\eta_p^2 = .06$, but not a significant main effect of Emotion, $F(2, 59) = .86$, $p = .43$, $\eta_p^2 = .03$, or List x Emotion interaction, $F(4, 118) = .77$, $p = .55$, $\eta_p^2 = .03$. Pairwise comparisons show *criterion C* scores were higher for neutral lists (*M* = 1.24, *SD* = .15) compared to sad lists (*M* = 1.17, *SD* = .17) but the difference was not significant, $p = .06$. The differences were also not significant between neutral lists and fear lists (*M* = 1.19, *SD* = .15), $p = .23$, and between sad and fear list, $p = 1.00$.

The results of the response bias analysis support theories that negative stimuli induce less selective responding. However, beyond the overall false recognition data, this pattern was only evident in the *know* responses. For *remember* responses participants were more selective with sad related list words compared to fear, however there were no differences between the negative lists and neutral lists. This suggests that the increase in *remember* responses for the fear compared to the neutral lists were due to an increase in false memories rather than response bias.

True memory data. An analysis of *d’* scores was also conducted for true memories in the same manner as above, using true recognition responses as the signal responses and filler items as noise.

Sensitivity analysis. For *old* recognition responses to target items, the corresponding *d'* scores yielded a significant main effect of List, *F* (1.67, 98.21) = 10.37, *p* < .01, η_p^2 = .15, no significant main effect of Emotion, *F* (2, 59) = .58, *p* = .56, η_p^2 = .02, or List x Emotion interaction, *F* (3.33, 98.21) = .92, *p* = .44, η_p^2 = .03. Pairwise comparisons show scores for the neutral lists (*M* = .89, *SD* = .20) were significantly greater than the fear lists (*M* = .80, *SD* = .14), *p* < .01, and the sad lists (*M* = .80, *SD* = .15), *p* < .01, but the difference between fear and sad lists was not significant, *p* = 1.00.

For *d'* scores of *remember* responses there was a significant main effect of List, a significant main effect of List, *F* (2, 118) = 4.80, *p* < .05, η_p^2 = .08, no significant main effect of Emotion, *F* (2, 59) = .21, *p* = .81, η_p^2 = .01, or List x Emotion interaction, *F* (4, 118) = .10, *p* = .98, η_p^2 = .00. Pairwise comparison show scores for the neutral lists (*M* = .82, *SD* = .21) were significantly greater than the fear lists (*M* = .71, *SD* = .21), *p* < .05, but the difference between the neutral and sad lists (*M* = .75, *SD* = .19) was not significant, *p* = .11, nor was the difference between the fear and sad, *p* = .78.

For d' scores of *know* responses there was a significant main effect of List, *F* (1.78, 105.05) = 4.47, *p* < .05, η_p^2 = .07, no significant main effect of Emotion, *F* (2, 59) = 1.08, *p* = .35, η_p^2 = .04, or List x Emotion interaction, *F* (3.56, 105.05) = .36, *p* = .82, η_p^2 = .01. Pairwise comparison show scores for the fear lists (*M* = .82, *SD* = .21) were significantly greater than the sad lists (*M* = .71, *SD* = .21), *p* < .05, but the difference between the fear and neutral lists (*M* = .75, *SD* = .19) was not significant, *p* = .29, nor was the difference between the sad and neutral, *p* = .77. For *d'* scores of *guess* responses there was also no significant main effect of List, *F* (2, 118) = 2.18, *p* =.12, η_p^2 = .04, no significant main effect of Emotion, *F* (2, 59) = .16, *p* =.85, η_p^2 = .01, and no significant List x Emotion interaction, *F* (4, 118) = .26, *p* = .90, η_p^2 = 01.

At all levels of the recognition measurements the negative filler items elicited greater response rates compared to the neutral items. This difference influences the signal detection analysis and it is unsurprising therefore to see that with *old* and *remember* responses, sensitivity is higher for neutral stimuli compared to negative. This finding should be taken into consideration when analysing the true memory data since the higher rate of *old* responses for fear and sad items compared to neutral items may be due to less selective responding for negative stimuli. Within the *know* responses the sensitivity scores suggest greater signal detection for the fear stimuli. However, given that the same filler items were used for the negative lists this difference may simply be a reflection of the already higher recognition responses to target fear items.

Response bias analysis. The *criterion C* scores for overall true recognition showed a significant main effect of List, F (1.45, 85.79) = 54.40, $p < .001$ $\eta_p^2 = .48$, a significant main effect of Emotion, $F(2, 59) = 3.54$, $p < .05$, $\eta_p^2 = .11$, but no significant List x Emotion interaction, $F(2.91, 85.79) = .75$, $p = .52$, $\eta_p^2 = .03$. For List, pairwise comparisons show that *criterion C* was significantly higher for neutral lists (M = 1.00, SD = .12) compared to sad lists (M = .87, SD = .11), $p < .001$, and fear lists (M = .87, SD = .11), $p < .001$, but the difference between sad lists and fear lists was not significant, p = 1.00. For Emotion, the *criterion C* scores were significantly higher for the control group (M = .95, SD = .11) compared to the fear group (M = .87, SD = 0.10), $p < .05$, and compared to the sad group (M = .90, SD = .12) but this difference was not significant, p = .37. The difference between fear and sad group was also not significant, p = .72.

For *remember* responses there wasn't a significant main effect of List, F(2, 118) = .71, p = 50, $\eta_p^2 = .01$, no significant main effect of Emotion, $F(2, 59) = 1.83$, p = .17, $\eta_p^2 = .06$, and no significant interaction effect of List x Emotion, $F(4, 118) = .05$, p

= 1.00, η_p^2 = .00. For *know* responses there was a significant main effect of List, *F*(2, 118) = 40.36, *p* < .001, η_p^2 = .41, no significant main effect of Emotion, *F*(2, 59) = 2.45, *p* = .10, η_p^2 = .08, and no significant List x Emotion interaction, *F*(4, 118) = 1.80, *p* = .14, η_p^2 = .06. Pairwise comparisons for the main effect of List show scores were significantly higher for neutral lists (*M* = 1.32, *SD* = .06) compared to fear lists (*M* = 1.21, *SD* = .09), *p* < .001, and sad lists (*M* = 1.25, *SD* = .10), *p* < .001, and for sad lists were significantly higher than fear lists, *p* < .05.

For *guess* responses there was a significant main effect of List, *F*(2, 118) = 7.28, *p* < .01, η_p^2 = .11, but not a significant main effect of Emotion, *F*(2, 59) = .03, *p* = .97, η_p^2 = .00, or List x Emotion interaction, *F*(4, 118) = .10, *p* = .98, η_p^2 = .00. Pairwise comparisons show *criterion C* scores were significantly higher for neutral lists (*M* = 1.23, *SD* = .13) compared to fear lists (*M* = 1.19, *SD* = .11), *p* < .05, and were higher compared to sad lists (*M* = 1.16, *SD* = .12) but the difference was not significant, *p* = .09. The difference between fear and sad lists was also not significant, *p* = .42.

Similar to the false memory data, these results show that negative stimuli induce less selective responding, but again, this was not significant in the *remember* responses. In addition, as well as in the *old* and *know* responses, the *guess* responses were more selective for neutral stimuli compared to fear (but not sad). This is congruent with accounts that suggest recognition responses for negative valence stimuli increases for fillers and targets equally (Dougal & Rotello, 2007; Windmann & Kutas, 2001). In addition, fear at encoding induced less selective responding at retrieval compared to the control group.

3.3.3. Summary

Experiment 2 shows evidence of an enhanced emotional false memory effect. The results from the false recognition responses support past research showing that recognition of critical lures is greater for negative stimuli compared to neutral (Howe, et al., 2010). The results also suggest that response bias was less selective for negative lists than neutral lists.

In the *remember* data there is evidence that participants produced more false memories for fear-related stimuli compared with sad-related stimuli. Analysis of response bias suggests that this effect may have been caused by a general increase in responding for fear stimuli over that of sad stimuli. Based on previous research, it could be predicted that there would be a difference in response bias between negative and neutral lists such that negative stimuli leads to an increase in general responding for targets and fillers alike (Windmann & Kutas, 2001). However, this would not account for the difference between fear and sad lists. In fact, Dougal and Rotello (2007) examined recognition of emotional versus neutral stimuli and demonstrated that response bias was more lenient for negative-arousing stimuli compared to positive-arousing and neutral stimuli. That negative and positive stimuli were matched on arousal indicates a valence driven effect. However, this would predict the opposite result to that found for the fear and sad lists since valence scores were lower for the sad lists compared to fear lists.

An additional explanation for the enhanced fear-related false memories is that fear and sad stimuli differ with regards to arousal. FTT predicts that valence related increases in semantic connections among targets increases gist traces leading to greater false memory production (Bookbinder & Brainerd, 2016). Likewise, AAT posits that the increased sematic density facilitates spreading activations enhancing false memory production (Howe et al., 2009). Predictions regarding arousal however are not so consistent with the current findings. FTT predicts that within the stimuli, moderate arousal increases attention, enhancing memory for verbatim traces, and supressing false memories (Bookbinder & Brainerd, 2016). The results do not support such predictions however, and analysis of the *old* and *remember* responses indicate greater false memory production for stimuli with higher arousal. AAT on the other hand predicts that increased attention to target items would increase subsequent spreading activations leading to greater false memory production.

AAT also predicts an enhancement of emotion-congruent false memory production seen in previous studies (Knott & Thorley, 2013; Ruci et al., 2009). Experiment 2 did not support the experimental hypothesis of a discrete emotion-congruent effect with DRM false memories. A limitation of this study is that it was underpowered, needing an additional 10 participants in each group, however it is unlikely this alone led to the rejection of the hypothesis as the basic pattern of results does not indicate any evidence to the contrary. It is possible that the lack of any such finding in this experiment is due to the overriding effects of valence and arousal. Matching arousal and valence for manipulated discrete-emotions would allow a much clearer examination of a discrete emotion-congruency effect. According to spreading activation theories one would expect experiencing a discrete emotion to increase spreading activation associated with the congruent stimuli. Similarly, appraisal theories of emotion would predict that memory process be enhanced for congruent stimuli since it is most relevant to the emotional motivation (Moors et al., 2013).

3.4. Experiment 3:

Discrete Emotion-Congruent DRM False Memories with Fear and Anger

Experiment 3 was conducted to further examine the presence of a discrete emotion-congruency effect on spontaneous production of false memories. The same basic design and procedure was used as in Experiment 2. However, improvements were made in order to better distinguish between the false memory production of the two negative emotions. The DRM paradigm was used to measure false memory production and two distinct negative emotions were induced at encoding. Fear and anger were chosen as the emotional manipulations as, according the circumplex model of affect, both emotions are similar in arousal and valence (Russell, 1980).

Lerner and Keltner (2000) looked at the effect of fear and anger on risk perception in an attempt to highlight the limitation of focussing on valence effects. Fear led to more pessimistic decision making while anger led to more optimistic judgements. Fear and anger have also been used to demonstrate the effect of discrete emotion on memory, irrespective of arousal and valence effects. In an investigation of arousal and negative affect on memory for peripheral and central details, Talarico, Berntsen, and Rubin (2009) found that although negative affect impaired recall of peripheral details, there were distinct differences in the results for fear and anger. Talarico et al. took a measure of reliving at retrieval and found that this was negatively correlated with peripheral recall for anger but not fear, regardless of the similarities in dimensions between these two emotions.

Given the high semantic relatedness of negative emotions, and the increased chances of interconnectivity between lists, it is possible that randomising list presentation (in Experiment 2) may enhance spreading activation across what are intended to be incongruent emotional lists. In order to avoid this confound in Experiment 3, the lists were blocked and the presentation orders were counterbalanced within the control group in order to assess whether list order itself effects false memory production. In addition, emotional word lists have been used to induce emotion, and therefore to avoid an additional confound of incongruent lists affecting participants emotional state the congruent emotion lists were always presented first.

A final alteration in the design relates to the filler items. It is usual to select negative and neutral filler items that are unrelated to the target stimuli in order to get a measure of signal detection. However, in order to look specifically at each of the discrete emotions induced there is a need for filler items, unrelated to the specific words presented, but still related to the emotion category. Thus, fillers used in Experiment 3 are grouped according to the three categories of the lists.

3.4.1. Method

Participants

A total of 83 (25 male) A-level students, all aged 18, took part in the experiment, voluntarily. For an 80% chance of finding a medium effect size with an alpha of .05 we need 90 participants. The experiment was conducted at the participants' school, with the approval of the teachers. All participants gave written informed consent and were fully debriefed at the end of the experiment.

Design

A 3(Emotion: anger vs. fear vs. control) x 3(List: anger, fear, neutral) mixed design was used, with a standard DRM paradigm and recognition memory test. Emotion was the between-participant variable and list type was the within-participant variable. Recognition responses were taken for target words, filler items, and critical lures, along with additional judgements of either remember, know, or guess (R/K/G). Instructions were again based on those from (Rajaram, 1993). Participants were randomly assigned to the anger condition (N = 27), fear condition (N = 28), or control condition (N = 28).

Materials

As with Experiment 2, participants in the control group underwent no emotion induction procedure. The two experimental groups, fear and anger, were presented with short film clips from Rottenberg et al. (2007). Anger was induced by showing people a clip from the film “My Bodyguard”, in which one male was harassing and bullying another. Fear was induced by showing participants a clip from the movie “The Shining”, in which a young boy is troubled and playing in a haunted building[8]. To demonstrate that any differences in memory were not the result of a temporary mood change at retrieval, all participants watched a neutral video clip (from a wildlife documentary) lasting 5 minutes prior to retrieval. To monitor emotional states throughout the experiment participants reported levels of valence and arousal through the SAM questionnaire.

A total of six 10-item DRM word lists were presented, two of which were related to fear, two to anger, and two were neutral (see Appendix D). Lists were presented in emotion consistent pairings and the list orders for the fear and anger groups were different so that the lists congruent to the participants’ emotion always came first. This was done to prevent incongruent lists contaminating the emotional state of the participants at the beginning of encoding. To ensure this choice of list order was not a confounding variable, the different list orders were replicated and counterbalanced within the control group to enable later comparison[9]. Lists were created from those used by Stadler, Roediger, and McDermott (1999) and using The University of South Florida word association database (Nelson et al., 2004). The six critical lures were *anger, war, fear, danger, earth,* and *hair*. Backward associative strength (BAS) was controlled across the lists and word frequency for the critical lures was equated across the negative lists, but was slightly higher for the neutral

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[8] Different film clips were used for the fear induction within Experiments 2 and 3 however comparison of the SAM results shows no significant difference between valence scores for experiment 2 (M = 4.06, SD = 1.63) and 3 (M = 4.81, SD = 1.36), $t(37) = 1.58$, $p = .12$, and no significant difference between the arousal scores for experiment 2 (M = 6.44, SD = 1.82) and 3 (M = 5.86, SD = 1.62), $t(37) = 1.07$, $p = .29$.

[9] Independent samples t-tests were conducted for all true and false recognition responses, as well as for *remember* responses, within the control group, to look at the different list orders used. No significant differences in recognition responses to list words were found between participants who received the anger lists first and those who received the fear lists first, all p’s > .1.

lists. Valence and arousal scores were taken from the Affective norms for English words database (Bradley & Lang, 1999) for all available words (see Table 3.6). For both negative lists, valence was lower than the neutral lists and arousal was higher. Between the negative lists, both valence and arousal were equal. The recognition test contained 42 words. These were made up of the 6 critical lures, 18 old words, and 18 new words. Old words were those from positions 1, 5, and 10 in each of the 6 presented lists, and new words consisted of 3 emotionally congruent non-presented low associates for each of the critical lures.

Table 3.6: ***Average BAS, arousal, and valence scores for fear, anger, and neutral DRM lists.***

	BAS		Arousal		Valence	
	M	*SD*	*M*	*SD*	*M*	*SD*
List:						
Neutral	0.26	0.11	5.15	1.00	5.21	1.68
Fear	0.19	0.17	5.97	1.18	4.36	1.14
Anger	0.22	0.14	5.93	1.15	4.10	1.69

Procedure

Participants received a standard set of instructions at the start of the experiment, along with the first SAM questionnaire. Comprehensive instructions were given with the first SAM to avoid confusion later in the task (subsequent SAM questionnaires contained basic instructions). Experimental groups watched one of the short video clips, and completed a SAM questionnaire afterwards. All groups were then presented with the 6 DRM lists in auditory form, with words 2 seconds apart, and 3 seconds between lists. Following this the neutral video clip was presented, and again participants filled out a SAM questionnaire. They then began the recognition test. Standard instructions to indicate old and new words were given, as well as instructions to report if recognition of old words was based on a *remember, know,* or *guess* judgement. Finally, participants were asked to complete one more SAM questionnaire to ensure there were no lasting effects of the negative emotion induction.

3.4.2. Results

Emotion Manipulation

Of the 83 participants, 8 were removed from the analysis as their arousal scores decreased following the emotion induction video and 3 were removed because their valence scores increased following the video. Of the remaining participants 28 were in the control group, 21 in the fear group, and 23 in the anger group. No significant differences were found between the groups for arousal, $F(2, 69) = .51$, $p = .60$, or valence, $F(2, 69) = 2.93$, $p = .06$, before the emotion manipulation. However, following the emotion induction the difference between groups for arousal was significant, $F(2, 69) = 7.14$, $p < .01$, as was the difference in valence, $F(2, 69) = 16.47$, $p < .01$. Bonferroni pairwise-comparisons (alpha set at .05) indicated that arousal scores for the fear group ($M = 5.85$, $SD = 1.62$. *95% CI* [5.12, 6.60]) and anger group ($M = 5.30$, $SD = 1.64$, *95% CI* [4.60, 6.01]) were significantly higher than the control group ($M = 4.21$, $SD = 1.26$, *95% CI* [3.73, 4.70]) following the emotion induction. In addition, valence scores were significantly lower in the fear ($M = 4.80$, $SD = 1.36$, *95% CI* [4.12, 5.43]) and anger group ($M = 4.52$, $SD = .67$, *95% CI* [4.23, 4.81]) compared to the control group ($M = 6.39$, $SD = 1.52$, *95% CI* [5.80, 6.98]) following the emotion induction.

These results provide validation for the emotion induction procedure since it was expected that participants experiencing fear and anger would score higher on measurements of arousal and lower on measurements of valence compared to participants in the control group. In addition, fear and arousal are very similar in terms of arousal and valence, and for the purposes of this experiment, these emotions were chosen specifically for this similarity. It is therefore reassuring that there were no differences in arousal or valence scores between the two negative emotion groups (p = .52 for arousal, and p = 1 for valence). Finally, arousal and valence scores were compared between the groups following the neutral video, before the recognition test. No significant differences were found between the groups in either arousal, $F(2, 69) = 2.30$, $p = .35$, or valence, $F(2, 69) = 1.33$, $p = .49$. Thus, participants' emotions differed only at encoding, and not at retrieval.

Recognition Responses

The proportion of correct recognition of old words, false recognition of critical lures, and false recognition of filler words were coded. Separate 3 (Emotion: fear, anger, control) x 3 (List: fear, anger, neutral) ANOVAs were conducted for overall recognition responses for each set of words, one each for *remember* responses, for *know* responses, and for *guess* responses. Before analysing data for all conditions, the responses for the control group were analysed based on the order in which the lists were presented. For target items and critical lures, analyses of old and remember responses showed no significant differences between the different list orders ($p > .05$ in all cases). Thus, it was concluded that the order of list presentation is not likely to have had an effect on performance on the memory task.

False recognition of critical lures. Where critical lures were recognized as being present in the original lists, responses were first analysed for false recognition, and then separately for whether the recognition was accompanied by remember, know, or guess responses (see Table 3.7). For all false recognition of critical lures (see Figure 3.3) there was no significant main effect for Emotion, $F(2, 69) = .40$, $p = .70$, $\eta_p^2 = .01$, but a significant main effect of List $F(2, 138) = 10.00$, $p < .001$, $\eta_p^2 = .13$, and a significant interaction effect between List and Emotion $F(4, 138) = 3.83$, $p < .01$, $\eta_p^2 = .10$.

Pairwise comparisons using the Bonferroni correction showed that within the control group there were no significant differences between the lists (all *p*'s > .05). Within the fear group the proportion of recognition of critical lures was significantly higher for congruent emotion lists, fear lists, compared to incongruent lists, anger ($p < .01$) and neutral ($p < .01$) and there were no differences between the anger and neutral list ($p = 1.00$). This enhancement of fear related false memories supports the hypothesis that discrete emotional states increase false memory production for congruent stimuli above and beyond the generic emotion-congruent effects that have been previously demonstrated (Knott & Thorley, 2013; Ruci et al., 2009).

However, this is only one of the two experimental groups. When the results from the anger group were analysed the pattern was not so clear. Within the anger group, the proportion of false recognition was significantly higher for anger lists compared to neutral lists ($p < .05$) but no significant difference was found between the anger and fear lists ($p = .62$) or fear and neutral lists ($p = .33$). These results indicate the presence of a generic emotion congruence effect, since false memories for the neutral lists were much lower in this group. However, there is no evidence of a difference in false memory rates between the two negative emotions and therefore the hypothesis is not supported. These results represent the *old* recognition responses. Not only do these data encompass uncertain, guess, responses but it is also important to separate memory responses based on familiarity judgements and those whereby participants report having an explicit, vivid memory.

For false *remember* responses (see Figure 3.4) there was a significant main effect of Emotion, $F(2, 69) = 3.61$, $p < .05$, $\eta_p^2 = .10$, no significant effect of List, $F(2, 138) = 2.63$, $p = .08$, $\eta_p^2 = .04$, and a significant Emotion x List interaction, $F(4, 138) =$

12.45, $p < .001$, $\eta_p^2 = .27$. For the fear emotion group, pairwise comparisons revealed that the proportion of remember responses was significantly higher for fear lists than anger lists ($p < .01$) and neutral lists ($p < .01$), but the difference between the anger and neutral lists was not significant ($p = .93$). For participants in the anger group, the proportion of false memories for anger lists was significantly greater than fear lists ($p < .01$) and neutral lists ($p < .05$) but the difference between the fear and neutral lists was not significant ($p = .78$). For the control group there were no significant differences between the lists (all *p*'s > .05). Here there is strong evidence for the hypothesised discrete emotion-congruency effect. Participants believed to be experiencing fear or anger falsely *remembered* significantly more critical lures from the lists for which the content was congruent to their emotional state. Not only does this replicate previous findings of an emotion congruency effect driven by valence (Knott & Thorley, 2013; Ruci et al., 2009), but extends these findings to discrete emotions, even when arousal and valence are similar across experimental conditions.

Participants additionally made *know* or *guess* responses to a selection of the falsely recognized critical lures, however the figures for these categories were very low, thus reducing the power for any subsequent analyses. For the know judgements the main effect for List, $F(2, 138) = 1.08$, $p = .34$, $\eta_p^2 = .02$, main effect for Emotion, $F(2, 69) = 1.3$, $p = .28$, $\eta_p^2 = .04$, and the List x Emotion interaction, $F(2, 138) = 2.30$, $p = .06$, $\eta_p^2 = .06$, were all not significant. For guess judgements the main effect of List, $F(2, 138) = 1.37$, $p = .26$, $\eta_p^2 = .02$, main effect of Emotion, $F(2, 69) = 1.10$, $p = .34$, $\eta_p^2 = .03$, and the Emotion x List interaction, $F(2, 69) = 1.25$, $p = .29$, $\eta_p^2 = .04$, were also not significant.

Table 3.7: ***False recognition responses to critical lures as a function of emotion and list***

	Fear Group				**Anger Group**				**Control Group**			
			95% CI				*95% CI*				*95% CI*	
	M	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*
Overall Recognition												
Fear lists	.93	.04	.85	1.01	.63	.07	.48	.78	.77	.06	.64	.89
Anger lists	.57	.08	.42	.77	.78	.07	.62	.90	.61	.07	.46	.75
Neutral lists	.53	.09	.34	.71	.48	.08	.31	.64	.61	.06	.47	.74
Remember												
Fear lists	.74	.07	.58	.89	.09	.05	-.02	.19	.36	.07	.21	.51
Anger lists	.17	.07	.02	.32	.39	.05	.28	.50	.39	.08	.23	.55
Neutral lists	.29	.08	.12	.46	.20	.07	.05	.34	.36	.06	.23	.48
Know												
Fear lists	.12	.05	.02	.22	.30	.06	.18	.43	.25	.05	.14	.36
Anger lists	.21	.07	.08	.35	.24	.07	.10	.38	.09	.04	.01	.16
Neutral lists	.12	.05	.02	.22	.15	.07	.01	.29	.21	.05	.12	.31
Guess												
Fear lists	.07	.04	-.01	.15	.24	.08	.08	.40	.16	.05	.05	.27
Anger lists	.19	.08	.02	.36	.15	.06	.03	.27	.13	.04	.04	.21
Neutral lists	.12	.06	.00	.24	.13	.05	.03	.23	.04	.02	-.02	.09

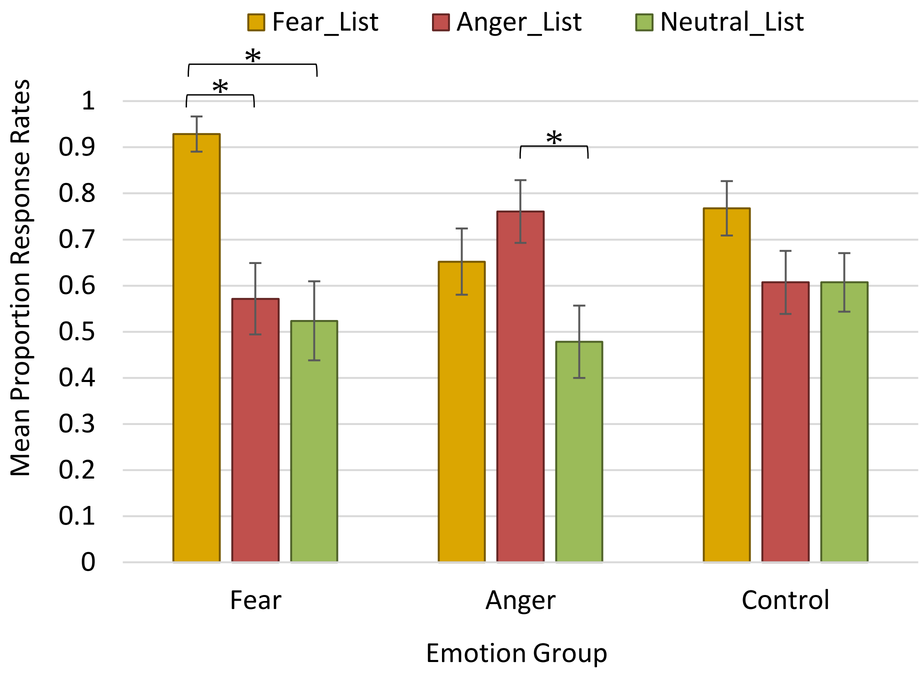

Figure 3.3. ***Proportion of 'old' responses to critical lures as a function of emotion group and list emotion (Error bars represent SE)***

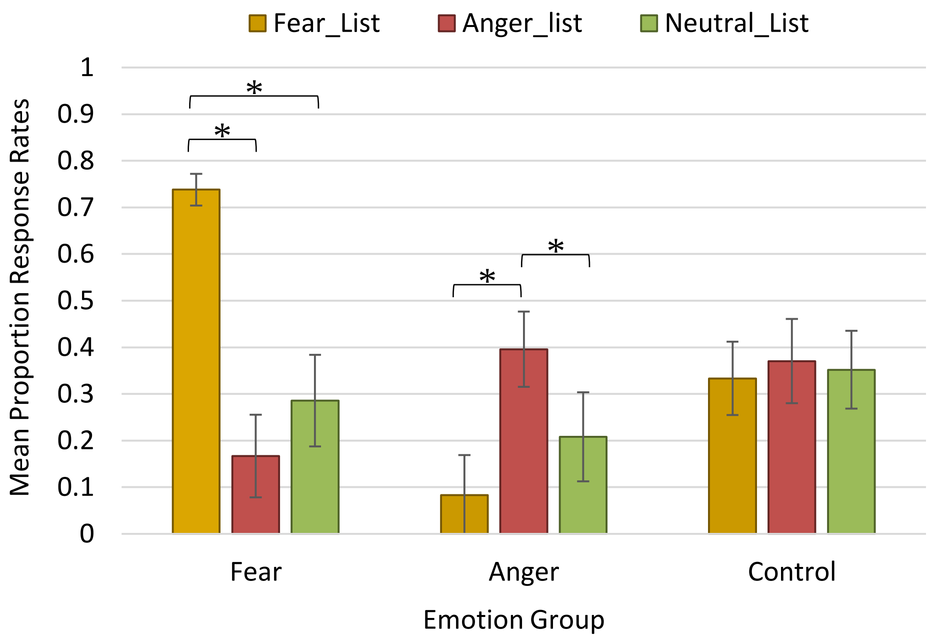

Figure 3.4. ***Proportion of false 'remember' responses as a function of emotion group and list emotion (Error bars represent SE) *p < .05***

True recognition of list items. For true recognition responses (see Table 3.8) there was a significant main effect of List, $F(2, 138) = 5.63$, $p < .01$, $\eta_p^2 = .07$, no significant main effect of Emotion, $F(2, 69) = .84$, $p = .44$, $\eta_p^2 = .02$, and a significant List x Emotion interaction, $F(4, 138) = 3.75$, $p < .01$, $\eta_p^2 = .1$. Pairwise comparisons within the fear group showed partial evidence for an emotion congruency effect whereby recognition for fear lists was significantly higher than neutral lists ($p < .05$) but the difference between fear and anger lists was not significant ($p = 1.00$) nor was the difference between anger and neutral lists ($p = .25$). Within the anger group, the proportion of correct recognition responses was significantly higher for anger lists compared to fear lists ($p < .01$). However, the difference between the anger and neutral lists was not significant ($p = .48$) and the difference between the neutral and fear lists was also not significant ($p = .14$). Within the control group there were no significant differences between lists (all *p*'s > .05).

For *remember* responses to correctly recognised items there was a significant main effect of List, $F(2, 138) = 3.56$, $p < .05$, $\eta_p^2 = .05$, but not Emotion, $F(2, 69) = 1.02$, $p = .37$, $\eta_p^2 = .03$, and a significant List x Emotion interaction, $F(4, 138) = 6.53$, $p < .05$, $\eta_p^2 = .16$. Pairwise comparisons for the fear group and control group revealed no significant differences between lists (all *p*'s > .05). Within the anger group the remember responses to anger lists were significantly greater than fear lists ($p < .01$). However, the difference between the anger and neutral lists was not significant ($p = .18$). In addition, the responses for the neutral lists were also significantly greater than the fear lists ($p < .05$).

Table 3.8: ***Recognition responses to target items as a function of emotion and list***

	Fear Group				**Anger Group**				**Control Group**			
			95% CI				*95% CI*				*95% CI*	
	M	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*
Overall Recognition												
Fear lists	.60	.05	.50	.70	.38	.04	.30	.45	.56	.05	.46	.65
Anger lists	.57	.05	.45	.68	.66	.06	.51	.76	.61	.05	.51	.70
Neutral lists	.42	.06	.30	.54	.50	.05	.40	.61	.52	.04	.44	.60
Remember												
Fear lists	.44	.05	.33	.56	.14	.03	.08	.20	.36	.05	.25	.47
Anger lists	.37	.06	.24	.49	.49	.04	.39	.58	.38	.05	.28	.47
Neutral lists	.33	.06	.21	.46	.33	.05	.24	.43	.35	.03	.28	.42
Know												
Fear lists	.13	.03	.06	.19	.15	.04	.08	.23	.12	.03	.06	.18
Anger lists	.09	.02	.04	.14	.10	.03	.04	.17	.18	.04	.11	.26
Neutral lists	.03	.01	.00	.06	.10	.02	.06	.14	.09	.03	.03	.15
Guess												
Fear lists	.03	.01	.00	.06	.09	.03	.03	.14	.08	.02	.03	.13
Anger lists	.11	.04	.03	.19	.07	.02	.03	.11	.05	.02	.01	.09
Neutral lists	.06	.02	.01	.11	.07	.02	.03	.11	.08	.02	.04	.11

For *know* responses to correctly recognised list items there was a significant effect of List, $F(2, 138) = 4.30$, $p < .05$, $\eta_p^2 = .06$, but not of Emotion, $F(2, 69) = 1.46$, $p = .24$, $\eta_p^2 = .04$, or the List x Emotion interaction, $F(4, 138) = 1.91$, $p = .11$, $\eta_p^2 = .05$. Within the fear group pairwise comparisons show that know responses for the fear lists were significantly higher than the neutral lists ($p < .05$). No significant differences were found between the fear and anger lists ($p = .78$) and anger and neutral lists ($p = .21$). Within the anger group and control group there were no significant differences (all *p*'s > .05).

For *guess* responses there was no significant main effect of List, $F(2, 138) = .35$, $p = .70$, $\eta_p^2 = .01$, no main effect of Emotion, $F(2, 69) = .13$, $p = .88$, $\eta_p^2 = .00$, or any List x Emotion interaction, $F(4, 138) = 1.93$, $p = .11$, $\eta_p^2 = .05$. Within the fear group the guess responses for anger lists were significantly higher than fear lists ($p < .05$) however no other differences were significant (all *p*'s > .05).

False recognition of fillers*.* For recognition of filler items (see Table 3.9) there was a significant main effect of List, $F(2, 138) = 35.59$, $p < .01$, $\eta_p^2 = .34$, but not Emotion, $F(2, 69) = .08$, $p = .93$, $\eta_p^2 = .00$, or the List x Emotion interaction, $F(4, 138) = 1.32$, $p = .27$, $\eta_p^2 = .04$. Pairwise comparisons for List show that recognition of fillers was significantly higher for fear lists ($M = .34$, $SD = .26$) compared to anger ($M = .15$, $SD = .19$), $p < .01$, and neutral lists ($M = .09$, $SD = .16$), $p < .01$. The difference between anger and neutral lists was not significant, $p = .07$.

For *remember* responses there was a significant main effect of List, $F(2, 138) = 4.17$, $p < .05$, $\eta_p^2 = .06$, but not Emotion, $F(2, 69) = 1.59$, $p = .21$, $\eta^2 = .04$, or the List x Emotion interaction, $F(4, 138) = .91$, $p = .46$, $\eta_p^2 = .03$. Pairwise comparisons show responses for fear lists ($M = .09$, $SD = .14$) were significantly higher than neutral lists ($M = .04$, $SD = .10$), $p < .05$, and were higher than anger lists ($M = .05$, $SD = .11$) but this difference was not significant, p = .12. The difference between anger and neutral lists was also not significant, p = 1.00.

For *know* responses there was a significant effect of List, $F(2, 138) = 23.02$, $p < .01$, $\eta_p^2 = .25$, but not Emotion, $F(2, 69) = .98$, $p = .38$, $\eta_p^2 = .03$, or the List x Emotion interaction, $F(4, 138) = 2.43$, $p = .07$, $\eta_p^2 = .06$. Pairwise comparisons again show significantly greater responses for fear lists (M = .13, SD = .17) compared to anger (M = .03, SD = .07), $p < .01$, and neutral lists (M = .02, SD = .06), $p < .01$. The difference between anger and neutral lists was not significant, p = .83.

For *guess* responses to filler items there was a significant effect of List, $F(2, 138) = 7.91$, $p < .01$, $\eta_p^2 = .10$, but not Emotion, $F(2, 69) = 2.98$, $p = .06$, $\eta_p^2 = .08$, and the List x Emotion interaction was significant, $F(4, 138) = 2.68$, $p < .05$, $\eta_p^2 = .07$. Within the fear and control group the pairwise comparisons show no significant differences between lists (all p's > .05). For the anger group the guess responses to anger lists were significantly greater than neutral lists ($p < .05$) and the responses to fear lists were significantly greater than neutral lists ($p < .05$). The difference between the anger and fear lists was not significant (p = 1.00).

The consistently greater responses for the fear related filler items may be due to an increase in response bias. There is evidence in the literature that negative stimuli elicit higher proportions of unselective responding (Windmann & Kutas, 2001) even when accounting for sematic density (Dougal & Rotello, 2007). However, this would not account for the differences seen between the fear and anger lists.

Table 3.9: ***Recognition responses to filler items as a function of emotion and list***

	Fear Group				**Anger Group**				**Control Group**			
			95% CI				*95% CI*				*95% CI*	
	M	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*
Overall Recognition												
Fear lists	.34	.06	.22	.46	.28	.05	.21	.40	.36	.06	.25	.48
Anger lists	.15	.04	.05	.23	.20	.05	.10	.29	.11	.03	.06	.17
Neutral lists	.07	.03	.01	.14	.05	.03	.01	.12	.12	.03	.05	.20
Remember												
Fear lists	.08	.02	.03	.13	.07	.02	.02	.11	.11	.03	.04	.18
Anger lists	.09	.04	.01	.16	.01	.01	-.01	.04	.04	.01	.01	.07
Neutral lists	.04	.03	-.01	.09	.02	.02	-.02	.07	.04	.02	.01	.08
Know												
Fear lists	.18	.04	.10	.27	.08	.03	.02	.14	.14	.04	.06	.21
Anger lists	.02	.01	-.01	.04	.04	.02	.01	.08	.04	.02	.01	.08
Neutral lists	.01	.01	-.01	.02	.01	.01	-.01	.04	.04	.02	.01	.08
Guess												
Fear lists	.08	.02	.03	.13	.13	.03	.07	.19	.11	.03	.05	.17
Anger lists	.04	.02	.01	.07	.15	.05	.06	.25	.03	.01	.00	.06
Neutral lists	.02	.02	-.01	.06	.02	.01	.00	.05	.04	.02	.00	.08

Signal Detection Analysis

False Memory Data. Signal detection analysis (Stanislaw & Todorov, 1999) was conducted using false critical lure responses and false filler items. These scores were then entered into the same ANOVAs as above.

Sensitivity analysis. For overall false recognition responses, the corresponding *d'* scores yielded no significant main effect of List, F (2, 138) = .47, p = .63, η_p^2 = .01, Emotion, F(2, 69) = .35, p = .71, η_p^2 = .01, or List x Emotion interaction, F(4, 138) = 2.11, p = .08, η_p^2 = .06. For *d'* scores of *remember* responses there was no significant main effect of List, F(1.66, 114.84) = .75, p = .48, η_p^2 = .01, no significant main effect of Emotion, F(2, 69) = .2.57, p = .08, η_p^2 = .07, but a significant interaction effect of List x Emotion, F(4, 118) = 14.53, p < .01, η_p^2 = .30. Pairwise comparisons for the anger group showed scores were significantly higher for anger lists (*M* = .90, *SD* = .26) compared to fear lists (*M* = .53, *SD* = .27), p < .05, and neutral lists (*M* = .68, *SD* = .30), p < .05. The difference between fear and neutral lists however was not significant, p = .33. For the fear group scores were significantly higher for fear lists (*M* = 1.16, *SD* = .30) compared to anger lists (*M* = .59, *SD* = .28), p < .05, and neutral lists (*M* = .76, *SD* = .35), p < .05. The difference between anger and neutral lists however was not significant, p = .32. With the control group there were no significant differences (all *p's* > .05) between the *d'* scores for fear (*M* = .77, *SD* = .37), anger (*M* = .85, *SD* = .40), and neutral lists (*M* = .83, *SD* = .33). There is evidence here of an emotion congruency effect as the sensitivity scores are higher for the congruent emotion lists compared to the incongruent list for each negative emotion group. Since there was no interaction effect for recognition of filler items, this finding is most likely due to the increased responses in the recognition of critical lures for congruent emotion stimuli.

For *d'* scores of *know* responses there was no significant main effect of List, *F*(2, 138) = .17, *p* = .84, η_p^2 = .00, and no significant main effect of Emotion, *F*(2, 69) = .1.29, *p* = .28, η_p^2 = .04. There was a significant interaction effect of List x Emotion *F*(4, 138) = .2.78, *p* < .05, η_p^2 = .07, however after adjusting for multiple comparisons no pairwise comparisons were significant (all *p's* > .05). For *d'* scores of *guess* responses there was also no significant main effect of List, *F*(2, 138) = .1.32, *p* = .27, η_p^2 = .02, Emotion, *F*(2, 69) = .82, *p* = .44, η_p^2 = .02, or List x Emotion interaction, *F*(4, 138) = .94, *p* = .45, η_p^2 = .03.

Response bias analysis. The *criterion C* scores for overall false recognition responses showed a significant main effect of List, *F* (2, 138) = 26.94, *p* < .001 η_p^2 = .28, no significant main effect of Emotion, *F*(2, 69) = .19, *p* = .83, η_p^2 = .00, and a significant List x Emotion interaction, *F*(4, 138) = 4.26, *p* < .01, η_p^2 = .11. Post-hoc tests of the interaction effect show that within the anger group scores for the neutral lists (*M* = .94, *SD* = .21) were significantly higher than the anger lists (*M* = .76, *SD* = .20), *p* < .05, and fear lists (*M* = .77, *SD* = .19), *p* < .05. The difference between the fear and anger lists was not significant, *p* = 1.00. Within the fear group response bias was significantly lower for the fear lists (*M* = .63, *SD* = .13) compared to the anger lists (*M* = .87, *SD* = .20), *p* < .01, and neutral lists (*M* = .92, *SD* = .22), *p* < .01. The difference between the anger and neutral lists was not significant, *p* = 1.00. In the control group response bias was significantly lower for the fear lists (*M* = .70, *SD* = .19) compared to the anger (*M* = .86, *SD* = .20), *p* < .01, and neutral lists (*M* = .86, *SD* = .19), *p* < .01. The difference between then anger and neutral lists was not significant, *p* = 1.00.

For *remember* responses there was a significant main effect of List, *F*(2, 138) = 4.08, *p* < .05, η_p^2 = .06, a significant effect of Emotion, *F*(2, 69) = 3.64, *p* < .05, η_p^2 = .10, and a significant interaction effect of List x Emotion, *F*(4, 138) = 10.01, *p* < .01,

η_p^2 = .23. Pairwise comparison for the anger group show scores for the anger lists (*M* = 1.00, *SD* = .14) were significantly lower than the fear lists (*M* = 1.14, *SD* = .13), $p <$ .01, and lower than the neutral lists (*M* = 1.11, *SD* = .19) but this difference was not significant, p = .07. The difference between the fear and neutral lists was also not significant, p = 1.00. Within the fear group response bias was significantly lower for the fear lists (*M* = 0.81, *SD* = .18) compared to the anger lists (*M* = 1.10, *SD* = .21), p < .01, and neutral list (*M* = 1.10, *SD* = .21), p < .01. The difference between the anger and neutral lists was not significant, p = 1.00. In the control group the differences between the anger (*M* = 1.00, *SD* = .21), fear (*M* = 1.00, *SD* = .22), and neutral lists (*M* = 1.01, *SD* = .17) were not significant (all *p's* = 1.00).

For *know* responses there was a significant main effect of List, $F(2, 138)$ = 6.88, p < .01, η_p^2 = .09, no significant main effect of Emotion, $F(2, 69)$ = 1.16, p = .32, η_p^2 = .03, and no significant List x Emotion interaction, $F(4, 138)$ = 2.39, p = .05, η_p^2 = .07. Pairwise comparisons for the main effect of List show *criterion C* scores were significantly lower for fear lists (*M* = 1.03, *SD* = .16) compared to anger (*M* = 1.09, *SD* = .16), p < .05, and neutral lists (*M* = 1.12, *SD* = .15), p < .01. The difference between anger and neutral lists was not significant, p = .66. For *guess* responses there was also a significant main effect of List, $F(2, 138)$ = 4.56, p < .05, η_p^2 = .06, but not a significant main effect of Emotion, $F(2, 69)$ = 1.01, p = .37, η_p^2 = .03, or List x Emotion interaction, $F(4, 138)$ = 1.27, p = .29, η_p^2 = .04. Pairwise comparisons show *criterion C* scores were significantly higher for neutral lists (*M* = 1.16, *SD* = .11) compared to fear lists (*M* = 1.08, *SD* = .16), p < .05, and were higher compared to anger lists (*M* = 1.12, *SD* = .15) but the difference was not significant, p = .37. The difference between fear and anger lists was also not significant, p = .52.

These results show that response bias for fear stimuli is consistently lower than for neutral stimuli and that anger stimuli elicited significantly lowered response bias in the anger group for *old* responses. Previous research has shown a general decrease in response bias to emotional stimuli compared to neutral (e.g. Windmann & Kutas, 2001) and has claimed that recognition data is not evidence of a false memory effect but instead represents this unselective responding. However, the interaction effect for *remember* responses shows that this effect is not present in the control group, suggesting the increased response bias is not simply due to the valance of the stimuli but of the congruency between the stimuli and emotion.

True Memory Data. Likewise, *d'* and *criterion C* scores were calculated for true memory data using recognition responses for target items and for corresponding filler items, and entered into the same ANOVAs as before.

Sensitivity analysis. For overall true recognition responses, the corresponding *d'* scores yielded a significant main effect of List, *F* (2, 138) = 27.04, *p* < . 001, η_p^2 = .28, no significant main effect of Emotion, *F*(2, 69) = .30, *p* = .74, η_p^2 = .01, and no significant List x Emotion interaction, *F*(4, 138) = 1.36, *p* = .25, η_p^2 = .04. For *d'* scores of *remember* responses there was a significant main effect of List, *F*(2, 138) = .4.50, *p* < .05, η_p^2 = .01, no significant main effect of Emotion, *F*(2, 69) = .75, *p* = .48, η_p^2 = .02, and a significant interaction effect of List x Emotion, *F*(4, 118) = 7.10, *p* < .001, η_p^2 = .17. Pairwise comparisons for the anger group showed scores were significantly higher for anger lists (*M* = .78, *SD* = .11) compared to fear lists (*M* = .57, *SD* = .08), *p* < .05, and higher scores for neutral lists (*M* = .69, *SD* = .13) compared to fear lists, *p* < .05. The difference between anger and neutral lists was not significant, *p* = .16. For the fear group there were no significant differences (all *p's* > .05) between scores for fear lists (*M* = .74, *SD* = .33) anger lists (*M* = .70, *SD* = .14) and neutral lists (*M* = .69, *SD* = .14). For the control group there were also no significant differences (all *p's* = 1.00) between scores for fear lists (*M* = .69, *SD* = .15) anger lists (*M* = .71, *SD* = .13) and neutral lists (*M* = .70, *SD* = .10).

For *d′* scores of *know* responses there was no significant main effect of List, *F*(2, 138) = 2.14, *p* = .12, η_p^2 = .03, and no significant main effect of Emotion, *F*(2, 69) = 1.46, *p* = .24, η_p^2 = .04, or List x Emotion interaction *F*(4, 138) = 1.83, *p* = .13, η_p^2 = .05. For *d′* scores of *guess* responses there was also no significant main effect of List, *F*(2, 138) = 1.27, *p* = .28, η_p^2 = .02, Emotion, *F*(2, 69) = .01, *p* = 1.00, η_p^2 = .00, or List x Emotion interaction, *F*(4, 138) = 1.81, *p* = .13, η_p^2 = .05.

Response bias analysis. The *criterion C* scores for true recognition responses showed a significant main effect of List, *F* (2, 138) = 21.42, *p* < .001 η_p^2 = .24, no significant main effect of Emotion, *F*(2, 69) = .41, *p* = .67, η_p^2 = .01, and a significant List x Emotion interaction, *F*(4, 138) = 2.96, *p* < .05, η_p^2 = .08. Pairwise comparisons show that within the anger group scores for the neutral lists (*M* = 1.04, *SD* = .09) were higher than the anger lists (*M* = .96, *SD* = .12) and fear lists (*M* = .98, *SD* = .11), and were higher for the fear lists compared to the anger lists, but none of the differences were significant (all *p′s* > .05). Within the fear group response bias was significantly lower for the fear lists (*M* = .91, *SD* = .12) compared to the anger lists (*M* = 1.00, *SD* = .11), *p* < .01, and neutral lists (*M* = 1.06, *SD* = .11), *p* < .01. The difference between the anger and neutral lists was not significant, *p* = .13. In the control group response bias was again significantly lower for the fear lists (*M* = .92, *SD* = .13) compared to the anger lists (*M* = 1.00, *SD* = .09), *p* < .01, and neutral lists (*M* = 1.01, *SD* = .10), *p* < .01. The difference between the anger and neutral lists was not significant, *p* = 1.00.

For *remember* responses there was no significant main effect of List, *F*(2, 138) = 3.07, *p* = .05, η_p^2 = .04, no significant effect of Emotion, *F*(2, 69) = 1.30, *p* = .28, η_p^2 = .04, but a significant interaction effect of List x Emotion, *F*(4, 138) = 6.406, *p* < .01, η_p^2 = .16. Pairwise comparison for the anger group show scores for the fear lists (*M* = 1.19, *SD* = .04) were significantly higher than the anger lists (*M* = 1.07, *SD* =

.06), $p < .05$, and neutral lists ($M = 1.12$, $SD = .06$), $p < .05$, The difference between the anger and neutral lists was not significant, $p = .19$. Within the fear and control group there were no significant differences between lists (all *p's* > .05).

For *know* responses there was a significant main effect of List, $F(2, 138) = 8.29$, $p < .01$, $\eta_p^2 = 11$, no significant main effect of Emotion, $F(2, 69) = 1.32$, $p = .27$, $\eta_p^2 = .04$, and no significant List x Emotion interaction, $F(4, 138) = 2.04$, $p = .09$, $\eta_p^2 = .06$. Pairwise comparisons for the main effect of List show *criterion C* scores were significantly higher for neutral lists ($M = 1.19$, $SD = .04$) compared to anger ($M = 1.17$, $SD = .05$), $p < .05$, and fear lists ($M = 1.16$, $SD = .15$), $p < .01$. The difference between anger and fear lists was not significant, $p = .29$. For *guess* responses there was no significant main effect of List, $F(2, 138) = .83$, $p = .44$, $\eta_p^2 = .01$, no significant main effect of Emotion, $F(2, 69) = .64$, $p = .53$, $\eta_p^2 = .02$, and no significant List x Emotion interaction, $F(4, 138) = 2.07$, $p = .09$, $\eta_p^2 = .06$.

As with the false memory data, in many instances the response bias for fear related stimuli is lower compared to anger and neutral stimuli. For the *old* responses participants in the fear and control group appear to have more selective responding for neutral and anger lists compared to fear, and in the *know* responses there is a general enhancement for selective responding to neutral lists compared to both fear and anger lists. This pattern is reversed in the *remember* responses as participants were more selective in their responding to fear stimuli compared to anger and neutral stimuli.

3.4.3. Summary

Experiment 3 extends previous research on the emotion congruency effect (Howe & Malone, 2011; Knott & Thorley, 2013; Ruci et al., 2009) by using discrete emotions that are dimensionally similar with regard to arousal and valence. In order to better understand the link between memory and emotion, we need to go beyond a simple examination of the effects of emotional arousal and valence and instead be able to classify to-be-remembered information as emotionally congruent or incongruent with a specific emotional state (e.g., fear, anger).

The results from this study are the first to demonstrate evidence of a discrete emotion congruency effect with DRM false memories. Participants experiencing fear were more likely to report explicit false memories for fear related stimuli compared to anger and neutral, whereas participants experiencing anger were more likely to report explicit false memories for anger related stimuli compared to fear and neutral. This pattern of discrete emotion congruency is consistent with spreading activation theories, such as AAT (Howe et al., 2009) and Bower's (1981) Network Theory of Affect, as well as other theories such as FTT (Brainerd & Reyna, 2002), and appraisal theories of emotion (Oatley & Johnson-Laird, 2014).

According to AAT, we would be more likely to produce false memories related to the emotion we are experiencing due to the heightened activation of the related emotion node in the associative network, which contains both semantic and affective memory structures. Where past research has demonstrated this through activation of general negative emotion nodes, Experiment 3 shows that this associative network activation is much more selective, activating discrete emotion nodes. This account is in line with appraisal theories of emotion since discrete emotions serve a purpose and so cognitive mechanisms process relevant, emotionally congruent, stimuli differently to irrelevant stimuli.

An alternative explanation can be found in the response bias literature (Dougal & Rotello, 2007; Windmann & Kutas, 2001). Dougal and Rotello (2007) demonstrated that when semantic densitiy was matched between negative, neutral, and positive stimuli there was no difference in sensitivity or memory accuracy between the three conditions. They did, however, find a difference in response bias whereby participants were more liberal in their recognition responses to negative stimuli compared to neutral and positive. This finding suggests that negative stimuli generally elicit higher proportions of responding and may, therefore, cause one to question whether an increased response to negative emotional stimuli is in fact due to a congruent emotion induction or simply an increased bias. However, this prediction can only account for a general increase for negative stimuli. The experimental manipulation used here involves two different negative emotions, each with similar levels of valence and arousal, and any increase in recognition rates for negative stimuli within each of our groups is specific to the congruent emotion. This suggests that there is more to the increase in negative false memories than response bias alone.

Although the results support the assumption that the emotion induction procedure was successful there are limitations in the method used that need to be addressed. Ethically, one could not induce the same emotional state experienced when being attacked. However, the chosen induction technique has been normed extensively for producing the desired discrete emotions (Bartolini, 2011; Gross & Levenson, 1995; Jonathan Rottenberg et al., 2007a). With regard to the emotion groups, when inducing anger it must also be noted that there is often a subsequent induction of disgust. While this may be the case with the chosen film clip it would only be a mild induction and unlikely to confound the results. In addition, due to the nature of the stimuli being used it was not possible to employ a more comprehensive subjective measure of emotion. The emotion words necessary for any such measure would have confounded the results of the memory test. Nevertheless, analysis of the SAM scales confirmed the appropriate changes in mood following the induction procedures, and the clips used are not known to induce the contrasting emotion.

With regard to the DRM lists used none of the words presented had high BAS for the critical lures on the incongruent emotion lists. However, given the nature of fear and anger there may be weak, indirect, associations across lists. With most typical DRM studies false recognition rates for filler items would be relatively low. This however was not the case. The filler items used were congruent to each of the list emotions and therefore not strictly unrelated. It was expected therefore that the same congruency effects, although much weaker, would be produced. According to AAT, very weak associates would not normally create spreading activation significant enough to produce false memories. However, the congruent emotional states would have enhanced these activations, subsequently bringing many of these items to the threshold necessary to produce false memories.

3.5 Conclusions

In this chapter, there is novel evidence that discrete emotional states experienced at encoding can increase production of subsequent false memories for emotionally congruent stimuli. As mentioned in the introduction, previous research had begun looking at the emotion-congruency effect with false memories but had focussed solely on valence effects (Knott & Thorley, 2013; Ruci et al., 2009). It is now apparent that this congruency effect can act independently of valence, and arousal, when the discrete emotions manipulated are similar across these two dimensions (e.g. fear and anger). These novel findings highlight the need for researchers to look beyond the effects of valence and arousal, and support models of discrete emotion effects (Moors, Ellsworth, Scherer, & Frijda, 2013; Oatley & Johnson-Laird, 2014; Smith & Ellsworth, 1985).

This is not to say that research should abandon valence and arousal effects, far from it in fact. Experiment 2 replicates past research and demonstrates that high arousal stimuli elicit greater spontaneous false memory rates compared to low arousal stimuli. Arousal and valence are important dimensions and account for many of the effects of emotion on cognition (Colibazzi et al., 2010). However, research should be cautious to consider additional explanations (possibly masked by the effects of arousal and valence) and to seek out additional effects that may occur irrespective of these dimensions.

One alternative dimension to be considered is the approach/avoidance model of emotion (Elliot, 2006). This posits that emotions can be plotted on a scale going from those promoting approach behaviours to those promoting avoidance behaviours. Typically, negative emotions are considered to be avoidance emotions since they encourage the person to avoid similar situations, while positive emotions encourage behaviours to approach and seek out situations. With regard to fear and anger, although both emotions are often associated with similar situations, fear is considered to provoke avoidance behaviours, where an organism retreats from the stimulus, whereas anger would provoke an approach response, where the organism may attack the stimulus (Carver & Harmon-Jones, 2009; Elliot, 2006; Rutherford & Lindell, 2011).

The approach/avoidance mechanism has clear adaptive value and aligns well with appraisal theories mentioned throughout this chapter. Emotions are adaptive mechanisms for survival. They can increase the efficiency of reactions to events and optimise the response by biasing cognitive resources toward relevant stimuli in the environment (Clore & Huntsinger, 2007; Oatley & Johnson-Laird, 2014). This biasing effect can subsequently increase activation of concepts accounting for subsequent increases in false memories.

As well as emotions being adaptive, Howe (2011) highlights the adaptive nature of false memories, and their role in survival and goal attainment. Research has shown that memory is biased towards survival relevant conditions (Nairne, 2010; Nairne, Thompson, & Pandeirada, 2007). It adapts to encode information that will be most beneficial to the present goals and future survival of the person. The different appraisals and actions associated with different emotions therefore benefits from a memory system that is biased towards information most associated with that specific emotion and subsequently the desired goal.

The effect of emotion congruency on spontaneous false memory production has significant implications for clinical settings in which therapists may discuss emotional memories with patients, or therapies aimed at encouraging new positive memories. Research has shown how important specific emotional states may be in false memory. For example, Howe and Malone (2011) showed that the presence of major depressive disorder significantly increased false memory production for depression relevant information. Although caution is appropriate when generalizing from psychopathology to everyday emotional experiences, the evidence presented in this chapter demonstrates that this highly specific emotion congruency effect is also present outside of the clinical disorder. Those not diagnosed with major depressive disorder are still at risk of producing false memories congruent to the specific negative emotion that they experience at encoding.

In addition, in legal cases, in which much weight is put on eyewitness testimonies, it is important to consider that the emotional state and the motivations of the person at the time of, experiencing, or witnessing, a crime may affect the false memories produced. Although many advances have been made with regards to interviewing techniques (Fisher, & Geiselman, 2010) and procedures designed to minimise the production of false memories after the fact, little can be done about spontaneously produced false memories at the time of the event. Therefore, it is important for research to continue its exploration of the factors leading to less accurate memory.

Chapter 4

Misinformation and Emotion

4.1 Overview

In the previous chapter the effect of emotion at encoding on the production of spontaneous false memories was examined and evidence was presented of a discrete emotion congruency effect within the DRM paradigm. Emotion can also affect false memory production at other stages. After a memory has been formed additional information may be presented and through reconsolidation or source monitoring errors the new, incorrect details are perceived as part of the original event memory. The current chapter is used to examine the effect of emotion on manipulating memories and source memory for new erroneous information.

Literature on the effect of emotion within the misinformation paradigm is reviewed, looking specifically at both the effect of the emotional content of the stimuli as well as the effect of the emotional state of the participants. There is a wealth of research on this topic (for reviews see Kaplan, Van Damme, Levine, & Loftus, 2015; Loftus, 2005). However, due to the complexity of the paradigm there remain many unanswered questions. Novel findings from modified versions of the misinformation paradigm are also presented. The experiments conducted demonstrate that in the absence of suggestion participants remain prone to endorsing misinformation and that source memory for misinformation is worse for negative stimuli compared to positive and neutral stimuli. In addition, in this chapter there is evidence that a negative emotion induction at retrieval can also affect the qualitative properties of a memory.

4.2 Introduction

The misinformation paradigm was first developed by Elizabeth Loftus in order to emulate suggestive interviewing techniques used in legal and clinical settings. Within the legal and clinical sectors, there is evidence of the use of various suggestive techniques that have a dangerous side effect of increasing the chances of false memories being produced and reported as veridical. In contrast to the DRM paradigm discussed in Chapter 3, the misinformation paradigm investigates more directly the real-life impact of false memories. Where the DRM paradigm elicits the production of spontaneous endogenous false memories, exposing underlying cognitive mechanisms, the misinformation paradigm examines the fallibility of already formed memories and the effect external influences may have on distorting such memories.

The classic paradigm involves presenting participants with an event, in this case a car crash, and in a later session they are given misleading information about the event (Loftus, 1975). In subsequent recognition memory tests, many participants are found to incorporate the misleading information into their memory for the event, misremembering the severity of the crash. Another well-known example of this is that from Stark, Okado, and Loftus (2010), where participants were shown images of a man stealing a woman's purse and hiding it in his jacket pocket. In the misinformation stage participants were presented with narratives in which the event is described with the alteration that the purse was placed into the thief's pants pocket. In a later memory test, many participants falsely reported the misinformation. Even more compelling is that many participants also reported that they remembered these details from the photographs and not just from the interview phase.

Soon after the popularity of this paradigm became apparent, McCloskey and Zaragoza (1985) cautioned that a distinction should be made between the acceptance of misinformation and a reconsolidation effect. Without evidence that participants in the original study encoded the stop sign, the misleading suggestion of a yield sign does not conflict with a stored memory and may therefore be incorporated to fill this gap in the memory. Therefore, misinformation experiments should not only ask if a participant has a memory of the misinformation but also what their memory of the source is. Incorrect source monitoring responses subsequently indicate a serious failure in memory and highlight the issue of using these memories as evidence.

As well as implications for clinical and legal settings the misinformation paradigm has been applied to various other sectors. Misinformation is a common occurrence in everyday life. As well as occurring through suggestive questioning, misinformation can be encountered through discussions with other witnesses, doctored photographs, and misrepresentations of events in the media. Over the years there have been several reviews of this literature (e.g. Frenda, Nichols, & Loftus, 2011; Loftus, 2005), however, the focus of this chapter is the role emotion plays in the manipulation of source memory. In both clinical and legal settings, emotional influences are common and may affect the misinformation acceptance rate, either via the individual's emotional state, the emotional content of the stimuli being remembered, or in the case of misinformation, the emotional content of the new information being presented. Chapter 3 contained evidence that at encoding emotion enhances activation of related concepts and leads individuals to confuse that activation with the stimuli originally presented to them, producing false memories for emotionally congruent information. Within the misinformation paradigm, however, the results are not as straightforward.

There is evidence that misinformation acceptance is more likely for negative stimuli compared to positive and neutral. It has been argued that this is due in part to the increased semantic density (Dougal & Rotello, 2007) or conceptual relatedness (Gallo et al., 2009) of negative emotional stimuli. Increased associations between emotional concepts may increase the chances of additional information being misremembered as part of the event, just as AAT predicts spreading activation increases spontaneous false memory production (Howe et al., 2009). This has been shown with adults viewing photographs (e.g. Gallo, Foster, & Johnson, 2009; Porter, Spencer, & Birt, 2003; Van Damme & Smets, 2014), with memory for media (Porter, Taylor, & ten Brinke, 2008), and with young children (Otgaar et al., 2008). This enhancement appears to be more so for peripheral details than central (e.g. Harmon-Jones, Gable, & Price, 2012; Porter, ten Brinke, Riley, & Baker, 2014; Van Damme & Smets, 2014). In earlier work, the "weapon focus" effect (Loftus, Loftus, & Messo, 1987) demonstrates a clear example of this centrality bias. The arousal induced by seeing a weapon focuses attention on the central relevant details (the weapon itself), consequently improving memory for those aspects, but at the expense of peripheral details, such as the identity of the perpetrator (Christianson & Loftus, 1991). Contradictory to much of the evidence discussed so far, Forgas, Laham, and Vargas (2005) failed to find any effect of emotional content on misinformation acceptance. In their experiment participants were given one minute to study each emotional image. In typical settings images are shown briefly on the screen and make up part of a whole scene. Given additional time to study solitary images may have overridden any narrowing effects of attention, allowing participants to study central and peripheral aspects of both emotional and neutral images equally.

There are also limits found to the argument that arousal enhances memory for central aspects. Morgan, Southwick, Steffian, Hazlett, and Loftus (2013) demonstrated extreme levels of arousal can inhibit memory for all aspects of an event and subsequently increase vulnerability to misinformation. In a mock 'prisoners of war camp' experiment with the U.S. Navy Survival School, participants underwent a stressful interrogation. Not only was memory poor for details about the interrogation and the interrogator, more than half falsely identified the interrogator. As suggested, the emotional state of the individual is also an important consideration as in many cases, the emotional content of the event will induce an emotional reaction and subsequently affect memory.

Autobiographical memories for a Red Sox game were evaluated and positive emotion at the time of the event was found to decrease memory consistency, through broadening attention, while the opposite effect was found for individuals in a negative emotional state (Kensinger & Schacter, 2006). Hess, Popham, Emery, and Elliott (2012) found similar results in younger and older adults, where more positive moods at encoding predicted greater endorsement of misinformation. Arousal appears to have similar effects to negative valence as higher inductions of arousal during encoding predict decreases in misinformation endorsements (Hoscheidt et al., 2014).

The affect as information hypothesis explains these findings as it states that negative emotion encourages item-specific processing while positive emotion encourages more abstract heuristic processing. Negative valence signals item-specific processing to monitor and solve problems however positive valence signals relational processing to encourage seeking out new opportunities (Kensinger, 2009). FTT promotes a similar dual-process mechanism by which emotional valence, negative more so than positive, would strengthen gist traces (over verbatim traces) leading to an increase in subsequent false memory production (Bookbinder & Brainerd, 2016). In addition to these dual-process theories, AAT (Howe et al., 2009) accounts for these findings as spreading activation at encoding is enhanced for emotional concepts and these activations confuse later source monitoring judgments for consistent misinformation. With central items being encoded better than peripheral, there is an increased chance that central items will be encoded correctly but that activation spreading to associated concepts may match that of the activation of the true peripheral details present and thus increase susceptibility to memory errors even more.

Each of these theories provides reasonable explanations for the effect of emotion at encoding. However, there is less research concerned with the effect of emotional states after encoding, specifically at the misinformation stage. In legal and clinical settings, as well as in general everyday scenarios, individuals are often in an emotional state when retrieving memories and this is likely to affect the susceptibility to misinformation acceptance. For example, Forgas, Laham, and Vargas (2005) induced emotion immediately before misleading questions were presented and found that negative emotion decreased, while positive emotion increased, the rates of misinformaiton acceptance. The authors argued that the results support accounts that negative valence narrowed attention and focussed cognitive processes on item-specific information thus reducing processing of the additional misleading details, while positive valence encouraged more heuristic processing and broadened attention to such information. Looking instead at arousal, English and Nielson (2010) found that inducing arousal immediately after misinformation was presented decreased the endorsement of the misinformation at a later memory test. It is likely in this case that arousal acted to enhance reconsolidation of the original memory retrieved, as well as enhancing memory for the misinformation, and more specifically the source of the misinformation. There is evidence in the true memory literature to support this theory as arousal immediately after learning has been shown to increase the strength of the memory (Finn & Roediger, 2011) possibly by modulating the strength of connections coming from the amygdala (Mickley Steinmetz et al., 2010).

Much like spontaneous false memories then, the effect of emotion on misinformation acceptance depends greatly on whether the emotion is embedded in the stimuli or is experienced by the participant. Negative emotional states appear to focus attention on the stimuli, increasing the strength of subsequent memories and reducing errors, while negative stimuli increase the chances of false memories being produced through increased semantic density among related concepts. AAT accounts for each of these effects when considered alongside leading theories of emotion processing. False memories occur when activation of associated, but non-presented, concepts reaches a threshold, likely similar to that of the true memories produced. Information related to negative emotion is more densely associated (Dougal & Rotello, 2007) and therefore spreading activation is enhanced and related concepts are more likely to be encoded. Misinformation may then be more readily accepted due to the increased source confusion and congruency between concepts. With regard to centrality effects, increased attention, and hence activation, of central details increases the strength of the true memories and so, while spreading activation may also be greater, the central details themselves are protected from errors. Peripheral details, on the other hand, are not only vulnerable to misinformation due to a decrease in attentional processes, but also through the increased confusion of additional activated concepts. The reverse effect seen with negative emotional states can be accounted for by the attentional bias negative emotion elicits toward relevant stimuli. As with the central details of emotional stimuli, increased processing through emotional attention narrowing leads to better overall memory for the stimuli, and thus a decreased vulnerability to errors, essentially negating any corresponding increases in spreading activation.

Although past research provides some ideas as to the effect of emotion on memory errors the question of emotion congruency is yet unanswered. In addition, there is a confound between memory errors for the source of information and errors related to suggestibility. With the typical misinformation paradigm, there are many contributing factors to consider, such as memory distrust, whereby participants may be easily suggestible due to an innate uncertainty about their own memory or a disproportionate trust in others memories or accounts of events (Frenda, Nichols, & Loftus, 2011). The dissociation between the visually presented stimuli at encoding and the verbally presented misinformation may increase errors through a lack of concrete retrieval cues and a reliance on conceptual activation strengths to analyse the content of the memory. In order to focus more on the effect of emotion alone, Experiment 4 uses a modification of the misinformation paradigm to reduce these additional, confounding factors. Although by definition the standard misinformation phase involves providing misleading details about the memorised event, in Experiment 4 participants are exposed to manipulated versions of the original images with new items embedded in either the central of peripheral focus of the images. Such a change in the design means that any memories for these manipulated images will be true memory traces. However, what is of interest is participants' ability to monitor the source of the images and the production of false memories that these embedded images were in fact the original items presented. Often in the media, and especially with the prevalence of fake news reports on social media, people may be exposed to a variety of false images. By removing the element of suggestion, Experiment 4 provides insight into the effect of emotion on the production of false memories for the source of information.

Although in Chapter 3 the importance of going beyond valence and arousal effects to examine discrete emotion effects was stressed, it is still necessary to begin with this simplified model of emotion. Experiment 4 therefore examines the induction of negative valence on source memory errors for a variety of negative, positive, and neutral images. The simple exposure aspect of the design, as opposed to the standard suggestion procedure, is likely to produce slightly lower levels of misinformation acceptance. However, this should, in turn, enable a clearer assessment of the effect of emotional content, emotion induction, and emotional congruency effects.

4.3 EXPERIMENT 4:

Negative Emotion Effects on Source Memory Errors

Experiment 4 was designed to investigate the combined effect of emotional state and the emotional content of the stimuli on source memory for central and peripheral details. Unlike the standard misinformation paradigm, where false information is introduced using suggestive techniques, this experiment introduced misinformation simply by exposing participants to manipulated stimuli containing new additional details. The emotional state of the participants was manipulated using sad and neutral film clips (Rottenberg et al., 2007). Neutral emotion inductions are problematic, as outlined in Chapter 2, in that they can induce a range of different emotions, from mild negative to mild positive emotions. However, in Experiment 4, a neutral clip was necessary to avoid confounds of only showing the negative emotion group a video clip at the misinformation stage. In addition, sadness was chosen as the negative emotion induction because, as demonstrated in

Chapter 2, self-report measures show greater intensity of the emotional experience compared to other negative emotion inductions.

Past research on the effect of emotion on misinformation would suggest that misinformation acceptance be greater for negative compared to positive and neutral stimuli, and this increase would be most pronounced for peripheral details compared to central (e.g. Porter, Spencer, & Birt, 2003; Van Damme & Smets, 2014). In addition, the negative emotion induction compared to the neutral should increase processing of the manipulated image and increase the strength of any new memory traces formed. In the case of peripheral details this would likely result in an increase in source monitoring errors due to increased endorsement rates. Whereas for central details participants are most likely to recognise these as false and the increased processing should enhance source memory for these details.

Considering discrete emotion theories and the issue of appraisals and motivations, interactions between the emotion and the central and peripheral details are only likely if the central details are relevant to the motivations of the participant at the time of encoding (Kaplan, Van Damme, & Levine, 2012). Given the complexity and variety of concepts presented in the images it is unlikely that an emotional component alone will have such an effect on the pattern of results. AAT predicts an increase in the source monitoring errors if the misinformation is consistent with the original spreading activation, without a motivational component there should be no distinction between so-called central and peripheral details and therefore errors are equally likely. The congruency between the emotion induction and the emotional content of the stimuli may inflate memories for misinformation items. AAT would predict faster and stronger activation of the negative stimuli, resulting in increased processing, as the same concepts would already be activated by the induction. Therefore, processing of misinformation items in congruent stimuli would be enhanced, leading to an increased likelihood of errors.

4.3.1 Method

Participants

A total of 59 volunteers (16 male) from within and around City, University of London participated, with an age range of 18-47 (M = 21.81, SD = 5.89). For an 80% chance of finding a medium effect size with an alpha of .05 we need 58 participants. An additional 43 participants completed voluntary online pilot surveys to create the stimuli sets (10-12 participants completed each of 4 surveys). Participants were fully informed, for the pilot and main experimental procedure, as to the emotional, and at times disturbing, nature of the stimuli. However, participants in the memory experiment were not informed that some of the images shown again at session 2 had been altered from their original state. This deception was explained fully in the debrief procedure and participants were reminded of their right to withdraw their data at this time.

Design

The experiment was conducted across three short sessions, each conducted on three consecutive days. A 2 (Emotion: negative, neutral) x 3 (Stimuli: negative, neutral, positive) x 2 (Change: central, peripheral) x 3 (Presentation: session 1, session 2, session 1&2) mixed design was used, where Emotion was a between-participants variable, and Stimuli, Change, and Presentation were within-participant variables. The dependent variable was recognition responses and post-hoc measures were taken of recollective experience and source monitoring. Recognition responses were recorded for true items presented only on day 1, true items presented again on day 2, misinformation items, and filler items. Recollective experience was measured using the standard *remember*, *know*, *guess* paradigm, where *remember* responses correspond to explicit memory for item presentation, *know* corresponds to familiar items, and *guess* corresponds to recognition responses based upon guess work. For items recognised by participants, source-monitoring questions were used to determine from which of the two proceeding sessions the participants remember the item being presented. Participants were randomly allocated to the Emotion groups with roughly an equal number in each, and Stimuli, Change, and Presentation were counterbalanced across 6 permutations of the experiment.

Permutations/Counterbalancing. A total of 24 image pairs were created for each emotion category: negative, neutral, and positive (72 in total). For each category, the images were split into 3 sub-groups and arranged so that mean valence, arousal, and pair-similarity scores were equal across sub-groups. All sub-groups also had an equal split of image pairs with central or peripheral changes. Sub-groups were then matched, across the different emotion categories, on mean pair-similarity scores to create three super-ordinate groups of image pairs, each containing 24 images (8 Negative, 8 Positive, 8 Neutral [50% Peripheral changes, 50% Central changes]). Each of the three super-ordinate groupings were then used in the experiment as either true items presented once at session 1 (no-reminder), true items presented at session 1 and again at session 2 (reminder), or misinformation items presented in their original form in session 1 but changed when presented at session 2. Six permutations of the experiment were created to allow for all combinations of this.

Stimuli Creation

Images were first selected from The International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1999) which provides arousal and valence ratings for each image and therefore facilitates the creation of emotion related sub-groups.

Three groups were created; positive, neutral, and negative images. Negative images were classified as those images with valence ratings below 3, neutral between 4 and 5, and positive above 7. Images with valence ratings between 3 and 4, and 6 and 7 were excluded to avoid ambiguity between the sub-groups, and images with an arousal rating above 5.5 were excluded in order to reduce the difference in arousal between the emotion, positive and negative, and neutral groups.

Images were altered using the freely available GNU Image Manipulation Program (GIMP; www.gimp.org) by either adding or removing central or peripheral items. Changes were validated as being related to either central or peripheral aspects of the images by 4 independent researchers and only images with an agreement of 75% or more were used. Three initial pilot surveys were created, one for each sub-group, with 32 pairs of images in each. Ratings for noticeable differences between image pairs were measured on a 7-point Likert scale and individual image ratings of arousal and valence were measured on a 9-point Likert scale, and were used to calculate differences in arousal and valence within the pairs. Image pairs differing in average arousal or valence ratings by more than 1 point were excluded as well as those with average ratings for noticeable differences below 4 ('moderately') or above 6 ('very'). Finally, an additional pilot survey was created to bring the total number of usable image pairs to 24 per sub-group (see Appendix E).

Materials

To-be-remembered stimuli were made up of 72 IAPS images with an additional 15 IAPS images used as filler items in the recognition test. Of these 72 images, 24 were negative, 24 were neutral, and 24 were positive (the same 1:1:1 ratio was used for the 15 filler items). Within each of these emotion groups, 12 had central aspects changed and 12 had peripheral details changed. Although changes were made to images by both adding and removing aspects, images presented in the first session were always the version with missing aspects. Misinformation items were therefore characterised as having new aspects not originally present in the images. Figure 4.1 shows examples of the image pairs.

Film clips to induce emotion were chosen from those normed by Rottenberg et al. (2007). Negative emotion (sadness) was induced using a clip from the film “Champ” in which a young boy cries over the death of his father, and neutral emotion was induced using a clip from the film “All the President’s Men” in which a reporter is asking questions around a courtroom. Both videos lasted approximately 5 minutes. The neutral clip chosen has been shown to induce little to no changes in emotional experience (Rottenberg et al., 2007), and in particular in Chapter 2 was shown to be elicit minimal changes in valence. Emotional states were validated using the self-assessment manikin (SAM; Bradley & Lang, 1994).

Procedure

There were three experimental sessions, completed on consecutive days, and each lasted approximately 10 minutes. In session 1 participants completed the SAM and were shown 72 images, presented in a random order for 5 seconds each with a fixation cross between each, presented for 500ms. In session 2 participants watched either the neutral or negative clip and completed a second SAM. Following this, participants saw a second slide show of images, again presented in a random order for 5 seconds with a fixation between. The second slide show consisted of 48 images, 24 seen previously, and 24 manipulated versions of those seen previously. Participants were informed at this stage that they would see a shortened slide show of images to that seen in session 1. No indication was given as to whether the images were the same or new images, participants were simply asked to try to remember as many as possible.

In session 3 participants completed another SAM and a recognition test with 63 images. Participants were shown 24 misinformation images, 12 original images shown at time 1 only, 12 original images shown at both time 1 and time 2, and 15 filler images. For images recognised as 'old' participants were asked to report if recognition was based on a remember, know, or guess judgement (Rajaram, 1993), as well as providing source monitoring information whereby they indicated whether they recognise the image from session 1, 2 or both. Participants were lastly asked to complete a forced choice task in which they were shown the pairs of images (original and manipulated) and asked to select which image was presented at time 1. 'Unsure' was provided as an option to reduce results at chance level.

Central Changes **Peripheral Changes**

Positive Images

Neutral Images

Negative Images

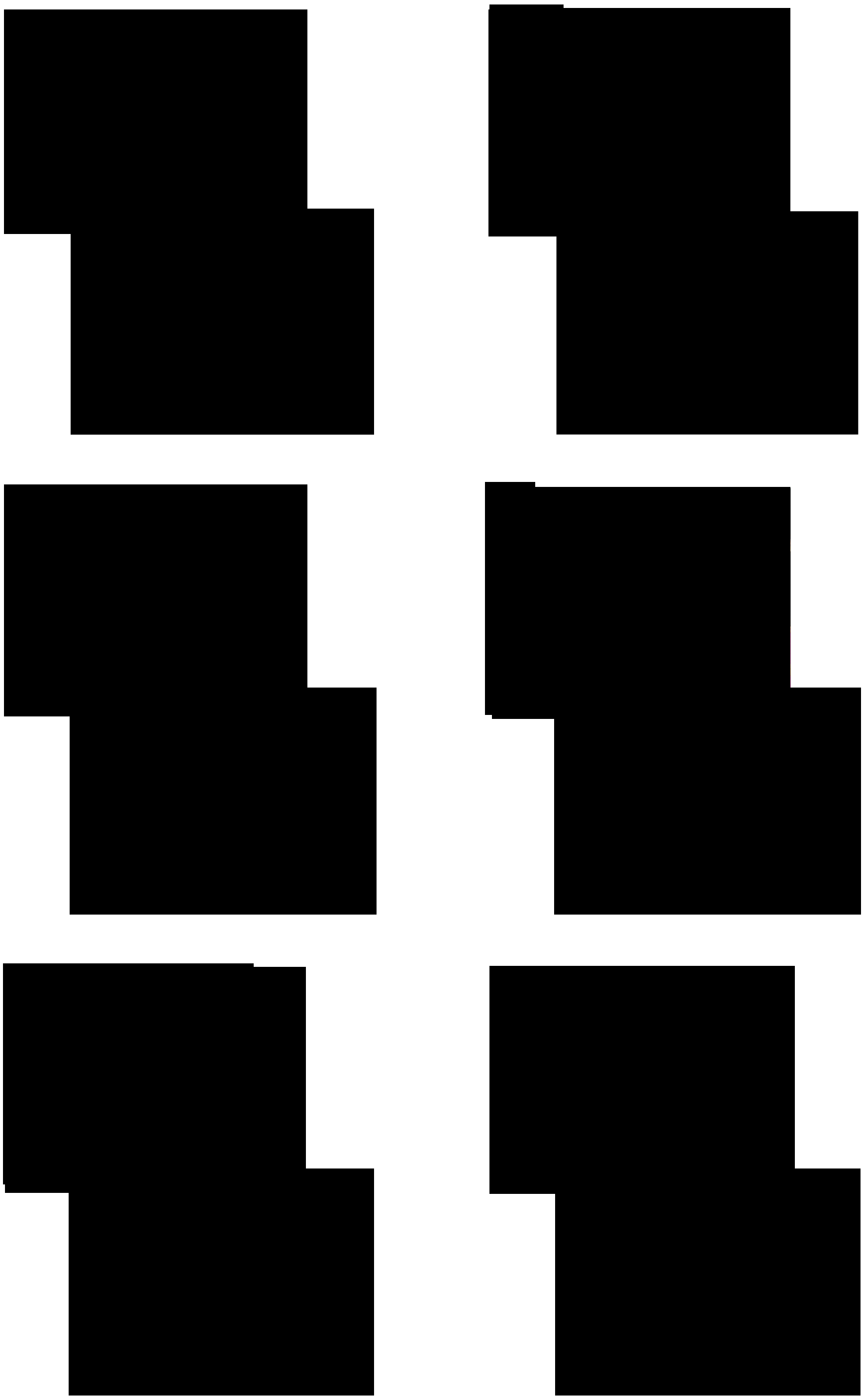

Figure 4.1: ***Example Image pairs presented in either their original form or as manipulated (misinformation) images***

4.3.2 Results

One participant was removed from the analysis as their valence score following the negative induction was higher than before, leaving 31 participants in the negative group and 27 in the neutral group.

Emotion Manipulation

Separate 2 (Emotion: negative, neutral) x 3 (Time: Encoding, Misinformation, Test) ANOVAs were run for arousal and valence scores (see Table 4.1). For arousal there was no significant effect of Time, $F(2, 112) = .79$, $p = .46$, $\eta_p^2 = .01$, Emotion, $F(1, 56) = 1.21$, $p = .28$, $\eta_p^2 = .02$, or significant interaction effect of Time x Emotion, $F(2, 112) = .64$, $p = .53$, $\eta_p^2 = .01$. For valence scores there was a significant effect of Time, $F(2, 112) = 22.92$, $p < .001$, $\eta_p^2 = .29$, Emotion, $F(1, 56) = 4.90$, $p < .05$, $\eta_p^2 = .08$, and a significant interaction effect of Time x Emotion, $F(2, 112) = 25.15$, $p < .001$, $\eta_p^2 = .29$. Post-hoc analyses of the valence scores showed that differences between the negative and neutral group were not significant at encoding, $p = .34$, nor at the recognition test, $p = .55$. However, at the misinformation stage the valence scores for the negative group ($M = 3.90$, $SD = 1.74$) were significantly lower than the neutral group ($M = 6.26$, $SD = 1.10$), $p < .001$.

Recognition and Source Memory

Results were separated into the recognition responses of *old*, *remember*, *know*, and *guess*. Because *guess* responses for misinformation items were at floor these data were not analysed further. Memory was analysed in two ways. First incorrect source monitoring responses for misinformation items were analysed as a function of the emotion induction, emotional content of the images, and the location of the misinformation (central versus peripheral). Second, recognition memory rates were analysed for target items. Source monitoring responses for target items shown on both sessions could be argued as correct regardless of the response given therefore only recognition rates were analysed for these images. For filler items the reverse is true – that no source monitoring responses are correct therefore only recognition responses were analysed (see Table 4.2 for descriptive statistics). However, results of this analysis are omitted from the chapter because the values were extremely low and there were no significant main or interaction effects (all *p's* > .05; see Appendix F).

Table 4.1: ***Arousal and Valence ratings for each emotion group at each stage of the experiment***

	Encoding		Misinformation		Recognition	
	M	*SD*	*M*	*SD*	*M*	*SD*
Arousal						
Negative	3.63	2.01	3.97*	1.56	4.00	2.17
Neutral	4.19	2.22	4.07*	1.73	4.56	1.93
Valence						
Negative	6.73	1.14	3.80*	1.67	6.53	1.14
Neutral	6.37	1.28	6.26*	1.10	6.07	1.47

** post-emotion induction ratings*

Table 4.2: ***Proportion of false recognition of filler items, for each emotion group, as a function of recognition response and stimuli emotion***

	Negative Group				**Neutral Group**			
			95% CI				*95% CI*	
	M	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*
Overall Recognition								
Positive	.08	.03	.02	.15	.08	.02	.03	.13
Neutral	.06	.02	.01	.11	.09	.03	.03	.14
Negative	.06	.02	.02	.11	.10	.03	.04	.16
Remember								
Positive	.03	.01	.00	.06	.01	.01	-.01	.04
Neutral	.02	.01	.00	.04	.03	.02	-.01	.07
Negative	.02	.01	.00	.04	.02	.01	.00	.05
Know								
Positive	.01	.01	-.01	.03	.03	.01	.00	.06
Neutral	.01	.01	-.01	.03	.01	.01	-.01	.04
Negative	.02	.01	.00	.04	.04	.02	.00	.08
Guess								
Positive	.04	.03	-.02	.10	.04	.02	.01	.07
Neutral	.03	.02	-.01	.06	.04	.02	.00	.09
Negative	.03	.02	-.01	.06	.03	.02	-.01	.07

Misinformation items. Incorrect source monitoring responses for misinformation items were analysed for *old* responses, and then for *remember*, *know*, and *guess* responses using a 2 (Emotion: negative, neutral) x 3 (Stimuli: negative, neutral, positive) x 2 (Change: central, peripheral) mixed ANOVA, for 'both session' responses (see Table 4.3) and then for 'session 1 only' responses (see Table 4.4). In cases where the assumption of sphericity was violated the Greenhouse-Geisser correction is reported.

Source monitoring for sessions 1 and 2. For *old* recognition the ANOVA revealed a significant main effect of Stimuli, $F(2, 112) = 8.68$, $p < .05$, $\eta_p^2 = .13$, no significant main effect of Change, $F(1, 56) = .25$, $p = .62$, $\eta_p^2 = .00$, and no main effect of Emotion, $F(1, 56) = .13$, $p = .72$, $\eta_p^2 = .00$. There was also no significant interaction effects of Stimuli x Emotion, $F(2, 112) = .55$, $p = .58$, $\eta_p^2 = .01$, Change x Emotion, $F(1, 56) = 0$, $p = .97$, $\eta_p^2 =.00$, Stimuli x Change, $F(2, 112) = .56$, $p = .57$, $\eta_p^2 = .01$ or Stimuli x Change x Emotion, $F(2, 112) = .45$, $p = .64$, $\eta_p^2 = .01$. Post-hoc analysis of the main effect of Stimuli showed that false memories for negative stimuli (*M* = .43, *SD* = .27) were significantly greater than positive (*M* = .32, *SD* = .25), $p < .01$, and neutral stimuli (*M* = .34, *SD* = .28), $p < .01$, and the difference between neutral and positive was not significant, $p = 1.00$. This finding supports a plethora of past research showing that misinformation acceptance is more likely for negative information (e.g. Gallo et al., 2009; Porter, Spencer, & Birt, 2003; Van Damme & Smets, 2014) and extends it to this simplified paradigm. This finding is typically found more so for peripheral compared to central information (Harmon-Jones, Gable, & Price, 2012; Porter, ten Brinke, Riley, & Baker, 2014). However, the current results show no such distinction.

Table 4.3: ***Proportion of false 'session 1 and 2' source monitoring responses for each emotion group, as a function of recognition response, stimuli emotion, and type of misinformation***

		Negative Group				**Neutral Group**			
				95% CI				*95% CI*	
		M	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*
Overall Recognition									
Positive	Central	.29	.04	.21	.37	.34	.05	.24	.44
	Peripheral	.31	.04	.22	.41	.33	.06	.22	.45
Neutral	Central	.36	.05	.26	.47	.36	.05	.25	.47
	Peripheral	.33	.05	.23	.43	.30	.05	.19	.40
Negative	Central	.43	.05	.32	.53	.43	.05	.32	.53
	Peripheral	.40	.05	.30	.50	.47	.05	.36	.58
Remember									
Positive	Central	.26	.04	.18	.34	.30	.05	.20	.40
	Peripheral	.27	.05	.17	.36	.29	.06	.17	.41
Neutral	Central	.29	.05	.18	.40	.31	.06	.19	.42
	Peripheral	.28	.05	.17	.39	.26	.05	.15	.37
Negative	Central	.36	.05	.25	.47	.34	.05	.23	.45
	Peripheral	.33	.05	.23	.43	.39	.06	.27	.51

Know										
	Positive	Central	.03	.02	-.01	.07	.05	.02	.01	.09
		Peripheral	.04	.02	-.01	.09	.03	.02	-.01	.07
	Neutral	Central	.07	.04	.00	.15	.06	.03	.00	.11
		Peripheral	.04	.02	.00	.08	.04	.02	-.01	.08
	Negative	Central	.06	.03	.00	.13	.07	.03	.01	.14
		Peripheral	.06	.03	.00	.11	.06	.03	.01	.12
Guess										
	Positive	Central	-	-	-	-	-	-	-	-
		Peripheral	.01	.01	-.01	.02	.02	.01	-.01	.04
	Neutral	Central	-	-	-	-	-	-	-	-
		Peripheral	.01	.01	-.01	.02	-	-	-	-
	Negative	Central	-	-	-	-	.01	.01	-.01	.03
		Peripheral	.02	.01	-.01	.04	.02	.01	-.01	.04

** values are omitted where data is constant at zero*

Table 4.4: ***Proportion of false 'session 1 only' source monitoring responses for each emotion group, as a function of recognition response, stimuli emotion, and type of misinformation***

			Negative Group				Neutral Group			
					95% CI				*95% CI*	
			M	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*
Overall Recognition										
	Positive	Central	.19	.03	.12	.26	.23	.05	.13	.33
		Peripheral	.18	.04	.11	.25	.22	.04	.13	.31
	Neutral	Central	.13	.03	.06	.20	.19	.05	.08	.29
		Peripheral	.21	.04	.13	.29	.20	.04	.12	.29
	Negative	Central	.11	.03	.05	.18	.14	.04	.06	.21
		Peripheral	.18	.04	.10	.26	.20	.04	.11	.29
Remember										
	Positive	Central	.17	.03	.11	.23	.11	.03	.04	.18
		Peripheral	.14	.03	.07	.21	.12	.03	.06	.18
	Neutral	Central	.10	.03	.05	.16	.17	.05	.06	.27
		Peripheral	.16	.03	.09	.23	.14	.03	.08	.20
	Negative	Central	.10	.03	.04	.16	.11	.04	.04	.19
		Peripheral	.15	.04	.07	.22	.14	.04	.06	.22

Know										
	Positive	Central	.02	.01	.00	.05	.06	.02	.01	.11
		Peripheral	.03	.02	.00	.06	.06	.03	.01	.12
	Neutral	Central	.02	.01	.00	.05	.02	.01	-.01	.04
		Peripheral	.02	.01	-.01	.04	.02	.01	-.01	.04
	Negative	Central	.02	.01	-.01	.04	.03	.02	.00	.06
		Peripheral	.02	.01	.00	.05	.04	.02	.00	.07
Guess										
	Positive	Central	-	-	-	-	.06	.03	.01	.12
		Peripheral	.01	.01	-.01	.02	.04	.02	.00	.07
	Neutral	Central	-	-	-	-	-	-	-	-
		Peripheral	.03	.02	.00	.06	.04	.02	-.01	.08
	Negative	Central	-	-	-	-	-	-	-	-
		Peripheral	.01	.01	-.01	.02	.03	.02	.00	.06

** values are omitted where data is constant at zero*

For *remember* recognition responses (Figure 4.2) the ANOVA revealed similar results to before, with a significant main effect of Stimuli, $F(2, 112) = 4.55$, $p < .05$, $\eta_p^2 = .08$, no significant main effect of Change, $F(1, 56) = .16$, $p = .69$, $\eta_p^2 = .00$, and no main effect of Emotion, $F(1, 56) = .08$, $p = .79$, $\eta_p^2 = .00$. There was also no significant interaction effects of Stimuli x Emotion, $F(2, 112) = .17$, $p = .84$, $\eta_p^2 = .00$, Change x Emotion, $F(1, 56) = .05$, $p = .83$, $\eta_p^2 = .00$, Stimuli x Change, $F(2, 112) = .22$, $p = .81$, $\eta_p^2 = .00$, or Stimuli x Change x Emotion, $F(2, 112) = .65$, $p = .52$, $\eta_p^2 = .01$. Post-hoc analyses again showed that false source monitoring responses were significantly greater for negative stimuli ($M = .36$, $SD = .26$) compared to positive ($M = .28$, $SD = .22$), $p < .05$, and neutral stimuli ($M = .28$, $SD = .25$), $p < .05$, and the difference between neutral and positive was not significant, $p = 1.00$.

For *know* responses there was a significant main effect of Stimuli, $F(1.7, 94.9) = 4.35$, $p < .05$, $\eta_p^2 = .07$, where responses were significantly greater for negative stimuli ($M = .07$, $SD = .14$) compared to positive ($M = .04$, $SD = .09$), $p < .05$, but not neutral ($M = .05$, $SD = .14$), $p = .20$, and the difference between neutral and positive was not significant, $p = .53$. The ANOVA also revealed no main effect of Change, $F(1, 56) = 1.75$, $p = .19$, $\eta_p^2 = .03$, or Emotion, $F(1, 56) = 0$, $p = 1$, $\eta_p^2 = .00$. There was also no interaction effect of Stimuli x Emotion, $F(1.7, 94.9) = .5$, $p = .58$, $\eta_p^2 = .01$, Change x Emotion, $F(1, 56) = .06$, $p = .81$, $\eta_p^2 = .00$, Stimuli x Change, $F(1.67, 93.63) = .26$, $p = .73$, $\eta_p^2 = .01$, or Stimuli x Change x Emotion, $F(1.67, 93.63) = .23$, $p = .76$, $\eta_p^2 = .00$.

Source monitoring for session 1. For *old* recognition responses the ANOVA revealed no significant main effects of Stimuli, $F(2, 112) = 1.87$, $p = .16$, $\eta_p^2 = .03$, Change, $F(1, 56) = 3.67$, $p = .06$, $\eta_p^2 = .06$, Emotion, $F(1, 56) = .71$, $p = .4$, $\eta_p^2 = .01$, nor significant interaction effects of Stimuli x Emotion, $F(2, 112) = .07$, $p = .94$, $\eta_p^2 = .00$, Change x Emotion, $F(1, 56) = .27$, $p = .61$, $\eta_p^2 = .01$, Stimuli x Change, $F(2, 112) = 1.64$, $p = .2$, $\eta_p^2 = .03$, or Stimuli x Change x Emotion, $F(2, 112) = .35$, $p = .7$, $\eta_p^2 = .01$. The same was found for *remember* responses as there was no significant main effects of Stimuli, $F(2, 112) = .44$, $p = .64$, $\eta_p^2 = .01$, Change, $F(1, 56) = .82$, $p = .37$, $\eta_p^2 = .01$, Emotion, $F(1, 56) = .02$, $p = .88$, $\eta_p^2 = .00$, nor significant interaction effects of Stimuli x Emotion, $F(2, 112) = .97$, $p = .38$, $\eta_p^2 =.02$, Change x Emotion, $F(1, 56) = .49$, $p = .49$, $\eta_p^2 = .01$, Stimuli x Change, $F(2, 112) = .61$, $p = .55$, $\eta_p^2 = .01$, or Stimuli x Change x Emotion, $F(2, 112) = .97$, $p = .38$, $\eta_p^2 = .01$.

For *know* responses the ANOVA revealed a significant main effect of Stimuli, $F(1.58, 88.71) = 17.24$, $p < .05$, $\eta_p^2 = .24$, where feelings of familiarity were greater for negative stimuli ($M = .12$, $SD = .16$) compared to positive ($M = .04$, $SD = .09$), $p < .01$, and neutral ($M = .02$, $SD = .05$), $p < .01$, stimuli. However, there was no significant difference between positive and neutral stimuli, $p = .19$. Negative stimuli are more densely related and associated and this increased noise can account for the source memory errors for familiar stimuli. The ANOVA also revealed no main effect of Change, $F(1, 56) = 1.42$, $p = .24$, $\eta_p^2 = .03$, Emotion, $F(1, 56) = .37$, $p = .54$, $\eta_p^2 = .01$, or interaction effect of Stimuli x Emotion, $F(1.58, 88.71) = .48$, $p = .58$, $\eta_p^2 = .01$, Change x Emotion, $F(1, 56) = .03$, $p = .88$, $\eta_p^2 = .00$, Stimuli x Change, $F(1.48, 82.83) = 1.04$, $p = .34$, $\eta_p^2 = .02$, Stimuli x Change x Emotion, $F(1.48, 82.83) = .13$, $p = .82$, $\eta_p^2 = .0$.

Target items. Correct source monitoring responses for target items were analysed for *old* responses, and then for *remember*, *know*, and *guess* responses (see Table 4.5) using a 2 (Emotion: negative, neutral) x 3 (Stimuli: negative, neutral, positive) x 2 (Presentation: reminder, no-reminder) mixed ANOVA. In cases where the assumption of sphericity was violated the Greenhouse-Geisser correction is reported.

For *old* recognition responses there was a significant main effect of Presentation, *F*(1, 56) = 154.59, *p* < .05, η_p^2 = .73, whereby recognition was significantly greater for the reminder condition (*M* = .85, *SD* = .22) compared to the no-reminder condition (*M* = .60, *SD* = .28), *p* < .001. There was no significant effect of Emotion, *F*(1, 56) = .00, *p* = 0.97, η_p^2 = .00, but a significant effect of Stimuli, *F*(2, 112) = 3.92, *p* < .05, η_p^2 = .07, whereby recognition was significantly greater for neutral images (*M* = .75, *SD* = .25) compared to positive images (*M* = .68, *SD* = .26), *p* < .05, but no differences where significant with the negative images (*M* = .73, *SD* = .24), *p* = .13, *p* = 1.00. For the interaction effects, there was a significant effect of Reminder x Emotion, *F*(1, 56) = 9.17, *p* < .05, η_p^2 =.14, and Reminder x Stimuli, *F*(2, 112) = 5.14, *p* < .05, η_p^2 = .08, but no significant effect of Stimuli x Emotion, *F*(2, 112) = .22, *p* = .81, η_p^2 = .00, or Reminder x Stimuli x Emotion, *F*(2, 112) = .88, *p* = .42, η_p^2 = .02.

Post-hoc analyses of the interactions revealed that within the negative emotion group recognition was significantly higher for the reminder condition (*M* = .82, *SD* = .22) compared to no-reminder (*M* = .62, *SD* = .24), *p* < .05. The same pattern is seen in the neutral group, however the difference between the reminder condition (*M* = .88, *SD* = .12) and no-reminder (*M* = .56, *SD* = .18), *p* < .05, is greater. Recognition for the reminder condition is also significantly greater compared to the no-reminder condition when the results are broken down into negative stimuli (*M* = .84, *SD* = .22; *M* = .63, *SD* = .27), *p* < .001, positive (*M* = .85, *SD* = .23; *M* = .50, *SD* = .30), *p* < .001 and neutral (*M* = .84, *SD* = .22; *M* = .65, *SD* = .28), *p* < .001, however the difference is greatest in the positive condition.

For *remember* responses (Figure 4.3) there was a significant main effect of Presentation, $F(1, 56) = 81.87$, $p < .05$, $\eta_p^2 = 0.59$, whereby recognition was significantly greater for the reminder condition ($M = .68$, $SD = .28$) compared to the no-reminder condition ($M = .43$, $SD = .21$), $p < .001$. There was no significant effect of Emotion, $F(1, 56) = 0.18$, $p = 0.67$, $\eta_p^2 = .00$, but a significant effect of Stimuli, $F(2, 112) = 8.33$, $p < .05$, $\eta_p^2 = .13$, whereby recognition was significantly greater for neutral images ($M = .60$, $SD = .28$) compared to positive images ($M = .50$, $SD = .24$), $p < .01$, and significantly greater for negative images ($M = .58$, $SD = .26$) compared to positive, $p < .01$, but there was no different between negative and neutral images, $p = 1.00$. For the interaction effects, there was a significant effect of Reminder x Emotion, $F(1, 56) = 7.40$, $p < .05$, $\eta_p^2 =.12$, and Reminder x Stimuli, $F(2, 112) = 5.17$, $p < .05$, $\eta_p^2 = .09$, but no significant effect of Stimuli x Emotion, $F(2, 112) = .08$, $p = 0.92$, $\eta_p^2 = .00$, or Reminder x Stimuli x Emotion, $F(2, 112) = 0.96$, $p = 0.39$, $\eta_p^2 = .02$.

Post-hoc analyses of the interactions revealed that same pattern of results as the *old* responses. Responses for the reminder condition were significantly greater than the no-reminder condition in both the negative group ($M = .66$, $SD = .30$; $M = .48$, $SD = .23$), $p < .001$, and neutral group ($M = .70$, $SD = .29$; $M = .38$, $SD = .21$), $p < .001$, but the difference was greater in the neutral group. Recognition for the reminder condition was also significantly greater compared than the no-reminder condition when the results were broken down into negative stimuli ($M = .67$, $SD = .32$; $M = .48$, $SD = .28$), $p < .001$, positive ($M = .67$, $SD = .33$; $M = .31$, $SD = .28$), $p < .001$ and neutral ($M = .69$, $SD = .32$; $M = .51$, $SD = .32$), $p < .001$, however the difference is again greatest in the positive condition.

For the *know* responses there was no significant effect of Reminder, $F(1, 56) = 1.34$, $p = .25$, $\eta_p^2 = .02$, Stimuli, $F(2, 112) = .72$, $p = .49$, $\eta_p^2 = .01$, Emotion, $F(1, 56) =$

.13, *p* = .72, η_p^2 = .00, or Reminder x Emotion, *F*(1, 56) = .02, *p* = .89, η_p^2 = .00, Stimuli x Emotion, *F*(2, 112) = .34, *p* = .71, η_p^2 = .01, Reminder x Stimuli, *F*(2, 112) = .08, *p* = .93, η_p^2 = .00, or Reminder x Stimuli x Emotion, *F*(2, 112) = 2.23, *p* = .11, η_p^2 = .04. For the *guess* responses however there was a significant effect of Reminder, *F*(1, 56) = 5.16, *p* < .05, η_p^2 = .08, whereby responses were significantly higher for the no-reminder condition (*M* = .05, *SD* = .08) compared to the reminder condition (*M* = .03, *SD* = .05). There was no significant effect of Stimuli, *F*(2, 112) = .36, *p* = 0.70, η_p^2 =.01, Emotion, *F*(1, 56) = 1.08, *p* = 0.30, η_p^2 =.02, or interaction effects of Reminder x Emotion, *F*(1, 56) = 2.88, *p* = 0.1, η_p^2 = 0.05, Stimuli x Emotion, *F*(2, 112) = .48, *p* = .62, η_p^2 = .01, Reminder x Stimuli, *F*(2, 112) =.38, *p* = 0.69, η_p^2 = .01, Reminder x Stimuli x Emotion, *F*(2, 112) = .09, *p* = .92, η_p^2 = .00.

Table 4.5: ***Proportion of correct recognition responses for each emotion group as a function of recognition responses, stimuli emotion, and reminder condition***

		Negative Group				Neutral Group			
				95% CI				*95% CI*	
		M	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*
Overall Recognition									
Positive	Reminder	.53	.06	.41	.65	.47	.05	.37	.58
	No Reminder	.82	.05	.72	.93	.88	.03	.82	.95
Neutral	Reminder	.69	.05	.58	.79	.61	.05	.5	.71
	No Reminder	.79	.05	.69	.89	.91	.03	.85	.96
Negative	Reminder	.65	.05	.55	.76	.61	.05	.51	.72
	No Reminder	.83	.05	.74	.92	.84	.03	.77	.91
Remember									
Positive	Reminder	.35	.06	.23	.46	.29	.05	.19	.38
	No Reminder	.67	.06	.54	.80	.68	.06	.55	.80
Neutral	Reminder	.58	.06	.46	.70	.43	.06	.31	.55
	No Reminder	.65	.06	.53	.77	.73	.06	.61	.86
Negative	Reminder	.52	.05	.42	.63	.44	.06	.32	.55
	No Reminder	.65	.06	.53	.76	.70	.06	.58	.83

Know										
	Positive	Reminder	.14	.03	.07	.21	.11	.03	.05	.17
		No Reminder	.11	.04	.02	.20	.18	.05	.08	.28
	Neutral	Reminder	.09	.03	.03	.14	.11	.03	.05	.18
		No Reminder	.11	.04	.02	.20	.14	.06	.02	.26
	Negative	Reminder	.08	.02	.03	.13	.11	.03	.04	.18
		No Reminder	.15	.04	.08	.23	.11	.04	.03	.19
Guess										
	Positive	Reminder	.05	.02	.00	.09	.07	.02	.03	.12
		No Reminder	.04	.02	.00	.08	.03	.02	.00	.06
	Neutral	Reminder	.02	.01	-.01	.04	.06	.03	.01	.12
		No Reminder	.02	.01	.00	.05	.04	.02	.00	.07
	Negative	Reminder	.05	.02	.00	.09	.06	.02	.02	.11
		No Reminder	.03	.02	.00	.06	.03	.02	.00	.06

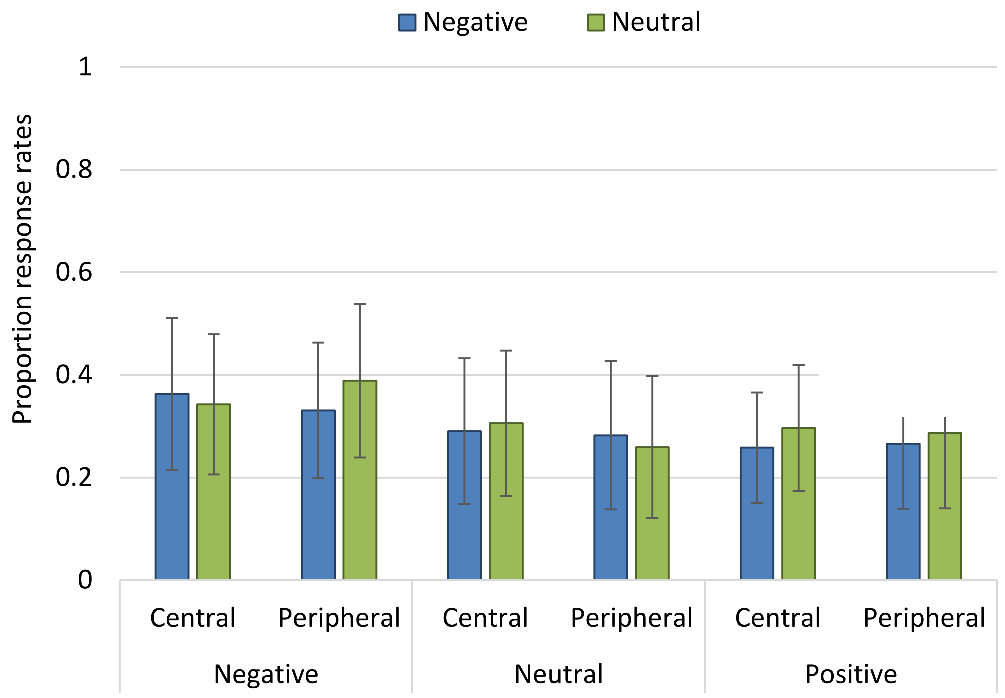

Figure 4.2: ***Proportion of incorrect, session 1 and 2, source memory responses for misinformation items for each emotion group, as a function of the stimuli emotion and location of the embedded detail (error bars represent SD)***

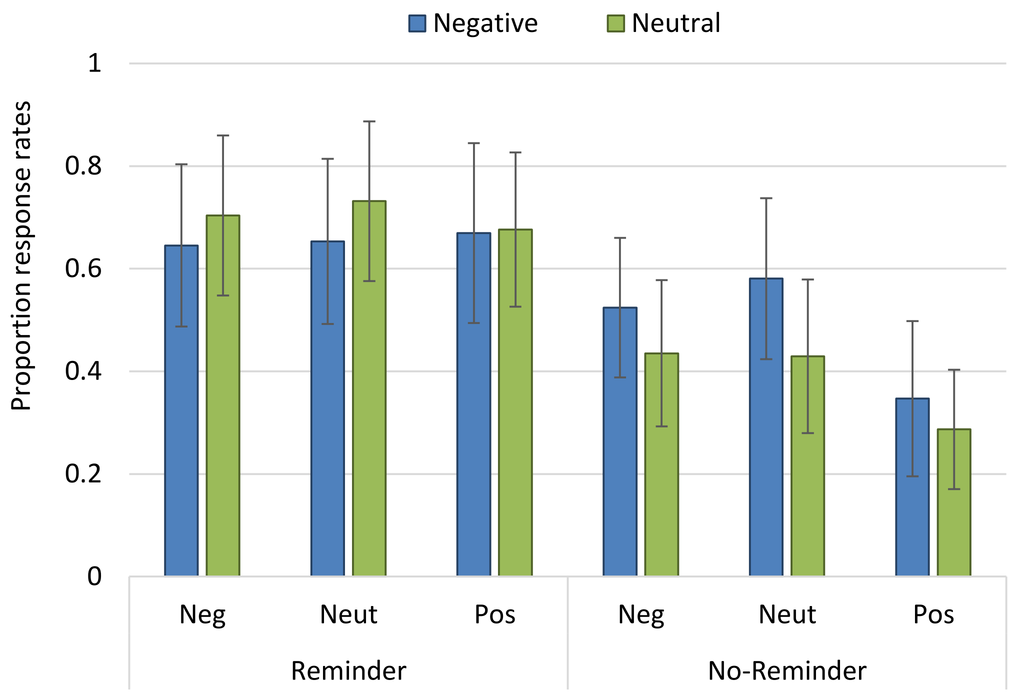

Figure 4.3: ***Proportion of correct recognition of target items for each emotion group, as a function of the stimuli emotion and presentation reminder (error bars represent SD)***

Signal Detection Analysis

Signal detection analysis was conducted with correct recognition responses to target items and false recognition of filler items[10]. Because there were many proportion rates of 0 and 1, the data were transformed using the Snodgrass correction (Stanislaw & Todorov, 1999).

Sensitivity analysis. For *old* recognition responses to target items, the corresponding *d'* scores yielded no significant effect of Stimuli, $F(2, 112) = 2.08$, $p = .13$, $\eta_p^2 = .04$, Emotion, $F(1, 56) = .06$, $p = 0.80$, $\eta_p^2 = .00$, or interaction effect effect of Stimuli x Emotion, $F(2, 112) = .53$, $p = .59$, $\eta_p^2 = .01$. Results for the *remember* responses revealed a significant effect of Stimuli, $F(2, 112) = 5.04$, $p < .05$, $\eta_p^2 = .08$, whereby participants responding was more selective toward target than filler items for negative (M = .35, SD = .14) and neutral stimuli (M = .35, SD = .15) when compared to positive stimuli (M = .30, SD = .16), $p < .05$ and $< .05$. The analysis also showed no significant effect of Emotion, $F(1, 56) = 1.65$, $p = .21$, $\eta_p^2 = .03$, or interaction effect of Stimuli x Emotion, $F(2, 112) = .09$, $p = .92$, $\eta_p^2 = .00$. *Know* responses gave no significant effects of Stimuli, $F(2, 112) = 0.75$, $p = .48$, , $\eta_p^2 = .01$, Emotion, $F(1, 56) = .17$, $p = .68$, $\eta_p^2 = .00$, or Stimuli x Emotion, $F(2, 112) = .73$, $p = .49$, $\eta_p^2 = .01$. *Guess* responses also showed no effects of Stimuli, $F(2, 112) = .35$, $p = .70$, $\eta_p^2 = .01$, Emotion, $F(1, 56) = 3.54$, $p = .07$, $\eta_p^2 = .06$, Stimuli x Emotion, $F(2, 112) = 1.47$, $p = .24$, $\eta_p^2 = .03$.

Response bias analysis. The *criterion C* scores for *old* responses showed no significant effect of Stimuli, $F(2, 112) = 1.42$, $p = .25$, $\eta_p^2 = .03$, or interaction effect of Stimuli x Emotion, $F(2, 112) = .20$, $p = .82$, $\eta_p^2 = .00$, but a significant effect of Emotion, $F(1, 56) = 12.51$, $p < .05$, $\eta_p^2 = .18$. Participants in the neutral group (M =

[10] The same analyses were conducted using the false memory data as the target responses but no significant effects were found in any category. See Appendix G.

1.59, SD = .07) were more selective in their responding compared to the negative group (M = 1.53, SD = .08), $p < .01$. For the *remember* responses there was a significant main effect of Stimuli, $F(2, 112) = 5.33$, $p < .05$, $\eta_p^2 = .09$. As *criterion C* scores show that responses for positive stimuli (M = 1.63, SD = .07) were more selective than responses for neutral stimuli (M = 1.61, SD = .08), $p < .05$, however, the difference between negative stimuli (M = 1.61, SD = .08) and positive and neutral stimuli was not significant, $p = .06$ and $p = 1.00$ respectively. This is somewhat contradictory to previous research that has shown that participants are more liberal in their responses to negative stimuli compared to neutral and positive (Dougal & Rotello, 2007). There was no significant effect of Emotion, $F(1, 56) = 2.85$, $p = .10$, $\eta_p^2 = .05$, or interaction effect of Stimuli x Emotion, $F(2, 112) = .16$, $p = .85$, $\eta_p^2 = .00$. For *know* responses there was no significant effect of Stimuli, $F(2, 112) = 1.13$, $p = 0.33$, $\eta_p^2 = .02$, Emotion, $F(1, 56) = 2.02$, $p = .16$, $\eta_p^2 = .04$, or Stimuli x Emotion, $F(2, 112) = 1.88$, $p = .16$, $\eta_p^2 = .03$. Finally, for *guess* responses there was no significant main effect of Stimuli, $F(2, 112) = .75$, $p = .48$, $\eta_p^2 = .01$, or Emotion, $F(1, 56) = 2.88$, $p = .10$, $\eta_p^2 = .05$, however, there was a significant interaction effect of Stimuli x Emotion, $F(2, 112) = 4.15$, $p < .05$, $\eta_p^2 = .07$. Within the negative group there were no significant differences between scores for positive stimuli (M = 1.77, SD = .06), negative stimuli (M = 1.77, SD = .06), and neutral stimuli (M = 1.76, SD = .06), all *p's* > .05. Within the neutral group, however, participant's responses were more selective for the neutral stimuli (M = 1.80, SD = .02) compared to the positive stimuli (M = 1.77, SD = .04), $p < .05$. The difference between the positive and negative stimuli (M = 1.79, SD = .03) was not significant, $p = .24$, nor was the difference between the negative and neutral stimuli, $p = .41$.

4.3.3 Summary

Experiment 4 investigated the direct effect of emotion on false memories for the source of information using manipulated images. Although typical misinformation experiments introduce misinformation through suggestive and misleading verbal information, with the prevalence of erroneous visual information and questionable sources it is also important to consider source memory errors for simple manipulated images. Experiment 4 therefore measured errors in participants' memory for the source of manipulated emotional images and the effect of emotion during the encoding of these new images.

The results supported the hypothesis that memory errors would be greater for negative images compared to positive and neutral images. This is seen within the overall recognition memory and explicit memories for manipulated images falsely remembered as being presented during both sessions. There is also evidence of this within the recognition responses for images reported as being familiar. Although the explicit memory data is the key interest, as it gives the strongest indication of an existing memory trace and has great theoretical implications, the familiarity judgements are also important to consider from a practical perspective. In most everyday situations, a feeling of familiarity can be enough for individuals to report having a memory of an event. Combined with motivation to use the memory, for example, to help solve a crime, or getting to the route of an underlying psychological issue, individuals' confidence in, and reporting of, these memories may be inflated.

The response bias literature would caution that these effects are not a reflection of memory but of more liberal responding associated with negative stimuli (Dougal & Rotello, 2007; Windmann & Kutas, 2001). However, the analysis of sensitivity and response bias scores revealed no significant effect of the emotional content of the stimuli or the emotion induction. In addition, this explanation relates specifically to increased responding with recognition responses, whereas the results from Experiment 4 considered source memory responses. While more liberal responding may inflate recognition rates, it is not clear whether this would extend to source memory errors.

This effect of negative stimuli is also seen in previous misinformation research (e.g. Otgaar et al., 2008; Porter, Spencer, & Birt, 2003; Porter, Taylor, & ten Brinke, 2008; Van Damme & Smets, 2014). An additional effect often found in the literature is that misinformation acceptance is also greater for peripheral details compared to central (Harmon-Jones, Gable, & Price, 2012; Porter, ten Brinke, Riley, & Baker, 2014; Van Damme & Smets, 2014). However, the results from this study found no such distinction. Centrality effects are attributed to a narrowing of memory for central, relevant, details that leaves the periphery vulnerable to more errors. Levine and Edelstein (2009) argued, however, that discrepanies in the reulsts of memory narrowing due to emotion could be explained by the view that the narrowing is related to the current goals of the individual. Given the variety of emotional scenes presented in the images, and lack of a consistent focus or story, there was no specific motivation tied to the content and thus no distinction was made between central and peripheral information.

Experiment 4 also examined the effect of the negative emotion induction, and emotion congruency but found no effect of either. It was predicted that the negative emotional state would increase processing and encoding of the misinformation images, thus increasing source monitoring for manipulations identified as new and increasing errors for those misidentified as old. In addition, spreading activations as a result of the induction were predicted to increase source confusions for congruent images. However, these congruency effects may be specific to discrete emotions whereas the present design manipulated negative valence only. Assocations between sadness and the variety of negative images shown may be too convoluted.

So far the experiments and research disucssed focus solely on manipulating explicit details of a memory or event. However, the affect qualities of the emotions have not yet been considered. The emotions assoicated with specific memories have obvious implications for clinical settings, and as demonstrated in Chapter 1, autobiographical recall can be an effective emotion induction tool. Over time memories may become assoicated with specific emotions. However, if these emotions don't match the original manner in which the memory was encoded they can be argued to be false. Experiment 5, therefore, investigates whether mundane neutral memories can be altered from their original true state and later associated with negative emotion.

4.4 EXPERIMENT 5:

Emotion Induced Changes to Affective States of Existing Memories

Experiment 4 investigated the effect a negative emotional state would have on encoding information into an already existing memory. However, it does not consider the changing affective state of the memory itself. As well as creating false memories by adding erroneous details, memories may also stray from accurate recollections if they are later associated with different emotional states.

Research on memory reconsolidation suggests that brief periods of rehearsal return the memory to a labile state and render it vulnerable to reconsolidation processes and possible alterations. While the misinformation paradigm incorporates factors of suggestibility, and memory distrust (Loftus, 2005), memory reconsolidation research has shown that in very simple experimental designs, new information can be incorporated into the original memory trace

(Hupbach, Gomez, & Nadel, 2009, 2011; Hupbach, Hardt, Gomez, & Nadel, 2008). These findings have also been extended to procedural memories (Walker, Brakefield, & Hobson, 2003).

The effects of emotion on reconsolidation have been considered briefly, however, the focus has been on the strengthening or disruptive properties rather than on any new associations formed (e.g. Coccoz, Maldonado, & Delorenzi, 2011; Finn & Roediger, 2011; Schwabe & Wolf, 2009). Finn and Roediger (2011) gave participants pairs of Swahili-English words to learn. At test, presentation of negative arousing images following correct recall enhanced future recall of the corresponding pair, compared with correct recall that was followed by a neutral, or no, image. The effects of valence, however, and the production of new associations has not yet been investigated. AAT has so far been discussed in terms of affective stimuli and emotional states activating associated concepts. Based on this, it is also possible that if specific memories are retrieved and reconsolidated during an emotional experience a new association may form. With complex memories of events these new associations may take time and resources. However, by investigating memories for meaningless stimuli, with no pre-existing emotional associations, it may be possible to change the affective state of the memory itself.

Experiment 5 therefore investigates the effect of a negative emotional state on the affective properties of reconsolidated nonsense stimuli. Participants are asked to remember nonsense words, and immediately following a recognition test for half of the items, go through an emotion induction. As with the previous Experiment, a neutral induction is used to control for any effects of simply viewing a video, and sadness was chosen as the negative emotion due to the effectiveness of the inductions. At a final recognition test, participants are also asked to rate the nonsense words they have seen according to how negative or positive they seem.

Affective ratings for the words can then be compared between the groups for items presented before the emotion induction and those not presented, as well as for items remembered during the first recognition test and those not remembered.

4.4.1 Method

Participants

For the main experiment 49 participants volunteered, 10 of which were male, between the ages of 18 and 22 (M = 18.73, SD = .96). For an 80% chance of finding a medium effect size with an alpha of .05 we need 54 participants. Participants were informed of the basic procedure, memory tests, and emotion induction, but were not told about the affective ratings questionnaire given at the very end of the experiment. An additional 50 participants completed an online pilot questionnaire to create the stimuli.

Design

A 2 (Emotion: negative, neutral) x 2 (Reactivation: reminder, no-reminder) mixed design was used, with Emotion as the between group variable, with participants randomly allocated to each group (25 in the negative, and 24 in the neutral). Reactivation was the within group variable with randomly selected of stimuli for the reminder condition. Recognition responses for the reminded stimuli was also used as a within-group post-hoc variable (Memory: old, new).

Stimuli Creation and Materials

Participants rated 100, 6-letter, nonsense words, according to how positive or negative they seemed to them on a 7-point scale (1 being extremely negative and 7 extremely positive). Participants were also given space to report any real words that immediately came to mind upon seeing each nonsense word. The nonsense words were selected from the The ARC Nonword Database (Rastle, Harrington, & Coltheart, 2002). Although the words hold no meaning they are pronounceable.

Nonsense words with associations to real words were excluded and the final 60 chosen (see Appendix H) were those with the highest ratings (*M* = 3.97, *SD* = 0.30).

For the emotion induction procedure, the negative film clip was again taken from the film "Champ", in which a young boy cries over the death of his father, and the neutral film clip was from the film "All the President's Men", in which a reporter is asking questions around a courtroom (Bartolini, 2011; Gross & Levenson, 1995). As with Experiment 4, the neutral clip chosen depicts interactions between people and is therefore intended to hold participants' attention without inducing any emotion. Both videos lasted approximately 5 minutes. The SAM was used to measure emotional valence and arousal levels, and was completed at the start of each session and immediately after the emotion induction.

Procedure

Participants attended three separate testing sessions, run on consecutive days. In session 1, participants were shown 30 nonsense words presented one at a time, for 5 seconds, in a random order. Participants were informed in advance that there would be a later memory test for the nonsense words and asked to try and remember as many as possible. In session 2, participants were shown a collection of 30 nonsense words, made up of 15 old nonsense words and 15 new nonsense words presented in the same way as before, and asked to report whether they recognised the nonsense words from the first session. Immediately following this, participants were asked to watch one of the two emotion induction videos. In session 3, participants were given a second recognition test, this time with all 30 original nonsense words, and a new set of 15 filler items. For old responses to items, participants were also asked whether this was based on a *remember*, *know*, or *guess* judgement. Finally, before leaving the participants were asked to provide affective ratings, on a 7-point scale, for each of the original 30 nonsense words.

4.4.2 Results

Of the 49 participants, one did not return for session 3 and so was removed from the analysis, leaving 25 participants in the negative group and 23 in the neutral group. Mean recognition rates were recorded for session 2 and 3, with additional recollective experience (*remember*/*know*/*guess*) responses rates for session 3. Recognition rates from session 3 were also calculated using old and new responses from session 2 as a variable (see Table 4.6). Mean affective ratings were then also calculated for nonsense words according to the Reactivation condition (reminder, no reminder), the corresponding recognition responses at the final recognition test, and as a function of the recognition responses for reminded items (Memory: old, new).

Emotion Manipulation

Arousal and valence scores from the SAM were compared between Emotion groups at stages of the experiment using separate 2 (Emotion: negative, neutral) x 4 (Time: Session 1, Session 2, Induction, Session 3) ANOVAs (see Table 4.7). For arousal, there was no significant effect of Time, $F(3, 138) = 2.04$, $p = .11$, $\eta_p^2 = .04$, Emotion, $F(1, 46) = 1.41$, $p = .24$, $\eta_p^2 = .03$, or significant interaction effect of Time x Emotion, $F(3, 138) = 1.30$, $p = .28$, $\eta_p^2 = .03$. For valence scores, there was a significant effect of Time, $F(3, 138) = 22.59$, $p < .001$, $\eta_p^2 = .33$, Emotion, $F(1, 46) = 9.68$, $p < .01$, $\eta_p^2 = .17$, and a significant interaction effect of Time x Emotion, $F(3, 138) = 12.88$, $p < .001$, $\eta_p^2 = .22$. Post-hoc analyses of the valence scores showed that differences between the negative and neutral group were not significant at the start of Session 1, 2, or 3 (all *p*'s > .10). However, immediately following the emotion induction, the valence scores for the negative group ($M = 4.33$, $SD = 1.42$) were significantly lower than the neutral group ($M = 6.09$, $SD = 1.28$), $p < .001$.

Table 4.6: ***Final recognition responses for nonsense words as a function of Emotion and intermediate recognition response***

	Neutral				Negative			
			95% CI				*95% CI*	
	M	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*
Old								
Old	.90	.03	.83	.97	.87	.02	.82	.92
Remember	.65	.06	.52	.78	.55	.05	.44	.66
Know	.14	.03	.07	.20	.20	.04	.11	.28
Guess	.11	.04	.03	.18	.12	.02	.07	.17
New								
Old	.66	.07	.50	.81	.50	.06	.38	.62
Remember	.34	.06	.22	.46	.24	.06	.12	.37
Know	.12	.04	.05	.20	.12	.03	.06	.19
Guess	.19	.06	.08	.31	.14	.04	.05	.22

Table 4.7: ***Arousal and Valence ratings for each emotion group at each stage of the experiment***

	Arousal								Valence							
	Session 1		**Session 2**		**Induction**		**Session 3**		**Session 1**		**Session 2**		**Induction**		**Session 3**	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Negative	3.96	1.72	4.44	2.04	4.84	1.49	4.20	2.16	5.84	1.62	6.24	1.36	3.44	1.42	6.68	1.44
Neutral	4.30	1.94	5.22	1.65	4.65	2.04	5.13	2.03	6.43	1.47	6.65	1.03	6.09	1.28	6.43	1.56

Recognition Rates

Separate 2 (Emotion: negative, neutral) x 2 (Reactivation: reminder, no reminder) ANOVAs were run for old, remember, know, and guess responses, obtained at the final recognition test during Session 3. For old responses, there was a significant effect of Reactivation, $F(1, 46) = 37.79$, $p < .01$, $\eta_p^2 = .45$, for which final recognition responses from Session 3 of nonsense words shown in the recognition test at Session 2 ($M = .77$, $SD = .12$) were significantly greater compared to those not presented ($M = .60$, $SD = .14$), $p < .01$. There was no significant main effect of Emotion, $F(1, 46) = 1.49$, $p = .23$, $\eta_p^2 = .03$, nor a significant interaction effect of Reactivation x Emotion, $F(1, 46) = 1.34$, $p = .25$, $\eta_p^2 = .03$. For remember responses, the same patterns were observed as there was a significant effect of Reactivation, $F(1, 46) = 27$, $p < .01$, $\eta_p^2 = .37$, again with recognition responses being greater for reminder items ($M = .46$, $SD = .16$) compared to no-reminder items ($M = .31$, $SD = .14$), $p < .01$. There was again no significant effect of Emotion, $F(1, 46) = 1.28$, p = .27, $\eta_p^2 = .03$, and no significant effect of Reactivation x Emotion, $F(1, 46) = .30$, $p = .59$, $\eta_p^2 = .01$. For know and guess responses, respectively, there was no significant effect of Reactivation, $F(1, 46) = 1.86$, $p = .18$, $\eta_p^2 = .04$, $F(1, 46) = .95$, $p = .34$, $\eta_p^2 = .03$, Emotion, $F(1, 46) = .03$, $p = .86$, $\eta_p^2 = .00$, F(1, 46) = .00, $p = 1.00$, $\eta_p^2 = .00$, or interaction effect of Reactivation x Emotion, $F(1, 46) = .03$, $p = .87$, $\eta_p^2 = .00$, $F(1, 46) = .42$, $p = .52$, $\eta_p^2 = .01$.

Looking only at the nonsense words in the reminder condition, and taking into account the recognition responses at this intermediate test, separate 2 (Emotion: negative, neutral) x 2 (Memory: old, new) ANOVAs were run for old, remember, know, and guess, responses, obtained at the final recognition test during. For old responses there was a significant effect of Memory, $F(1, 43) = 39.62$,

$p < .01$, $\eta_p^2 = .48$, whereby final recognition responses were significantly greater for items reported as old (*M* = .88, *SD* = .10) at Session 2 compared to those reported as new (*M* = .58, *SD* = .23), $p < .01$. There was no effect of Emotion, $F(1, 43) = 2.83$, $p = .10$, $\eta_p^2 = .06$, or a Memory x Emotion interaction, $F(1, 43) = 1.64$, $p = .21$, $\eta_p^2 = .04$. For remember responses, there was also a significant effect of Memory, $F(1, 43) = 54.51$, $p < .01$, $\eta_p^2 = .56$, whereby responses were significantly greater for items reported as old (*M* = .60, *SD* = .20) at Session 2 compared to those reported as new (*M* = .29, *SD* = .20), $p < .01$. There was again no effect of Emotion, $F(1, 43) = 1.94$, $p = .17$, $\eta_p^2 = .04$, and no effect of Memory x Emotion, $F(1, 43) = .00$, $p = .97$, $\eta_p^2 = .00$. For know and guess responses respectively, there was no effect of Memory, $F(1, 43) = 2.33$, $p = .13$, $\eta_p^2 = .05$, $F(1, 43) = 1.62$, $p = .21$, $\eta_p^2 = .04$, Emotion, $F(1, 43) = .59$, $p = .45$, $\eta_p^2 = .01$, $F(1, 43) = .34$, $p = .57$, $\eta_p^2 = .01$, or Memory x Emotion, $F(1, 43) = .97$, $p = .33$, $\eta_p^2 = .02$, $F(1, 43) = .69$, $p = .41$, $\eta_p^2 = .02$.

Signal detection analyses were run using the correct and incorrect recognition rates for responses from the intermediate recognition test at Session 2, and for responses from the final recognition test at Session 3. No significant effects were found for both sets of analyses in either the response bias or sensitivity scores (see Appendix I for results of these analyses).

Affective Ratings

A 2 (Emotion: negative, neutral) x 2 (Reactivation: reminder, no reminder) ANOVA was run with the affective ratings of nonsense words. There was no significant effect of Reactivation, $F(1, 46) = 1.08$, $p = .30$, $\eta_p^2 = .02$, no significant effect of Emotion, $F(1, 46) = .07$, $p = .80$, $\eta_p^2 = .00$, and no significant effect of Reactivation x Memory, $F(1, 46) = .07$, $p = .80$, $\eta_p^2 = .00$. In order to look at the effects on reconsolidation an additional 2 (Emotion: negative, neutral) x 2 (Memory:

old, new) ANOVA was run for affective ratings of images shown at Session 2. There was no significant main effect of Memory, $F(1, 36) = .36$, $p = .55$, $\eta_p^2 = .01$, and no significant main effect of Emotion, $F(1, 36) = 1.12$, $p = .30$, $\eta_p^2 = .03$, however there was a significant interaction effect of Memory x Emotion, $F(1, 43) = 4.36$, $p < .05$, $\eta_p^2 = .11$. Post-hoc analyses revealed that for items recognised as old in Session 2, affective ratings were significantly higher in the neutral group (*M* =5.36, *SD* = 1.49) compared to the negative group (*M* =4.46, *SD* = 1.36), $p < .05$. For items recognised as new however, affective ratings were lower in the neutral group (*M* =4.84, *SD* = 1.38) compared to the negative group (*M* =5.07, *SD* = 1.49), however this difference was not significant, $p = .63$ (see Figure 4.4).

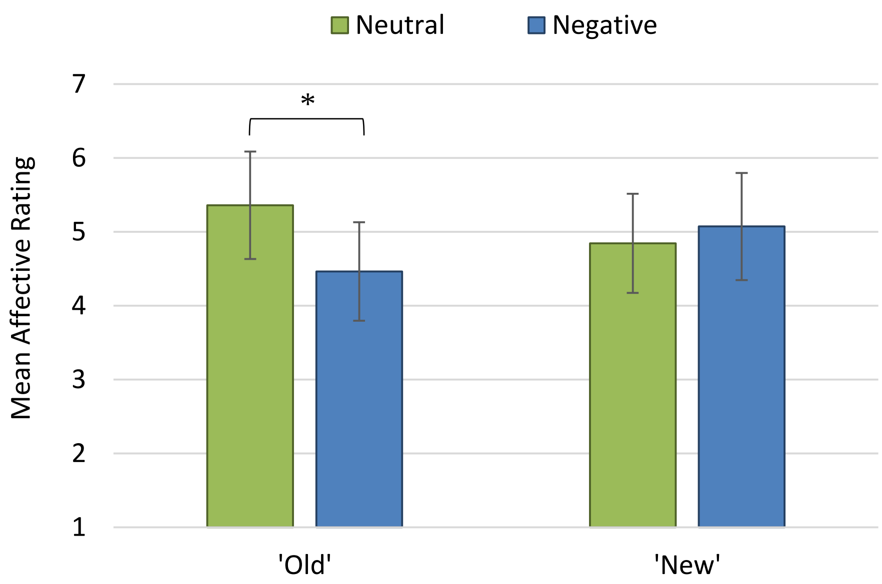

Figure 4.4: ***Affective ratings for nonsense words reactivated at Session 2, as a function of Emotion group and recognition response from Session 2 (error bars represent SD)***

4.4.3 Summary

Experiment 5 presents novel findings of a change in affective ratings for stimuli retrieved immediately before a negative emotion induction. The most interesting finding here is that the effects of the emotion induction are not apparent when the stimuli are grouped according to whether they were presented or not before the induction, but only when those presented are grouped according to whether participants reported remembering the items. This suggests that the assoication between the items and the negative emotion did not occur through mere exposure but through reconsolidation of the retrieved and recognised items.

The findings support the hypothesis that concepts activated by the emotion induction would remain active when the nonsense items were reconsolidated into memory, and that subsequent new associations would be formed. When participants were asked to rate the items according to how negative or positive they seemed, the activation of the item would have caused spreading activations to various negative concepts. In addition, the findings support theories of reconsolidation processes occuring when a memory enters a labile state (Lee, 2009), and expand on emotion and reconsolidation literature by showing that, as well as affecting quantitative properties (Finn & Roediger, 2011), emotion at rehearsal can also alter the qualitative properties. The experiment also highlights a novel approach to considering false memories as it demonstartes more abstract ways in which a true memory may be manipulated and altered.

As expected there was no effect of the negative emotion induction on recognition rates. Certain levels of stress and arousal have been shown to strengthen and disrupt reconsolidation of memory traces (Coccoz et al., 2011; Finn & Roediger, 2011). However, no effects of valence have been investigated since it is unlikely valence alone would have the same effect. Ecker (2015) argued that reconsolidation of existing memories is not activated unless there is something worth learning, and along the same lines, emotion effects on memory have been argued to be motivational (Levine & Edelstein, 2009), thus without a goal or motivation for change there is little effect seen. Negative valence, in the absense of high arousal, typically corrseponds to post-goal emotions (Kaplan et al., 2012). Although the emotions still indicate important information, any assoicated future goals are not immediate and thus cognitive resources may not be activated.

4.5 Conclusions

In this Chapter two alternate approaches to examining exogenous false memory production are presented. Experiment 4 demonstrates the prevalence of errors in source moniroting for manipulated images. Many participants falsely identified manipulated images presented at an intermediate session as being presented at the beginning of the experiment, and this was enhanced for negative images. In contrast, Experiment 5 shows that mundane, neutral memories can be altered and associated with a negative emotion induction.

Experiment 4, along with previous research, shows the prevalence of misinformation effects and the falibility of individuals source memory for erroneous information. The experimental results in particular highlight the issue that many people fail to monitor the source of information, and especially so for negative stimuli. Negative concepts are considered more interrelated (Dougal & Rotello, 2007; Gallo et al., 2009) than positive or neutral and thus, associated concepts are more readily activated resulting in increased noise and source monitoring errors. The implications of misinformation effects and source monitoring errors are significant for both clinical and legal sectors which rely heavily on the accuracy of memory. In addition, individuals may be presented with erroneous images or information in a variety of settings and as the results of Experiment 4 show, even with central details being changed, people are highly vulnerable to memory errors.

In addition to increased errors for negative the stimuli, it was predicted that this would be greater for peripheral changes, and that the negative emotion induction would increase noise and subsequent source monitoring errors. No such effects were observed. However, this may be explained by considering appraisal theories of emotion (Erbas, Ceulemans, Koval, & Kuppens, 2015; Moors et al., 2013). Levine and Edelstein (Levine & Edelstein, 2009) argued that discrepanies in the results of memory narrowing could be explained by considering the current goals of the individual. In the absense of any clear goal, or motivation, associated with the emotion, there is little benefit to any memory narrowing or enhancement.

Research into emotion and false memory production would benefit from further investigation of the possible mediating role of motivation and goal appraisal. In a review of emotion and false memory research, Kaplan, Van Damme, and Levine (2016) argue that considering emotions as either pre- or post-goal can account for motivational effects on cognitive resources. In both experiments presented in this Chapter the emotion induced was sadness which is considered a post-goal emotion. Post-goal emotions are said to broaden the scope of attention, thus processing and memory for the manipulated images in Experiment 4 would be similar to that in a neutral condition.

Although explicit details of memory in Experiment 4 were unaffected by the negative emotion induction, in Experiment 5 the same induction was shown to succesfully alter the qualitative properties of memory. It is important to remember that although emotions may not always effect the production of explicit false memories, potential associations that are formed may still draw memories away from their original true state. It should also be highlighted that since the same emotion induction was used in each experiment, the differences in results are likely due to the different types of memory paradigms used. In Experiment 4 the emotion driven centrality and biasing effects hypothesised rely on the motivational aspects of the emotion induction and the stimuli. Whereas, the paradigm used for Experiment 5 relies on associations forming between the memories and the emotional state of the individual. The efffect of the emotion induction in Experiment 5 therefore is not so affected by the motivations associated with the emotion.

Chapter 5

General Discussion

In summary, the work in this thesis examined the effect of negative emotion inductions on the production of endogenous and exogenous false memories. The thesis presents a new understanding of the specificity of emotion congruency effects, in which discrete negative emotions can greatly inflate the production of false memories for congruent emotional stimuli. In addition, the thesis presents new perspectives on the effect of negative emotion on source memory errors for new and false information associated with an existing memory. Moreover, it presents evidence that the affective qualities of a memory may also be changed, providing a novel approach to investigations of how memories may deviate from their original true state.

In this chapter the key findings and conclusions from each of the experimental chapters are summarised, limitations of the experiments are considered, and the broader implications of the research and directions for future investigations are discussed.

5.1 Chapter Summaries

5.1.1 Chapter 2

To successfully examine the effect of emotion on false memory production a reliable and effective emotion induction technique is needed. Therefore, a review was conducted of several different techniques currently used in the literature and experimental evidence of the success of a selection of these techniques was presented. Inductions were examined for a variety of discrete emotions and two different modes of measurement were assessed. Consistent with past research, it was concluded that autobiographical recall and film clips were both effective methods of emotion induction (Salas et al., 2012), and that they were preferred over the alternatives (news reports and pictures slideshow).

Autobiographical recall has been shown to be highly effective with regard to the intensity of emotions induced (e.g. Hazlett, 2012; Jallais & Gilet, 2010) and has good ecological validity. However, there is little experimental control over the selectivity and discriminability of the emotions induced. Interactive manipulations were also discussed, but not assessed experimentally. Evidence shows interactive manipulations are highly effective at inducting intense and natural emotional experiences (Kučera & Haviger, 2012; Lobbestael et al., 2008; Roberts et al., 2007). However, there is again a lack of experimental control, but even more so, this technique is highly problematic from a practical and ethical perspective.

Film clips, on the other hand, may be slightly less ecologically valid for some, mainly those individuals able to detach from the scenes. For others however, the emotions induced by the films ability to draw a viewer in are arguably much like any emotion induced through witnessing real life events. A key advantage of film clips, especially in relation to autobiographical memory, is the control afforded over which emotions are induced and to what extent (Gross & Levenson, 1995; Rottenberg, Ray, & Gross, 2007). Also, Experiment 1 demonstrated a clear advantage to film clips over pictures. News reports did not appear as effective as other techniques, however there is potential with this technique if developed as a more personally relevant alternative to film clips.

In addition to the inductions of different discrete emotions, in Chapter 2 the use of neutral emotion inductions were discussed. A common argument being that there is no such thing as a neutral emotion. The results from Experiment 1 highlight the variability of neutral inductions between mildly negative and mildly positive on a valence scale, and for the potential for neutral induction to fall quite low on an arousal scale. The alternative, control group, however poses a similar issue in terms of variability as these approaches allow for no control over the emotional state of the participants. In Chapter 2 it was concluded that the choice is best made by considering the design of the experiment itself and the characteristics of the other emotion inductions employed. Use of neutral inductions should consider carefully the specific characteristics of the emotional state being induced and the comparison being made.

Finally, theories of emotion were considered, with specific reference to the collective opinion that goal relevance and motivations are key in understanding the effect of emotion on cognition (e.g. Coppin & Sander, 2016; Erbas et al., 2015; Moors et al., 2013). Consequently, for induction techniques to induce more intense ecologically valid emotional experiences, future work should focus on the corresponding motivations, and facilitate expression of the emotions being induced, thus encouraging activation and manipulation of associated cognitive processes.

5.1.2 Chapter 3

In Chapter 3 the first evaluation of the effect of emotion on false memory production is presented, by examining spontaneous, endogenous false memories. Research on this topic typically examines the effect of valence and arousal and has shown that, when manipulating the emotional state of the participants, arousal increases false memory production while valence has no effect (Corson, Verrier, & Bucic, 2009). When the stimuli being remembered is varied in terms of arousal and valence, studies find that false memory rates are higher for negative compared to neutral and positive stimuli, and for high arousal negative stimuli compared to low arousal negative stimuli (Brainerd et al., 2010; Steinmetz, Addis, & Kensinger, 2010). Research also demonstrated that these effects are compounded when the emotional state of the participant is congruent with the stimuli and subsequent false memories were increased (Knott & Thorley, 2013; Ruci et al., 2009).

Experiments 2 and 3 extended this line of research by considering discrete emotion congruency effects. Although arousal and valence highlight many important effects of emotion on cognition, researchers have rightly argued that there is little sense in limiting research to these dimensions (Kaplan et al., 2016; Levine & Pizarro, 2004). Manipulating sadness and fear, and anger and fear, in the DRM paradigm allowed an examination of the effects of emotion irrespective of arousal and valence dimensions.

The findings of Experiment 3 supported the hypothesis that discrete emotions would increase false memory production for emotionally congruent stimuli. The findings supported assumptions of Associative Activation Theory (Howe et al., 2009) that congruent emotions would increase spreading activation to associated concepts, enhance activation of the associated critical lures, thus increasing false memory production. The findings also support theories of discrete emotions and emphasise the need to investigate additional characteristics and dimensions of emotion.

There are several papers and reviews now highlighting the motivational aspects of emotions and the advantage of considering emotions effects on cognitive processes in terms of their survival relevance and the current goals of the individual (Coppin & Sander, 2016; Erbas et al., 2015; Kaplan, Damme, & Levine, 2012; Lazarus, 1991; Moors et al., 2013). It was also stressed, however, that research should not abandon investigations of arousal and valence, but rather, consider the limited view these dimensions give in terms of behavioural responses and consider carefully motivational distinctions. In addition, the cognitive mechanisms underlying these effects of discrete emotions are still unclear. There is evidence of neural correlates with the effects of valence and arousal on memory, however, the effect of motivation is less well understood (Erk et al., 2003; Kragel & LaBar, 2016; LaBar & Cabeza, 2006).

5.1.3 Chapter 4

As well as being produced spontaneously, and as a result of natural processes underlying memory production, false memories may be produced through manipulations and alterations to already established true memories. The research in Chapter 4 examined these exogenous false memories from two perspectives. First by looking at errors in memory for the source of new false information presented after an event and second by looking at reconsolidation processes in which the affective qualities of an originally neutral memory may be altered.

The literature reviewed, and findings from Experiment 4, highlight the prevalence of source memory errors. Although many participants reported knowing images had been manipulated and were therefore vigilant in reporting the correct sources at the recognition test, many manipulated images were still falsely reported as being presented in the first session. In addition, the ability to monitor memory errors and manipulated images was worse in the negative stimuli condition compared to the positive and neutral stimuli. Negative emotions and negative stimuli are considered to be more semantically associated and thus spreading activation and source confusions are more likely (Dougal & Rotello, 2007; Gallo et al., 2009; Howe et al., 2009).

Contrary to some of the hypotheses, there were no centrality effects associated with the negative stimuli and no effect of the emotion induction. As discussed previously, emotion research now stresses the importance of motivation and goal relevance for emotions to have an effect on cognitive processes (e.g. Coppin & Sander, 2016; Erbas et al., 2015; Kaplan, Damme, & Levine, 2012; Lazarus, 1991; Moors et al., 2013). The false memory paradigm used in this experiment relies in particular on motivational aspects of the emotion. Centrality effects assume aspects of the stimuli are more important to the individual, however, with little to no motivation associated with the emotion induction chosen, it is possible this prevented any changes being observed in the cognitive processes underlying source memory errors.

In contrast, in Experiment 5, the same emotion induction successfully altered the properties of the memories produced. Where Experiment 4 examined errors in memory for explicit details added after the event, Experiment 5 instead examined a change in the affective properties of memory through the formation of new associations with the negative emotion induction. Neutral, meaningless, stimuli were retrieved for a recognition test immediately before a negative or neutral induction was conducted. At a later recognition test, those stimuli remembered correctly at the intermediate test were rated as more negative by participants who underwent the negative induction compared to those who received a neutral emotion induction.

5.2 Practical and Theoretical Implications

The research presented in this thesis has significant implications for any settings in which the accuracy of memory is relied upon, and more specifically, in settings where emotion may influence such memories. Most notably, these implications extend to legal and counselling practices. In each, memories of events are used as evidence, either in discerning the details of a crime or in assessing personal events that may be impacting psychological wellbeing.

Evidence in Chapter 3 demonstrated the fallibility of memory processes for encoding emotional information. Memories for associated emotional stimuli that were not actually presented to participants were reported as being explicitly remembered. There are novel findings that this false memory production is enhanced for stimuli that specifically matches the discrete emotion being experienced. Such false memories are experienced as true memories and may therefore be reported in eyewitness statements or in accounts to therapists. In legal practice, it is important to understand the likelihood that the memories being reported are false. The results from Experiment 2 highlight the fact that memories for negative-arousing aspects of crimes are more likely to induce false memories than neutral aspects. Experiment 3 expanded on this and demonstrates that aspects of a crime congruent to the emotional state elicited in the individual are even more likely to produce false memories.

In relation to clinical practice it is important to remember that with vivid emotional memories the accuracy or objective truth is not as important as it is with legal practice as the implications of the memory for the person experiencing it will be the same regardless. A more pertinent issue would be to avoid eliciting new false memories associated with the negative emotional state an individual might be in during a counselling session. The results of Experiments 2 and 3 demonstrate that discussing memories and information with details congruent to an individual's emotional state may increase the risk of creating new false memories.

In Chapter 4 the fallibility of memory was highlighted as memories that have been altered were reported as true. Participants' memory for the source of new information, especially negative, was shown to be quite poor, and neutral mundane memories were later reported as being more negative. This is further evidence that in counselling settings, in which memories are retrieved and reported in an emotional state, there is a need for caution as the emotions being experienced may inadvertently change the affective state of the memory, and consequently its relevance and meaning to the individual.

It is also important to note the potential positive ramifications of this finding. There are already practices focussed on reappraising and re-scripting memories in order to reduce any emotional distress associated with them. The results from Experiment 5 demonstrate that this may also be achieved through simply creating new associations between the memories and different emotional states. In terms of Experiment 4, although many usual effects of misinformation and emotion were not replicated, the finding that even mere exposure created false memories, and errors in source monitoring, has implications for the surplus of fake images and news found online and especially on social media. Individuals find it difficult to remember the source of information, especially for negative stimuli, and this may cause problems for any future decision making that may be influenced by the information provided.

These manipulations of memory indicate the need for vigilance when dealing with memory as evidence so as not to inflate the risk of false memories being produced. In addition, the findings should be taken as a caution that regardless of how memories are reported there is always a risk that details of, or even the affective qualities, are false. Memories that elicit a negative emotional response may be regarded or reported differently and so it is important to avoid changing the affective nature of otherwise neutral memories.

The research discussed also has implications for theories of false memory production. As mentioned in the Introduction Chapter fuzzy trace theory (FTT; Brainerd & Reyna, 2002; Brainerd & Reyna, 2001) and associative activation theory (AAT; Howe, Wimmer, Gagnon, & Plumpton, 2009; Wimmer & Howe, 2009) are the two main theories focussed on throughout the thesis. FTT comes from a dual-processing perspective, suggesting that false memories arise when verbatim memory traces decay and gist traces are relied upon. AAT on the other hand suggests that spreading activations to associated concepts may cause these internally activated concepts to be falsely encoded. Overall, both theories seem to be able to account for the effects of emotion on false memory production, however there are some limitations and weaknesses.

The results from Experiment 2 support previous research in showing an enhancement of false memory produced for negative, arousing, stimuli (Brainerd et al., 2010; Steinmetz, Addis, & Kensinger, 2010). AAT accounts for these findings in two ways. First, activation of emotion concepts elicit greater speading activations due to increased semantic density (Dougal & Rotello, 2007; Windmann & Kutas, 2001). Emotions are fundamental to human experience and as such greater associations exist. Increased spreading activations to assoicated concepts subsequently increases the chances of false memories being produced. Second, moderate increases in arousal are likely to draw and increase attention. This increased processing of the information would increase subsequent spreading activations and lead to a greater chance of false memories being produced.

FTT also accounts for the increase in false memories for emotional stimuli as the theory suggests that gist traces are stronger for emotional information. In contrast however FTT is said to predict fewer false memories with moderate arousal as the arousal would increase the strength of verbatim traces thus reducing the reliance on gist (Bookbinder & Brainerd, 2016). This prediction however conflicts with the findings. Results from Experiment 3 do not cause such conflicts however as both theories are able to account for the congruency effect. AAT posits that the emotional enhancement of false memories through increased spreading activations is compounded when the emotional state of the individual is congruent to that of the stimuli presented (Knott & Thorley, 2013). FTT suggests that false memories in this instance are increased because the congruent emotional experience provides additional gist traces consistent with the gist of the stimuli.

With regards to misinformation effects discussed in Chapter 4, past research supports the idea that memory errors are more likely for peripheral details of negative stimuli compared to central (Porter, ten Brinke, Riley, & Baker, 2014; Van Damme & Smets, 2014), as well as an overall increase in errors for negative compared to neutral stimuli (Porter, Spencer, & Birt, 2003; Porter, Taylor, & ten Brinke, 2008). Increased processing of negative stimuli, whether through greater semantic density (Dougal & Rotello, 2007) or enhanced item-specific processing (Kensinger, 2009), would subsequently increase gist traces available and thus FTT can account for the increased false memory production. However, FTT is also limited as it does not clearly explain the distinction between central and peripheral items. It is unclear whether an increased focus on central items would increase gist traces only or also increase verbatim traces. AAT on the other hand does account for these centrality effects. Increased activation of central details would increase the strength of the true memory trace and thus reduce memory errors for central details, while decreased processing of peripheral details increases the vulnerability to errors and increased spreading activations enhances memory errors.

The mutual limitation of both theories in this specific context is that neither theory can account for the assumption that processing is enhanced for central details, or indeed what defines a detail as central versus peripheral. This can only be explained by considering appraisal theories of emotion (see Moors, et al., 2013). Information that is central to an image is more relevant or more important and thus narrows attention. It is therefore essential to understand the current goals and motivations of an indidivudal in order to explain emotional memory narrowing (Levine & Edelstein, 2009). It is also this reliance on motivation and relevance that explains the lack of some findings in Experiment 4. Combined with these appraisal theories, AAT is effective in predicting the production of subsequent false memories. Finally, the findings from Experiment 5 are especially difficult for either theory to explain since it takes an unconventional approach to false memories. The results suggest that associations form between the old memory and the current emotional state of the participants. This suggests some support for AAT however both false memory theories are typically applied to the production of false content and thus cannot be applied in this context.

Although both theories account for many of the findings discussed, AAT is more reliable because FTT fails to account for the effect of arousal, and does not clearly explain the centrality effect with misinformation. In addition, AAT is relatable to neural activations and so easier for many to conceive as a theory of cognitive processes. Finally, associations and associative strength are concrete measures that can be operationalised in research and could be used to predict more accurately the rates of false memory production. The systematic and comprehensible nature of AAT gives additional weight and support to the theory.

5.3 Limitations

Throughout the thesis, the research discussed has been related to legal and clinical settings, however, caution should be taken when generalising laboratory findings to real-life situations. In Chapter 2 this issue was particularly salient as Experiment 1 attempted to induce emotional states in participants. As the results demonstrated, experiences of sadness and happiness were more intense than fear and anger, and one explanation given was the suppression of corresponding emotional expressions. While happiness and sadness can be expressed in a passive environment, the responses associated with fear and anger are more active, but in a laboratory these aspects of the emotions are supressed. In addition, many emotion inductions often induce a blend of emotions. Although Experiment 1 took this into account when evaluating induction techniques, emotion inductions may still be confounded on some level by the simultaneous presence of more than one basic emotion (Schaefer, et al., 2010).

The false memory research discussed and presented in Chapter 3 and Chapter 4 is also limited due to the laboratory environment in which the memories were encoded and measured. The DRM paradigm especially, used in experiments 2 and 3, lacks ecological validity. Researchers have argued (e.g., Pezdek & Lam, 2007) that conclusions drawn using this list learning paradigm can not be generalised to more typical forensic situations involving the (mis)recollection of an entire autobiographical event. However, Howe et al. (2010) point out that the results from DRM experiments are often similar to those of more complex experiments of false autobiographical memories (e.g., Otgaar et al., 2008), and thus it is likely that the mechanisms underlying the production of DRM false memories are also operational outside the laboratory. Moreover, Howe discusses the cross over between recognition and recall memory in "real-life" situations. Recall of autobiographical memories if often cued by recognition of stimuli in the environment (e.g. looking at photographs) or recognition-like prompts from reminiscing or discussing past events with others.

The purpose of the misinformation experiment used in Chapter 4 was designed to somewhat overcome the issue of ecological validity by using a paradigm that was designed to mimic forensic interview techniques. In addition, the stimuli often used are more complex scenes, similar to witnessing an event in real-life. That said, the stimuli used in Experiment 4 and Experiment 5 are much different from typical misinformation studies (e.g. Forgas, Laham, & Vargas, 2005; Van Damme & Smets, 2014). Using slideshows of a variety of images in experiment 4 retains some ecological validity, however the emotional content of the stimuli is somewhat lost as the context and meaning of the images is confounded by the variety of other information being presented.

Experiment 5 on the other hand used much less ecologically valid stimuli. The purpose of this study was not to mimic everyday memory processes but to demonstrate the effect negative emotion can have on the affective associations of originally neutral and mundane stimuli. As this experiment was novel in its design and findings, the stimuli used were very basic, allowing for a controlled and clear examination of the affective changes. The same effect with autobiographical memories would be much more complicated given the complexities of the associations already established, however, the implications of such an effect make it an important avenue to follow. The affective qualities of a memory may change how that memory is processed and how it interacts with other cognitive processes, such as decision making. Future research should therefore aim to extend these findings to more ecologically valid stimuli.

Finally, there are general issues relating emotion research to clinical settings. It should be clear that the research discussed and presented in this thesis can't be generalised to clinical disorders. However, there are many clinical and counselling therapies, regardless of the presence of a clinical disorder, in which memories are the main point of focus. Often the content of these memories is emotional, or the state of the individual is emotionally laden. The research presented in this thesis demonstrates the effect emotion can have on encoding and retrieving these everyday emotional memories.

5.4 Future Research

In all three experimental chapters the question of motivation and goal relevance of the emotions arose. In Chapter 2 the more effective emotion inductions were discussed as being those that allow for a natural response or expression of the emotions. Emotions act as a fast and effective way to evaluate survival relevant aspects of the environment and guide responses associated with the specific goals of the individual (Frijda, 1988; Moors, Ellsworth, Scherer, & Frijda, 2013). It has been argued that cognitive resources are not activated unless there is a need to do so (e.g. Ecker, 2015), some emotions induced in the lab may not elicit a motivation to act and therefore a key element of the emotional experience is supressed, consequently supressing activation of cognitive resources that would otherwise have affected memory production.

With respect to the effect of emotion on memory, the difference in false memories produced in Chapter 3 when inducing fear and anger can be accounted for by considering the different responses and actions that these emotions elicit. In Chapter 4 the lack of effect of the emotion induction on memory narrowing can be accounted for by the lack of corresponding emotional motivation. Without a purpose or goal there is no need for cognitive resources to be activated and thus no effect on memory processes is observed. Future research should therefore focus on the possible mediating role of motivation and goal appraisal with emotion effects on false memory production.

In many legal and clinical settings there is a motivation to remember as much as possible and therefore discover the truth. In doing so there may be an interaction effect between the motivation-driven activation of cognitive processes and the emotional state of the individual at the time, or emotional content of the memories being retrieved. In addition, theoretical understandings of emotion and false memory would benefit from an investigation of the attentional process that may correlate with these findings. Increased processing of emotion congruent, or goal relevant, information may be due to an immediate biasing of the attentional system, therefore changing what is attended and encoded into memory, or alternatively through a biasing of cognitive resources to those aspects of the environment without the engagement of any outward changes in behaviour.

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APPENDICES

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Appendix A

Stimuli used for Experiment 1

IAPS images selected for each emotion induction:

Anger	Fear	Sad	Happy	Neutral
2115	9810	9940	9830	8461
2345.1	1050	9941	9831	8470
2688	1052	2278	9926	8497
2691	1201	2301	1440	2002
2694	1202	2375.1	1460	2026
2730	1205	2400	1463	2480
2745.2	1220	2455	1500	2516
2751	1300	2456	1610	2595
3500	1304	2457	1630	5130
3530	1525	2520	1710	5395
3550	4664.2	2703	1722	5534
6021	5971	2710	1750	5535
6212	5973	2715	1811	7002
6220	6020	2716	1920	7006
6312	6250	2718	2040	7009
6315	6260	2722	2045	7010
6360	6263	2750	2050	7012
6530	6300	2752	2058	7013
6800	6313	2753	2070	7018
6838	6370	2800	2071	7020
7136	6510	2900	2150	7025
9005	6520	3005.1	2154	7030
9006	6540	3191	2158	7031
9042	6550	3300	2160	7032
9043	6555	3350	2208	7034
9075	6560	4233	2216	7035
9140	6563	5120	2303	7036

9145	8485	6010	2345	7037
9163	9120	6311	2346	7038
9180	9160	6561	2347	7040
9181	9254	7520	2352.1	7041
9183	9600	9000	4612	7044
9184	9611	9001	5621	7045
9187	9620	9002	5623	7050
9290	9621	9040	5825	7055
9291	9622	9041	5833	7059
9330	9623	9102	5910	7060
9404	9630	9171	7330	7110
9409	9635.1	9186	7405	7130
9413	9902	9280	8180	7150
9414	9903	9331	8185	7161
9419	9904	9415	8186	7180
9500	9905	9432	8190	7184
9520	9908	9440	8200	7185
9530	9909	9445	8208	7186
9560	9910	9469	8300	7211
9570	9921	9471	8350	7217
9571	9925	9472	8370	7224
9800	9930	9561	8380	7234

Appendix B

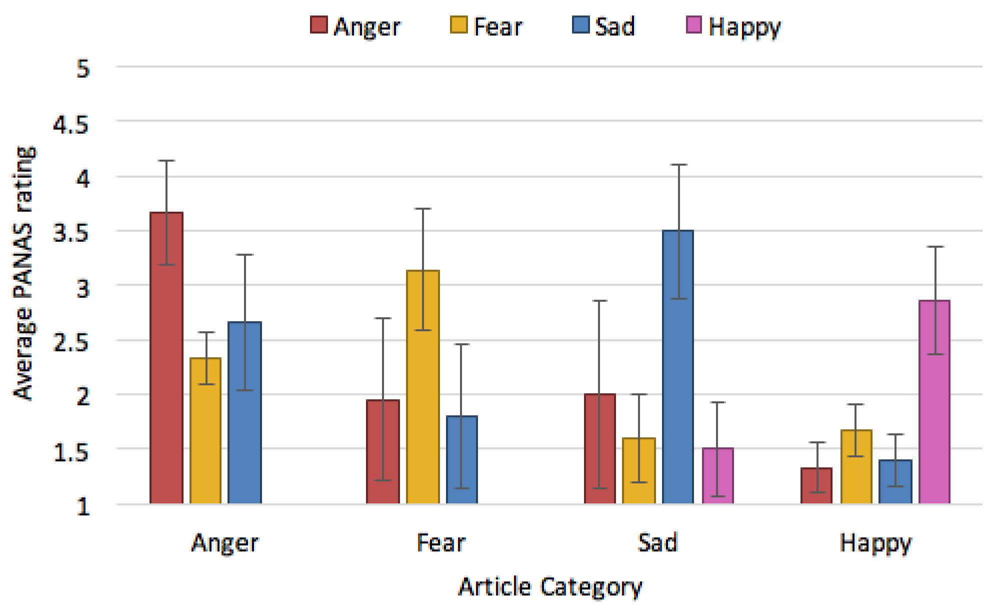
Pilot of News Reports for Experiment 1

Pilot results for articles and target emotions:

	Anger		Fear		Sadness		Happiness	
	M	SD	M	SD	M	SD	M	SD
Anger								
Gay Clubber*	3.67	0.94	2.33	0.47	2.67	1.25	1.00	0.00
Israeli Police	3.33	0.75	1.40	0.49	3.25	0.97	1.00	0.00
Fear								
Swimmer*	1.95	1.48	3.14	1.12	1.80	1.33	1.00	0.00
Bus fire	3.14	1.55	2.20	0.75	3.00	0.67	1.00	0.00
Sad								
Toddlers killed*	2.00	1.73	1.60	0.80	3.50	1.22	1.50	0.87
Inseparable pair	1.60	0.80	1.25	0.43	2.71	1.39	1.75	0.43
Happy								
Great Escaper*	1.33	0.47	1.67	0.47	1.40	0.49	2.86	0.99
Girl and her dog	1.00	0.00	1.00	0.00	1.00	0.00	2.83	1.21

* chosen article

Pilot results for chosen articles:



Appendix C

Stimuli used for Experiment 2

DRM word lists

Neutral			Fear			Sad		
Critical Lure:								
Needle	**Cup**	**Slow**	**Scared**	**Fear**	**Danger**	**Sad**	**Upset**	**Sorrow**
thread	saucer	fast	fright-ened	cape	hazard	un-happy	disapp-oint	grief
pin	mug	leth-argic	nervous	terror	risk	happy	frust-rate	sym-pathy
eye	meas-uring	snail	panic	doubt	beware	dep-ressed	pissed	regret
sewing	straw	turtle	coward	fright	warn	frown	angry	remorse
sharp	tea	quick	insecure	afraid	caution	happi-ness	dismay	empathy
point	coaster	stop	timid	mon-ster	warning	blues	frantic	joy
prick	handle	speed	super-stition	horror	safe	lonely	disturb	repen-tance
thim-ble	coffee	delay	vulner-able	scare	safety	misery	anxiety	apathy
hay-stack	drink	wait	brave	trem-ble	jeop-ardy	gloomy	despair	shame
thorn	plastic	traffic	hostage	hesi-tant	daring	pity	emo-tional	cry
inject-ion	lid	hesi-tant	running	scary	motor-cycle	tears	mad	tragedy
Knit-ing	sip	cau-tious	nerves	snake	poison	glad	uneasy	apology

BAS for presented words was checked across list categories. All available values are negligible with the exception of “hesitant” which appears on both the slow and fear list.

Appendix D

Stimuli used for Experiment 3

DRM word lists

	Neutral		Anger		Fear	
Critical Lure:	**Earth**	**Hair**	**War**	**Anger**	**Fear**	**Danger**
	planet	strand	battle	mad	terror	risk
	world	scalp	bomb	frustrate	fright	caution
	globe	lice	fight	hate	anxiety	warning
	ground	conditioner	revolution	rage	afraid	safe
	gravity	comb	nuclear	temper	panic	daring
	environment	headband	missile	fury	scared	trouble
	worm	dandruff	soldier	ire	horror	zone
	heaven	mousse	gun	wrath	monster	fire
	sphere	bald	destruction	fight	scream	accident
	geology	clippers	defeat	hatred	darkness	harmful

BAS for presented words was checked across list categories. All values are negligible with the exception of "scream" (found in the fear list), which has a BAS of .02 with anger. In addition, fear and anger have BAS of .01 and .02.

Appendix E

Stimuli used for Experiment 4

IAPS images presented for each emotion category:

	Positive	**Neutral**	**Negative**
Subgroup 1:			
	5825b	2272b	6242b
	1610	7161b	3185
	8120b	9171b	2900b
	2057b	2026	9419
	1750b	2525b	9610
	2035b	7038b	3215b
	1630	7006	9340b
	2156b	3550.2b	2750b
Subgroup 2:			
	2388b	7217b	9342b
	1811b	9913b	9927b
	2346b	5130	6311b
	2391b	8010b	9332
	8540b	1505b	9291b
	7492b	2400	9520b
	2398b	2695b	2456b
	5830b	1645	2141
Subgroup 3:			
	5833b	2410b	9421
	2598b	7180	9041b
	1441b	2002	3230b
	8467b	7595	9415b
	5831b	2780b	9530b
	8461b	5535b	9000b
	5760b	7234b	9220b
	1340b	2393b	9295b

Appendix F

Filler analysis for Experiment 4

Analysis of incorrect recognition responses for filler items:

	Negative				Neutral			
			95% CI				*95% CI*	
	M	***SE***	***LL***	***UL***	***M***	***SE***	***LL***	***UL***
Old								
Positive	.08	.03	.02	.15	.08	.02	.03	.13
Neutral	.06	.02	.01	.11	.09	.03	.03	.14
Negative	.06	.02	.02	.11	.10	.03	.04	.16
Remember								
Positive	.03	.01	.00	.06	.01	.01	-.01	.04
Neutral	.02	.01	.00	.04	.03	.02	-.01	.07
Negative	.02	.01	.00	.04	.02	.01	.00	.05
Know								
Positive	.01	.01	-.01	.03	.03	.01	.00	.06
Neutral	.01	.01	-.01	.03	.01	.01	-.01	.04
Negative	.02	.01	.00	.04	.04	.02	.00	.08
Guess								
Positive	.04	.03	-.02	.10	.04	.02	.01	.07
Neutral	.03	.02	-.01	.06	.04	.02	.00	.09
Negative	.03	.02	-.01	.06	.03	.02	-.01	.07

For *old* responses there was no significant effect of Stimuli, $F(2, 112) = .13$, $p = .88$, $\eta_p^2 = .00$, or Emotion, $F(1, 56) = .40$, $p = .53$, $\eta_p^2 = .01$, and no significant interaction of Stimuli x Emotion, $F(2, 112) = .52$, $p = .60$, $\eta_p^2 = .01$. For *remember* responses there was no significant effect of Stimuli, $F(2, 112) = .05$, $p = .95$, $\eta_p^2 = .00$, no significant effect of Emotion, $F(1, 56) = .02$, $p = .90$, $\eta_p^2 = .00$, and no significant interaction effect of Stimuli x Emotion, $F(2, 112) = .75$, $p = .48$, $\eta_p^2 = .01$. For *know* responses, likewise, there was no significant effect of Stimuli, $F(2, 112) = 1.37$, $p = .26$, $\eta_p^2 = .02$, Emotion, $F(1, 56) = 1.48$, $p = .23$, $\eta_p^2 = .03$, or Stimuli x Emotion, $F(2, 112) = .58$, $p = .56$, $\eta_p^2 = .01$. Finally for *guess* responses there was no significant effect of Stimuli, *F*(2, 112) = .21, *p* = .81, η_p^2 = .00, Emotion, *F*(1, 56) = .11, *p* = .74, η_p^2 = .00, or Stimuli x Emotion, *F*(2, 112) = .21, *p* = .81, η_p^2 = .00.

Appendix G

Signal Detection Analysis for Experiment 4

Sensitivity analysis using false memory data as the hits:

	Negative				Neutral			
			95% CI				*95% CI*	
	M	***SE***	***LL***	***UL***	***M***	***SE***	***LL***	***UL***
Old								
Positive	.44	.02	.40	.49	.40	.03	.34	.46
Neutral	.43	.02	.38	.48	.40	.03	.34	.47
Negative	.46	.02	.42	.50	.43	.03	.38	.49
Remember								
Positive	.37	.03	.31	.43	.41	.03	.35	.46
Neutral	.38	.03	.32	.45	.39	.03	.32	.45
Negative	.40	.03	.34	.46	.43	.03	.37	.48
Know								
Positive	.10	.02	.05	.15	.03	.02	-.01	.07
Neutral	.07	.02	.03	.12	.06	.03	.00	.11
Negative	.08	.03	.03	.14	.05	.03	-.01	.11
Guess								
Positive	.02	.02	-.03	.07	-.01	.02	-.04	.03
Neutral	.01	.02	-.02	.04	-.01	.02	-.05	.03
Negative	.02	.02	-.02	.05	.00	.02	-.04	.03

For *old* responses there was no significant effect of Stimuli, $F(2, 112) = 1.71$, $p = .19$, $\eta_p^2 = .03$ or Emotion, $F(1, 56) = 1.10$, $p = .30$, $\eta_p^2 = .02$, and no significant interaction of Stimuli x Emotion, $F(2, 112) = .09$, $p = .91$, $\eta_p^2 = .00$. For *remember* responses there was no significant effect of Stimuli, $F(2, 112) = 2.24$, $p = .11$, $\eta_p^2 = .04$, no significant effect of Emotion, $F(1, 56) = .31$, $p = .58$, $\eta_p^2 = .01$, and no significant interaction effect of Stimuli x Emotion, $F(2, 112) = .65$, $p = .53$, $\eta_p^2 = .01$. For *know* responses, likewise, there was no significant effect of Stimuli, $F(2, 112) = .01$, $p = .99$, $\eta_p^2 = .00$, Emotion, $F(1, 56) = 2.13$, $p = .15$, $\eta_p^2 = .04$, or Stimuli x Emotion, $F(2, 112) = 1.35$, $p = .26$, $\eta_p^2 = .02$. Finally for *guess* responses there was no significant effect of Stimuli, $F(2, 112) = .05$, $p = .95$, $\eta_p^2 = .00$, Emotion, $F(1, 56) = 1.02$, $p = .32$, $\eta_p^2 = .02$, or Stimuli x Emotion, $F(2, 112) = .01$, $p = .99$, $\eta_p^2 = .00$.

Response Bias analysis using false memory data as the hits:

	Negative				**Neutral**			
			95% CI				***95% CI***	
	M	***SE***	***LL***	***UL***	***M***	***SE***	***LL***	***UL***
Old								
Positive	1.52	.01	1.50	1.55	1.54	.02	1.51	1.57
Neutral	1.54	.01	1.52	1.57	1.53	.02	1.50	1.57
Negative	1.52	.01	1.51	1.54	1.51	.02	1.48	1.55
Remember								
Positive	1.59	.01	1.56	1.62	1.59	.01	1.56	1.62
Neutral	1.60	.01	1.57	1.62	1.59	.02	1.55	1.62
Negative	1.59	.01	1.56	1.62	1.57	.01	1.54	1.60
Know								
Positive	1.74	.01	1.72	1.77	1.76	.01	1.74	1.79
Neutral	1.76	.01	1.73	1.78	1.76	.01	1.74	1.79
Negative	1.75	.01	1.72	1.77	1.74	.01	1.72	1.77
Guess								
Positive	1.77	.01	1.75	1.79	1.78	.01	1.76	1.79
Neutral	1.78	.01	1.76	1.79	1.77	.01	1.75	1.79
Negative	1.78	.01	1.76	1.79	1.78	.01	1.77	1.80

For *old* responses there was no significant effect of Stimuli, $F(2, 112) = 2.56$, $p = .08$, $\eta_p^2 = .04$ or Emotion, $F(1, 56) = .00$, $p = .95$, $\eta_p^2 = .00$, and no significant interaction of Stimuli x Emotion, $F(2, 112) = 1.47$, $p = .23$, $\eta_p^2 = .03$. For *remember* responses there was no significant effect of Stimuli, $F(2, 112) = 1.28$, $p = .28$, $\eta_p^2 = .02$, no significant effect of Emotion, $F(1, 56) = .26$, $p = .81$, $\eta_p^2 = .01$, and no significant interaction effect of Stimuli x Emotion, $F(2, 112) = .21$, $p = .81$, $\eta_p^2 = .00$. For *know* responses, likewise, there was no significant effect of Stimuli, $F(2, 112) = 2.23$, $p = .11$, $\eta_p^2 = .04$, Emotion, $F(1, 56) = .42$, $p = .52$, $\eta_p^2 = .01$, or Stimuli x Emotion, $F(2, 112) = 1.35$, $p = .22$, $\eta_p^2 = .03$. Finally for *guess* responses there was no significant effect of Stimuli, $F(2, 112) = .30$, $p = .74$, $\eta_p^2 = .01$, Emotion, $F(1, 56) = .15$, $p = .70$, $\eta_p^2 = .00$, or Stimuli x Emotion, $F(2, 112) = .38$, $p = .69$, $\eta_p^2 = .01$.

Appendix H

Stimuli used for Experiment 5

Non-words presented and the pilot study affective ratings:

Non-words	Affective Rating		Non-words	Affective Rating	
1-30	*M*	*SD*	31-60	*M*	*SD*
blaige	3.80	1.31	krinte	3.84	1.00
blikte	3.85	1.02	kwegue	3.68	1.03
clerlt	3.98	1.21	kwerle	4.22	1.08
coodge	4.10	1.36	leamms	4.31	1.13
creuce	3.58	1.10	mermed	4.38	1.20
crurms	3.80	1.13	mophte	3.90	1.06
cwoize	3.90	1.27	phoffs	3.84	1.42
dralfs	3.84	0.73	phrong	3.96	1.13
drawge	3.64	1.07	pleebe	3.68	1.54
drilcs	3.66	0.97	plures	4.45	1.09
dweitt	3.92	1.23	queish	3.68	1.32
dweufs	3.52	1.24	quirph	4.14	1.18
dylped	3.56	1.15	rhuibb	4.24	1.05
feenth	4.12	0.99	rirphs	3.90	1.19
flaufs	4.16	1.27	sennth	4.28	1.02
flufed	4.58	1.72	slembs	3.60	1.20
gheenn	4.12	1.05	sloole	3.52	1.14
ghlinz	4.46	1.14	snunns	3.55	1.20
glelce	3.90	0.95	sprild	4.00	1.11
glinse	4.72	0.94	suibed	3.82	1.18
graick	3.78	1.19	swaush	4.30	1.17
guects	3.72	1.10	swylms	3.86	1.18
gweade	3.72	1.22	tannth	4.10	0.79
hernth	3.76	1.07	thoves	4.18	1.03
jemmth	4.58	0.96	thweep	4.28	1.39
jirgns	3.84	1.08	trerke	4.06	1.46
kealte	4.16	1.09	twique	4.68	1.30
klafed	3.84	1.16	yauped	3.86	1.34
knaced	3.61	1.37	yeuned	3.94	1.01
koarfs	3.70	1.15	yorphs	4.20	1.33

Appendix I

Signal Detection Analyses for Experiment 5

Signal Detection analysis of final recognition responses:

	Neutral				Negative			
			95% CI				*95% CI*	
	M	*SE*	*LL*	*UL*	*M*	*SE*	*LL*	*UL*
D Prime								
Old	.15	.02	.10	.19	.13	.02	.09	.16
Remember	.17	.02	.13	.21	.14	.02	.11	.18
Know	.05	.02	.01	.09	.05	.02	.02	.08
Guess	-.04	.02	-.08	.00	-.03	.01	-.05	-.01
Criterion C								
Old	2.00	.02	1.97	2.04	2.01	.02	1.98	2.05
Remember	2.14	.01	2.11	2.17	2.15	.01	2.13	2.18
Know	2.22	.01	2.20	2.24	2.21	.01	2.19	2.23
Guess	2.17	.02	2.14	2.20	2.18	.02	2.14	2.21

One-way ANOVA of *d'* scores revealed no significant main effects of the emotion induction for *old* responses, $F(1, 46) = .00$, $p = .54$, *remember* responses, $F(1, 46) = .01$, $p = .32$, *know* responses, $F(1, 46) = .00$, $p = .91$, and *guess* responses, $F(1, 46) = .00$, $p = .66$. The same pattern was found for *C* scores as there were no significant effects for *old* responses, $F(1, 46) = .00$, $p = .59$, *remember* responses, $F(1, 46) = .00$, $p = .50$, *know* responses, $F(1, 46) = .00$, $p = .57$, and *guess* responses, $F(1, 46) = .00$, $p = .79$.