The Role of Negative Emotion on Suggestibility Using the Misinformation Paradigm

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Declaration

I submit this thesis to City, University of London for the degree of Doctor of Philosophy in Psychology. I confirm that the work contained within this thesis is my own, and none of this work has been submitted for another degree.

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Abstract

This thesis investigates the influence of negative emotion on suggestibility within the misinformation paradigm. Existing research has indicated that negative events, especially those high in arousal, are more susceptible to misleading information compared to neutral events. However, several gaps in our understanding of this phenomenon remain. This thesis includes six experiments that use the three-stage misinformation paradigm to examine the effects of limited attention, post-warnings, and retention interval on individuals' susceptibility to post-event misleading information. These factors have previously been studied in relation to misleading information but have received limited exploration in the context of negative emotion. Experiments 1-3 examined the role of attention during event encoding. The interaction between attention, misinformation, and picture valence was found only in Experiment 3 after changing the type of recognition test used in Experiments 1 and 2. In Experiment 3, the reduced attention at encoding did not increase misinformation susceptibility or decrease misinformation resistance for the negatively arousing picture and, surprisingly, the neutral picture, but did so for the negative low-arousing picture. Experiments 4 and 5 investigated the impact of different misinformation post-warnings. Interestingly, there was no effect of post-warnings, compared to no warning, for the negatively arousing picture. However, for the neutral picture, the enlightenment and item-specific warnings (although not a simple warning), reduced the endorsement of misinformation and increased misinformation resistance. This was only found when the warning stated the definite exposure (Expt. 5), rather than the possible exposure (Expt. 4), to prior misinformation. Finally, Experiment 6 investigated the retention interval between misinformation and test. The misinformation effect persisted over one week for the negatively arousing picture, but for the negative low-arousing and neutral pictures, the effect of misinformation at immediate testing disappeared after a delay. These findings were obtained regardless of whether picture details were categorized as central or peripheral, suggesting, at least in these presented findings, that memory effects were not specific to certain details. The main findings of this thesis are discussed in relation to the adaptive function of emotion, differential encoding processes, and source monitoring and activation-based theories. Overall, this thesis demonstrates the detrimental impact of misinformation on memory for negative events and emphasises the significance of these findings in forensic settings where the reliability of eyewitness testimony is paramount.

Chapter One: General Introduction

Human memory is considered to be constructive (e.g., Schacter et al., 1998). That is, memories are not exact replicas of past events; we do not simply retrieve a stored copy of the event. Instead, we reconstruct the memory based on various cues and contextual information, filling in any gaps, and making assumptions about what happened based on our prior knowledge and expectations (Howe & Knott, 2015). Memory has been said to be "fallible at best and unreliable at worst" (p.634; Howe & Knott, 2015). This implies that the process of memory reconstruction can sometimes lead to false memories. False memories occur when one recalls an entirely new experience that never happened or incorrectly recalls details of an experienced event (Roediger & McDermott, 1995). Over the past four decades, researchers have increasingly set out to understand the factors affecting the production of false memories and the mechanisms behind them (Zhang et al., 2021). From a practical standpoint, the importance of understanding the development of false memories and implementing reliable procedures for eyewitness testimony gained significant attention in the 1980s and 1990s. This surge in interest was sparked by the exposure of poor investigative techniques in historic cases of childhood sexual abuse (Howe & Knott, 2015). The momentum carried forward due to the practical legal implications associated with comprehending the formation of false memories and identifying strategies that can enhance the reliability of eyewitness testimony (Dehon et al., 2010). The latter is very important considering that eyewitness testimony is involved at different stages of a case/investigation, from reporting the event and police interviews to providing evidence in a courtroom.

Researchers have developed numerous paradigms to study factors that increase or decrease the production of false memories in a laboratory setting. For example, spontaneous false memories for materials not previously encountered have been studied using the Deese/Roediger- McDermott paradigm (DRM; Deese, 1959; Roediger & McDermott, 1995). Here, participants are presented with a list of words (e.g., bed, rest, wake) that are semantically related to a non-presented word known as a *critical lure* (e.g., sleep). False memory is measured through the recognition or recall of this critical lure in a later memory test. This paradigm has been extended to study false emotional memories (e.g. Brainerd et al., 2008; Dehon et al., 2010; Dewhurst et al., 2012) by presenting participants with emotional words (e.g., crook, robber, burglar) all related to a critical lure (e.g., thief). It is typically shown that emotional, particularly negative, words are associated with higher false memories compared to neutral words (although these findings are often found with recognition, not recall tests).

Researchers have also developed a paradigm to implant false memories for entirely fictitious events, often referred to as rich implanted false memories. For example, Loftus and Pickrell (1995) asked participants to read stories about events that occurred during their childhood, including a false story about being lost in a shopping mall. After two interviews spaced apart, they found that 25% of the participants falsely recalled details about the 'shopping mall' fictitious event. Wade et al. (2002) used photographs instead of narratives. They presented participants with three real photos from their childhood and one fake doctored photo showing the participants riding in a hot-air balloon. After being exposed to the photos a few times over 2 weeks, the researchers found that 50% of the participants were able to recall something about the fictitious event and that often, this recollection was rich in detail. Garry and Wade (2005) compared false memory "implantation" using fake narratives and fake photographs and found narratives to be superior in generating false reports. Although there are a number of factors that impact this, susceptibility to suggestion is typically lower for an entire event.

Both paradigms are popular amongst researchers studying false memories and they powerfully demonstrate how false memories can be elicited in a laboratory setting. Although relevant to mention these, the paradigm of interest for this thesis is one that allows us to examine false memories for explicitly suggested false details. Namely, the Misinformation Paradigm (Loftus, 2005). The next section provides an overview of this paradigm.

1.1 The Misinformation Paradigm

A popular technique used by researchers to induce false memories for suggested details is the misinformation paradigm (Loftus et al., 1978). In the standard three-stage paradigm, participants are first presented with an event (e.g., in the form of a slide show, video, or a staged event). Thereafter, participants receive misleading information about the event that they have witnessed. The misinformation could be embedded in a questionnaire or a written narrative. Finally, recognition or recall memory is tested for the original event to determine the impact of misinformation on memory performance. The misinformation effect is demonstrated when participants falsely report the misleading information in their memory reports as being part of the original event. The size of the misinformation effect can vary depending on factors surrounding the study design, memory assessment methods, and individual differences (Roediger et al., 1996).

Research on the effect of misinformation was driven by Elizabeth Loftus in the 1970s. In a seminal paper, Loftus et al. (1978) presented participants with a slide sequence depicting an auto-pedestrian accident near a stop sign. Thereafter, participants completed a questionnaire about the slide event, which included a critical question: 'Did another car pass the red Datsun when it was stopped at the ____ sign?' Depending on the participants' condition, the detail about the sign was either misleading (i.e., yield sign), correct (i.e., stop sign), or neutral (i.e., traffic sign). In a subsequent recognition memory test where participants had to choose between the correct or the misleading detail, it was found that participants who were misled were significantly less accurate in recognising the original detail (stop sign) since they endorsed the misleading detail (yield sign) more often. The adverse effects of misleading information on memory performance have been consistently replicated across numerous studies (for reviews, see Ayers & Reder, 1998; Zaragoza et al., 2007), and have even been observed in real-world contexts (e.g., Loftus et al., 1992). Over the years, several theories have emerged to explain the underlying mechanisms of the misinformation effect.

1.2 Theoretical Explanations for the Misinformation Effect

One of the earliest theories put forward to explain the effect of misinformation was the memory impairment or trace alteration theory (see Loftus, 1975; Loftus et al., 1978). According to this theory, exposure to misinformation alters or overwrites the original memory trace with the new information. When participants are later tested on the original information, they can only access the updated memory trace containing the misinformation since the original memory trace no longer exists. However, other researchers (e.g., Bowers & Bekerian, 1984; Bekerian & Bowers, 1983; Chandler, 1991; Christiaansen & Ochalek, 1983) have criticised this theory by arguing that both the original detail and the misleading detail *coexist* in memory, rather than one overwriting the other. Such researchers have suggested the misinformation effect arises due to misleading information interfering or blocking access to the original information. The misleading information is often more accessible for retrieval because it is more recent. Thus, errors can arise because the misleading information comes to mind with little effort (i.e., retrieval fluency) or because new information hinders the retrieval of previously acquired information (i.e., retroactive interference). Support for this theory comes from misinformation research administering warnings. Here, some participants are warned at the time of the test about prior exposure to misinformation and such manipulation has shown that participants can successfully retrieve memory for the original information, indicating that the original memory trace can exist alongside the misinformation memory trace (e.g., Chambers & Zaragoza, 2001; Christiaansen & Ochalek, 1983; Oeberst & Blank, 2012; Zaragoza & Koshmider, 1989). Overall, there appears to be an agreement in the misinformation field that the detrimental impact of misinformation is best explained by a multiple memory trace account (Ayers & Reder, 1998).

An alternative explanation of the misinformation effect centres around strategic responses and task demands as opposed to memory impairment. According to McCloskey and Zaragoza's (1985a; see also McCloskey & Zaragoza, 1985b) strategic effects account, participants who do not successfully encode the original information might rely on guessing or might choose the misleading information if they have a memory for it. Additionally, some participants may recall both the original and misleading information but intentionally choose the misleading option to (1) align with what they think the experimenter expects (known as demand characteristics) or (2) perceive the post-event information as consistent with the original event since the experimenter created the post-event source and assume that the experimenter has better knowledge of the event. To test this, McCloskey and Zaragoza administered a modified recognition test where the participants would choose between a correct detail and a novel detail, instead of a correct detail and a misleading detail. It was argued that if misinformation impaired memory for the original information, then misled participants should still be less likely than non-misled participants to select the correct detail. Across six experiments, there was no significant difference in the recognition of correct information between misleading and control participants, thus going against the view that misinformation overwrites the original memory or blocks access to the original information. McCloskey and Zaragoza concluded that the misinformation effect seen in studies can instead be attributed to guessing, response bias, and demand characteristics.

Several studies using the modified test have supported McCloskey and Zaragoza's (1985a) account by failing to find a clear misinformation effect (e.g., Belli, 1993; Bowman & Zaragoza, 1989; Loftus et al., 1989). However, findings are mixed and it is important to note that several studies have also found memory impairment due to misinformation exposure when the modified test was used (e.g., Belli, 1989; Belli et al., 1992; Windschitl, 1996). For example, Belli (1989) used a yes/no recognition test instead of a 2-AFC test. They showed a slide show of a maintenance man stealing money, followed by a narrative containing misleading information. After a short interval, they received statements concerning the event (original) items and novel items. They found that participants who were exposed to misleading information were less accurate in their memory of the original details. Belli et al. (1992) argued that to detect memory impairment using the modified test, a longer retention interval is required. They gave a 2-AFC test either 15 minutes (short interval) or 5-7 days (long interval) after the encoding phase. A misinformation effect was observed at longer retention intervals, but not at the short delay. They concluded that the long retention led to significant forgetting of the original items, making one more susceptible to misleading information (i.e., less likely to be correct). Furthermore, a meta-analysis by Payne et al., (1994) of studies using the modified recognition procedure revealed that, when the data was aggregated, memory impairment by misinformation indeed occurred using the modified recognition procedure. Overall, even under modified test conditions, misinformation effects have been obtained, suggesting that such a test may be insensitive under certain circumstances. Thus, support still remains for the hypothesis that misinformation impairs or interferes with memory.

One of the most prominent theories to explain the misinformation effect is errors arising from source monitoring failure. According to the source monitoring framework (Johnson et al., 1993), memories are stored along with cues that help identify their sources. These cues include, for example, perceptual details (e.g., visual and auditory), spatial information, and affective information (Horry et al., 2014). During memory tests, individuals can retrieve these cues to differentiate accurate information from misleading details. From a source monitoring perspective, accurate performance on a memory test after having been exposed to misinformation relies on two factors. First, an active engagement of the source monitoring process is required at memory retrieval. Second, they need access to the source cues that differentiate between the original and post-event sources. Together, the task of source attribution recruits heuristic and strategic decision-making processes (Johnson et al., 1993; Mitchell & Johnson, 2000). Errors in source monitoring can arise if participants do not encode or access the necessary source information that characterise the retrieved information or can occur if participants respond to a memory test in the absence of active source monitoring (Johnson et al., 1993; Mitchell & Johnson, 2000). Previous research has demonstrated the significant contribution of source confusions in the impact of misinformation on memory performance (see Mitchell and Johnson, 2000; Zaragoza et al., 2007, for reviews). That is, participants misattribute the source of the incorrect post-event information to the original event, leading them to claim that they remember seeing the misinformation in the witnessed event.

In general, source misattributions can typically occur when there are similarities between the original information and the misleading information, making accurate source monitoring difficult (Johnson et al., 1993). Specifically, the post-event information would be about the same witnessed event, and therefore it would include semantically similar aspects of information (e.g., people, objects, surroundings) to what was witnessed during the encoding stage. There are two possible ways that can further increase the overlap between the two sources of information and increase source misattribution errors. First, the post-event information may acquire characteristics typically found in the original event (i.e., sensory and perceptual characteristics) when one reflects back and retrieves the original event during the post-event source, but also by potentially mentally visualising the suggested information. Second, participants may mentally reconstruct the original event by including elements from both sources, thus binding them together. This would mean that when answering test questions about the misinformation, participants may confuse the source of the misinformation as being part of the original event (Mitchell & Johnson, 2000). Indeed, empirical evidence (e.g., Dobson & Markham, 1993; Hyman & Pentland, 1996; Zaragoza & Lane, 1994) has shown that when a post-event task requires the retrieval of the original event or requires imagining suggested events (e.g., remembering pseudo-events using doctored photos), this can increase source misattribution errors. For example, Zaragoza and Lane (1994) showed participants a slide event and then asked them to either read a narrative or answer questions about the event or unscramble the order of the narrative sentences to reconstruct the original order of the slide event. All three tasks included misleading details that were not present in the slide event. The crucial difference is that the questions and unscrambled narrative required retrieval of the event. The researchers found that, when the post-event task required the retrieval of the original event (the questions and the scrambled narrative), participants were more likely to make source misattribution errors than they were when they simply read the narrative. They concluded that participants are more likely to form vivid mental images of the misleading information when reconstructing the event and mistake them as being part of the slides. This blurs the distinction between the original and post-event sources and consequently mistakenly attributing the source of the incorrect information to the original event. Moreover, forming vivid images of the misleading information may lead to deeper levels of processing through perceptual elaboration (Drivdahl & Zaragoza, 2001), subsequently enhancing the misinformation memory trace. It also must be pointed out that misattribution of the misinformation to the witnessed event can arise even when participants are aware of encountering it in the post-event source (Mitchell & Johnson, 2000). This is because much of the information in the post-event source would be consistent with the original event so correctly identifying the source of the misleading item does not suggest that the detail was not present in the original event.

Last but not least, research has considered the possible neural contributions to the misinformation effect. For example, Okado and Stark (2005) presented participants with eight slide events. Half of the participants were then exposed to misinformation in pictorial form, whereby some details changed across the original and misinformation phases. Finally, all participants were tested on their recognition memory for the original events. During both the original event and misinformation phases, they employed functional magnetic resonance imaging (fMRI) to examine brain activity. The findings of the study revealed interesting neural activation patterns. They found that the degree of activation in the left hippocampus and left perirhinal cortex was associated with the later endorsement of correct and misleading details on a forced-choice recognition. More specifically, both these brain regions showed higher activity during the slide presentation phase for details that participants would later accurately recognise. However, during the misinformation phase, these regions exhibited higher activity for the subsequent recollection of misleading details. These findings highlight the crucial role of activity in both regions for what is later correctly remembered but also what is later falsely remembered.

In sum, researchers have proposed several theories to explain the impact of misleading information on memory performance. These include the trace alteration theory, retrieval blocking, strategic effects account concerning guessing and biases, source-monitoring account, and neural mechanisms to highlight the role of brain activity. Whilst extensive, this list of theoretical explanations is not exhaustive (see later reference to the Source of Activation Confusion Model; Ayers & Reder, 1998). Although the specific mechanisms may vary across these theories, it could be argued that misinformation effects may arise due to multiple reasons, spanning from mere guessing to genuine impairments in memory processes.

1.3 Factors Affecting Misinformation Susceptibility

Since its inception, the misinformation paradigm has served as a tool for investigating various factors that can either increase or decrease the magnitude of the misinformation effect. This section provides an overview of at least three factors that have received empirical investigation using the misinformation paradigm.

The first factor is *reduced attention*. Studying this factor offers insights into how individuals process and retrieve information under conditions of reduced attention, as often encountered in real-world scenarios such as eyewitness testimonies. Researchers have manipulated attention at different stages of the three-stage misinformation paradigm to explore its impact. For example, Lane (2006) asked participants to view the slides either with divided attention (between slides and a music recognition task) or undivided attention. They found that divided attention at encoding reduced memory for the event details and increased participants' endorsement of the misleading details as having appeared in the event. They argued that divided attention disrupts the encoding of source-specifying information for the event details. Consequently, this increases the overlap between the sources and reduces the ability to distinguish between memory for the event from memory for the suggested details, leading to greater misinformation susceptibility. Zaragoza and Lane (1998, Expt. 2) manipulated attention during the post-event stage through means of a divided attention task and found that the source misattribution of the misleading detail to the original event increased under divided attention conditions. They argued that the encoding of source information surrounding the misinformation was impaired by the divided attention task, resulting in poor source monitoring and increased memory errors.

The second factor is the *retention interval* between the stages of the misinformation paradigm. This is an important investigation considering that there can be a delay between witnessing an event and encountering misinformation or recalling the event (e.g., hours or weeks after the event; Neubauer & Fradella, 2011). Research has shown that the size of the misinformation effect increases when memory retrieval is delayed (e.g., Frost, 2000; Frost et al., 2002; Holmes & Weaver, 2010). It is argued that the association between the event details and their source fades over time (Frost et al. 2002). That is, the perceptual distinctive quality of event details fades with time, making its memory more like that of verbal misleading information. This overlap in sources consequently increases source misattribution errors. Other studies imposing a delay between the event and misinformation have also showed that the negative impact of misleading information on memory performance increases (e.g., Loftus et al., 1978; Paz-Alonso & Goodman, 2008). This is considered to be due to weaker memory traces for the original event over time, making one less resistant to the more recently presented misleading information.

Last but not least, researchers have set out to examine whether the effect of misinformation can be weakened after one has been exposed to such false information by means of administering *(post-)warnings* (Chambers & Zaragoza, 2001). Since misinformation has been robustly found to have a detrimental impact on memory accuracy of witnessed events, and that we can make mistakes in our recollection of events that are forensic-related, it is important to understand whether misinformation warnings can improve eyewitness accuracy. Research has shown that warnings can reduce the effect of misinformation on memory or event eliminate it (e.g., Chambers & Zaragoza, 2001; Christiaansen & Ochalek, 1983; Oeberst & Blank, 2012; Higham et al., 2017), with a meta-analysis (Blank & Launay, 2014) revealing that warnings can reduce misinformation endorsement by 57%. These studies have argued that the presence of warnings alert participants about possible differences between an event and the post-event information. This serves as a crucial reminder for participants to carefully monitor the source of their memories. As a result, participants may approach the memory task more critically by evaluating the information in the memory task and adopt a thorough and strategic process to monitor the source of the retrieved memories (Higham et al., 2017).

As can be seen, certain factors can increase the sheer negative effect of misinformation on memory performance, but there are also methods to reduce misinformation's impact. Thus, understanding the conditions that affect false remembering is vital. This is particularly important for legal settings where the reliability of eyewitness testimony is paramount, especially if this is the only evidence available. It also seems crucial to explore how specific misinformation factors interact with emotion. The focus of this thesis is to investigate the impact of misleading information on memory for negative events, particularly those high in emotional arousal. The emphasis on negative events stems from the practical implications of these findings in the legal field. Given that most witnessed crimes, especially severe offenses (e.g., assault or theft), are likely to evoke negative emotions and high levels of arousal, it becomes necessary to understand the influence of negative emotion on susceptibility to misinformation. It is also noteworthy that the legal system has limited control over the emotions experienced by (eye)witnesses during the event. Therefore, the research conducted in this thesis aims to uncover how negative emotion influences an individual's vulnerability to misleading information, and this provides valuable insights into the complex memory processes underlying emotionally charged events. The subsequent sections will present empirical research that examines both true and false memory for emotional (negative) information.

1.4 Emotion and Memory

Within the emotion and memory field, emotions have been conceptualised and studied in different ways. The common conceptualisation of emotion has been along valence and arousal dimensions (LaBar & Cabeza, 2006; Russell, 1980). Valence can refer to experiences ranging from positivity and negativity (e.g. happiness categorised as a positive emotion and anger categorised as a negative emotion). Arousal can refer to experiences that vary from calm (low arousal) to excited (high arousal). However, emotions have also been conceptualised in a discrete manner, such that each emotion has unique qualities. According to appraisal theories (e.g., Ellsworth & Dougherty, 2016), individuals attend to their environments to gather information that is in line with the goal(s) that are currently active. Emotions arise when individuals consider goal attainment or failure to occur or to have already occurred. These emotions then direct cognition and behaviour (i.e., approach or avoid specific environmental stimuli). Thus, how one perceives and interprets events leads to specific emotions and drives distinct motivations (Levine & Pizarro, 2004). From a goal-relevance perspective (Levine &

Edelstein, 2009; Levine & Pizzaro, 2004), specific emotions can be categorised into *pre-goal* emotions (e.g., fear, anger, excitement), which indicate the anticipation of goal attainment/failure, and *post-goal* emotions (e.g., sadness, happiness), which reflect the already-occurred goal attainment/failure (more on the goal-relevance approach later in the chapter). This thesis focuses only on the valence and arousal dimensions of emotion.

Furthermore, regardless of emotion's conceptualisation, emotions have been manipulated in two broad ways (see Bookbinder & Brainerd, 2016; Levine & Pizzaro, 2004). Emotions can be tied to the events themselves (emotional content), making those events emotional. Content emotion can be manipulated using various stimuli, including emotional word lists and emotional pictures (e.g., Burke et al., 1992; Humphreys et al., 2010; Van Damme & Smets, 2014; Tse & Altarriba, 2022). Alternatively, emotions can stem from an individual's internal emotional state (i.e. mood) at the time of experiencing an event (emotional context). These internal emotions might align with the emotional content of the event or might not match it at all. Emotion-induction methods can include autobiographical recall (e.g., Forgas et al., 2005; Jeon et al., 2020) and emotional videos (e.g. Knott & Thorley, 2014; Thorley et al., 2016; Zhang et al., 2021). The research within this thesis exclusively focuses on the impact of misinformation on memory for *emotional content*. Thus, such literature is discussed next.

Research has shown that emotionally arousing stimuli/events, particularly those that are negatively valenced, are better remembered than neutral stimuli/events (Hamann, 2001; Talmi et al., 2007a). This phenomenon is known as *Emotion Enhanced Memory* (EEM) and has been demonstrated using different types of materials, such as pictures (e.g. Bradley et al., 1992) and emotional words (e.g. Kensinger & Corkin, 2004; LaBar & Phelps, 1998). The EEM effect has been observed when memory retrieval occurs immediately or after a short delay. According to Sommer et al. (2008), cognitive characteristics associated with emotional stimuli contribute to immediate EEM.

One characteristic is that emotional information tends to be attention-grabbing. Numerous studies have supported the phenomenon of emotional prioritization of attention. For instance, behavioural and neural evidence has shown that emotional stimuli benefit from early information processing (e.g., Hulse et al., 2007; Kissler et al., 2007). Evidence from behavioural studies measuring eye movements, which provide insights into overt visual attention, have also demonstrated that individuals tend to fixate faster and for longer on emotional stimuli compared to neutral stimuli (e.g., Calvo & Lang, 2004; Chipchase & Chapman, 2013; Christianson et al., 1991; Humphreys et al., 2010). Thus, attention is initially directed towards emotional information, and individuals find it more challenging to disengage attention from such information. It is argued that we are cognitively biased towards preferentially attending to emotional stimuli as a way of an adaptive function to prioritise the attention and processing of harmful and/or important information for survival (Ohman et al., 2001).

Several studies have found that enhanced attention to emotional stimuli is accompanied by enhanced memory for those stimuli (Schmidt & Saari, 2007; Talmi et al., 2007a). For instance, Schmidt and Saari (2007) found that taboo words attracted more attention compared to neutral words, as indicated by the time taken to name the colour in which they were presented. Additionally, taboo words were better remembered than neutral words, regardless of whether they were presented in separate blocks or mixed together in lists. However, the link between attention and emotion-enhanced memory is more complicated with evidence showing that the level of attention at encoding does not always predict later memory. The difference has been shown between positive and negative valenced stimuli (e.g., Humphreys et al., 2010; Kang et al., 2014; Talmi et al., 2007a). For example, Humphreys et al. (2010) found that attention was biased towards positively-valenced pictures, with negatively-valenced pictures receiving fewer fixations and total fixation duration. However, a recognition test one-week later revealed a memory enhancement only for the negative pictures. Kang et al. (2014) conducted a study whereby participants' attention was either divided between the pictures and a secondary task or undivided (i.e., a dual-task paradigm). They varied the arousal level of positive and negative words. The findings revealed that the memory improvement observed for non-arousing positive and negative words compared to neutral words, as well as for positive-arousing words compared to positive non-arousing words, disappeared when participants' attention was divided. However, the memory enhancement for negative-arousing over non-arousing words observed under a full attention condition persisted even when participants' attention was divided.

What these findings suggest is that negative information, in particular negative-arousing information, may be processed relatively automatically while neutral (and positive) information is dependent on controlled processes. The ability for humans to process negatively arousing information quickly and automatically likely serves an adaptive and evolutionary function (Carretie´ et al., 2004). That is, attending to dangerous and undesirable events slowly would result in greater negative consequences than attending to positive and neutral events (Carretie´ et al., 2004). Further support for automatic processing of negative information comes from neuroimaging studies. For example, Kensinger and Corkin (2004) found that the enhanced memory for negatively arousing words was associated with the activation of the amygdala and hippocampus, which are responsible for quick and automatic processing. On the other hand, the improved memory for negative low-arousing and neutral words was linked to activations in the prefrontal cortex and hippocampus, which are involved in controlled and elaborative encoding processes. Overall, prioritised attention towards emotional stimuli may contribute to subsequent memory enhancement to an extent, but the level of attention required varies depending on the valence and arousal of the stimulus.

Organisation (or semantic relatedness) is another cognitive characteristic of emotional stimuli that can contribute to immediate EEM. Emotional stimuli are often semantically related to each other, either through script-based associations or thematic connections (Talmi & McGarry, 2012). Research has indicated that the improved memory for emotional items can be attributed not only to their emotional content but also to their relatedness. Talmi and Moscovitch (2004), for instance, found that the improved memory performance for emotional words disappeared when compared with related neutral words. It is argued that the immediate EEM may be due to organisation facilitating the elaboration of the relationship between the items during the encoding process (Einstein & Hunt, 1980) and serves as a retrieval cue during memory retrieval (Tulving & Pearlstone, 1966). However, organization may only partially explain the EEM effect. For example, Buchanan et al. (2006) found equivalent memory for emotional and related-neutral words, but they extended it by showing that taboo words, which are typically high in arousal than non-taboo emotional words, were better recalled than related-neutral words. This suggests that emotional arousal, rather than just valence, is responsible for the emotion enhanced memory.

Talmi et al. (2007a) examined the contribution of semantic relatedness and attention. They presented arousing positive and negative pictures and low-arousing neutral pictures under full and divided attention conditions The pictures were semantically related as much as possible. When attention was controlled for, the study revealed that semantic relatedness alone did not fully explain the EEM effect. That is, attention completely mediated the positive EEM but not the negative EEM. Therefore, unlike positively-valenced stimuli, enhanced memory for negatively-valenced stimuli may go beyond the influence of these two cognitive factors.

Distinctiveness is a further cognitive characteristic of emotional stimuli that contributes to the immediate EEM. Emotional stimuli are often better remembered because they possess unique qualities that differentiate them from non-emotional or neutral stimuli, making them stand out (Schmidt, 1991; Talmi & McGarry, 2012). Schmidt (1991) differentiates between absolute and relative distinctiveness. Absolute distinctiveness refers to the limited overlap of features between an item and the typical items stored in long-term memory. Relative distinctiveness arises from an item's limited overlap with the items stored in working memory. Schmidt (1991) concluded that only relative distinctiveness enhances memory, while absolute distinctiveness alone does not. Assessing relative distinctiveness can be achieved by presenting stimulus sets as pure-lists and mixed-lists. For example, Dewhurst and Parry (2000) presented participants with emotionally positive, negative, and neutral words. When the words were presented as mixed-valenced lists, the emotional words were remembered more than the neutral words, with a stronger effect for the negative words. However, when the emotional and neutral words were presented as pure lists (i.e., all emotional or all neutral), the emotion-enhanced effect disappeared. It was concluded that the relative distinctiveness of emotional stimuli against non-emotional stimuli contributes to the EEM.

The influence of relative distinctiveness could be attributed to encoding processes, such that distinct items could attract attentional resources that enhance encoding and memory, or could enhance the processing of item’s contextual information (Talmi et al., 2007b). However, the enhanced memory for distinctive items may be solely due to retrieval processes. Items with greater distinctiveness, which possess more unique attributes, are more likely to be retrieved during memory search, resulting in improved memory performance (Tomlinson et al., 2009). Empirical evidence has shown that when distinctiveness is controlled at encoding through a pure list presentation but is allowed to vary at retrieval by allowing participants to recall items from lists in any order, memory is enhanced for distinctive items (e.g. Talmi et al., 2007b; McDaniel et al., 2005). This suggests that the relative distinctiveness effect during retrieval is sufficient to observe an EEM effect.

Factors of distinctiveness and organization can work together to enhance memory performance. For example, Talmi and colleagues (2007b) conducted a study where they manipulated the organization (emotional versus related neutral) and the distinctiveness (mixed versus pure lists) of negative-arousing pictures and neutral pictures. Their findings indicated that memory for negative-arousing pictures was enhanced in immediate memory tests when either organization or distinctiveness was present. However, when these factors were removed, such as when emotional and related neutral pictures were compared in pure lists, the advantage of emotional memory disappeared. This suggests that cognitive processes, such as distinctiveness and organization, can influence the enhanced memory for emotional items.

From the research presented above, it has been shown that semantic relatedness, distinctiveness, and attention, have been shown to contribute to the enhanced memory of emotional stimuli. Talmi and McGarry (2012) conducted two experiments to explore the *combined* influence of these factors on immediate EEM. Participants were presented with negative-arousing and neutral pictures under divided and undivided conditions. They found that both organisation and distinctiveness contributed to EEM and when both factors were controlled for, but attention was not (in the divided attention condition), emotional memory enhancement was demonstrated. This showed the necessary contribution of attention. However, when all three factors were controlled, the EEM effect disappeared. These findings highlight the interplay between these three cognitive factors on emotional memory such that, when any of these factors become more prominent for emotional stimuli compared to neutral stimuli, an emotion-enhanced memory effect emerges as has been demonstrated in research presented above.

The enhanced memory for emotional stimuli relative to neutral stimuli has also been found after a period of delay. Several studies have demonstrated that memories for arousing stimuli remain stable or even improve over time (e.g., after one day and event 2 weeks), while memories for neutral stimuli tend to decline (e.g., Christianson, 1984; Kleinsmith & Kaplan, 1963; Sharot & Phelps, 2004; Sharot & Yonelinas, 2008; Wang, 2018). For instance, in a study by Sharot and Phelps (2004), participants were presented with arousing or neutral words on the periphery while fixating on a central word. The recognition of peripheral words was tested immediately and after 24 hours. While recognition of neutral words deteriorated over time, recognition of arousing words remained the same and was superior to neutral word recognition after the delay, regardless of the level of attention during encoding. This suggests that negative stimuli are resistant to forgetting over time and thus remembered over time compared to neutral stimuli.

The slow consolidation process is thought to occur to allow neurohormonal processes triggered by emotional information to strengthen the memory for such information (McGaugh, 2000). The amygdala, a brain region dedicated to processing emotions, consistently contributes to the consolidation of emotionally arousing information (Cahill & McGaugh, 1998; McGaugh, 2018). Research has shown that the activation of the amygdala during the encoding of arousing stimuli predicts later memory performance (Dolcos et al., 2005; Hamann et al., 1999). Indeed, individuals with amygdala damage struggle with long-term memory for emotional information (e.g., LaBar & Phelps, 1998; Phelps et al., 1998). The amygdala contributes to the encoding and consolidation of emotional memories by modulating the activity of other brain areas, such as the hippocampus and para-hippocampus, which are important for memory formation and consolidation (Dolcos et al., 2003, 2011; McGaugh, 2002). Additionally, visual, prefrontal, and parietal brain regions are activated when encoding emotional information (Dolcos et al., 2011, 2012; Kensinger & Corkin, 2004). Moreover, stress hormones (e.g., epinephrine and cortisol) also play a role in the consolidation of emotional memories. Recent studies suggest that stress hormones modulate emotional memory consolidation, but not neutral information, by releasing noradrenaline into the amygdala (see Roozendaal et al., 2009).

Sleep also plays a crucial role specifically in the consolidation of emotional memories. While asleep, various processes related to memory, such as replaying and reactivating memories, occur, aiding in the consolidation and integration of emotional experiences (Walker & van der Helm, 2009). For example, Payne et al. (2008) demonstrated that when participants were shown scenes containing neutral or negatively arousing objects placed on neutral backgrounds, those who slept strengthened their memory for the emotional objects. However, their memory for the accompanying neutral backgrounds or for either the objects or backgrounds in neutral scenes deteriorated. In contrast, individuals who stayed awake exhibited a poorer memory overall. To date, the literature suggests that this impact of emotion on memory is heightened during sleep (Payne and Kensinger, 2011), highlighting the long-term consolidation specifically for emotionally arousing memories.

To summarise, research has shown that emotionally arousing information, especially negatively valenced, is better remembered than neutral information. This memory advantage applies to both immediate and short-term retrieval. The enhanced memory for emotional stimuli can be attributed to their ability to capture attention, their semantic associations, and their distinctiveness compared to neutral stimuli. When emotional stimuli exhibit heightened attention, semantic relatedness, or distinctiveness compared to neutral stimuli, this can lead to an emotion-enhanced memory effect. Additionally, there are distinctions between positive and negative stimuli. Negative information, particularly those that are arousing, appears to be processed automatically, while neutral (and positive) information relies on controlled processes. Also, enhanced memory for negatively-valenced stimuli may involve factors beyond attention and semantic relatedness, unlike positively-valenced stimuli. The EEM effect has also been found after a period of delay. Research findings indicate that (negative) emotional stimuli undergo differential consolidation compared to neutral stimuli. Emotionally arousing information tend to benefit from enhanced consolidation, show resistance to forgetting, and result in better long-term retention. Further, the presence of brain regions such as the amygdala and hippocampus, along with the influence of stress hormones and sleep, play a role in the differential consolidation processes of emotional and neutral stimuli.

However, it is important to note that negative emotions can also impair memory. An important question in the emotional memory literature is concerned with the impact of emotion on memory for neighbouring information. The next section will discuss how negative emotions also narrow our attention and focus, which can lead to a different pattern of memory effect known as *emotional memory narrowing* (Kaplan et al., 2012).

1.5 Emotional Memory Narrowing

Emotional Memory Narrowing (otherwise referred to as "tunnel memory" and "central/peripheral trade-off") is a phenomenon whereby one remembers information that is central to an emotionally arousing event but has poorer memory for peripheral or background information of the same event (Kaplan et al., 2012). Understanding memory performance for details at the core of an emotional event is important considering its forensic relevance, such as weapons, and descriptions and actions of the perpetrator(s). Although peripheral information tends not to play a key role in the event or be forensically relevant, poorer memory for such information can make it difficult to recall the scene of the crime.

Emotional memory narrowing could be understood in terms of Easterbrook's (1959) cue-utilization hypothesis. This is the proposal that an individual has a limited number of cues that they can process at any one time. Consequently, their attention is focused towards the arousing aspects of the emotional event, thereby decreasing the amount of attention allocated to peripheral information. As the emotional intensity increases, the attentional focus becomes narrower. Indeed, using eye-tracking technology to measure overt attention to central and peripheral details, research has shown that eye movements during emotional events were consistent with attention narrowing (Loftus et al., 1987). The narrowed attention may improve the encoding of, and enhance memory for, central information, whereas the encoding and memory for peripheral information are impaired as a result (Burke et al., 1992; Christianson & Loftus, 1991).

The emotional memory narrowing phenomenon was first demonstrated in weapon-focus research. Typically, when participants are presented with a crime that involves a weapon, it is found that they attend to and remember the weapon more at the expense of other details, such as the perpetrator's clothing (e.g., Loftus et al., 1987; Steblay, 1992). This finding is known as the *weapon focus effect* (Kaplan et al., 2012). In such an emotionally negative and arousing situation, one would be concerned with safety. Thus, the weapon is considered a critical central detail whilst all other information would be considered peripheral, such as the perpetrator's face and clothing. In terms of Easterbrook's (1959) hypothesis, the weapon focus effect could be attributed to increased emotional arousal due to the fear and threat posed by the weapon. This heightened arousal can cause attention to narrow to the salient central piece of information, resulting in enhanced encoding and memory for the weapon at the expense of other (peripheral) details in the visual scene (Pickel, 1998). However, the notion that heightened arousal is solely responsible for the weapon effect has been empirically challenged (e.g., Kramer et al., 1990; Pickel, 1999), as the effect has been observed even in low arousal conditions. Alternatively, the presence of a weapon may be considered unusual, unexpected, and surprising, making it distinctive from the surrounding visual scene (e.g., Loftus & Mackworth, 1978; Mitchell et al., 1998; Pickel, 1998). This is because it is not typical to encounter a weapon such as a gun to be revealed in many normal everyday contexts such as in a corner shop. Therefore, objects that are unusual or distinctive tend to capture attention more readily and for a longer duration (Loftus & Mackworth, 1978), leading to improved memory for the weapon but a decrease in memory for peripheral details. This *unusual item hypothesis* has received empirical support using different contextually unusual objects such as a gun, celery, and raw chicken (for a review, see Fawcett et al., 2013).

Beyond the weapon focus research, studies have also demonstrated emotional memory narrowing using complex events (e.g. Burke et al., 1992; Christianson et al., 1991; Heuer & Reisberg, 1990). For example, Burke et al. (1992) presented participants with a series of slides depicting a mother and son visiting the father at work (same slide sequence used by Heuer & Reisberg, 1990). The middle portion of the slide event was manipulated to either be negatively arousing (i.e., father operating on a crash victim) or emotionally neutral (i.e., father working in a garage). Recognition memory for details in the slides was then tested. The results showed that, relative to the neutral condition, arousal improved memory for the gist (i.e., basic-level information about the plot of the story) and the central information, but impaired memory for the peripheral/background information. In the slide event, the critical details between the arousing and neutral conditions were not equated. Could it be that the critical slides were more salient and unique and thus better remembered? To control for this, Christianson and Loftus (1991) presented a different slide event whereby the middle portion was largely similar except for one critical slide in the event: an injured woman near a bicycle (negatively arousing) and a woman riding a bicycle (neutral). Nevertheless, the results continued to demonstrate an emotional memory narrowing effect. That is, relative to the neutral condition, participants better remembered the central information (the colour of the woman's coat) in the arousing event but had a poor memory for the peripheral information (the colour of the car in the background). Furthermore, not restricted to the laboratory setting, the emotional memory narrowing effect has been demonstrated in real-world situations such as natural disasters (Bahrick et al., 1998), physical injuries (Peterson & Bell, 1996), and criminal events (e.g., Christianson & Hubinette, 1993). The enhanced memory for central information over peripheral information can be due to a number of explanations. For instance, the threat and/or fear associated with the emotional event may lead to a selective processing of only the core details of the event, thereby enhancing memory for central details (e.g., Christianson & Hubinette, 1993). The central event may also be more unusual/distinctive relative to other features of the event, thus capturing attention. Furthermore, the central information may be of greater significance. For example, Christianson and Loftus (1991) suggested that participants' primary focus and concern may have been directed towards the central woman involved in the emotional event and the potential outcomes of the situation.

It is necessary to highlight that some investigators have shown that attention narrowing may be specific to negative emotion (e.g., Van Damme & Smets, 2014; Waring & Kensinger, 2009; Yegiyan & Yonelinas, 2011). For example, Waring and Kensinger (2009) presented visual scenes whereby a central item was placed within neutral backgrounds. The central item was manipulated by valence (positive and negative) and arousal (high and low) and performance was compared with neutral scenes (i.e., a neutral item within neutral background). Recognition memory for both the central items and the backgrounds was tested 10 minutes and 24 hours after scene presentations. They found that memory for background items was poorer for both positive and negative scenes after a short study-test interval. However, after a long study-test interval, the memory-narrowing effect was only found for negative high-arousing scenes. Yegiyan and Yonelinas (2011) presented participants with positive and negative scenes and assessed recognition memory for central and peripheral details in each scene. As the arousal level for positive and negative pictures increased, memory for central details improved. However, impaired memory for peripheral details (i.e., memory narrowing) was shown only for negative high-arousing pictures. Furthermore, Van Damme and Smets (2014) found that emotional arousal improved memory for central information regardless of the valence of visual scenes, but the memory for peripheral details was impaired for both high *and* low-arousing negative pictures, indicating that negative emotion in general narrows attention. Furthermore, in visual perception literature, there is evidence that negative emotion narrows the attentional scope (e.g., Nobata et al., 2010) whereas positive emotion leads to a broader attentional scope (e.g., Rowe et al., 2007). Overall, there appears to be a consensus amongst researchers that, compared to no emotion (i.e., neutral), negative emotions can narrow attention and enhance memory for central information (Luna & Martin-Luengo, 2018).

Why might negative emotion specifically narrow attention? Kensinger (2009) showed that a narrowed attentional scope to central/specific details was associated with negative emotion due to the increased sensory processing when encoding negative information. In contrast, a broader attentional scope was associated with positive emotion due to increased semantic and heuristic processing when encoding positive information. According to the affect-as-information theory (e.g., Clore et al., 2001; Schwarz & Clore, 1983), positive emotion encourages broader and more heuristic processing, whereas negative emotion encourages item-specific processing. Positive emotion indicates a safe and unproblematic situation that does not require the need for increased attention to specific details, thereby resulting in broader information processing. In contrast, negative emotion suggests a problem that must be dealt with, thus there is a greater need to focus on relevant information within the environment, resulting in a narrow item-specific processing (Kensinger, 2009).

The view that emotional (negative) arousal narrows attention is complicated by inconsistent findings. For example, studies have shown that emotion does not impair memory for peripheral information or does enhance memory for both central and peripheral information (e.g., Cahill & McGaugh, 1995; Heuer & Reisberg, 1990; Hulse et al., 2007; Laney et al., 2004; Libkuman et al., 1999), and sometimes impairs memory more generally (e.g., Deffenbacher et al., 2004; Morgan et al., 2004). One reason for the inconsistent findings, as also acknowledged by other researchers (e.g., Kaplan et al., 2012), is how central and peripheral information is categorised. Researchers can categorise details as central or peripheral by using a specific definition or by asking participants to free-recall details of the study materials. For the latter, details frequently recalled are considered central and details less frequently or not at all recalled are considered peripheral (see Luna & Albuquerque, 2018). For the former method, various definitions have been used to determine what information would be central (and peripheral). For example, central items have been defined in terms of *visuospatial location* (i.e., centrally presented items or those near or part of the main action; e.g., Burke et al., 1992; Christianson & Loftus, 1991; Luna & Migueles, 2009), as *conceptual* (i.e., items that cannot be changed/removed without changing the core aspects of the event; e.g., Heuer & Reisberg, 1990; Peterson & Whalen, 2001), as *temporal* (i.e., details during the event, rather than before or after the event; e.g., Hulse et al., 2007), as *attention magnets* (i.e., items that capture one's attention due to, for example, salience and distinctiveness; e.g., see Laney et al., 2004; Peace & Constantin, 2016), or as *goal-relevant* (i.e., information attended to is determined by goals or motivations associated with people's emotions; e.g., Van Damme et al., 2017). It is worth noting that there can be an overlap between the definitions such that details classified using one definition can also be relevant under a different definition. Furthermore, some studies categorise central/peripheral details in terms of *emotional significance* (e.g., Peace & Constantin, 2016; Porter et al., 2003; Van Damme & Smets, 2014). For example, Christianson (1992) defined central as "information that is connected with the source of the emotional arousal" (p. 291). However, Luna and Albuquerque (2018) argued that such a definition can be interpreted as conceptually or spatially connected to the source of the arousal in the emotional event. Christianson also defined peripheral as "information that is irrelevant or spatially peripheral to the source of the emotional arousal" (p. 291). Here, peripheral information that is irrelevant or spatially away from the main event can be interpreted in conceptual or visuospatial terms, respectively. The use of different definitions could lead to the same details being considered central or peripheral. For example, consider the colour of a thief's shirt. Under a conceptual definition, this would be a peripheral detail because changing the colour of the shirt would not affect the nature of the event. However, under a visuospatial definition, the detail would be central because it is connected to the main person in the event. Overall, how researchers set out to determine what details are central and peripheral can influence the study outcomes concerning emotion and memory.

Although this thesis focuses on the valence and arousal dimensions of emotion, it is relevant to briefly consider the motivational or goal-relevance perspective on emotional memory, which will be referenced at certain points in the thesis. Levine and Edelstein (2009) conducted a comprehensive review of research on emotion and memory, suggesting that understanding the relationship between the two requires considering the specific motivations or goals associated with different emotions, rather than solely focusing on arousal and valence. The motivational, or goal-relevance, component of emotion may contribute to memory narrowing. This could explain the mixed findings regarding the impact of arousal and valence on emotional memory narrowing. Kaplan et al. (2012, 2016) support this perspective. According to appraisal theories (e.g., Ellsworth & Dougherty, 2016), emotions are influenced by situation-specific goals. Levine and Edelstein (2009) distinguish between pre-goal and post-goal emotions. Pregoal emotions (e.g., desire, hope, anger, fear, & disgust) signify the anticipation of goal attainment or failure. These emotions are associated with a strong motivation to approach or avoid certain stimuli, making them high in "motivational intensity" (Gable & Harmon-Jones, 2010a). For instance, anger motivates individuals to overcome obstacles hindering their goals, while fear prompts them to evade or escape potential threats to their goals (Cunningham & Brosch, 2012). In such emotional states, it is advantageous to focus on and remember information that is relevant to the current goal, even if it means withdrawing attention away from irrelevant details. On the other hand, post-goal emotions (e.g., happiness & sadness) have less motivational intensity because they indicate that the goals have already been achieved or failed. In these states, it is advantageous to pay attention to and remember a wide range of information, considering the implications of success or failure and shifting focus to new goals. Therefore, post-goal emotions enable the processing and storage of peripheral details. There is indeed empirical evidence for the effect of pregoal and postgoal emotions on attentional breadth and memory narrowing (e.g., Gable & Harmon-Jones, 2008, 2010b; Threadgill & Gable, 2018; Van Damme et al., 2017). Overall, different emotions, depending on whether they occur before or after goal attainment, can influence attentional breadth and memory processes. Thus, it can be important to consider the motivational component of emotion and the role of goals in understanding the relationship between emotion and memory.

Research has shown that emotions can narrow our attention and focus, resulting in a memory phenomenon called emotional memory narrowing. In this phenomenon, memory for central information related to an emotional event is better retained compared to peripheral/surrounding information. This effect has been observed not only in studies focusing on the weapon-related stimuli but also in research involving complex events. Moreover, there is evidence that memory narrowing may be specific to negatively (arousing) events by enhancing the processing of specific sensory details. However, this emotional memory narrowing can also contribute to the development of false memories, where our memories of emotional events become distorted or even entirely fabricated. In the next section, this phenomenon is explored in more detail by specifically considering research on the effect of misleading post-event information on memory for valenced events, with a focus on negatively valenced events.

1.6 Emotion and Misinformation

What impact does misleading information have on memory for negatively-valenced events? To date, there has been limited research studying the impact of content emotion using the misinformation paradigm. There is evidence that negative emotion increases vulnerability to misleading information. For example, Porter et al. (2003) was the first to examine the impact of emotion on suggestibility. In their study, participants were presented with positive, negative, and neutral photographs. The level of arousal was similar for positive and negative pictures but higher than the neutral ones. After viewing the pictures, participants were misled about central and peripheral aspects of the pictures, of which one detail was a major suggestion (i.e., a salient false peripheral detail that was not present in the picture but would be noticeable if it existed). On later cued-recall tests, it was found that the endorsement of misleading information did not significantly change across the pictures, though there was a trend such that misinformation led to a lower accuracy for details about the negative pictures. However, for *major* details specifically, negative images were associated with greater susceptibility to major misinformation compared to positive and neutral pictures (see also Peace & Constantin, 2016). In a follow-up study, Porter et al. (2010) varied the retention interval of the cued-recall tests. Participants were tested immediately after misinformation exposure and again one week or one month later. No neutral pictures were included in this study. They found that the increased endorsement of major misinformation in negative pictures relative to positive pictures persisted over time. Although the two studies above found an effect of valence only for major misinformation, some studies not examining major misinformation have shown that negative valence leads to greater misinformation effects in general (e.g., Monds et al., 2017; Porter et al., 2008; Zhang et al., 2021).

The finding that negative valence increases the endorsement of misleading information was explained in evolutionary terms. Porter and colleagues (2008) proposed that negative or "dangerous" events would be recalled better but also be more open to false suggestions (i.e., paradoxical negative emotion hypothesis). That is, it would be adaptive to incorporate relevant information concerning the negative event from others deemed trustworthy (e.g. parents, or researchers) to further prepare for a related threatening event in the future. As a result, false information about a negative event is also incorporated into memory and remembered. Also, it would be adaptive to incorporate *major* details since major details indicate a significant change in one's recollection, thus constituting valuable information that may serve a greater benefit in the future. (Porter et al., 2008; 2010). On a more theoretical position, the finding that susceptibility to major (peripheral) misinformation was greater for emotionally negative events also align with Easterbrook's (1959) attention narrowing hypothesis by showing that the central information associated with the emotionally arousing event may have captured attention away from the peripheral information.

However, there is also evidence showing the positive impact of negative emotion on susceptibility to misleading information. For example, Schmidt et al. (2013) asked participants to watch eight movie clips, whereby four of the clips depicted neutral events (e.g., shopping) four depicted highly negative events (e.g., a fight). The next day, participants filled out a questionnaire about the clips and some of the questions contained misleading information. Finally, on the third day, participants completed a four-alternative forced-choice memory test about each clip. They found that the misinformation effect was reduced for the negative clips compared to the neutral clips. It was explained that arousal activates the amygdala and hippocampus regions which enhances encoding and strengthens memory traces (McGaugh, 2000), leaving one less vulnerable to misleading information. The effect of arousal may be a consolidatory one considering that memory testing took place two days after watching the video clips.

The research presented thus far has not specifically examined the effects of both valence and arousal on suggestibility. This was first investigated by Van Damme and Smets (2014; see also Jobson et al., 2022). They presented participants with high- and low-arousing positive and negative pictures and average- to low-arousing neutral pictures. Half of the participants were later exposed to misleading information about central and peripheral details in the pictures.

Recognition memory was finally measured for details in the scenes. They found that, for the peripheral details, correct recognition was lower for negative pictures compared to positive and neutral pictures. For false recognition, the misleading peripheral details were endorsed more for the negative compared to the positive pictures, and for the neutral average-arousing compared to the neutral low-arousing pictures, regardless of prior misinformation exposure. From this, the authors concluded that *negative valence* narrowed attention. As for central details, accuracy was better for high arousal pictures compared to the low arousal pictures. Further, control participants were less likely to endorse false central details associated with the negative pictures and the high-arousing positive picture. However, when misleading information was suggested, the misled participants were more susceptible to the misinformation about these pictures.

Van Damme and Smets suggested a few reasons for memory narrowing observed in both high and low-arousing negative pictures. The main parts of the negative scenes may act as attention magnets (Laney et al., 2003). The central information in the negative pictures can be considered salient and relatively distinct from the rest of the visual scene. This may have captured attention and benefited from enhanced encoding and increased processing. Alternatively, memory narrowing may have been due to an activation of goals associated with the negative emotion, where the narrowing effect occurs towards details that are goal-relevant (i.e., the goal-relevance approach; Levine & Edelstein, 2009). For both the negative pictures, Van Damme and Smets suggested that the events depicted in the pictures are associated with survival and health. Such goals may be activated when empathising with the characters and events in the pictures (Levine & Edelstein, 2009), and only the central details would be relevant to these goals. Furthermore, considering that the positive effect of negative valence and high arousal on memory for central details disappeared for those participants exposed to misleading suggestions, Van Damme and Smets simply explained that the benefits of negative valence and high arousal on central memory was observed in control participants, but this protective influence was overruled when false suggestions were introduced.

Overall, research has shown that negative events are susceptible to misleading information. Though, as can be seen, how negative events are impaired by misinformation varies. For example, misinformation may only impair memory for major peripheral information in negative-arousing events or impair central detail memory in negative events regardless of the level of arousal. Nevertheless, the research area on event emotion and misinformation remains in its early stages. There is still little evidence on how particular factors interact with emotion and misinformation that would be relevant for the forensic field, specifically attention, retention interval, and post-warning. The next section sets out the aims of the thesis and the experiments that will address some gaps in this research area.

1.7 Summary and Thesis Outline

What impact does post-event misleading information have on memory for emotionally negative events? This is the overarching question of this thesis. Although research has been conducted to understand the relationship between misinformation and negative emotion, there are many questions still yet to be answered. Therefore, this thesis consists of six empirical studies that aim to further advance our understanding of the impact of misleading information on memory for emotionally negative events. Across the six experiments, the role of three factors will be examined – attention, post-warning, and retention interval - which have previously been shown to influence memory accuracy and the endorsement of misleading information. This research is necessary because it will add to the growing body of work on emotion and misinformation to help further our theoretical understanding of whether and how misinformation influences memory for emotionally negative events differently from emotionally neutral events through manipulations of the three factors. The research will also have applied implications, particularly in legal/forensic settings where eyewitness testimony is an important part of criminal investigations and may sometimes be the only evidence available. The research will help us to understand the situations the legal system needs to be aware of that may increase the effect of misinformation but what procedures could be taken to mitigate misinformation's influence on memory.

This thesis will begin with a pilot study (Chapter Two) conducted to select three categories of visual scenes for use in the main experiments: negative high-arousal, negative low-arousal, and neutral scenes. Next, Chapter Three will examine the role of attention on suggestibility. Using dual-task paradigms, research has shown that memory accuracy declines (e.g., Baddeley et al., 1984; Craik et al., 1996) and susceptibility to misleading information increases (Lane, 2006) when one's attentional resources are reduced during the encoding of to-be-remembered stimuli. However, no research has yet investigated the interaction between limited attention at encoding and misinformation exposure on memory for negative-arousing and neutral events. To rationalise this investigation, two lines of research are of relevance. First, and as previously mentioned, behavioural (e.g., Kang et al., 2014; Kern et al., 2005) and neuroimaging (e.g., Kensinger & Corkin, 2004) research have shown that enhanced memory for negative-arousing information may be less dependent on attentional resources (i.e., benefit from automatic processing) whereas negative low-arousing and neutral information may require controlled encoding processes. Second, and as discussed earlier, negative events have been found to be associated with memory narrowing. Both lines of research have not yet been combined to study misinformation suggestibility, therefore the three experiments in the chapter will explore this. In all experiments, participants were shown negative high-arousing, negative low-arousing, and neutral pictures. Thereafter, a questionnaire was given containing misleading information about central and peripheral aspects of the scenes. Finally, memory performance was assessed using a recognition test. To examine the role of attention, two approaches from previous research was used: participants' attention was divided between the pictures and a secondary task (Experiment 1), and the presentation duration of the pictures was varied (Experiments 2 & 3). In Experiment 1, eye movements were also collected to examine "online" encoding processes that may contribute to the endorsement of misleading information.

Chapter Four will examine whether the damaging effect of misleading information on memory for negatively arousing events can be reduced. This is an important investigation considering that misinformation has been shown to impair memory for negative events (e.g., Porter et al., 2003; Van Damme & Smets, 2014; Experiment 3 in this thesis). To do so, post-warnings were administered. As mentioned earlier, research has shown that warning participants about prior exposure to misinformation can be successful at reducing the impact of misleading information (see Blank & Launay, 2014). Different types of post-warnings have been given to participants. In the chapter, empirical research and theoretical explanations for three types of post-warnings will be presented which are of particular interest. These are *general* warnings that simply state the (possible) exposure to misinformation, *enlightenment* warnings that additionally provide a reason for the misinformation manipulation, and *item-specific* warnings that explicitly indicate which test questions contain misleading information. Although these warnings have been found to reduce the effect of misinformation, enlightenment and item-specific warnings have been shown to be more effective (see Blank & Launay, 2014; Higham et al., 2017). Moreover, the chapter will present the limited research that studied memory for misleading central and peripheral details using only general warnings, which have revealed mixed findings (Leding & Antonio, 2019; Wyler & Oswald, 2016). To date, no study has investigated the effect of different post-warnings on susceptibility to misinformation for details in negative-arousing events, and whether the outcome would be different from neutral events. This is what Experiments 4 and 5 in the chapter explored. Participants were presented with a negatively arousing scene and a neutral scene, followed by exposure to misleading information via a post-event questionnaire. Before a forced-choice recognition test and a source monitoring test, participants received one of three types of post-warnings: a general warning (Expt. 4 & 5), an enlightenment warning (Expt. 4 & 5), or an item-specific warning (Expt. 5).

In the final empirical chapter (Chapter Five), the role of retention interval will be explored. The chapter will present research showing that memory for emotional (negative) information is stable or improves over time. To explain this, neurobiological mechanisms will be outlined which highlight the role of the amygdala and stress hormones in memory consolidation of arousing information. Furthermore, empirical research about the effect of misinformation on memory over time will be presented. In particular, the Porter and colleagues (2010) study mentioned above will be discussed, which found that negative events were more susceptible to major misinformation, an effect that persisted over time. To date, we have yet to understand the impact of delayed retrieval on susceptibility to misinformation for negative events (high and low arousing), with a neutral event for comparison, and central and peripheral aspects of these events. This is of interest considering that negative events have been shown to be vulnerable to misinformation for central and peripheral details (e.g., Van Damme & Smets, 2014), and that memory consolidation associated with the amygdala activity is found specifically for arousing (negative) information (e.g., Dolcos et al., 2005; Fastenrath et al., 2014). Therefore, in Experiment 6, participants were shown negative high-arousing, negative low-arousing, and neutral scenes, followed by exposure to misinformation. Recognition memory for central and peripheral scene details was measured 10 minutes after misinformation exposure and one week later.

Each chapter will comprehensively examine the findings in light of previous research and relevant misinformation theories. Moreover, the practical implications of the main findings within legal settings will be briefly highlighted. Chapter Six serves as the concluding chapter of this thesis, wherein the theoretical and practical implications of the research will be carefully considered. Furthermore, the chapter will address the limitations of the research and provide suggestions for future research.

Chapter Two: Picture Pilot

2.1 Introduction

A pilot study was undertaken to identify appropriate picture scenes to serve as stimuli for the experiments conducted in this thesis. Given the specific purpose on the forensic implications of false recollection, the focus is on negative emotional stimuli. Accordingly, three distinct categories of pictures were piloted: negative and high-arousing, negative and low-arousing, and neutral and low-arousing. The selection of these categories aligns with the research objectives of examining the influence of negative emotion on (false) memory performance. To choose the final stimuli, several measures were collected. First, valence and arousal ratings were obtained. Although these ratings are available in normed databases, the ratings were collected for two main reasons: (1) to see whether the pictures based on average ratings from new participants are appropriately categorised as negative or neutral valence and high or low arousal, and (2) to standardise the ratings because some databases used different rating scales. Second, central and peripheral areas in each scene were defined using a line-drawing approach similar to previous studies (e.g., Porter et al., 2003; Van Damme & Smets, 2014). The details were selected from these areas to examine false recognition of central and peripheral misleading information in subsequent experiments. Third, visual complexity ratings were collected. It is acknowledged that selecting pictures that are comparable on all important dimensions can be difficult (Van Damme & Smets, 2014). However, an attempt was made to control for visual complexity in terms of the amount of detail in the pictures since it may affect, for example, the distribution of attentional resources and memory performance. Indeed, a study by Murphy and Greene (2016) found that when the event contained a high level of information, participants were more susceptible to misleading information and were less accurate in their memory for peripheral details. The pilot study aimed to ensure the inclusion of at least two pictures within each category. This criterion was essential since the first experiment in this thesis required two pictures per category.

2.2 Method

2.2.1 Participants

Thirty participants (12 males and 18 females) aged 18 - 50 (*M* = 28.97, *SD* = 9.31) completed the study in return for either course credits or a small fee. Participants had normal or corrected vision and English as their first language. Participants were recruited via City's SONA system. All participants gave written informed consent and were fully debriefed at the end of the experiment. The City, University of London's Psychology Research Ethics Committee approved the study.

2.2.2 Materials

Pictures. Twenty-four pictures were chosen to include in the pilot. Several databases containing normed pictures were screened: International Affective Picture System (IAPS; Lang et al., 2008), Emotional Picture System (EmoPicS; Wessa et al., 2010), Open Affective Standardised Image Set (OASIS; Kurdi, Lozano, & Banaji, 2017), The Geneva Affective Picture Database (GAPED; Dan-Glauser & Scherer, 2011), The Nencki Affective Picture System (NAPS; Marchewka et al., 2014), The Disgust-Related Images (DIRTI; Haberkamp et al., 2017), and EmoMadrid Affective Picture Database (EmoMadrid; Carretié et al., 2019). These databases consist of standardised pictures depicting a wide range of emotional and semantic content, with available valence and arousal normed ratings on a 9-point scale (IAPS, EmoPicS, NAPS, & DIRTI), 7-point scale (OASIS), a scale from -2 to +2 (EmoMadrid), and a 0-100 scale (GAPED). Since the piloted pictures did not come from GAPED and NAPS databases, these databases will not be mentioned further. The 24 selected pictures formed three categories: nine pictures were negative valenced and high arousing, seven were negative valenced and low arousing, and eight were neutral valenced and low arousing. All pictures were chosen by the experimenter (DS) and reviewed with the supervisor (LK). A final collective decision was made on its inclusion or exclusion. See Table 1 for a list of the selected pictures.

Table 1. *The 24 pictures were selected for the pilot, with their corresponding database and reference number, a brief description, and normed valence and arousal ratings.*

Database	Reference Number	Description	Valence	Arousal
Negative High-Arousal				
EmoPicS	246	Hospital	2.90	5.65
EmoPicS	252	Dying man	2.21	6.12
IAPS	9433	Dead man	1.84	5.89
IAPS	9254	Injured people	2.03	6.04
IAPS	9163	Soldiers	2.10	6.53
IAPS	9050	Plane crash	2.43	6.36
IAPS	2691	Riot	3.04	5.85
OASIS	Car Crash 3	Car crash	2.03	4.66
EmoMadrid	EM0488	Fight	-1.81	1.76
Negative Low-Arousal				
IAPS	2490	Man with a saucepan	3.32	3.95
IAPS	9415	Handicapped	2.82	4.91
IAPS	2590	Elderly woman	3.26	3.93
IAPS	9220	Couple in a cemetery	2.06	4.00
IAPS	4621	Harassment	3.19	4.92
IAPS	9002	Memorial	3.39	4.55
DIRTI	1254	Rubbish on the streets	3.45	3.02
Neutral Low-Arousal				
EmoPicS	124	People in an office	4.86	3.04
EmoPicS	138	Supermarket	4.91	2.68
EmoPicS	157	Dog Walking	5.29	3.54
EmoPicS	161	Pedestrians	4.70	2.72
EmoPicS	163	Elderly couple	5.89	3.29
EmoPicS	191	Gas station	4.89	2.93
IAPS	2579	Bakers	5.53	3.85
IAPS	2593	Men at a restaurant	5.80	3.42

Note. The valence and arousal normed ratings cannot be fully comparable across each picture because the databases used different scale ranges: IAPS, EmoPicS, and DIRTI used a 9-point scale, OASIS used a 7-point scale, and EmoMadrid used a -2 to +2 scale. Table 2 provides the specific valence and arousal ranges for each scale.

The following selection criteria were used when screening the databases for the pictures:

1. Scale categories were set up for valence and arousal (see Table 2), which was used as a rule for choosing the pictures from the databases. However, some flexibility was exercised such that pictures that were also close to the restrictions set were considered (as can be seen in Table 1)[1]. The categories for the 9-point scale were taken from Kensinger and Corkin (2004), but the negative valence category was modified by extending the range to 3.5 since it would have been likely that only a limited number of suitable negative *low arousing* pictures would have a normed valence of less than 3. Nevertheless, previous research has used negative pictures in a 'negative' category with a valence greater than 3 (e.g., Gavazzeni et al., 2012; Porter et al., 2010; Yegiyan & Yonelinas, 2011). These categories were then approximately applied to the remaining scales of different ranges to form their categories.

Table 2. *A summary of the valence (negative/neutral) and arousal (high/low) ranges for the different rating scales.*

Rating Scale	**Valence**	**Arousal**
9-point scale	Negative: 1 – 3.5 Neutral: 4.5 - 6	Low arousal: 1 - 5 High arousal: 6 - 9
7-point scale	Negative: 1 – 2.5 Neutral: 3.5 - 5	Low arousal: 1 - 4 High arousal: 5 - 7
-2/+2 scale	Negative: -2 to -1 Neutral: -0.5 to 0.5	Low arousal: -2 to -0.5 High arousal: 0.5 - 2

[1] The pilot included EmoPicS 246, even though the normed arousal was 5.65, which can be considered quite low. However, it was unclear whether the pilot participants would rate the hospital scene as high arousing. Therefore, the picture was included to check this.

2. The pictures had to be in colour
3. The pictures had to contain people and have a visual background.
4. Taboo pictures (e.g., nudity or mutilations) and pictures that are likely to cause high emotional distress were not included, following Van Damme and Smets (2014).
5. The main event in the scene had to be clear, with enough useable details in the picture.
6. Any normed neutral pictures that were perceived as contextually/thematically quite positive or negative were not included.

Picture Ratings. To rate the valence and arousal of each picture, the Self-Assessment Manikin (SAM; Bradley & Lang, 1994) was used. SAM is a non-verbal pictorial assessment method employing a 9-point Likert scale to directly evaluate an individual's emotional state. For the valence scale, low scores represent a negative mood, and high scores represent a positive mood. For the arousal scale, the higher the score, the greater the level of arousal.

2.2.3 Defining Central and Peripheral Information.

Christianson (1992) distinguished between "information that is connected with the source of the emotional arousal (i.e., the gist of the event and its central details) and information that is irrelevant or spatially peripheral to the source of the emotional arousal" (pp. 291). In the current pilot, central information was defined "as the main information that is directly connected to the event, or gist of the event, depicted in the scene". The phrase "source of the emotional arousal" was replaced with a neutral phrase (i.e., "to the event"). Although previous studies have asked participants to indicate the "source of the emotion" in the pictures (e.g., Porter et al., 2003; Van Damme & Smets, 2014), the use of "emotion" in the definition may lead to confusion and/or inaccurate data if some of the pictures (particularly neutral pictures) are not judged to be clearly emotional. Nevertheless, previous research has also defined central information as being part of the event. For example, Luna and Martin-Luengo (2018) used

Christianson's (1992) and Burke et al.'s (1992) definitions and considered central information as "any feature perceptually or conceptually related with the main actions and characters of the event" (pp. 7).

Van Damme and Smets (2014) and Porter et al. (2003) considered the emotional part of the scene to be of greater importance. They defined central information as "the source of the emotion and all details in the immediate surrounding of this source" (Van Damme & Smets, 2014, pp. 4). It is most likely that the emotional arousal would be connected to the event (i.e., the actions, characters, and objects of the event). However, since the research in this thesis concerns emotion, it is of interest to see whether the information judged to be central in the main pilot is also considered to be the source of the emotion. Therefore, a new set of participants were tested[2] who judged central information only on the negative pictures. Central information was defined as "information that is connected with the source of the emotion". These participants did not complete any other tasks from the main pilot.

2.2.4 Procedure

Participants were presented with an information sheet and consent form and were reminded of their ethical rights. After providing informed consent, participants filled in a demographic questionnaire and were then instructed on the rating procedure for the pictures. The instructions for both the valence and arousal SAM scales were a modification of those from Lang et al. (2008). Participants were told that they will use the mouse to provide their judgements on the rating scales after each picture. Once participants had understood how to complete the scales, they were presented with the pictures in three blocks (negative-high, negative-low, and neutral) with each block counterbalanced across participants. The pictures in each block were presented in random order. Each picture remained on-screen for 10 seconds, preceded by a fixation cross lasting three seconds so that all participants looked at each picture

[2] Twenty-three participants (8 males and 15 females) aged 18 – 49 ($M = 26.13$, $SD = 6.48$) were tested.

from approximately the same position. Immediately after each picture, participants provided the valence and arousal ratings using the mouse to click on the number on the SAM scale.

Once all pictures were presented from all blocks, participants were provided with a booklet containing all 24 pictures in colour. A PowerPoint presentation with all the pictures in the same order as in the booklet was provided so that the participants could view the pictures in larger sizes should they need to. Participants were informed that, for each picture, they need to indicate the complexity of the pictures and identify the central information. Participants were provided with the following definition for complexity: “Complexity is defined as the amount of detail in the scene. A scene that is of low complexity will have very little detail with a lot of space, whereas a highly complex scene will be filled with a large number of details. Consider all kinds of details (e.g., people, objects, colours, patterns) when judging the complexity of the image. To judge the complexity of the scene, **choose a number from 1 (indicating low complexity) to 9 (indicating high complexity)** and write this number above the picture in the booklet”

After explaining the complexity definition, participants were provided with the definition for the central information (see above). Following Porter et al. (2003) and Van Damme and Smets (2014), participants were asked to draw lines clearly and precisely around the central information on each picture (i.e., area(s) on the pictures that contained the central information). The experimenter ran through two example pictures (EmoPicS: 195; OASIS: Exercise 2). The experimenter indicated and explained what they judged to be the central information in these two pictures. Importantly, participants were told that what they consider to be central information in these example pictures may be different to the experimenter’s judgement. The purpose of this was to simply demonstrate the application of the central definition and how the central information needs to be clearly indicated in the pictures.

Once participants completed these tasks for each picture, they were shown a short clip from a wildlife documentary due to the negative pictures included in the study to ensure that they leave the study in a neutral/positive mood state. A full debrief about the purpose of the pilot study was provided at the end of the experiment.

2.3 Results

Two participants were removed from all analyses for failing to follow the instructions appropriately. Further participants were removed for specific measures which will be highlighted in a footnote where relevant.

2.3.1 Valence and Arousal Ratings

The valence and arousal ratings provided by the participants were considered first, to determine which pictures produced the relevant emotional effects. Table 3 presents the average ratings made by the participants for each of the pictures[3]. Averages for the valence and arousal ratings were calculated and pictures were removed if the means did not fall within, or close to, the scale categories (see the Method section). 'Close' averages were defined as those that are no more than .20 outside of the scale category ranges. As can be seen from Table 1, the valence and/or arousal averages were not within, or close to, the scale category ranges for eight of the pictures: five negative high-arousing, two negative low-arousing, and one neutral. These pictures were removed from further consideration.

[3] Two participants were removed due to failure to appropriately use the valence and/or arousal rating scale.

Table 3. *The 24 pictures with their corresponding database and reference number, a brief description, and average valence and arousal ratings from the pilot.*

Database	Reference Number	Description	Valence	Arousal
Negative High-Arousal				
EmoPicS	246	Hospital	2.15	**5.00**
EmoPicS	252	Dying man	2.23	**5.04**
IAPS	9433	Dead man	1.62	6.88
IAPS	9254	Injured people	1.92	6.77
IAPS	9163	Soldiers	2.27	6.12
IAPS	9050	Plane crash	2.54	**5.73**
IAPS	2691	Riot	**3.81**	**5.08**
OASIS	Car Crash 3	Car crash	3.65	**4.96**
EmoMadrid	EM0488	Fight	2.50	5.88
Negative Low-Arousal				
IAPS	2490	Man with a saucepan	**4.19**	3.19
IAPS	9415	Handicapped	2.81	5.12
IAPS	2590	Elderly woman	**4.31**	3.62
IAPS	9220	Couple in a cemetery	2.81	3.92
IAPS	4621	Harassment	2.96	5.00
IAPS	9002	Flower memorial	3.46	3.77
DIRTI	1254	Rubbish on the streets	3.35	4.12
Neutral Low-Arousal				
EmoPicS	124	People in an office	4.69	2.31
EmoPicS	138	Supermarket	4.92	2.19
EmoPicS	157	Dog Walking	5.85	3.81
EmoPicS	161	Pedestrians	5.00	2.62
EmoPicS	163	Elderly couple	**6.62**	4.12
EmoPicS	191	Gas station	4.96	2.31
IAPS	2579	Bakers	5.77	3.19
IAPS	2593	Men at a restaurant	5.77	3.46

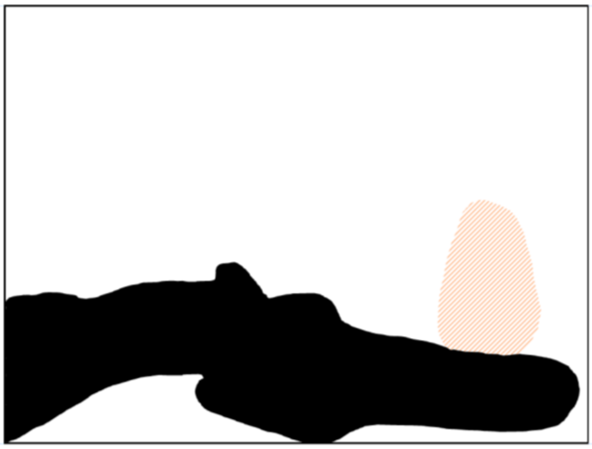
Note. The shaded reference numbers indicate that these pictures were removed from further consideration, and the bold valence and arousal values indicate that they did not fall within, or close to, the scale category ranges.

2.3.2 Central and Peripheral Information

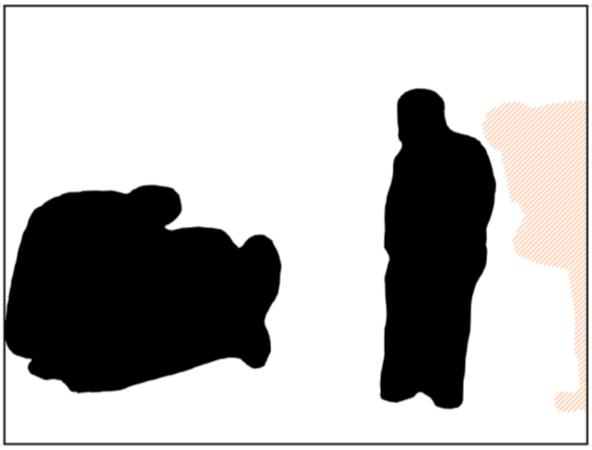
Next, the central information data was inspected. To classify details in the pictures as central or peripheral, count values were assigned to the details[4]. A count value represented the number of participants that indicated a detail to be central. For example, if 20 participants drew lines around a particular piece of information in a picture (such as a person or an object), a value of 20 would then be assigned to that information. Once this was completed, a 70% threshold rule was applied. That is, details were considered central if at least 70% of the participants drew lines around the detail. Similarly, details were considered peripheral if at least 70% of the participants did not draw lines around the detail. Any details that did not meet this threshold were not considered for use in the main experiments. See Figure 1 for the final classification of the central and peripheral information for the 16 remaining pictures. As can be seen, the central information primarily represented the main event (i.e., the main characters, objects, and gist of the event). Due to the complexity of the central information data obtained from the participants for the 2579 picture (also, 9050 & 2691 that were already removed), it was not possible to provide a visual representation of what was central or peripheral, and so is not included in Figure 1 and was immediately removed from further consideration. When looking at the amount of central and peripheral information available for extraction for possible use in the experiments, five pictures were removed as they were deemed to not contain a sufficient level of central details and/or peripheral details (9163, EMO488, 9415, 1254, & 138). This left 10 pictures: two negative-high arousing, three negative low-arousing, and five neutral.

[4] Two participants were removed due to failure to appropriately complete the central information task.

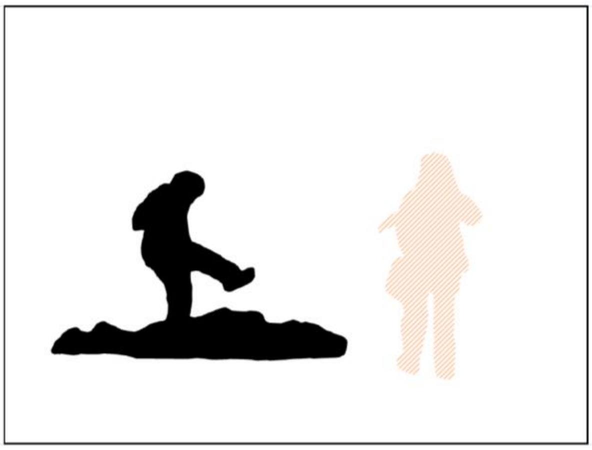
NH: Dead man



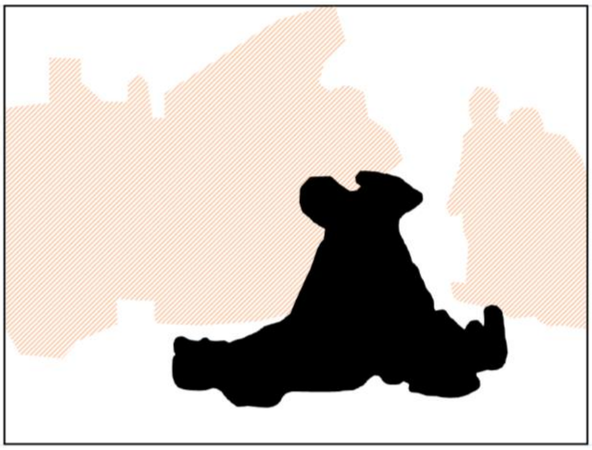
NH: Injured people



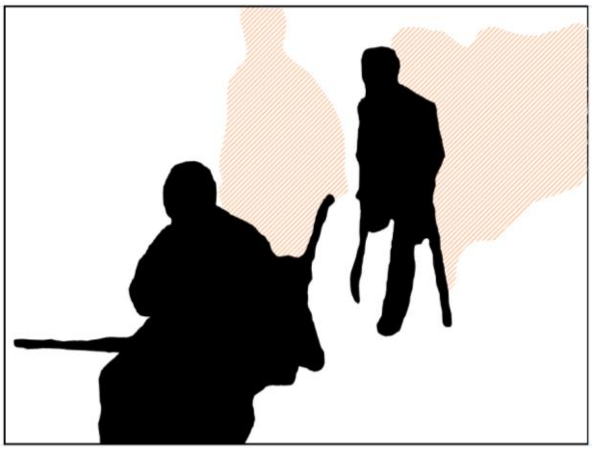
NH: Soldiers



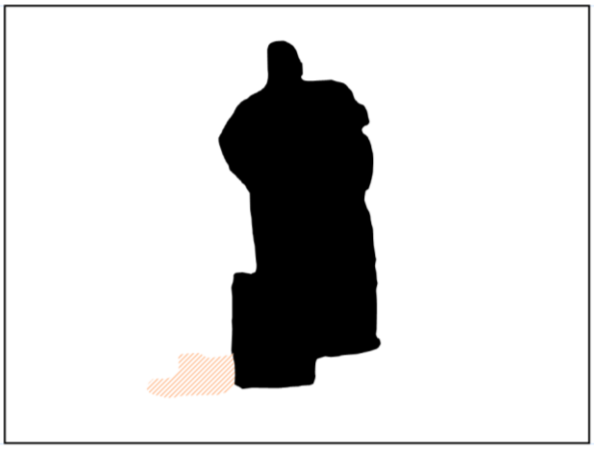
NH: Fight



NL: Handicapped

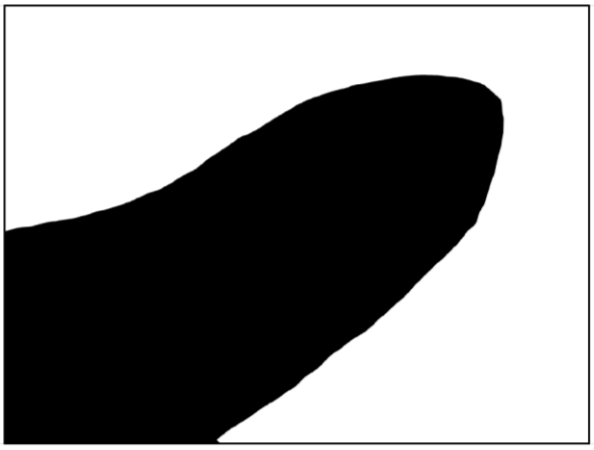


NL: Couple in a cemetery

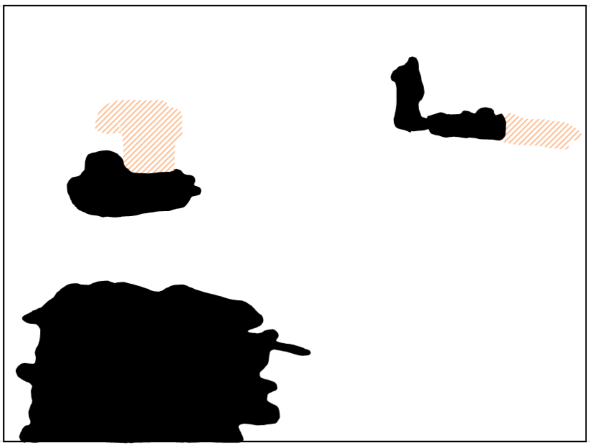


NL: Harassment

NL: Memorial

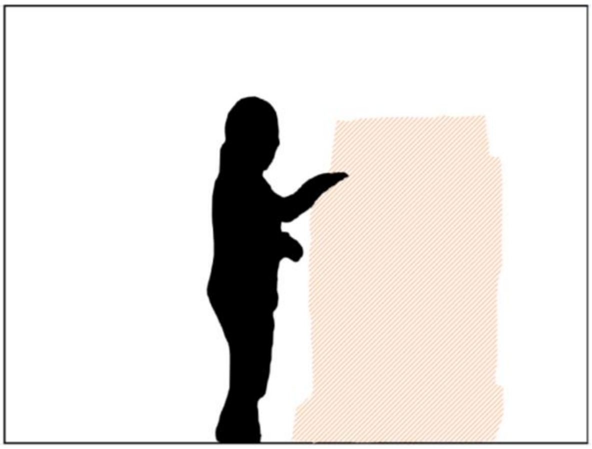


NL: Rubbish on the streets

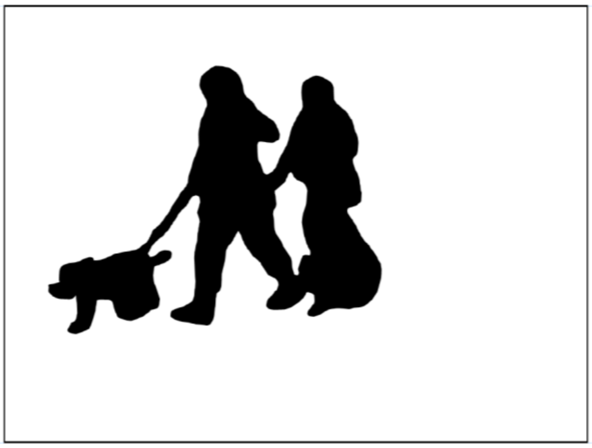


N: People in an office

N: Supermarket



N: Dog walking



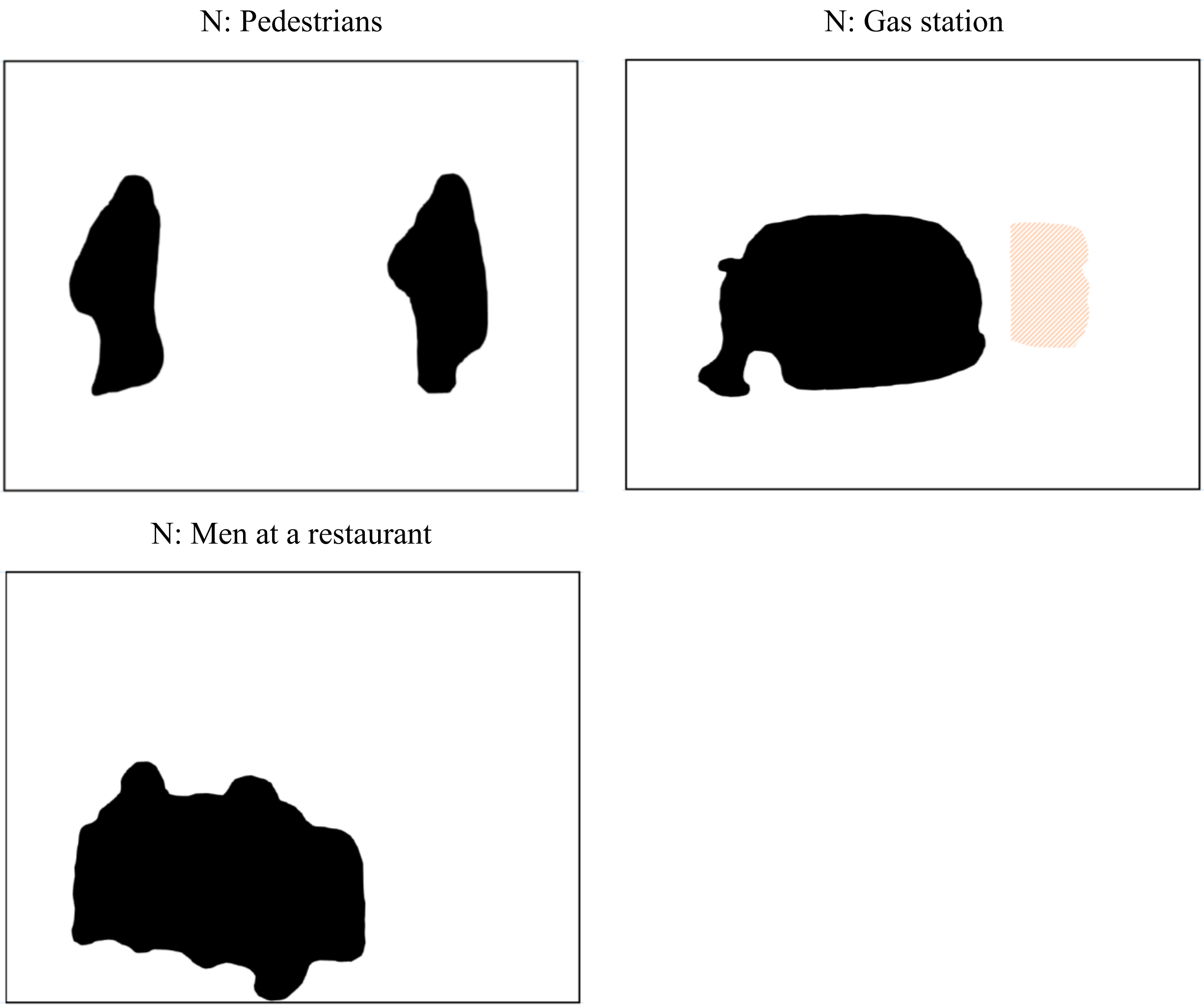


Figure 1. An approximate visual representation of the central and peripheral information in each picture. Black = central information, white = peripheral information, and patterned area = information having not met the 70% threshold.

As mentioned previously, a separate set of participants were asked to judge the central information in the negative pictures in terms of the source of the emotion. See Appendix A for a visual representation of central and peripheral information in the five negative pictures. As can be seen, there were mostly minor differences between the two definitions in some pictures for what information was judged to be central. This can be expected since how central information is defined can affect what information is judged to be central. However, the negative low-arousing picture 4621 [harassment scene] showed a significant difference in central areas between the two definitions. Therefore, 4621 was removed from further consideration, leaving nine pictures to choose from for my experiments.

2.3.3 Complexity Ratings

As mentioned in the introduction, the aim was to have at least two pictures in each picture category. Since only two pictures remained in each of the negative conditions, it was not possible to further remove pictures based on the complexity ratings. Nevertheless, as can be seen from Table 4, the complexity ratings for the negative high-arousing pictures were generally higher than those from the negative low-arousing and neutral pictures, making it difficult to control for complexity. This is interesting as it may suggest that arousal might be playing a role in complexity ratings provided by the participants, despite the definition only focusing on the level of visual information in the pictures. Indeed, Madan et al. (2018) found that visual complexity was related to affect, such that arousal, in particular, was related to higher visual complexity ratings. This possible issue will be addressed in Experiment 1.

Table 4. *Mean complexity ratings for the 24 pictures*

Negative/High	**M**	**Negative/Low**	**M**	**Neutral**	**M**
EmoPicS 246	4.68	IAPS 2490	2.82	EmoPicS 124	3.46
EmoPicS 252	5.07	IAPS 9415	5.25	EmoPicS 138	4.21
IAPS 9433	5.75	IAPS 2590	4.14	EmoPicS 157	3.71
IAPS 9254	6.93	IAPS 9220	2.96	EmoPicS 161	3.07
IAPS 9163	5.46	IAPS 4621	3.89	EmoPicS 163	3.18
IAPS 9050	7.71	IAPS 9002	4.39	EmoPicS 191	3.82
IAPS 2691	6.25	DIRTI 1254	4.36	IAPS 2579	4.79
OASIS Car Crash 3	5.07			IAPS 2593	3.96
EmoMadrid EM0488	5.39				

2.4 Summary

After consideration of all the data, there were nine useable picture scenes: two that were negative and high-arousing, two that were negative and low-arousing, and five that were neutral. The central details will be those that fall within the central area(s) and peripheral details will be those that fall outside of the central area(s). Memory will be tested on a range of details, such as articles of clothing, colours, patterns, and the number of people/objects. These kinds of details have been targeted in several studies examining central and peripheral memory in events (e.g., Christianson & Loftus, 1991; Luna & Martin-Luengo, 2018; Luna & Migueles, 2009; Van Damme & Smets, 2014). All post-event and test questions using such details in the subsequent experiments were created by the candidate (DS) and checked by the supervisor (LK). Finally, although picture complexity (i.e., level of detail) could not be controlled across the three stimulus categories, Experiment 1 will address the possible issue that arousal may be playing a role in the complexity ratings.

Chapter Three: The Role of Attention and Misinformation Exposure on Memory for Negative Events

3.1 Introduction

Understanding the role of attention on memory performance is of interest to memory researchers. It offers valuable insights into how individuals process and retrieve information in real-world situations, particularly when attention is compromised. For example, Lane (2006) suggested that, when individuals witness an event, their attention may be directed toward details beyond those that are relevant to a criminal investigation, such as one's thoughts and feelings at the time of the event or towards searching for an escape route. Such research suggests that the encoding ability is contingent upon the extent of our attention. Consequently, an absence of full attention to the event could impact eyewitness accounts of the event in terms of the level of detail and the veracity of the account. This poses a significant scientific question within the forensic field, urging us to examine the impact of limited attention on eyewitness memory.

One method that researchers have used to study the role of attention is the dual-task paradigm. This involves simultaneously dividing participants' attention between the experimental stimuli (e.g., words, pictures) and a demanding secondary task. Using this paradigm, research has shown that divided attention reduces accurate memory performance for various stimuli (e.g., word lists, actions, pictures) compared to full/undivided attention (e.g., Baddeley et al., 1984; Craik et al., 1996; Naveh-Benjamin et al., 2000). This has been demonstrated using tests of free recall and recognition (Craik et al., 1996). In addition to having a detrimental effect on item memory, divided attention also lowers memory performance for contextual information (e.g., word presentation order; Troyer & Craik, 2000). It is argued that divided attention disrupts encoding processes by reducing the attentional resources available to process the experimental stimuli (Lane, 2006). For example, divided attention may interfere with the depth to which one can process information and the degree to which one can elaborate on the information (Lane, 2006). Hence, when encoding information under reduced attention conditions, it is likely to be associated with an inadequate representation in memory, lacking in specific details that can be recollected, thereby making accurate retrieval difficult (Lane, 2006).

So limited attention at the encoding stage impairs memory performance, but what impact does it have on the production of false memories? Previous research has examined the role of attention during encoding on subsequent false memory formation using a different false memory paradigm - the DRM paradigm (e.g. Dewhurst et al., 2005; Dewhurst et al., 2007; Knott & Dewhurst, 2007a). Such research has shown that false remembering of critical lures decreased under divided attention conditions, explaining that a concurrent secondary task prevents the activation of critical lures due to a disruption to spreading activation processes within one's semantic network. Although a few studies have examined the effect of divided attention at the post-event and retrieval stages of the misinformation paradigm (e.g., Umanath et al., 2019; Zaragoza & Lane, 1998), very little research has been conducted to investigate the link between attention at encoding and suggestibility to misinformation. Lane (2006) presented participants with a slide event depicting a theft. Half of the participants watched the slides while performing a music recognition task to divide attention. Here, participants were required to listen to short clips of popular music throughout the slide presentation, after which they were asked to complete a recognition test identifying the songs that had been heard being played on the tape. After the event and music task, participants were given a post-event questionnaire containing misleading information about details that supplemented the slide sequence. Finally, participants completed a source test, where they had to indicate whether they saw the test item in the slides, questionnaire, both sources, and neither source. They found that divided attention at encoding reduced memory for the event details and increased participants' endorsement of the misleading details as having appeared in the event. Lane argued that divided attention reduced the ability to process the source information for the event details. According to the source monitoring theory (Johnson et al., 1993), this would lead to an increased overlap between the characteristics that help distinguish between memories of event details and misleading details. This, consequently, increases source misattribution errors.

Rivardo et al. (2011) supported Lane's (2006) findings with a study that integrated Inattentional Blindness and eyewitness memory. Inattentional blindness refers to the phenomenon where an individual is unable to perceive an unexpected event or stimulus that falls beyond their scope of attention (Rivardo et al., 2011). In their study, participants watched a shopping mall video clip where a bag was stolen. During the video, participants were asked to either engage in a particular task (e.g., counting the number of shoppers wearing or not wearing blue shirts) or simply watch the video. Participants later read a narrative about the theft that contained misinformation. Finally, they were asked questions about the theft, including questions related to the misinformation. They found that participants who were inattentionally blind were more vulnerable to misleading information. Even though Rivardo and colleagues did not employ a standard dual-task paradigm, they nonetheless showed that reduced levels of attention at encoding negatively affect memory accuracy and increase susceptibility to false suggestions.

Although there has been some research on the impact of reduced attention at encoding on the misinformation effect, we have yet to understand the impact this has on susceptibility to misinformation for *negatively arousing* events. This is relevant due to previous findings that have studied the interaction between attention and emotion-enhanced memory. For example, evidence from behavioural studies measuring eye movements has demonstrated that emotional information captures attention faster and for a longer duration compared to neutral stimuli (e.g., Calvo & Lang, 2004; Chipchase & Chapman, 2013; Christianson et al., 1991; Gülçay & Cangöz, 2016; Humphreys et al., 2010). Research has argued that our cognitive processes exhibit a bias towards selectively directing attention to emotional stimuli. This bias serves as an adaptive mechanism, allowing us to prioritize the allocation of attention and cognitive resources to potentially harmful or significant information crucial for survival (Ohman et al., 2001).

However, the link between attention and emotion-enhanced memory is more complicated from the simple assumption that memory for emotional information is better due to an increased allocation of attention. Research using eye-tracking technology has shown that the amount of attention dedicated to processing emotional information does not always predict subsequent memory (e.g., Christianson et al., 1991; Gülçay & Cangöz, 2016; Humphreys et al., 2010; Kim et al., 2013; Riggs et al., 2011; Wessel et al., 2000). For example, Humphreys et al. (2010; see also Gülçay & Cangöz, 2016) presented participants with pairs of pictures (emotional [positive or negative]-neutral, and neutral-neutral) whilst their eye movements were recorded. The emotional pictures were higher in arousal compared to neutral pictures. Participants were required to decide which picture from a pair they preferred. They found that attention was biased towards positively-valenced pictures, with negatively-valenced pictures receiving fewer fixations and less total fixation duration. However, when given a recognition test one week later, memory enhancement was found only for the negative pictures. Moreover, overt attention to emotional pictures did not predict later memory performance. In Christianson et al.'s (1991) third experiment, participants were presented with an emotionally negative or neutral event. They freely looked that the slides whilst having their eye movements recorded. They found that the number of fixations was greater for the central detail, but less for the peripheral details, in the emotional event compared to the non-emotional events. However, when comparing participants who devoted the same number of fixations on the central detail, memory for the central detail was better from the negative event than from the neutral event. Gülçay and Cangöz (2016) presented photographs of real-life scenes and found that, compared to negative and neutral scenes, participants focused more on the central and peripheral details of positive scenes, but only the details of negative scenes were better remembered. Furthermore, Kim et al. (2013) presented participants with negative arousing and neutral picture stories. They found evidence of emotional memory narrowing; however the eye tracking data did not support the explanation that emotional memory narrowing is mediated by attention (see Kaplan et al., 2012). Their hierarchical regression analysis indicated that memory for central details was less dependent on overt attention (viewing duration) compared to peripheral details. In addition, recognition for items overall from negative picture stories was also less dependent on overt attention than for items from neutral picture stories. Thus, the role of attention on later memory depended on detail type and stimulus emotion, but not their interaction. Kim and colleagues explained that such effects may be related to the involvement of differential neural processing. That is, studies have shown that the processing and enhanced memory of emotional information is specifically related to increased amygdala, hippocampus, and prefrontal activations (LaBar & Cabeza, 2006). Thus, qualitatively different processing systems may be associated with memory for negative information which relies less on attentional resources, whereas memory for neutral (and positive) information requires overt attention.

Indeed, one complementary explanation for the above findings may be that negative information, in particular negatively arousing information, is processed automatically while neutral (and positive) information is dependent on controlled processes. Further support for this explanation comes from behavioural studies using a dual-task paradigm (e.g., Clark-Foos & Marsh, 2008; Kang et al., 2014; Kensinger & Corkin, 2004; Kern et al., 2005; Rossi-Arnaud et al., 2018; Talmi et al., 2007a). Kensinger and Corkin (2004) conducted a behavioural study where they presented participants with neutral, negative non-arousing, and negative-arousing words. While encoding the words, participants either performed an easy or difficult auditory discrimination task (divided attention) or performed no auditory task (full attention). In the full attention condition, memory for negative words (both high and low arousing) was enhanced compared to neutral words. However, in the divided attention conditions, memory enhancement for the negative non-arousing words disappeared, whereas memory enhancement for the negative arousing words remained. Kang et al. (2014) included positive (arousing and non-arousing) words in their divided attention study. They found that the memory enhancement of the non-arousing positive and negative words over the neutral words, and positive-arousing words over the positive non-arousing words, disappeared in the divided attention conditions. However, the memory enhancement of the negative-arousing words in the full attention condition persisted even under divided attention conditions. The findings from both studies suggest that memory for negative-arousing stimuli benefits from relatively automatic processes, whereas memory for neutral and positive emotional stimuli is dependent on controlled and more elaborative encoding processes. Indeed, Talmi et al. (2007a) demonstrated that attention was found to mediate memory for positive-arousing pictures, but this was not the case for negative-arousing pictures, indicating that enhanced attention may not be an essential ingredient for an enhanced memory for negatively arousing information.

Neuroimaging studies have lent support to the behavioural findings that arousing (negative) information benefits from automatic processing (e.g., Kensinger & Corkin, 2004). The activation of the amygdala is implicated in enhancing consolidation by interacting other brain regions, such as the hippocampus, to ensure a strong and stable memory trace for the emotional information (McGaugh, 2002). For negatively valenced stimuli, the amygdala activation and connectivity with other brain regions has been found to be greater when the stimuli are high in arousal (e.g., Garavan et al., 2001; Mickley Steinmetz et al., 2010). In a neuroimaging study by Kensinger and Corkin (2004), participants encoded negative arousing, negative non-arousing, and neutral words followed by a recognition test. Encoding and retrieval of the words took place in an fMRI scanner. They found that successful encoding of the negative-arousing words was related to the activation of the amygdala and hippocampus. Activation in these brain regions were associated with the vivid recollection of negative arousing words. On the other hand, the improved memory for negative but non-arousing words was linked to the activation of the prefrontal cortex and the hippocampus. Although these brain regions were also involved in memory formation for neutral items, their impact on later memory was more pronounced for negative non-arousing words. The prefrontal cortex plays a role in the rehearsal and elaboration of information, and the divided attention during encoding is thought to interfere with these processes, leading to a negative impact on memory performance for negative non-arousing and neutral information (Kang et al., 2014). Overall, the evidence suggests that the amygdala-hippocampus network is associated with the rapid and automatic processing of arousing (especially negative) stimuli, whereas the prefrontal-hippocampus network is used for more elaborative and controlled processing of nonarousing valenced and neutral stimuli.

The evidence presented thus far has shown that increased attention does not always predict later memory performance. The necessity for greater attentional resources for successful encoding is dependent on the valence and arousal of the information. That is, behavioural and neuroimaging studies have shown that negative high-arousing information seems to benefit from automatic processing, whilst negative non-arousing and neutral information (and positive information) require controlled encoding processes. So, now going back to the main purpose of this chapter, how does disruption to the encoding processes relate to later false memory formation? The role of attention on false memories for emotionally arousing and neutral stimuli has been investigated using the DRM paradigm (e.g., Hellenthal et al., 2019; Knott et al., 2018). These studies have shown that false memories of negative arousing items remained high even when attention was reduced at encoding. In misinformation research, some studies using emotional and neutral stimuli have shown that negative events are most vulnerable to distortion (Porter et al., 2003, 2010; Van Damme & Smets, 2014) However, no study has yet investigated the effect of reduced attention at encoding, and the role of automatic and controlled processing, on susceptibility to misinformation for negative arousing and non-arousing events. This was examined over three experiments.

3.2 Experiment 1

Experiment 1 aimed to determine whether reduced attention during encoding significantly impacts suggestibility differently for negative emotional and neutral events. A standard three-stage misinformation paradigm was employed, and the procedure was based on Van Damme and Smets (2014). Based on Porter et al.'s (2003) and Van Damme and Smets' (2014) findings and from research showing that arousal or valence influences the extent of emotional memory narrowing (see Kaplan et al., 2012, 2016, for reviews), memory for central and peripheral details in a negative and neutral context was also assessed to understand how the level of attention at encoding affects misinformation about both types of details. This procedure was based on Forgas et al. (2005) and Van Damme and Smets.

Participants saw several negative and neutral pictures and were subsequently asked misleading questions about details from the events depicted in the pictures. Two pictures were negative high-arousing, two were negative low-arousing, and two were neutral low-arousing. These three groups of pictures were included to examine the role of automatic and controlled processing in a misinformation context since the research mentioned above has shown that automatic processing may be specific to negative high-arousing information. In addition, this experiment aimed to replicate Van Damme and Smets' (2014) finding that negative valence, regardless of the level of arousal, leads to memory narrowing.

While looking at the pictures, half of the participants simultaneously performed a secondary task. This dual-task approach was used to manipulate attention to examine the role of attention on the misinformation effect. In addition, all participants' eye movements were recorded while they viewed the scenes. This is an exploratory measure in this study. Measuring eye movements on details in the scenes might shed light on the role of encoding processes in the misinformation effect. Since research has investigated the role of visual attention on memory for emotional stimuli and memory for central and peripheral details (e.g., Gülçay & Cangöz, 2016; Humphreys et al., 2010; Kim et al., 2013), it is interesting to examine "online" encoding processes that may contribute to the later endorsement of misleading information. To the best of our knowledge, eye-tracking technology has not been used as an attention measure to directly examine the allocation of visual attention in an event and its relationship to later misinformation endorsement. As such, the outcome of this measure was exploratory.

A memory test containing true/false statements assessed the endorsement of correct and misleading information concerning central and peripheral details. For true memory, we expect to see an emotional memory narrowing effect. This effect may be due to negative valence (Van Damme & Smets, 2014) or high arousal (e.g. Easterbrook, 1959; Kaplan et al., 2012). For the false recognition of misleading information, we expect to find the robust misinformation effect. In addition, research has shown that negatively arousing information benefits from automatic encoding processes, whereas memory for other valenced and neutral information requires controlled processing (e.g., Kensinger & Corkin, 2004). Thus, it may be that attention will not affect the degree of misinformation susceptibility for negatively arousing events, but for the low-arousing events, susceptibility may increase under a divided attention condition. How might this vary with central and peripheral details? Van Damme and Smets (2014) found that a misinformation effect for peripheral details was found regardless of picture emotion (though negative events were more susceptible to false information regardless of misinformation exposure), whereas for central details, a misinformation effect was found only for negative high- and low-arousing pictures (and positive high arousing picture). It can be argued that the central information in a negatively arousing event is the most salient as it is directly part of the main event. As such, the automatic processing may specifically benefit central details. However, there is evidence from eye tracking studies that memory for central and peripheral details from a negatively arousing context may depend less on the amount of attention than from a neutral context (Kim et al., 2013; Gülçay & Cangöz, 2016). As for the negative low-arousing and neutral events, it may be that controlled processing is necessary to successfully encode both central and peripheral details. Taking the above together, the following hypotheses were put forward:

H_1: If negative emotion narrows attention, an enhanced memory for central over peripheral details would be found for both high- and low-arousal negative pictures.

H_2: If arousal narrows attention, an enhanced memory for central over peripheral details would be found only for the high-arousal negative pictures.

H_3: False recognition would be higher for misleading details than for the control details.

H_4: For the negatively arousing event, there would be no difference in the magnitude of the misinformation effect between the attention conditions, but for negative low-arousing and neutral events, there would be an increase in the endorsement of misinformation with divided attention at encoding.

H_5: If central information in a negatively arousing event benefits from automatic processing, divided attention would not increase the recognition of false central details but would increase the recognition of false peripheral details.

H_6: If memory for details in negative arousing events are overall less dependent on attentional resources, misinformation endorsement for both central and peripheral details would not change between full and divided attention conditions.

H_7: For the negative low-arousing and neutral events, the endorsement of misleading central and peripheral details would increase in a divided attention condition.

Although Van Damme and Smets (2014) did not find a misinformation effect for the central details in the neutral pictures, research suggests that neutral information does not benefit from automatic processing, and Lane (2006) argued that divided attention increases source misattribution errors. Therefore, detail memory for the neutral pictures should be affected by misinformation exposure. It is worth noting, however, that the research on automatic and controlled processing comes from outside of the misinformation field using different materials and procedures, and that the impact of emotion on memory for central and peripheral misinformation has been mixed (for a review, see Sharma et al., 2022). Thus, it is also possible that the predictions outlined above may not be confirmed in the experiments.

In addition to true/false recognition decisions, recollective experience for recognition decisions was measured using the remember/know procedure. According to the dual-processing theory, there are two distinct processes at play during recognition (Yonelinas, 2002). *Recollection* processes involve the retrieval of contextual and perceptual information associated with the study stimulus, whereas *familiarity* processes are relatively automatic and made in the absence of conscious recollection of contextual details (Yonelinas, 2002). Utilising the remember/know procedure developed by Tulving (1985), the remember/know model attributes remembering and knowing to the qualitatively distinct processes of recollection and familiarity. That is, remember responses reflect recollection, where individuals vividly and consciously recall encountering the test item during the study phase. On the other hand, know responses are associated with familiarity, where individuals recognise an item based on a sense of familiarity, without necessarily recalling specific contextual details (Yonelinas, 2002).[5]

Previous research has shown that participants vividly *remember* encountering misleading detail in the study phase (Frost, 2000; Roediger et al., 1996; Saunders & Jess, 2010;

[5] It should be acknowledged that not all findings agree that there is a direct relationship between the subjective experiences of remembering and knowing and the cognitive mechanisms involved in retrieving memories through recollection and familiarity (Gardiner et al 2006; Knott & Dewhurst, 2007b).

Zaragoza & Mitchell, 1996). Furthermore, in a study by Wright and Stroud (1998) that tested vulnerability to misleading information about central and peripheral aspects of a shoplifting scene, they found that the endorsement of the peripheral details was often accompanied by *remembering*, and no difference in memory quality was found for the central details. They argued that peripheral details are not well remembered, thus participants are unlikely to doubt much of the post-event information. Consequently, the misleading peripheral detail became vividly part of their memory. To date, no misinformation study has examined the impact of divided attention on recollective experience for details within negative high- and low-arousing events. Indeed, divided attention studies (e.g., Gardiner & Parkin, 1990) have shown that divided attention during encoding impairs recollection, but not familiarity. Remembering relies on the conscious retrieval of contextual information, which may be adversely affected by divided attention during encoding whereas familiarity involves an automatic retrieval process that is less affected by divided attention (Yonelinas, 2001). Not all findings agree with this. Albeit with word list stimuli, Knott and Dewhurst (2007b) instead found that divided attention at retrieval only affected know responses, suggesting that knowing but not remembering relies on controlled retrieval processes. In addition, emotional memories are considered to be more vivid and retrieved with high confidence compared to neutral events (Sharot et al., 2007; Wang et al., 2021), and the retrieval of emotional events is typically better and accompanied by vivid recollection (Humphreys et al., 2010). Given the aforementioned findings, the present investigation was motivated to also examine recollective experience.

3.2.1 Method

3.2.1.1 Participants

Seventy-two participants (age: M = 23.11, SD = 7.44, age range = 18 - 53; sex: 56 females & 16 males) took part in the study in return for course credits or a small fee. An a priori power analysis using MorePower 6.0 (Campbell & Thompson, 2012) indicated a required total sample size of between 32 and 80 for a medium to large effect size with Power 0.80. Van Damme and Smets (2014) tested 53 participants and obtained a medium to large interaction effect. Thus, the aim was to test *at least* this number of participants. The participants were not colour-blind and had English as their first language. Those who wore prescription glasses were asked to take them off during eye tracking due to calibration issues encountered previously when glasses were worn. However, these participants had short-sighted vision, so they were able to see pictures clearly on the screen without the use of prescription glasses. Participants were recruited via City's SONA system. Informed consent was obtained from all participants, and they were debriefed at the end of the experiment. The study was ethically approved by the City, University of London's Psychology Research Ethics Committee.

3.2.1.2 Design

The experiment had a mixed design consisting of four variables. Picture Emotion was manipulated within subjects. Each participant saw six pictures: two negative high-arousing (negative/high), two negative low-arousing (negative/low), and two neutral. The three levels of Picture Emotion was counterbalanced across participants. Detail Type was also a within-subjects variable, whereby participants were questioned on central and peripheral aspects of the scenes depicted in each picture. The presence of Misinformation (misled vs. control) was another within-subjects variable, whereby there were four misleading details (two central and two peripheral details) and four control details (i.e., no misinformation was provided for these details; two central and two peripheral details). The misleading and control details were counterbalanced. Finally, Attention was between subjects, whereby half of the participants encoded the pictures with full attention and half with divided attention. Participants were pseudo-randomly assigned to either the full attention condition ($n = 33$) or the divided attention condition ($n = 39$). The dependent variables for the recognition data were the True response rates to recognition items (misleading details, control details, and correct details) and the recollective judgement (remember and know) rates for the recognition responses. For the eye tracking data, the dependent variables were the time to first fixation and total fixation duration for the central and peripheral areas and total fixation duration for the specific misleading and control details for each picture. Both measures have previously been calculated in emotion and eye tracking research (e.g., Calvo & Lang, 2004; Humphreys et al., 2010, 2022).

3.2.1.3 Eye Tracking Recording

Picture presentation and recording were controlled via a computer with Tobii Studio version 3.1.6 (Tobii Technology, Stockholm, Sweden). Eye movements were monitored throughout the picture presentation stage using a Tobii TX300 eye tracker with a sampling rate of 120 Hz (i.e. 8.3ms per sample). The eye tracker was integrated at the bottom of a 23-inch computer monitor with a screen resolution of 1366 x 768 pixels. The firmware version of the TX300 at the time of testing was 1.1.1. Eye movements were captured at a viewing distance of approximately 65cm from the screen. To minimise head movements and to keep the participant in focal range of the camera, participants were required to place their heads on a forehead and chin rest while viewing the pictures.

Eye movements were recorded following a standard nine-point calibration procedure, on a 3 x 3 calibration grid. An animated object (i.e. a red circle) was displayed for two seconds at the nine points, one at a time, in random order. Participants were required to fixate on the object at each point, during which time their eye position was measured. To ensure that participants focused their gaze on the centre of the object, the displayed object had a decreasing radius. Once calibration was over, the resulting calibration plot was reviewed, and a calibration check was made at each of the nine points. If any points in the plot were missing or were considered low in accuracy or precision, or if the calibration check indicated any issues, the calibration process was repeated until it was deemed satisfactory by the experimenter. Calibration took place three times during the picture presentation stage: at the start of the picture presentation and then after every two pictures. Since the test on Tobii Studio had to be changed between Picture Emotion conditions (e.g., from negative/high to negative/low), re-calibration was required, particularly since the participants were allowed to move away from the chin rest during the test transition.

3.2.1.4 Materials

Picture Characteristics. Six pictures were chosen as to-be-remembered events: five from the IAPS database (Lang et al., 2008), and one from the EmoPicS database (Wessa et al., 2010). Two negative high-arousing pictures depicted an assault scene (IAPS number: 9254) and a dead man scene (IAPS number: 9433), two negative low-arousing pictures depicted a cemetery scene (IAPS number: 9220) and a flower memorial scene (IAPS number: 9002), and two neutral pictures depicted a restaurant scene (IAPS number: 2593) and a dog walking scene (EmoPicS number: 157). See Table 5 for the normed means for each of the pictures. Using the valence and arousal ratings obtained from the Pilot study, one-way repeated measure ANOVAs revealed significant differences in Valence, $F(2, 50) = 106.72$, $p < .001$, $\eta_p^2 = .81$, and Arousal, $F(2, 50) = 35.02$, $p < .001$, $\eta_p^2 = .58$, across the emotion conditions.

Bonferroni comparisons revealed that valence was significantly lower for both the negative high-arousing condition ($M = 1.77$, $SD = .99$; $p < .001$) and negative low-arousing condition ($M = 3.14$, $SD = 1.17$; $p < .001$) compared to the neutral condition ($M = 5.81$, $SD = .96$). Valence was also significantly lower for the negative high-arousal condition compared to the negative low-arousal condition ($p < .001$). However, overall negative valence (negative-high + negative-low) was significantly lower than the neutral valence, $t(25) = -11.89$, $p < .001$, $d = 3.58$. Arousal was significantly lower for the negative low-arousing condition ($M = 3.85$, $SD = 2.00$; $p < .001$) and the neutral condition ($M = 3.64$, $SD = 1.83$; $p < .001$) compared to the negative high-arousal condition (*M* = 6.83, *SD* = .2.16). Importantly, there was no significant difference between the two low-arousal condition (p = 1.00), and overall low-arousal (negative-low + neutral) was lower compared to the negative high-arousing condition, $t(25) = 9.45$, $p < .001$, $d = 1.66$.

Post-Event Questionnaire. There were two versions of the post-event questionnaire (titled "Perception Questionnaire" for the participants). Each version consisted of eight Yes/No questions about each picture (i.e., 48 in total). The questions were blocked by picture, and the questions for a given picture appeared on the screen individually and in a random order. In each post-event version, four misleading questions suggested inaccurate information and four control questions either omitted the misinformation or described the detail in a neutral form. See Appendix C for all the misleading and control post-event questions for each picture. For example [bold is misleading], "Did you see the **dark green** skirt the woman was wearing?" vs. "Did you see the skirt the woman was wearing?". Four questions targeted central information and four questions targeted peripheral information. The central and peripheral details were chosen based on the pilot study. The misleading and control details were counterbalanced, such that misleading details in Version A were controls in Version B and vice versa. The phrasing of the control questions was kept similar where possible except that the misinformation was omitted. Participants were told that this was a task about their perception of the scenes.

Memory Test. The recognition test consisted of 20 statements about each picture (120 statements in total). The statements were blocked by picture, and the statements for a given picture appeared on the screen individually and in a random order. Participants had to indicate whether the statement was True or False. For each picture, there were eight statements referring to false details, whereby four of the details had been previously suggested (i.e., misleading details) and the remaining four details were not previously mentioned (i.e., control details). See Appendix C for all the misleading and control statements. For example, “The woman’s skirt was dark green”. This enabled us to check for misinformation effects by making a misled-control comparison. Whether the detail was suggested or not depended on the post-event questionnaire version. There were also eight statements referring to *correct details* not previously mentioned in the post-event phase for all participants (e.g., “The woman in the foreground on the left wore white shoes”), and four statements referring to *incorrect filler details* not previously mentioned to all participants (e.g., “The woman had her hair in a bun”). For each set of statements, half were about central information and half about peripheral information.

Mood and Picture Ratings. To measure participants’ moods at different points during the experiment and to rate the pictures at the end of the experiment, the valence and arousal scales of SAM (Bradley & Lang, 1994) were used. See Chapter 2 for details of this measure. Mood was assessed at different stages of the experiment since there is evidence of the effect of mood on suggestibility (e.g., Forgas et al., 2005; Van Damme & Seynaeve, 2013; Zhang et al., 2021).

3.2.1.5 Procedure

Participants were told that the purpose of the study was to investigate the role of attention to understand how individuals process emotional and neutral scenes. There was no explicit mention of a memory test. After providing informed consent, participants filled in a demographic’s questionnaire followed by the valence and arousal scales of the SAM questionnaire to assess participants’ *current mood*.

After completing the SAM scales, the picture encoding phase began. Participants placed their heads on the forehead and chin rest and once they were comfortable, the eye tracker was calibrated (see details above regarding the eye tracker and calibration procedure). After calibration, the picture presentation began. Participants were shown six pictures for 30-seconds each. They were instructed to "Please look at each picture as if you unexpectedly witness the event". Preceding each picture was a fixation cross for two seconds to ensure as much as possible that all participants looked at each picture from the same position. The fixation cross appeared towards the left side of the screen, outside of the area where the pictures would appear. If participants' first fixation immediately on picture onset falls within the picture, this would simply represent the position from which participants started looking at the picture, thus affecting the eye tracking measures. Therefore, to deal with this, the fixation cross was placed outside of the picture area. The pictures were blocked by Picture Emotion conditions and the blocks were counterbalanced. The two pictures in each block were presented in random order. Participants in the divided attention condition additionally engaged in an attention-demanding secondary task during picture presentation. The secondary task was called Random Number Generation (RNG), which required participants to randomly generate numbers between 1 and 20 in time with the beep of a metronome played in the background on a second computer every 750ms (e.g., Knott & Dewhurst, 2007a; Knott et al., 2018). Participants were told to maintain the correct speed as much as possible, ensure a correct level of randomness in the sequence they generate, and to avoid counting in increments or decrements or following any familiar sequences. Importantly, before the calibration and picture presentation, the experimenter demonstrated the RNG task and invited participants to practice until the experimenter was satisfied that their performance on the task would be satisfactory. Consent was obtained to record participants' number sequences using a digital voice recorder so that their sequences can be analysed for their level of randomness. A program called RgCalc (Towse & Neil, 1998) was used to analyse participants' number sequences. An RNG value ranges from 0 to 1, where lower values indicate more random sequences.

Once all pictures had been presented, there was a 10-minute interval to prevent mental rehearsal of the details in the pictures. Participants completed two questionnaires (Emotion Regulation Questionnaire – Gross & John, 2003; Attention Control Scale – Derryberry & Reed, 2002)[6]. If participants completed the questionnaires in under 10 minutes, mazes were given so that the participants remained engaged during the interval. After this distractor stage, participants once again completed the two SAM scales to check their current mood state. Thereafter, participants completed the self-paced post-event questionnaire in which half of the questions suggested misleading information. The participants were not warned about potential discrepancies between the information in the questions and the picture. The order in which participants answered picture questions followed the Picture Emotion order at the encoding phase.

After the misinformation phase, there was another 10-minute interval to prevent the rehearsal of information mentioned in the questions. Participants completed two personality questionnaires (The Big 5 Personality Questionnaire; The Revised Eysenck Personality Questionnaire ['Lie' questions were excluded])[7] and if they finished early, mazes were given. After 10 minutes, all participants completed the SAM questionnaire to assess their mood one final time, followed by the recognition test. In the recognition test, participants were required to provide *True*/*False* responses to each statement. They were told to base their answers on their own memory of the pictures. If a *True* response was made, participants were asked to indicate the quality of their memorial experience of recollecting the detail through a *Remember*/*Know*/*Guess* procedure (R/K/G). A *remember* response would be made if

[6] These questionnaires were simply used as a distractor task, thus were not used in any analysis.
[7] These questionnaires were simply used as a distractor task, thus were not used in any analysis.

recognition was accompanied by a recollective experience (e.g., if they vividly remembered seeing the detail as it had appeared in the picture, or if they recollected what they were thinking, feeling, or doing when they saw the details). A *know* response would be made if recognition was accompanied by strong feelings of familiarity in the absence of any conscious recollection. Furthermore, an updated version of Tulving's (1985) procedure was used by including a *guess* response option, which would be made if participants did not have a recollective experience nor a sense of familiarity with the detail, but they think it is possible the detail is *True*, perhaps due to other strategic reasons, therefore they cannot reject the statement. Guess responses have been used in previous research employing the remember-know procedure (e.g., Dewhurst & Anderson, 1999; Gardiner et al., 1996; Knott & Dewhurst, 2007a). Dunn (2004) argued that when participants are faced with a situation where they suspect that the item was presented but that does not meet the criteria for either an R or K response, they may respond K, or less likely, the R response. This could lead to a decrease in the accuracy of R and K responses. To address this issue, including a "guess" category can potentially prevent this problem. As remember and know are the main recollective judgement responses of interest, guess responses were not included in the statistical analyses (see Knott & Dewhurst, 2007b).

Following Van Damme and Smets (2013), a picture manipulation check took place after the recognition test. Participants were re-presented with six pictures for six seconds per picture. After each picture, participants were asked to rate how they felt when looking at the picture in terms of valence and arousal, using the SAM scales. The valence and arousal ratings would be used to check for the successful manipulation of these two features of emotion. In addition, ratings on the complexity of each picture were also obtained. The aim was to take into consideration the possible issues with the previous visual complexity definition used in the Pilot (see the pilot study) and to see whether visual complexity would be controlled across the Picture Emotion conditions with a more elaborated definition of complexity (see Appendix B).

Along with the definition, participants were provided with an example of a low-complexity picture (IAPS number: 2191) and a high-complexity picture (IAPS number: 7496).

Finally, due to showing negatively-valenced pictures in the study, participants watched a short clip from a wildlife documentary to ensure that they leave the study in a neutral/positive mood state. Participants received a full debrief explaining the study's true purpose and the use of deception.

3.2.2 Results

Six participants were removed from all analyses due to not following instructions, disruption during the picture encoding phase (i.e., technical issue), and/or more than 90% *False* responses in the recognition test. The final sample consisted of 66 participants (age: $M = 22.71$, $SD = 7.18$, age range = 18 - 53; sex: 52 females & 14 males). There remained 35 participants in the divided attention condition and 31 participants in the full attention condition. Where additional participants had to be removed for a particular analysis, this has been indicated in a footnote.

To measure key manipulations, the initial analysis includes performance on the RNG task, mood ratings, and valence and arousal picture ratings. The main analysis includes recognition and associated recollective experience (i.e., remember & know) responses to correct, misleading, and control details. Signal Detection Analysis (Snodgrass & Corwin, 1988) were utilised to take into consideration participants' response bias in the recognition test. For eye tracking metrics (time to first fixation & total fixation duration) for central and peripheral areas and critical details were analysed. The statistical tests used to analyse the data are mentioned in the relevant sections below. Where the assumption of sphericity was violated, the Greenhouse-Geisser correction was reported. Bonferroni correction was applied to all t-tests and pairwise comparisons to reduce Type 1 errors.

3.2.2.1 Secondary Task Performance, Mood Ratings, & Picture Manipulation

Secondary Task Performance. To examine any differences between Picture Emotion conditions in the attention devoted to the secondary task, participants' number sequences were measured using the RNG score and *N* generated and were analysed using one-way ANOVAs. For the RNG score, there was no significant difference between the three picture emotion conditions (negative/high: M = .19, SD = .08; negative/low: M = .18, SD = .07; neutral: M = .19, SD = .07), $F(2, 68) = .10$, $p = .905$, $\eta_p^2 = .003$. For N generated, there was no significant difference between the picture emotion conditions (negative/high: M = 61.31, SD = 14.97; negative/low: M = 61.51, SD = 14.53; neutral: M = 62.06, SD = 14.18), $F(2, 68) = .29$, $p = .751$, $\eta_p^2 = .01$. Therefore, there appeared to be no differences in the attentional resources allocated to the completion of the secondary task as a function of picture emotion.

Mood Check. For both valence and arousal ratings, a 3 (Timepoint: Time 1 vs. Time 2 vs. Time 3) x 2 (Attention: Divided vs. Full) mixed-factors ANOVA with between-subjects on the Attention factor was conducted[8] to check whether the mood ratings varied between three different time points during the experiment (encoding, misinformation, and the memory test). Analysis revealed no significant main effects nor interaction effect (valence: Fs < 2.86, ps > .09; arousal: Fs < 2.48, ps > .08). Overall, mood ratings did not significantly vary across the experiment nor between the full and divided attention conditions.

Picture Manipulation Check. Table 5 presents the average valence, arousal, and complexity ratings made by the participants at the end of the experiment, along with mean values from the pilot study and normed database values for comparison. As can be seen, mean valence ratings generally increased, whilst mean arousal ratings generally decreased, compared

[8] Due to experimenter error, valence and arousal ratings immediately before the recognition test are not available from three participants. Therefore, these participants (two in divided attention & one in full attention) were excluded from the analysis.

to the mean ratings from the pilot study.[9] One-way ANOVAs revealed that the pictures were judged as significantly different on the three dimensions: valence: $F(1.66, 107.73) = 224.22$, $p < .001$, $\eta_p^2 = .78$, arousal: $F(1.70, 110.21) = 54.71$, $p < .001$, $\eta_p^2 = .46$, and complexity: $F(1.76, 114.30) = 39.54$, $p < .001$, $\eta_p^2 = .38$. Valence was significantly lower for the negative/high condition (*SD* = 1.06; $p < .001$) and the negative/low condition (*SD* = .99; $p < .001$) compared to the neutral condition (*SD* = 1.01), and lower for the negative/high compared to the negative/low conditions ($p < .001$). Furthermore, valence was significantly lower for the negative conditions (negative/high + negative/low) compared to the neutral condition, $t(65) = -16.12$, $p < .001$, $d = 3.09$.

For arousal, ratings were significantly higher for the negative/high condition (*SD* = 1.83) compared to the negative/low condition (*SD* = 1.55; $p < .001$) and the neutral condition (*SD* = 1.51; $p < .001$). No significant difference in arousal ratings was found between the negative/low and neutral conditions ($p = .081$). Furthermore, arousal ratings were significantly lower for the combined low-arousal conditions (negative/low + neutral) compared to the high-arousal condition, $t(65) = 9.40$, $p < .001$, $d = 1.28$.

[9] The normed and pilot ratings were obtained immediately after each picture was presented, whereas the ratings in this experiment were obtained at the end of the experiment. As a result, participants provided their ratings when viewing the images for the second time, and after being questioned about various details related to each image's content. This increased familiarity with the details and the pictures could have lessened the emotional impact of the images during the second viewing, thereby affecting the emotional ratings provided by the participants.

Table 5. *Valence and arousal mean ratings for each picture from normed databases, the pilot study, and from Experiment 1*

Picture	Number	Valence Normed	Arousal Normed	Valence Pilot	Arousal Pilot	Valence Expt. 1	Arousal Expt.1
Negative/High	IAPS 9433	1.84	5.89	1.62	6.88	2.18	5.38
Negative/High	IAPS 9254	2.03	6.04	1.92	6.77	2.39	5.33
Negative/High	**Average**	**1.94**	**5.97**	**1.77**	**6.83**	**2.29**	**5.36**
Negative/Low	IAPS 9220	2.06	4.00	2.81	3.92	3.65	3.47
Negative/Low	IAPS 9002	3.39	4.55	3.46	3.77	3.89	3.67
Negative/Low	**Average**	**2.73**	**4.28**	**3.14**	**3.85**	**3.77**	**3.57**
Neutral	EmoPicS 157	5.29	3.54	5.85	3.81	6.05	3.18
Neutral	IAPS 2593	5.80	3.42	5.77	3.46	5.85	3.03
Neutral	**Average**	**5.55**	**3.48**	**5.81**	**3.64**	**5.95**	**3.11**

For complexity, the negative/high pictures (M = 6.34, SD = 1.16) were judged to be more complex than the negative/low pictures (M = 4.77, SD = 1.30; $p < .001$) and the neutral pictures (M = 5.57, SD = 1.50; p = .001). In addition, pictures in the neutral condition were judged to be more complex than those in the negative/low condition ($p < .001$). This means that the elaborated definition of complexity still produced differences in ratings across emotion conditions. The valence/arousal/complexity findings were similar when analysing these dimensions within the full attention and the divided attention conditions separately.

3.2.2.2 Correct Recognition

Following Van Damme and Smets (2014), correct details were analysed to obtain a measure of veridical memory. Table 6 presents the means and standard deviations of the proportions of correct details endorsed and their associated recollective experience judgements. Recognition responses (those labelled as *true*, *remember*, and *know* judgements) to correct details were analysed separately using a 3 (Picture Emotion: Negative/High vs. Negative/Low vs. Neutral) x 2 (Detail Type: Central vs. Peripheral) x 2 (Attention: Divided vs. Full) mixed-factors ANOVA, with between subjects on the last factor.

Analysis of the *true* responses revealed a significant main effect of Detail Type, $F(1, 64) = 81.18$, $p < .001$, $\eta_p^2 = .56$, whereby accuracy was higher for central details ($M = .53$, $SD = .17$) compared to peripheral details ($M = .40$, $SD = .17$). Picture Emotion main effect was not significant, albeit marginal ($p = .061$), however, there was a significant Picture Emotion x Detail Type interaction, $F(2, 128) = 23.36$, $p < .001$, $\eta_p^2 = .27$. Within Picture Emotion, paired-samples t-tests revealed that, for both the negative/high, $t(65) = 6.85$, $p < .001$, $d = .89$, and neutral, $t(65) = 9.19$, $p < .001$, $d = 1.06$, conditions, memory was better for central details (negative/high: $M = .55$, $SD = .18$; neutral: $M = .56$, $SD = .23$) compared to peripheral details (negative/high: $M = .37$, $SD = .21$; neutral: $M = .33$, $SD = .21$), with no difference in the negative/low condition (central: $M = .48$, $SD = .24$; peripheral: $M = .50$, $SD = .19$), $t(65) = -.67$, $p = .508$, $d = .09$. There was no main effect of Attention or interactions involving attention (Fs < 1.558, ps > .21).

For *remember* judgements, there were significant main effects of Picture Emotion, $F(1.75, 111.76) = 3.79$, $p = .031$, $\eta_p^2 = .06$, and Detail Type, $F(1, 64) = 31.53$, $p < .001$, $\eta_p^2 = .33$, both qualified by a significant interaction, $F(2, 128) = 18.94$, $p < .001$, $\eta_p^2 = .23$. The interaction revealed similar results to *true* responses within Picture Emotion [negative/high (central: $M = .21$, $SD = .20$; peripheral: $M = .08$, $SD = .11$), $t(65) = 6.28$, $p < .001$, $d = .83$, neutral (central: $M = .15$, $SD = .16$; peripheral: $M = .07$, $SD = .10$), $t(65) = 4.08$, $p < .001$, $d = .62$, and negative/low (central: $M = .09$, $SD = .13$; peripheral: $M = .13$, $SD = .14$), $t(65) = -1.87$, $p = .066$, $d = .27$]. There was a significant main effect of Attention, $F(1, 64) = 18.33$, $p < .001$, $\eta_p^2 = .22$, whereby remember responses were made more in the full attention ($M = .17$, $SD = .10$) compared to the divided attention ($M = .08$, $SD = .07$) condition. Furthermore, a Detail Type x Attention interaction, $F(1, 64) = 10.18$, $p = .002$, $\eta_p^2 = .14$, revealed that in the full attention condition, vivid recollection was higher for central details (*M* = .22, *SD* = .12) compared to peripheral details (*M* = .12, *SD* = .10), *t*(30) = 5.38, $p < .001$, *d* = .89. No significant central-peripheral difference was found in the divided attention condition (central: *M* = .09, *SD* = .09; peripheral: *M* = .07, *SD* = .07), *t*(34) = 2.02, *p* = .051, *d* = .33, though note that the proportion of *Remember* responses were particularly low in the divided attention condition, hence making it difficult to find a significant difference between central and peripheral details. Since the central details are directly part of the event and benefit from enhanced memory compared to peripheral details, recognition is unsurprisingly accompanied more by vivid recollection. The greater reduction in remember responses was for central details from full to divided attention conditions and this supports studies showing that divided attention at encoding reduces remembering, but not knowing (e.g., Dewhurst et al., 2007; Gardiner & Parkin, 1990). This is because divided attention at encoding may disrupt the encoding of semantic and contextual information and reduces or prevents the attention-demanding process of forming vivid and detailed memories (Kensinger et al., 2003). This affects the subjective experience of recollection. However familiarity is considered a fairly automatic process in the absence of any recollection, thus *knowing* is less likely to be disrupted by divided attention (Yonelinas, 2002).

For *know* judgements, there was a significant main effect of Detail Type, $F(1, 64) = 28.93$, $p < .001$, $\eta_p^2 = .31$, whereby familiarity was greater for central details (*M* = .19, *SD* = .11) compared to peripheral details (*M* = .12, *SD* = .09). There was also a significant Picture Emotion x Detail Type interaction, $F(2, 128) = 7.56$, $p = .001$, $\eta_p^2 = .11$, where the pattern of results were similar to *remember* responses within Picture Emotion [negative/high (central: *M* = .19, *SD* = .15; peripheral: *M* = .10, *SD* = .11), *t*(65) = 4.39, $p < .001$, *d* = .65, neutral (central: *M* = .21, *SD* = .17; peripheral: *M* = .09, *SD* = .11), *t*(65) = 5.64, $p < .001$, *d* = .89, and negative/low (central: *M* = .18, *SD* = .16; peripheral: *M* = .17, *SD* = .15), $t(65) = .23$, $p = .820$, $d = .04$].

In sum, a clear emotional memory narrowing effect was not demonstrated in overall recognition responses and in recollective experience responses because a difference in the recognition of central and peripheral details was found in the negative/arousing condition and the neutral condition (thus not specific to emotion). Surprisingly, overall recognition did not change across attention conditions. However, vivid recollection (i.e., remember responses) did, whereby central details were more vividly recognised than peripheral details in the full attention condition, a difference that disappeared in the divided attention condition.

Table 6. *Mean proportions and standard deviations for the endorsement and associated recollective experience of the correct details as a function of picture emotion, detail type, and attention.*

Attention	Full Attention				Divided Attention			
Detail Type	Central		Peripheral		Central		Peripheral	
	M	SD	M	SD	M	SD	M	SD
	True Response							
Negative/High	.57	.19	.39	.21	.53	.17	.36	.22
Negative/Low	.52	.22	.48	.20	.45	.25	.52	.18
Neutral	.61	.22	.38	.23	.53	.24	.29	.20
	Remember Response							
Negative/High	.30	.22	.12	.12	.14	.16	.04	.09
Negative/Low	.14	.15	.15	.16	.06	.10	.11	.11
Neutral	.23	.18	.10	.12	.09	.11	.04	.08
	Know Response							
Negative/High	.16	.17	.09	.10	.21	.14	.11	.12
Negative/Low	.18	.14	.16	.15	.18	.18	.19	.16
Neutral	.23	.13	.12	.13	.19	.19	.05	.09

Note. M and SD refer to Mean and Standard Deviation, respectively.

3.2.2.3 False Recognition

Tables 7 and 8 present a full factorial breakdown of the mean proportions and standard deviations for the endorsement of the misleading and control details and associated recollective experience (remember and know) judgements. False recognition responses (those labelled *true*, *remember*, and *know* judgements) to misleading and control details were analysed separately using a 3 (Picture Emotion: Negative/High vs. Negative/Low vs. Neutral) x 2 (Detail Type: Central vs. Peripheral) x 2 (Misinformation: Misled vs. Control) x 2 (Attention: Divided vs. Full) mixed-factors ANOVA, with between subjects on the last factor. A *true* response to a false statement means that participants consider the detail to be a part of the picture.

Analysis of the *true* responses revealed a standard misinformation effect, whereby participants more frequently judged misleading details ($M = .53$, $SD = .20$) to be true compared to the control details ($M = .40$, $SD = .16$), $F(1, 64) = 57.03$, $p < .001$, $\eta_p^2 = .47$. There was also a significant main effect of Detail Type, $F(1, 64) = 17.74$, $p < .001$, $\eta_p^2 = .22$, whereby the false recognition was higher for central details ($M = .51$, $SD = .19$) compared to peripheral details ($M = .43$, $SD = .17$), regardless of prior exposure to misinformation. There were no further significant main effects nor interactions (Fs < 2.75, ps > .06), indicating that divided attention did not affect the endorsement of misleading information for negative and neutral pictures.

For false *remember* judgements, there was a significant main effect of Misinformation, $F(1, 64) = 19.54$, $p < .001$, $\eta_p^2 = .23$, indicating that participants were more likely to remember the misleading detail ($M = .12$, $SD = .12$) compared to the control details ($M = .08$, $SD = .08$). There was also a significant main effect of Attention, $F(1, 64) = 7.20$, $p = .009$, $\eta_p^2 = .10$, whereby there were more remember responses to false details (misleading and control combined) in the full attention condition ($M = .13$, $SD = .11$) compared to the divided attention condition ($M = .07$, $SD = .07$), regardless of prior misinformation exposure. There were no further significant main effects nor interactions (Fs < 2.42, ps > .12).

For false *know* judgements, participants judged misleading details (M = .19, SD = .11) to be more familiar than control details (M = .13, SD = .08), $F(1, 64) = 19.80$, $p < .001$, η_p^2 = .24, and judged central false details (M = .19, SD = .12) to be more familiar than peripheral false details (M = .13, SD = .08), $F(1, 64) = 22.91$, $p < .001$, $\eta_p^2 = .26$. Furthermore, there was a significant Picture Emotion x Attention interaction, $F(2, 128) = 4.01$, $p = .02$, $\eta_p^2 = .06$. However, Bonferroni-corrected independent samples t-tests (alpha set at .016) revealed no significant results within Picture Emotion conditions (*p*s > .037). In sum, the misleading details were endorsed with both vivid recollection and a sense of familiarity compared to control details. Although there was an attention effect only with vivid recollective experience (remember responses), this was for all false details and regardless of event emotion. Together, there was no evidence of an impact of limited attention during event encoding on the misinformation effect for negative or neutral pictures.

Table 7. *Mean proportions and standard deviations for the endorsement of the misleading and control details as a function of picture emotion, detail type, misinformation, and attention.*

Attention	Full Attention				Divided Attention			
Misinformation	Misleading		Control		Misleading		Control	
	M	SD	M	SD	M	SD	M	SD
Central Details								
Negative/High	.60	.28	.44	.30	.62	.26	.44	.25
Negative/Low	.55	.29	.46	.26	.54	.33	.44	.27
Neutral	.55	.31	.37	.31	.57	.30	.50	.30
Peripheral Details								
Negative/High	.44	.29	.31	.23	.42	.23	.37	.29
Negative/Low	.52	.27	.40	.23	.51	.33	.33	.26
Neutral	.52	.31	.39	.23	.54	.32	.38	.31

Note. M and SD refer to Mean and Standard Deviation, respectively.

Table 8. *Mean proportions and standard deviations for remember and know judgements for endorsed misleading and control details as a function of picture emotion, detail type, misinformation, and attention.*

Attention	Full Attention				Divided Attention			
Misinformation	Misleading		Control		Misleading		Control	
	M	SD	M	SD	M	SD	M	SD
	Remember Response							
Central Details								
Negative/High	.15	.20	.11	.20	.14	.16	.06	.11
Negative/Low	.14	.22	.11	.18	.10	.14	.08	.13
Neutral	.19	.26	.10	.21	.06	.14	.07	.16
Peripheral Details								
Negative/High	.13	.13	.08	.15	.06	.11	.03	.08
Negative/Low	.18	.18	.11	.14	.10	.15	.04	.09
Neutral	.15	.20	.10	.13	.06	.13	.04	.11
	Know Response							
Central Details								
Negative/High	.26	.25	.15	.20	.24	.22	.17	.21
Negative/Low	.24	.25	.18	.20	.19	.20	.14	.17
Neutral	.16	.18	.12	.16	.27	.27	.19	.24
Peripheral Details								
Negative/High	.10	.18	.09	.12	.10	.14	.11	.17
Negative/Low	.16	.17	.15	.22	.16	.20	.11	.15
Neutral	.15	.17	.10	.18	.22	.21	.07	.13

Note. M and SD refer to Mean and Standard Deviation, respectively.

3.2.2.4 Signal Detection Measure

Signal Detection Analysis was conducted on the endorsement of correct details (as hits) and the endorsement of misleading and control details (as false alarms) to correct for participant response bias in the recognition test. Below, values of discriminability (*d'*) and bias (*C*) parameters are reported[10]. Both parameters were analysed separately using the same mixed-factor ANOVA as in the recognition data analysis. The analysis of *d'* allows us to examine the participants' discriminability of the correct detail from the incorrect (misleading or control) detail. Higher *d'* scores indicate better discrimination, thus greater accuracy. Criterion *C* allows us to separately distinguish the decision-making criterion adopted by the participants. The higher the value above 0, the more conservative the bias is by making *False* responses. The lower the value, the more liberal the bias towards *True* response. The results of *d'* and *C* are summarised in Table 9.

For the analysis of *d'*, participants were better able to discriminate the correct details from the control details ($M = .14$, $SD = .33$) compared to the correct details from the misleading details ($M = -.16$, $SD = .39$), $F(1, 64) = 57.46$, $p < .001$, $\eta_p^2 = .47$. Discrimination ability was also better for central details ($M = .07$, $SD = .43$) compared to peripheral details ($M = -.09$, $SD = .37$), irrespective of prior exposure to misinformation, $F(1, 64) = 6.80$, $p = .011$, $\eta_p^2 = .10$. There was a significant Picture Emotion x Attention interaction, $F(2, 128) = 3.53$, $p = .032$, $\eta_p^2 = .05$. A difference was found only in the neutral condition, such that regardless of prior exposure to misinformation, discrimination ability was better in the full attention ($M = .08$, $SD = .55$) compared to the divided attention condition ($M = -.26$, $SD = .51$), $t(64) = -2.59$, $p = .012$, $d = .64$. Furthermore, there was a Picture Emotion x Detail Type interaction effect, $F(2, 128) = 13.24$, $p < .001$, $\eta_p^2 = .17$. A central-peripheral difference was only found in the neutral condition, $t(65) = 4.84$, $p < .001$, $d = .73$, such that discrimination ability was better for central details ($M = .15$, $SD = .74$) compared to peripheral details ($M = -.35$, $SD = .66$).

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[10] The calculation of these measures used the *True* responses to the correct details as hits and *True* responses to the misleading and control details as false alarms, specific to the picture emotion and detail type. Other research have typically used studied items as hits and non-studied items as false alarm (e.g., Calvillo et al., 2016; Sievwright et al., 2021; Thorley, 2013). The standard equation for d-prime is d' = z(Hit) - z(FA), z is z-score. For C we use, = -0.5(z(Hit) + z(FA)). Finally, the Snodgrass and Corwin (1988) correction for signal detection measures was applied. To prevent values of 0 and 1, 0.5 was added to false alarm rates and the corrected score was divided by *N* + 1.

For the analysis of criterion *C*, participants were more liberal in their responses towards misleading and correct details (*M* = .01, *SD* = .41) compared to control and correct details (*M* = .16, *SD* = .38), $F(1, 64) = 57.46$, $p < .001$, $\eta_p^2 = .47$, and more liberal when responding to central details (*M* = -.04, *SD* = .41) compared to peripheral details (*M* = .22, *SD* = .40), $F(1, 64) = 76.37$, $p < .001$, $\eta_p^2 = .54$. Furthermore, there was a Picture Emotion x Detail Type interaction, $F(2, 128) = 12.29$, $p < .001$, $\eta_p^2 = .16$, indicating (similar to correct recognition findings) that, in the negative/high, $t(65) = -7.52$, $p < .001$, $d = .88$, and neutral conditions, $t(65) = -6.02$, $p < .001$, $d = .71$, participants adopted a more liberal response bias for central details (negative/high: *M* = -.08, *SD* = .42; neutral: *M* = -.07, *SD* = .50) compared to peripheral details (negative/high: *M* = .31, *SD* = .46; neutral: *M* = .28, *SD* = .49), but no difference was found in the negative/low condition (central: *M* = .02, *SD* = .51; peripheral: *M* = .07, *SD* = .44), $t(65) = -.85$, $p = .396$, $d = .09$.

Overall, when false details were previously suggested, participants were less able to discriminate the correct detail from the false detail. For the neutral picture, but not the negative pictures, discrimination ability was better for central details than for peripheral details. As for response bias, participants were more liberal in their responses when exposed to misleading information. Participants were also more liberal in their responses to central than to peripheral details associated with the negative/high picture and the neutral picture, similar to the correct recognition outcome. Furthermore, discriminability was better in the full attention compared to the divided attention condition only for the neutral picture.

Table 9. *Signal detection measures of Discriminability (d') and Criterion Bias (C) for correct details against false details (misleading and control details) as a function of picture emotion, detail type, misinformation, and attention.*

Attention	Full Attention				Divided Attention			
Misinformation	Misleading		Control		Misleading		Control	
	M	SD	M	SD	M	SD	M	SD
				Discriminability (*d*')				
Central Details								
Negative/High	-.06	.54	.34	.69	-.23	.67	.20	.62
Negative/Low	-.08	.73	.12	.76	-.22	.77	.03	.78
Neutral	.16	.80	.58	.92	-.13	.80	.05	.76
Peripheral Details								
Negative/High	-.17	.80	.13	.45	-.20	.79	-.06	.68
Negative/Low	-.06	.71	.20	.67	.04	.69	.47	.65
Neutral	-.36	.89	-.07	.70	-.67	.75	-.29	.75
				Response Bias (*C*)				
Central Details								
Negative/High	-.20	.53	-.01	.51	-.17	.43	.05	.39
Negative/Low	-.08	.54	.02	.47	.01	.64	.13	.52
Neutral	-.18	.54	.03	.50	-.10	.56	-.02	.56
Peripheral Details								
Negative/High	.23	.51	.38	.52	.28	.42	.35	.57
Negative/Low	-.01	.45	.12	.42	-.04	.58	.18	.47
Neutral	.14	.53	.29	.48	.25	.57	.44	.55

Note. M and SD refer to Mean and Standard Deviation, respectively.

3.2.2.5 Visual Attention and Misinformation

Raw eye movement data were aggregated into fixations using the Tobii I-VT Fixation filter on Tobii Studio version 3.1.6 (Tobii Technology, Stockholm, Sweden). This filter categorises eye movements by evaluating the speed of the eye shifts. A velocity higher than 30 visual degrees per second would indicate a saccade, whereas a lower velocity would be classified as a fixation. The minimum fixation duration was set at 100ms.

Areas of Interest (AOIs) were defined on Tobii Studio. For each picture, AOIs were defined for the central and peripheral areas as determined from the pilot study, and around the specific misleading/control central/peripheral details for each picture. The eye tracking measures analysed below are (1) time to first fixation (TTFF; i.e., time taken (in seconds) for the participant to fixate on the AOI for the first time), which is associated with early processing (or attention capture) of the AOI, and (2) total fixation duration (TFD; the sum of all fixation durations (in seconds) on the AOI) to gain a more detailed representation of attentional capture. Both measures have previously been used in eye tracking and memory research (e.g., Humphreys et al., 2010. 2022).

Research suggests that attention is drawn to central information when emotional arousal increases (Kaplan et al., 2012). Therefore, the distribution of eye fixations to central and peripheral **areas** was analysed. Also, possible differences between the attention conditions were explored. The eye tracking measures were analysed separately using a 3 (Picture Emotion) x 2 (Area/Detail Type: Central vs. Peripheral) x 2 (Attention) mixed-factors ANOVA[11]. Table 10 presents the means and standard deviations for both measures. For TTFF, the analysis revealed significant main effects of Picture Emotion, Area Type, and Attention, and a significant Picture Emotion x Area Type interaction (Fs > 11.10, ps < .002, ηp^2's > .15).

[11] Five additional participants were removed from the analysis because they failed to look at the fixation cross for all pictures in at least one picture emotion condition.

Although the Picture Emotion x Area Type x Attention interaction was not statistically significant, it did approach significance, $F(2, 118) = 3.00$, $p = .053$, $\eta_p^2 = .05$. Thus, this interaction was decomposed to explore the effect of attention. The interaction was driven by differences within Picture Emotion. In the negative/high condition, there was a significant main effect of Area Type, $F(1, 59) = 7.85$, $p = .007$, $\eta_p^2 = .12$, with faster first fixation to the central area (*M* = .85, *SD* = 1.30) compared to the peripheral area (*M* = 1.51, *SD* = 1.07). There were no further significant effects (*F*s < .72, *p*s > .40). Similarly, for the neutral condition, there was a significant main effect of Area Type, $F(1, 59) = 16.23$, $p < .001$, $\eta_p^2 = .22$, with faster first fixation to the central area (*M* = 1.00, *SD* = 1.46) compared to the peripheral area (*M* = 2.33, *SD* = 2.41). There were no further significant effects (*F*s < 3.47, *p*s > .06). However, for the negative/low condition, the results varied with attention. That is, the Area Type x Attention interaction, $F(1, 59) = 5.75$, $p = .020$, $\eta_p^2 = .09$ revealed that the time taken to first fixate on the peripheral area was faster in the full attention condition compared to the divided attention condition, $t(39.92) = 2.44$, $p = .019$, $d = .63$. For the central area, this pattern did not reach significance, $t(59) = 1.90$, $p = .063$, $d = .49$. These results do not indicate that salient information captures attention faster. Instead, the results suggest that there was early attentional capture for the central area in the negative/high and neutral pictures, regardless of the attention condition, and an early attention capture for the peripheral area in the full attention condition in the negative/low pictures.

For TFD, participants fixated more on the pictures in the full attention condition (*M* = 22.19, *SD* = 1.85) compared to the divided attention condition (*M* = 19.73, *SD* = 5.16), $F(1, 59) = 6.23$, $p = .015$, $\eta_p^2 = .10$. There were significant main effects of Picture Emotion, $F(2, 118) = 7.01$, $p = .001$, $\eta_p^2 = .11$, and Area Type, $F(1, 59) = 13.61$, $p < .001$, $\eta_p^2 = .19$, which were qualified by a significant interaction, $F(2, 118) = 89.93$, $p < .001$, $\eta_p^2 = .60$. Paired-samples t-tests on each level of Picture Emotion revealed that, for the negative/high condition, *t*(60) = -.69, *p* = .492, *d* = .16, there was no difference in TFD between the central and peripheral areas (central area: *M* = 19.35, *SD* = 8.93; peripheral area: *M* = 20.81, *SD* = 9.81). However, for the negative/low condition, *t*(60) = 12.71, *p* < .001, *d* = 2.79, participants fixated more on the central area (*M* = 33.87, *SD* = 10.03) compared to the peripheral area (*M* = 10.04, *SD* = 6.75). An opposite pattern was found for the neutral condition (central area: *M* = 18.08, *SD* = 8.63; peripheral area: *M* = 23.72, *SD* = 10.68), *t*(60) = -2.64, *p* = .011, *d* = .58. Overall, there was no clear evidence that participants attend to the arousing emotional information more than non-arousing information (Easterbrook, 1959; Loftus et al., 1987).

Table 10. *Mean and standard deviations for eye tracking measures as a function of picture emotion, area type, and attention.*

Attention	Full Attention				Divided Attention			
Area Type	Central		Peripheral		Central		Peripheral	
	M	SD	M	SD	M	SD	M	SD
Time to First Fixation								
Negative/High	.82	1.61	1.38	.85	.88	.90	1.65	1.25
Negative/Low	.41	.15	3.21	2.04	.48	.15	5.43	4.55
Neutral	.68	.84	1.93	1.28	1.32	1.87	2.72	3.16
Total Fixation Duration								
Negative/High	22.07	8.24	19.52	7.03	16.54	8.87	22.14	12.01
Negative/Low	35.49	7.77	10.55	6.11	32.19	11.84	9.52	7.41
Neutral	19.54	6.17	25.96	7.85	16.56	10.49	21.41	12.70

Note. M and SD refer to Mean and Standard Deviation, respectively.

To *specifically* explore the direct link between visual attention and the endorsement of misinformation, Pearson Product-Moment Correlation Coefficients was conducted between TFD[12] and the recognition test responses for the misleading and control details[13]. Within each picture emotion condition, True responses to specific details (misleading/central, misleading/peripheral, control/central, control/peripheral, misleading [overall], and control [overall]) were correlated with the appropriate eye movement data (e.g., the endorsement of misleading/peripheral details were correlated with the TFD for these peripheral details). Although the key interest was the relationship between visual attention and the endorsement of misleading details, control details were also analysed for comparison. These emotion-specific attention-memory relationships were explored overall (i.e., collapsed across attention conditions) and separately within each attention condition. See Table 11 for all correlation coefficients. In general, correlational analysis showed mixed results, with no conclusive evidence of a relationship between visual overt attention and later recognition of misleading information. There were no significant relationships between the endorsement of the misleading details (overall and separated by Detail Type) and TFD in each emotion condition. This was the case overall (i.e., collapsed across attention conditions) and within each attention condition. As for the control details, collapsed across attention conditions, an increase in TFD on central details was related to a decrease in the endorsement of control central details in the negative/low condition (r = -.253, p = .049, N = 61). In the divided attention condition, an

[12] No correlational analysis was performed between TTFF and the recognition responses due to several empty cells where participants had not looked directly at some of the test details (e.g., misleading/peripheral details) in one or both pictures in a picture emotion condition.

[13] The number of participants was not the same for all correlations. First, before running the analysis, if a participant failed to hit the AOI around the fixation cross for one of the pictures in a picture emotion condition, all data from that condition was removed. This was because a correlation cannot take place between eye movement data from one picture with recognition data that is an average of both pictures. Second, the five participants who were removed in the previous eye tracking analysis were kept in this analysis. This was because these participants would not appear in correlations where they failed at least one fixation cross in a condition but can appear in the analysis for other picture emotion conditions where they passed both fixation crosses.

increase in the TFD on the peripheral details from the negative/low pictures correlated with a decrease in the endorsement of control peripheral details ($r = -.556$, $p = .001$, $N = 30$).

Table 11. *Pearson Product-Moment Correlation Coefficients between the total fixation duration on the recognition of misleading and control details*

Comparison		Picture Emotion		
TFD	Item	Negative/High	Negative/Low	Neutral
			Overall	
Misleading Central	Misleading Central	-.122	.032	-.064
Misleading Peripheral	Misleading Peripheral	.175	.145	-.193
Control Central	Control Central	-.046	-.253*	.245
Control Peripheral	Control Peripheral	-.152	-.009	.212
Misleading	Misleading	-.046	.031	-.043
Control	Control	-.023	-.121	.192
			Divided Attention	
Misleading Central	Misleading Central	-.096	.249	-.155
Misleading Peripheral	Misleading Peripheral	.111	-.046	-.164
Control Central	Control Central	-.168	-.278	.302
Control Peripheral	Control Peripheral	-.205	-.556**	.212
Misleading	Misleading	.108	.051	-.256
Control	Control	-.074	-.322	.298
			Full Attention	
Misleading Central	Misleading Central	-.127	-.271	.030
Misleading Peripheral	Misleading Peripheral	.212	.353	-.305
Control Central	Control Central	.139	-.311	.253
Control Peripheral	Control Peripheral	-.065	.181	.211
Misleading	Misleading	-.189	-.050	.159
Control	Control	.092	-.146	.118

Note. TFD = Total Fixation Duration. *$p < .05$, **$p < .01$.

3.2.3 Summary of Experiment 1

In Experiment 1, misleading information had an impact on memory performance as demonstrated by the robust standard misinformation effect. Also, participants vividly remembered, and had a sense of familiarity with, the misleading details over control details. This has been demonstrated in previous research (e.g., Frost, 2000; Roediger et al., 1996; Saunders & Jess, 2010). However, the study did not provide evidence that divided attention had a differential effect than full attention on the false recognition of misleading central and peripheral details for negative and neutral events. An effect of attention was only found with *remembered* experiences, but this was for all false details and regardless of event emotion. Furthermore, the level of attention at encoding (indicated by total fixation duration) did not relate to the endorsement of suggested misleading information in negative and neutral conditions. For correct recognition, there was no clear evidence of an emotional memory narrowing effect in terms of valence and arousal due to similar results in the negative/high and neutral conditions. Eye-fixation data further did not support the explanation that emotional arousal narrows attentional resources to central information (Easterbrook, 1959). All findings are discussed in the General Discussion of this chapter together with the findings from the following experiments.

A noteworthy consideration for this study pertains to the potential impact of the attention manipulation employed, as it did not yield any discernible effect on the endorsement of misleading information across pictures. Although the random number generation task is recognised as attention-demanding, participants had a full 30 seconds to look at the details within each picture. In Experiment 2, this issue was addressed by varying the presentation duration of the pictures, a method that has been used in previous research to manipulate attention given to target stimuli and has been shown to impact memory performance (e.g., Clark-Foos & Marsh, 2008; Hellenthal et al., 2019).

3.3 Experiment 2

Although there are studies that have shown the detrimental impact of divided attention on memory performance (e.g., Craik et al., 1996; Naveh-Benjamin et al., 2000), how this translates to the endorsement of misleading information across negative and neutral events remained to be seen. In Experiment 1, there was no evidence that divided attention affected misinformation endorsement differently for negative and neutral events and central and peripheral details. Nevertheless, the role of attention in the misinformation paradigm was further investigated in Experiment 2. Due to the COVID-19 pandemic, data collection moved to online platforms. Consequently, including a secondary task on an online experiment would be difficult and thus could not continue. Therefore, in Experiment 2, another method for manipulating attention was explored, which may be considered a more controlled manipulation of attention. The divided attention task limits attentional resources at encoding by dividing their attention between the pictures and the secondary task. However, participants still have full time to encode the pictures. One issue here is individual differences, whereby participants' performance on the secondary task varies which can mean variation in attentional resources allocated to the encoding task. One way to control for this is to vary the presentation duration of the pictures to reduce attentional resources at the encoding stage of the paradigm. Such an approach to manipulate attention has been used in previous research, including false memory studies (e.g., Clark-Foos & Marsh, 2008; Dewhurst et al., 2005; Knott et al., 2018; Hellenthal et al., 2019). Therefore, will varying the presentation duration of the pictures uncover the possible differential impact of limited attention on the suggestibility of negative-emotional and neutral events? Experiment 2 set out to explore this. The hypotheses for this experiment remained similar to Experiment 1 (see pages 75-77), but with slow presentation duration (instead of full attention) and fast presentation duration (instead of divided attention).

3.3.1 Method

3.3.1.1 Participants

One hundred and eighty-six participants (age: $M = 35.20$, $SD = 12.37$, age range = 18 - 60; sex: 107 females, 78 males, & 1 other) completed the study in return for a small fee. An a priori power analysis using MorePower 6.0 indicated a required total sample size of between 32 and 80 for a medium to large effect size with Power 0.80. Significantly more participants were tested for two reasons: (1) Van Damme and Smets (2014) tested 53 participants, but Lane (2006) tested 144 participants, 72 in each attention condition, and (2) to account for data removal from failed attention checks. All participants had a normal or corrected-to-normal vision. All but four participants indicated not being colour-blind, and all but one participant had English as their first language. Participants were recruited via the online participant recruitment platform Prolific. All participants provided informed consent and were debriefed at the end of the experiment. The study was ethically approved by the City, University of London's Psychology Research Ethics Committee.

3.3.1.2 Design

The experiment had a four-way mixed design like Experiment 1 but with the following main changes. First, for each Picture Emotion condition, participants saw only one negative/high, one negative/low, and one neutral picture. Experiment 2 discontinued having two pictures in each picture emotion condition to shorten the overall duration of the online experiment. This remains in line with previous emotion and misinformation research using only one event per emotion condition (e.g., Peace & Constantin, 2016; Van Damme & Smets, 2014). Second, the presence of Misinformation (misled vs. control) was now a between-subjects variable, whereby there were four critical details (two central and two peripheral details) that were all either misleading or control. Third, attention was manipulated by varying the picture presentation duration. Presentation Duration was a between-subjects variable, whereby half of the participants were presented with the pictures for a short [1 second] duration and half with the pictures for a long [30 seconds] duration (see below for an explanation for the chosen durations). Participants were randomly assigned to one of four conditions: Misled + Short duration [n = 46], Misled + Long duration [n = 47], Control + Short duration [n = 46], and Control + Long duration [n = 47]. The dependent variables for the recognition data were the True response rates to misleading/control details and correct details and the recollective judgement (remember and know) rates for the recognition responses for these details.

The duration for picture presentation in the fast presentation condition was set at one second. The decision to have a one second presentation rate in the fast presentation condition comes from considering differences between durations in previous research. Frost and Weaver (1997) carried out a misinformation study in which participants viewed a slide show depicting a robbery, where the presentation rate of each slide was either 7-seconds or 4-seconds. They found that the presentation rate did not affect memory performance, nor the size of the misinformation effect. Although their difference between the presentation rates was small which may have resulted in not finding an effect of presentation duration, Experiment 2 aimed to use a fast picture presentation rate to be less than 4 seconds based on this finding. In a face recognition study, Reynolds and Pezdek (1992) found that memory for faces was better after a 20-second exposure duration compared to a 3-second exposure duration. Another face recognition study (Weirich et al., 2011) examined an even shorter duration. That is, faces were presented for either 1, 5, or 10 seconds, and a later recognition test revealed, as would be expected, that there was better face recognition memory with a 5-second duration than with a 1-second duration. The authors also employed a remember-know procedure which showed that, as duration increased, so did the proportion of remember responses. They suggested that a 1-second presentation time is long enough for a conscious representation of the face. This could be applied to the current study whereby a one second presentation may be enough for a conscious representation of the event (i.e., to identify the theme of the event). Furthermore, Szolosi et al. (2014) studied recognition memory for high- and low-mystery scenes and manipulated the presentation duration of the scenes (300ms, 1 second, 5 seconds, and 10 seconds). Although their results were more focused on differences between the two types of scenes, when looking at their overall memory results, there were small increases in correct recognition, but a general reduction in false alarm rates, as presentation duration increased. Moreover, using a remember-know procedure, as the amount of study time increased, participants were more likely to provide a remember response compared to a know response. Considering the above findings, a decision was made to present pictures for one second for those participants in the fast presentation condition. Such a duration was considered by the candidate (DS) and the supervisor (LK) to be appropriately fast that (1) may reveal differences in false recognition and recollective experience against the 30-second picture presentation rate and (2) be a sufficient duration for participants to at least extract the theme of the event, which was important for answering questions in the later stages.

3.3.1.3 Materials

Picture Characteristics. From Experiment One, three pictures (one from each Picture Emotion condition) were chosen as to-be-remembered events. The negative high-arousing event was an assault scene (IAPS number: 9254), the negative low-arousing event was a cemetery scene (IAPS number: 9220), and the neutral event was a restaurant scene (IAPS number: 2593). Using the valence and arousal ratings obtained from the Pilot, one-way repeated measure ANOVAs revealed significant differences in Valence, $F(2, 50) = 84.63$, $p < .001$, $\eta_p^2 = .77$, and Arousal, $F(2, 50) = 27.85$, $p < .001$, $\eta_p^2 = .53$, across the emotion conditions. Valence was significantly lower for both the negative high-arousing picture ($M = 1.92$, $SD = 1.20$; $p < .001$) and the negative low-arousing picture ($M = 2.81$, $SD = 1.17$; $p < .001$) compared to the neutral picture ($M =$

5.77, *SD* = 1.24). Valence was also significantly lower for the negative high-arousal picture compared to the negative low-arousal picture (p = 018). However, overall negative valence (negative-high + negative-low) was significantly lower than the neutral picture, $t(25) = -12.15$, $p < .001$, $d = 3.12$. Arousal was significantly lower for both the negative low-arousing picture ($M = 3.92$, $SD = 2.19$; $p < .001$) and the neutral picture ($M = 3.46$, $SD = 2.18$; $p < .001$) compared to the negative high-arousal picture ($M = 6.77$, $SD = 2.22$). Importantly, there was no significant difference between the two low-arousal pictures ($p = 1.00$), and overall low-arousal (negative-low + neutral) was significantly lower compared to the negative high-arousing picture, $t(25) = 7.85$, $p < .001$, $d = 1.54$.

Post-Event Questionnaire. The post-event questionnaire (titled "Perception Questionnaire" for the participants) consisted of eight Yes/No questions about each picture (i.e., 24 in total). For each picture, the questions were presented individually and in random order. For participants in the misled condition, four of the questions contained misleading information. The same four questions were given to participants in the control condition except that the misinformation was omitted, or the critical detail was described in a neutral form. See Appendix D for all the misleading/control questions included in the questionnaire. For example [bold is misleading], "Near the woman's **dark green** skirt, did you see the flower on the ground?" vs. "Near the woman's skirt, did you see the flower on the ground?". The remaining four questions contained correctly suggested details (i.e., consistent questions). An example is: "Did you see that the **button shirt** worn by the man in the foreground sitting on the right had long sleeves?". The consistent questions were the same for all participants. These questions were included primarily to mask the misleading questions in the misled condition. The misleading and consistent details were embedded in the questions and not the focus of the question answer[14]. For both the misleading/control and consistent questions, two targeted central information and two targeted peripheral information. The central and peripheral details were determined from Pilot 1, with the majority of the details having been used in Experiment 1.

Memory Test. The recognition test was a 48-item True/False test (16 statements per picture). The statements were presented individually and in random order. In total, there were 8 true statements and 8 false statements, a balanced approach that has been used in other false memory studies (e.g., Dalton & Daneman, 2006). For each picture, four statements referred to false *misleading/control details* that were either suggested (misled condition) or not suggested (control condition; see Appendix D for all these misleading test statements; e.g., "The woman's skirt was dark green"), four statements referred to *consistent details* previously suggested (e.g., "The man in the foreground sitting on the right wore a button shirt"), four statements referred to *correct details* not previously mentioned (e.g., "The injured man sitting on the right wore black shoes"), and four statements referred to *incorrect filler details* not previously mentioned to all participants (e.g., "The woman had her hair in a bun"). Each set of four contained two statements about central information and two statements about peripheral information.

[14] In Experiment 1, misleading information was the focus of most post-event questions (e.g. "Did you see the blue ***striped*** top the injured woman on the ground was wearing?"). Lee and Chen (2013) argued that target post-event information presented as a question may draw participants' attention to the critical details or may create an effect similar to the testing effect, in which taking a memory test improves later retention. The way misinformation appears in post-event questions has varied in past research (e.g., Van Damme & Smets, 2014; Porter et al., 2003, 2010; Segovia et al., 2015). However, the common approach tends to be to embed the misinformation in the question so that it appears as extra, narrative-like, information rather than being the focus of the question. For example, "Concerning the injured woman on the ground in the **striped** blue top, did you see that she was lying on her side propped up on one arm?" Here, the position in which she is on the ground is the focus of the question. Therefore, to be more consistent with past research and with Van Damme and Smets (2014) study, the misleading (and consistent) details were embedded in the post-event questions and not the focus of the questions.

A *True* response to a statement was followed by a Remember/Know/Guess recollective judgement response. The RKG instructions were similar to Experiment 1.

3.3.1.4 Procedure

Participants were told that the purpose of the study was to examine the manner in which people process emotional and neutral scenes. There was no explicit mention of a memory test. Also, they were asked to complete the study in a suitable quiet environment. After providing informed consent, participants completed the SAM questionnaire to assess their *current mood* (see Experiment One for more details on this questionnaire). After completion of the valence and arousal scales, participants were told that they will be shown some pictures. Participants in the short presentation condition were told that each picture will be presented for one second and that they must pay careful attention so as not to miss the picture. Participants in the long presentation duration condition were told each picture will remain on the screen for 30-seconds. Preceding each picture was a fixation cross for two seconds. The presentation order of the pictures was counterbalanced.

Once all pictures had been presented, there was a 10-minute interval during which time participants completed unrelated filler tasks (i.e., mathematical problems and unrelated anagrams). Thereafter, participants completed the self-paced post-event/perception questionnaire, where participants in the misled group were exposed to misleading information. They were not made aware of the discrepancies. The order of the sets of questions about each picture followed the picture presentation order at the encoding stage. After the post-event stage, there was another 10-minute interval during which time participants completed reasoning problems. Then all participants read the instructions for the recognition test, which was immediately followed by a comprehension check to determine participants' understanding of the distinction between remembering, knowing, and guessing. Participants had to drag the definitions of these terms into the correct box. Again, in the recognition test, the order of the set of questions for each picture followed the counterbalancing order of the pictures at the encoding stage.

All participants then provided demographic information, watched a short clip from a wildlife documentary, followed by a full debrief explaining the true purpose of the study and the use of deception.

3.3.2 Results

Eight participants were removed from all analyses due to indicating being colour-blind, not having English as their first language, having more than 90% *False* responses in the recognition test, having a technical issue, and/or failing more than one attention check[15]. The final sample consisted of 178 participants (M_{age} = 35.11, SD_{age} = 12.50, age range = 18 - 60; Sex: 103 females, 74 males, & 1 other). The following number of participants remained in each condition: Misled + Short duration [n = 44], Misled + Long duration [n = 45], Control + Short duration [n = 44], and Control + Long duration [n = 45]. Where additional participants were removed in a particular analysis, this has been indicated in a footnote.

Mood ratings were analysed to check for any mood effects (which we do not expect to see any). The main analysis included recognition and recollective experience responses (i.e., remember & know) to correct and misleading/control details. Like Experiment 1, Signal Detection Analysis was conducted to take into consideration participants' response bias in the recognition test. The statistical tests used to analyse the data are mentioned in the relevant sections below. Where the assumption of sphericity was violated, the Greenhouse-Geisser correction was reported. Bonferroni correction was applied to all t-tests and pairwise comparisons to reduce Type 1 errors.

[15] The picture presentation stage has two attention checks. A 'click me' button appeared immediately after the first and the second picture. Participants had 3 seconds to click on the button. Furthermore, one question in the post-event questionnaire asked participants to select 'Yes' to pass this attention check. Since the misinformation manipulation takes place at this stage, this was an important check. Participants who failed more than one attention check overall or failed the post-event questionnaire check were removed.

3.3.2.1 Mood Check

Across Presentation Duration and Misinformation conditions, independent-samples t-tests revealed no significant differences in valence ratings (Presentation Duration: $t(176) = -.29$, $p = .770$, $d = .04$; Misinformation: $t(176) = -.80$, $p = .423$, $d = .12$), and arousal ratings (Presentation Duration: $t(169.16) = -.14$, $p = .891$, $d = .02$; Misinformation: $t(176) = .90$, $p = .372$, $d = .13$) between the conditions. This indicates that participants' mood at the start of the experiment was relatively similar across the conditions.

3.3.2.2 Correct Recognition

For comparison to Experiment 1, the endorsement of the correct details was analysed. Table 12 presents the descriptive statistics for the endorsement and associated recollective experience judgements of the correct details. Recognition responses (those labelled as *true*, *remember*, and *know*) to correct details were analysed separately using a 3 (Picture Emotion: Negative/High vs. Negative/Low vs. Neutral) x 2 (Detail Type: Central vs. Peripheral) x 2 (Presentation Duration: Short vs. Long) mixed ANOVA, with between subjects on the last factor[16].

Analysis of *true* responses revealed a significant main effect of Presentation Duration, $F(1, 176) = 6.78$, $p = .01$, $\eta_p^2 = .04$, whereby accuracy was higher in the long presentation ($M = .55$, $SD = .17$) compared to the short presentation ($M = .49$, $SD = .16$) condition. There were significant main effects of Picture Emotion, $F(2, 352) = 25.16$, $p < .001$, $\eta_p^2 = .13$, and Detail Type, $F(1, 176) = 58.96$, $p < .001$, $\eta_p^2 = .25$, which were qualified by a significant interaction, $F(1.93, 340.45) = 17.60$, $p < .001$, $\eta_p^2 = .09$. Paired-samples t-tests revealed that for the negative/high picture, $t(177) = 10.56$, $p < .001$, $d = 1.05$, and the negative/low picture, $t(177) = 3.63$, $p < .001$, $d = .40$, accuracy was higher for central details (negative/high: $M = .76$, $SD = .29$; negative/low: $M = .52$, $SD = .36$) compared to peripheral details (negative/high: $M = .44$,

[16] There were no interactions with the 'Misinformation' factor. As such, the reported analysis excludes this factor.

SD = .31; negative/low: *M* = .38, *SD* = .33). No difference was found for the neutral picture (central: *M* = .53, *SD* = .34; peripheral: *M* = .49, *SD* = .37), *t*(177) = 1.33, *p* = .184, *d* = .14. This suggests that memory for central information was enhanced more than peripheral information in negatively-valenced events regardless of the level of arousal.

There was also a significant Picture Emotion x Presentation Duration interaction, *F*(2, 352) = 3.28, *p* = .039, η_p^2 = .02. Bonferroni-corrected Independent-samples t-tests (alpha set at .016) revealed that there was no difference in accuracy between the Presentation Duration conditions for the negative/high picture, *t*(176) = -.18, *p* = .855, *d* = .03. For the negative/low picture, *t*(176) = -2.25, *p* = .026, *d* = .34, there was a trend such that accuracy dropped in the short duration condition (*M* = .41, *SD* = .23) compared to the long duration condition (*M* = .49, *SD* = .22). However, this difference was not significant when Bonferroni correction was applied. For the neutral picture, *t*(176) = -2.99, *p* = .003, *d* = .45, accuracy was higher in the long presentation condition (*M* = .57, *SD* = .26) compared to the short presentation condition (neutral: *M* = .45, *SD* = .25). Furthermore, there was a significant Detail Type x Presentation Duration interaction, *F*(1, 176) = 18.22, *p* < .001, η_p^2 = .09. For central details, there was no significant difference in accuracy between the presentation duration conditions, *t*(176) = .78, *p* = .437, *d* = .12. However, for peripheral details, accuracy dropped in the short duration condition (*M* = .36, *SD* = .21) compared to the long duration condition (*M* = .51, *SD* = .22), *t*(176) = -4.87, *p* < .001, *d* = .73.

For *remember* responses[17], there was a significant main effect of Presentation Duration, *F*(1, 104) = 8.65, *p* = .004, η_p^2 = .08, whereby more remember responses were made in the long presentation (*M* = .17, *SD* = .12) compared to the short presentation (*M* = .10, *SD* = .11) condition. There were also significant main effects of Picture Emotion, *F*(2, 208) = 3.61, *p* =

[17] Due to 40% (72/178) of the final sample failing the *remember/know/guess* comprehension check, these participants were removed from the analysis. Due to the low sample size, caution is appropriate when drawing conclusions from the remember/know data.

.029, η_p^2 = .03, and Detail Type, *F*(1, 104) = 4.09, *p* = .046, η_p^2 = .04, both qualified by a significant interaction, *F*(2, 208) = 9.19, *p* < .001, η_p^2 = .08. Paired-samples t-tests revealed that, for the negative/high picture, participants *remembered* more central details (*M* = .24, *SD* = .30) compared to peripheral details (*M* = .09, *SD* = .22), *t*(105) = 4.28, *p* < .001, *d* = .56. No central-peripheral difference was found for the negative/low picture (central: *M* = .10, *SD* = .22; peripheral: *M* = .12, *SD* = .22), *t*(105) = -.48, *p* = .633, *d* = .06, and the neutral picture (central: *M* = .13, *SD* = .23; peripheral: *M* = .15, *SD* = .26), *t*(105) = -.55, *p* = .582, *d* = .08. This suggests that, although memory for central details was better for both negative pictures, vivid recollection of central details only pertains to the arousing negative event. Furthermore, there was also a significant Detail Type x Presentation Duration interaction, *F*(1, 104) = 8.41, *p* = .005, η_p^2 = .08. Similar to *true* responses, remember response rates for central details did not vary across presentation duration conditions, *t*(104) = -.22, *p* = .823, *d* = .04, but was significantly lower for peripheral details in the short duration condition (*M* = .05, *SD* = .09) compared to the long duration condition (*M* = .18, *SD* = .17), *t*(85.45) = -4.71, *p* < .001, *d* = .89.

For *know* responses, there was a significant main effect of Detail Type, *F*(1, 104) = 12.15, *p* = .001, η_p^2 = .11, whereby know responses were assigned more to central details (*M* = .22, *SD* = .21) compared to peripheral details (*M* = .14, *SD* = .15). Furthermore, a Picture Emotion x Presentation Duration approached significance, *F*(2, 208) = 3.01, *p* = .052, η_p^2 = .03. Independent samples t-tests revealed that for both the negative/high picture, *t*(104) = -.71, *p* = .480, *d* = .14, and the negative/low picture, *t*(104) = .24, *p* = .810, *d* = .05, there was no difference in the proportion of know responses between the Presentation Duration conditions. However, for the neutral picture, *t*(104) = -2.85, *p* = .005, *d* = .55, more know responses were made in the long presentation duration condition (*M* = .23, *SD* = .22) compared to the short presentation duration condition (*M* = .13, *SD* = .16). This suggests that presentation duration only impacted familiarity judgements in the neutral event.

Table 12. *Mean proportions and standard deviations for the correct endorsements and associated recollective experience of the correct details as a function of picture emotion, detail type, and presentation duration.*

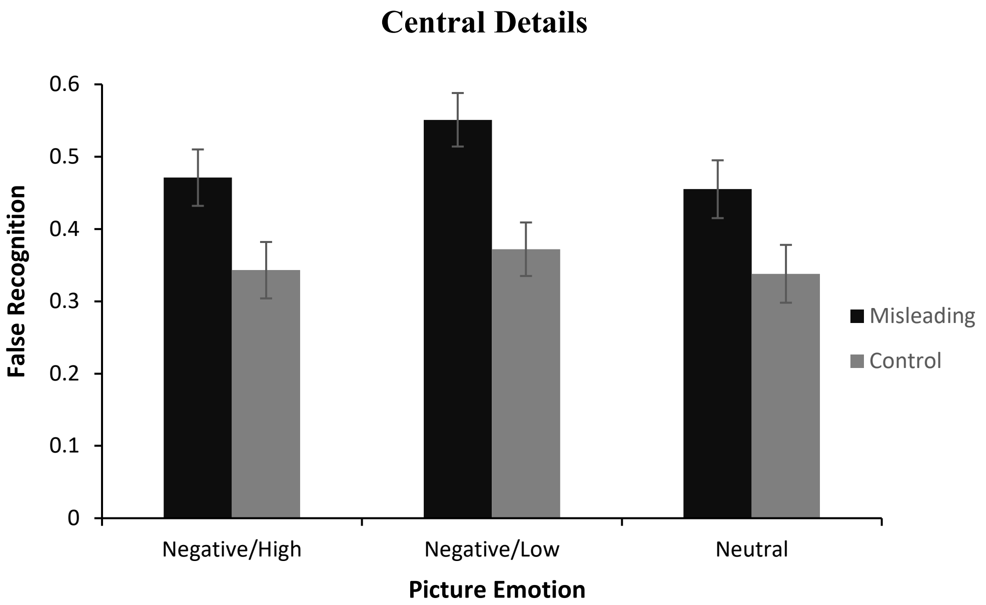
Presentation Duration	Long [30s] Presentation				Short [1s] Presentation			
Detail Type	Central		Peripheral		Central		Peripheral	
	M	SD	M	SD	M	SD	M	SD
				True Response				
Negative/High	.73	.28	.48	.33	.78	.29	.41	.29
Negative/Low	.49	.35	.48	.31	.54	.37	.28	.32
Neutral	.54	.35	.59	.36	.52	.34	.38	.35
				Remember Response				
Negative/High	.24	.27	.14	.26	.24	.34	.04	.14
Negative/Low	.13	.24	.20	.26	.08	.19	.03	.12
Neutral	.12	.21	.20	.30	.14	.25	.09	.19
				Know Response				
Negative/High	.25	.30	.17	.27	.24	.32	.12	.24
Negative/Low	.18	.26	.13	.22	.26	.34	.06	.16
Neutral	.25	.32	.21	.30	.13	.24	.12	.24

Note. M and SD refer to Mean and Standard Deviation, respectively.

3.3.2.3 False Recognition

Tables 13 and 14 present the mean proportions and standard deviations for the endorsement of the misleading and control details and associated recollective experience (remember and know) judgements. False recognition responses (those labelled *true*, *remember*, and *know* judgements) to misleading and control details were analysed separately using a 3 (Picture Emotion: Negative/High vs. Negative/Low vs. Neutral) x 2 (Detail Type: Central vs. Peripheral) x 2 (Misinformation: Misled vs. Control) x 2 (Presentation Duration: Short vs. Long) mixed-factors ANOVA, with between subjects on the last two factors.

Analysis of the *true* responses revealed that participants in the misled condition (M = .48, SD = .24) endorsed the false details more than those in the control condition (M = .37, SD = .18), $F(1, 174) = 12.44$, $p = .001$, $\eta_p^2 = .07$. There was also a significant main effect of Picture Emotion, $F(2, 348) = 13.13$, $p < .001$, $\eta_p^2 = .07$, but not Detail Type, $F(1, 174) = .08$, $p = .783$, $\eta_p^2 = .0004$. However, the three main effects were qualified by a significant interaction (see Figure 2), $F(2, 348) = 3.31$, $p = .038$, $\eta_p^2 = .02$. There were no further significant results (Fs < 2.76; ps > .098). To enable a comparison with Van Damme and Smets (2014) finding, a Picture Emotion x Misinformation ANOVA was conducted on central and peripheral details separately. For central false details, there was only a significant main effect of Misinformation, $F(1, 176) = 14.00$, $p < .001$, $\eta_p^2 = .07$, whereby more false central details were endorsed in the misled group (M = .49, SD = .28) compared to the control group (M = .35, SD = .23). Due to no interaction effect, the size of the misinformation effect was therefore similar for each level of Picture Emotion. For peripheral false details, however, the main effects of Picture Emotion, $F(2, 352) = 12.99$, $p < .001$, $\eta_p^2 = .07$, and Misinformation, $F(1, 176) = 4.97$, $p = .027$, $\eta_p^2 = .03$, were qualified by a significant interaction, $F(2, 352) = 5.59$, $p = .004$, $\eta_p^2 = .03$. Independent-samples t-tests revealed no misinformation effect for the negative/high picture (misled: M = .40, SD = .39; control: M = .42, SD = .35), $t(176) = -.31$, $p = .760$, $d = .05$, and the negative/low picture (misled: M = .55, SD = .41; control: M = .49, SD = .35), $t(171.54) = 1.09$, $p = .276$, $d = .16$. However, for the neutral picture, participants endorsed more false peripheral details in the misled group (M = .46, SD = .36) compared to the control group (M = .25, SD = .27), $t(176) = 4.23$, $p < .001$, $d = .63$. Regardless of the presentation duration, participants were vulnerable to misleading central information for all pictures, whereas a misinformation effect for peripheral information was found only for the neutral picture. The finding is discussed in the General Discussion of this chapter.



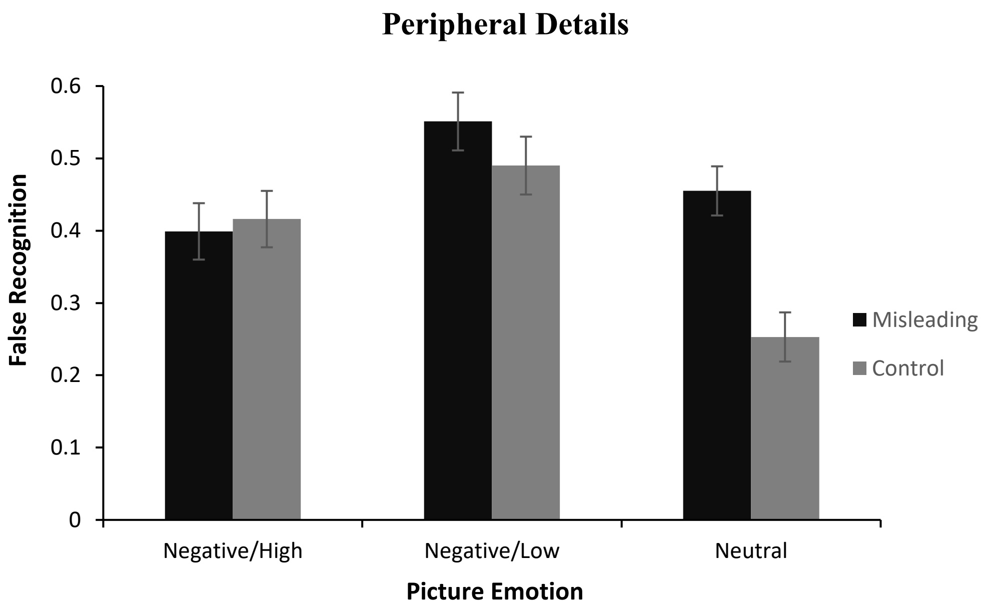


Figure 2. The proportion of false recognition for central and peripheral details as a function of Picture Emotion and Misinformation (Error bars represent the standard error).

Table 13. *Mean proportions and standard deviations for the false recognition of the misleading details as a function of picture emotion, detail type, misinformation, and presentation duration.*

Presentation Duration	Short [1s] Presentation				Long [30s] Presentation			
Misinformation	Misled		Control[a]		Misled		Control[a]	
	M	SD	M	SD	M	SD	M	SD
Central Details								
Negative/High	.42	.39	.40	.35	.52	.37	.29	.36
Negative/Low	.55	.35	.44	.31	.56	.40	.30	.33
Neutral	.46	.42	.41	.38	.46	.41	.27	.27
Peripheral Details								
Negative/High	.40	.37	.40	.35	.40	.41	.43	.35
Negative/Low	.55	.39	.57	.35	.56	.43	.41	.32
Neutral	.46	.35	.25	.27	.46	.37	.26	.27

Note. M and SD refer to Mean and Standard Deviation, respectively.
[a] Participants in the control group produced memory errors by endorsing details that were "misinformation" details for the misled group.

For false *remember* responses, the misled group (M = .09, SD = .13) produced more remember responses compared to the control group (M = .04, SD = .08), $F(1, 102) = 5.70$, p = .019, $\eta_p^2 = .05$. Participants also vividly remembered more false details from the negative/low picture (M = .09, SD = .15; $p < .001$) and the negative/high picture (M = .07, SD = .15; p = .05) compared to the neutral picture (M = .04, SD = .14), $F(2, 204) = 7.40$, p = .001, $\eta_p^2 = .07$. Furthermore, there was a significant Detail Type x Misinformation interaction, $F(1, 102)$ = 6.37, p = .013, $\eta_p^2 = .06$. This revealed that, for central details, false remembering was greater in the misled group (M = .12, SD = .16) compared to the control group (M = .03, SD = .08), $t(81.72) = 3.38$, p = .001, d = .64, but not for peripheral details, $t(104) = .99$, p = .323, d = .19.

For false *know* responses, there was a significant Picture Emotion x Presentation Duration interaction, $F(2, 204) = 3.21$, p = .042, $\eta_p^2 = .03$. Differences in *know* responses across picture emotion conditions was found only in the short presentation condition, $F(2, 98) = 3.24$,

p = .044, η_p^2 = .06. Bonferroni pairwise comparisons revealed that familiarity for the false details was significantly greater for the negative/low picture (M = .21, SD = .26) compared to the neutral picture (M = .13, SD = .17; p = .047). There were no further significant comparisons (ps > .39). There was also a significant Presentation Duration x Misinformation interaction, $F(1, 102)$ = 4.38, p = .039, η_p^2 = .04, but simple main effects using t-tests did not survive Bonferroni Correction.

Overall, the recollective experience data revealed that participants vividly remembered suggested false details more than non-suggested false details, and this pattern was further found for central details, but not for peripheral details. Regardless of prior exposure to misinformation, false remembering was greater for the negative pictures compared to the neutral picture. Furthermore, *remember* responses did not vary with presentation duration, but *know* responses did, such that only in the short duration condition was familiarity greater for the negative/low picture than the neutral picture, again irrespective of prior misinformation exposure. However, the theoretical reason behind this latter finding is unclear.

Table 14. *Mean proportions and standard deviations for remember and know recollective judgements for endorsed misleading details as a function of picture emotion, detail type, misinformation, and presentation duration.*

Presentation Duration	Short [1s] Presentation				Long [30s] Presentation			
Misinformation	Misled		Control		Misled		Control	
	M	SD	M	SD	M	SD	M	SD
				Remember Response				
Central Details								
Negative/High	.10	.20	.04	.14	.17	.28	.04	.13
Negative/Low	.14	.27	.08	.19	.16	.24	.02	.10
Neutral	.08	.23	.02	.10	.05	.20	.00	.00
Peripheral Details								
Negative/High	.04	.20	.02	.10	.09	.19	.07	.23
Negative/Low	.08	.18	.08	.24	.10	.21	.07	.23
Neutral	.06	.16	.00	.00	.05	.20	.02	.10
				Know Response				
Central Details								
Negative/High	.14	.27	.19	.29	.24	.32	.11	.29
Negative/Low	.23	.32	.21	.29	.19	.25	.15	.23
Neutral	.08	.18	.19	.32	.19	.28	.13	.22
Peripheral Details								
Negative/High	.15	.27	.15	.28	.10	.21	.07	.18
Negative/Low	.15	.31	.25	.36	.22	.29	.09	.20
Neutral	.12	.21	.13	.22	.29	.34	.13	.22

Note. M and SD refer to Mean and Standard Deviation, respectively.

3.3.2.4 Signal Detection Measure

Like Experiment 1, signal detection parameters *d'* and *C* (Snodgrass & Corwin, 1988) were computed for correct details against the endorsement of misleading and control details. The parameters were analysed separately using the four-way mixed ANOVA as in the false recognition analysis. See Experiment 1 for details on the calculation method and parameter interpretations. Table 15 summarises the means and standard deviations for *d'* and *C*.

Discriminability (*d'*). Discrimination of the correct detail was better in the control group (M = .32, SD = .40) compared to the misled group (M = .05, SD = .37), $F(1, 174)$ = 23.40, p < .001, η_p^2 = .12. There were also a significant main effect of Presentation duration, *F*(1, 174) = 11.32, $p < .001$, $\eta_p^2 = .06$, whereby discriminability was better in the long presentation duration condition (*M* = .28, *SD* = .45) compared to the short presentation duration condition (*M* = .09, *SD* = .35). There were significant main effects of Picture Emotion, *F*(2, 348) = 28.59, $p < .001$, $\eta_p^2 = .14$, and Detail Type, *F*(1, 174) = 41.78, $p < .001$, $\eta_p^2 = .19$, which were both qualified by a significant interaction, *F*(2, 348) = 14.47, $p < .001$, $\eta_p^2 = .08$. Paired-samples t-tests revealed that for both the negative/high picture, *t*(177) = 7.37, $p < .001$, *d* = .75, and the negative/low picture, *t*(177) = 4.38, $p < .001$, *d* = .43, participants were better able to discriminate correct central details (negative/high: *M* = .67, *SD* = .79; negative/low: *M* = .11, *SD* = .83) compared to correct peripheral details (negative/high: *M* = .07, *SD* = .82; negative/low: *M* = -.27, *SD* = .93). No difference was found for the neutral picture (central: *M* = .27, *SD* = .81; peripheral: *M* = .26, *SD* = .89), *t*(177) = .13, *p* = .894, *d* = .01.

There was also a significant Picture Emotion x Presentation Duration interaction, *F*(2, 348) = 3.54, *p* = .03, $\eta_p^2 = .02$. Independent-samples t-tests revealed that discriminability was not affected by Presentation Duration conditions for the negative/high picture, *t*(176) = .03, *p* = .974, *d* = .005. However, for the negative/low picture, *t*(176) = -2.92, *p* = .004, *d* = .44, and the neutral picture, *t*(176) = -3.02, *p* = .003, *d* = .45, discriminability was better in the long presentation duration condition (negative/low: *M* = .06, *SD* = .66; neutral: *M* = .40, *SD* = .70) compared to the short presentation duration condition (negative/low: *M* = -.23, *SD* = .64; neutral: *M* = .12, *SD* = .56). Furthermore, Detail Type also interacted with Presentation Duration, *F*(1, 174) = 8.52, *p* = .004, $\eta_p^2 = .05$. This was driven by patterns within Detail Type. That is, for central details, there was no significant difference in the discrimination of the correct detail from the incorrect detail between the Presentation Duration conditions, *t*(176) = -.51, *p* = .613, *d* = .08. However, for peripheral details, discriminability was better in the long presentation duration condition (*M* = .19, *SD* = .55) compared to the short presentation duration condition (*M* = -.15, *SD* = .52), *t*(176) = -4.22, $p < .001$, *d* = .63.

There was a significant Picture Emotion x Detail Type x Misinformation interaction, $F(2, 348) = 5.09$, $p = .007$, $\eta_p^2 = .03$, which was decomposed in a similar manner to the false recognition analysis. For central details, there was a significant main effect of Picture Emotion, $F(2, 352) = 25.71$, $p < .001$, $\eta_p^2 = .13$, whereby discriminability was better for the negative/high picture (*M* = .67, *SD* = .79) compared to the negative/low (*M* = .11, *SD* = .83; $p < .001$) and neutral (*M* = .27, *SD* = .81; $p < .001$) pictures. There was no difference between the latter two ($p = .192$). There was also a significant main effect of Misinformation, $F(1, 176) = 12.49$, $p = .001$, $\eta_p^2 = .07$. Participants were better able to discriminate the correct detail from the incorrect detail in the control condition (*M* = .48, *SD* = .53) than in the misled condition (*M* = .22, *SD* = .46). There was no interaction effect, $F(2, 352) = .59$, $p = .554$, $\eta_p^2 = .003$, suggesting that the effect of misinformation on the ability to discriminate the correct detail from the incorrect detail was similar for each picture. For peripheral details, there was a significant main effect of Picture Emotion, $F(2, 352) = 19.01$, $p < .001$, $\eta_p^2 = .10$, and Misinformation, $F(1, 176) = 11.91$, $p = .001$, $\eta_p^2 = .06$, which were both qualified by a significant interaction, $F(2, 352) = 4.73$, $p = .009$, $\eta_p^2 = .03$. Independent samples t-tests revealed that discriminability was better in the control condition (*M* = .54, *SD* = .73) than in the misleading condition (*M* = -.03, *SD* = .94) for the neutral picture, $t(176) = -4.57$, $p < .001$, $d = .69$, No difference was found for the negative/high, $t(176) = -.44$, $p = .661$, $d = .07$, and negative/low, $t(176) = -1.57$, $p = .117$, $d = .24$, pictures.

Response bias (*C*). Analysis revealed no significant main effect of Misinformation, $F(1, 174) = 2.78$, $p = .097$, $\eta_p^2 = .02$, but there was an expected trend such that participants were more liberal in their responses in the misled condition (*M* = .02, *SD* = .36) compared to the control condition (*M* = .10, *SD* = .27). Unlike Experiment 1, there was a significant main effects of Picture Emotion, $F(2, 348) = 7.81$, $p < .001$, $\eta_p^2 = .04$, which showed a more liberal response bias associated with the negative/high picture (*M* = -.01, *SD* = .40) compared to the neutral picture (*M* = .11, *SD* = .41; $p < .001$), with no further significant comparisons (*p*s > .09). Since Picture Emotion did not interact with the Misinformation variable, this suggests that the emotion pattern was similar in both misleading and control groups. This could be attributed to an enhanced memory for details from the negative arousing picture than the neutral picture, with a potential stronger bias in the misleading condition due to vivid recollection of the suggested misleading details at test.

There was a significant Detail Type main effect, $F(1, 174) = 25.78$, $p < .001$, $\eta_p^2 = .13$, and a Detail Type x Picture Emotion interaction, $F(2, 348) = 6.25$, $p = .002$, $\eta_p^2 = .04$. Paired-samples t-tests revealed that, for the negative/high picture, $t(177) = -6.33$, $p < .001$, $d = .59$, a more liberal response bias was associated to central details (*M* = -.16, *SD* = .51) compared to peripheral details (*M* = .14, *SD* = .51). However, no significant difference was found for the negative/low picture (central: *M* = .02, *SD* = .56; peripheral: *M* = .10, *SD* = .50), $t(177) = -1.35$, $p = .180$, $d = .14$, and the neutral picture (central: *M* = .07, *SD* = .57; peripheral: *M* = .15, *SD* = .51), $t(177) = -1.66$, $p = .099$, $d = .16$. Furthermore, there was a significant Detail Type x Presentation Duration interaction, $F(1, 174) = 11.47$, $p < .001$, $\eta_p^2 = .06$. For central details, there was no significant difference in response bias between the presentation duration conditions, $t(176) = -1.19$, $p = .236$, $d = .18$. However, for peripheral details, participants were more liberal in their responses in the long duration condition (*M* = .06, *SD* = .37) compared to the short duration condition (*M* = .20, *SD* = .36), $t(176) = 2.51$, $p = .013$, $d = .39$.

Overall, the discrimination data largely followed the recognition findings. Participants were better able to discriminate the correct detail from the false detail in the control group compared to misleading group. In line with false recognition, this misinformation pattern was found for central details regardless of picture emotion. but was found for peripheral details only associated with the neutral picture. Discriminability for correct central details was better than for correct peripheral details associated with the negative pictures, but not with the neutral picture. Furthermore, discriminability was better in the long presentation duration condition compared to the short presentation duration condition. This pattern was further only found for the negative/low and neutral pictures (not negative/high), and for peripheral not central details.

As for response bias, participants were more liberal in their responses in the misled condition compared to the control condition, which suggests that the misinformation effect found in the study may be attributed to the use of a lenient criterion when making *True* responses to misleading details. However, response bias results also revealed different patterns to false recognition. Participants adopted a more liberal response bias associated with the negative/high picture compared to the neutral picture, a pattern that was similar for both the misleading and control groups. Furthermore, participants were more liberal in their responses associated with central details compared to peripheral details. This detail type pattern was further found only for the negative/high picture (possibly due to the salience and stronger memory of the central details and central misinformation associated with an arousing event). Moreover, a liberal response bias for peripheral details was greater in the long presentation duration condition, but no difference across conditions for central details. This may be attributed to an increased rejection of the correct details due to poor memory for peripheral details when picture exposure duration is short.

Table 15. *Signal detection measures of Discriminability (d') and Criterion Bias (C) for correct details against false details (misleading and control details) as a function of picture emotion, detail type, misinformation, and presentation duration.*

Presentation Duration	Short [1s] Presentation				Long [30s] Presentation			
Misinformation	Misled		Control		Misled		Control	
	M	SD	M	SD	M	SD	M	SD
				Discriminability (*d*')				
Central Details								
Negative/High	.59	.79	.86	.76	.43	.81	.82	.74
Negative/Low	.07	.84	.11	.81	-.15	.82	.41	.79
Neutral	.13	.77	.22	.75	.24	.93	.47	.76
Peripheral Details								
Negative/High	.00	.72	.04	.86	.09	.92	.15	.80
Negative/Low	-.62	.86	-.46	.97	-.15	.87	.13	.84
Neutral	-.29	.85	.40	.70	.22	.96	.69	.73
				Response Bias (*C*)				
Central Details								
Negative/High	-.14	.56	-.23	.46	-.26	.48	.00	.52
Negative/Low	-.12	.54	.06	.52	-.03	.62	.18	.50
Neutral	.02	.66	.07	.55	-.03	.56	.22	.50
Peripheral Details								
Negative/High	.20	.54	.18	.44	.15	.54	.05	.52
Negative/Low	.22	.51	.10	.46	-.03	.55	.11	.48
Neutral	.23	.48	.29	.52	-.02	.55	.13	.44

Note. M and SD refer to Mean and Standard Deviation, respectively.

3.3.3 Summary of Experiment 2

Experiment 2 showed that for the misinformation effect was found for central details regardless of event emotion, whereas the effect of misleading information on peripheral details was found only for the neutral picture. However, these results did not vary with presentation duration. Thus, despite changing the attention manipulation method at encoding, the outcome continued to be that the level of attention at encoding does not impact the endorsement rates of misinformation for negative and neutral events. Experiment 2 did show that the short presentation duration led to a decrease in overall accuracy for the correct details, as expected. However, in both experiments, overall false recognition rates of misleading information did not significantly change across the presentation duration conditions. Based on previous research (e.g., Lane, 2006) it would be expected that the endorsement of misleading details would increase under reduced attention conditions.

Unlike Experiment 1, evidence of emotional memory narrowing was found, whereby memory for central details was better than for peripheral details within both negatively valenced events, with no central-peripheral difference found for the neutral event. Discrimination analysis also showed that only for the negative pictures were participants better able to discriminate the correct central details than the correct peripheral details. However, participants *vividly* remembered central details more than peripheral details only in the negative/high picture, supporting research showing that emotion and high arousal enhance the subjective sense of remembering (e.g., Pérez-Mata et al., 2012; Rimmele et al., 2011; Sharot et al., 2007).

Two further findings pertaining to correct recognition can be briefly commented on. First, it can be assumed that participants would rely more on less discriminative characteristics, such as familiarity, in the short duration condition because of poor memory for the event (Lane, 2006). This was not the case for the negative pictures because familiarity judgements did not change across presentation duration conditions (whereas remember responses reduced in the short duration condition, though regardless of picture emotion). The finding that know responses were unaffected by the attention condition at encoding supports some previous research (e.g., Dewhurst et al., 2007; Gardiner & Parkin, 1990). Thus, manipulating attentional resources during encoding has an impact on recollection but not familiarity. However, for the neutral picture, participants relied more on familiarity (i.e., know responses increased) in the long duration condition than in the short duration condition. This does not follow the automaticity of familiarity judgements (McCabe et al., 2011; Yonelinas, 2002) nor Lane's (2006) assumption. However, this finding supports research showing that familiarity judgements increase when attentional resources are undisrupted (Knott et al., 2018). It remains unclear why the negative pictures produced a different finding to the neutral picture. Though, as mentioned before, the remember-know analysis was based on a smaller sample size so the interpretation and conclusion of the findings should be made with caution. Nevertheless, future research can investigate recollection experience with emotional stimuli further. Second, there was no change in accuracy for central details across the presentation duration conditions. However, accuracy dropped for peripheral details in the short duration condition. Vivid recollective experience (i.e., remember responses) and discriminability analysis mirrored these results. This finding could be due to attention being directed initially to the main/central event, leaving little time to explore the scene in the short duration condition, thereby decreasing peripheral memory.

Overall, back to the main aim of the experiment, from Experiments 1 and 2, it could be concluded that false recognition of misleading information for negative and neutral events is not influenced by the level of attention during event encoding. However, emotion and misinformation studies have large heterogeneity in their methodology which have been shown to produce different outcomes (Sharma et al., 2022) and it is plausible to assume that this may also be the case regarding the impact of reduced attention on suggestibility. This is explored further in Experiment 3 by specifically changing the type of recognition test.

3.4 Experiment 3

Despite the increased sample size and a more controlled manipulation of attention at encoding, Experiment 2 did not find a significant difference in the effect of reduced attention on the endorsement of misleading information for negative and neutral events. However, previous research suggests that attention can impact memory performance (e.g., Baddeley et al., 1984; Craik et al., 1996; Clark-Foos & Marsh, 2008) and susceptibility to misinformation (e.g., Lane, 2006). Given the methodological differences in the misinformation field that can impact false recognition findings, Experiment 3 aimed to address this by changing the measurement of recognition performance to explore potential attention effects.

Misinformation research has employed different types of tests, other than True/False, to assess memory performance such as cued recall (e.g., Porter et al., 2003, 2010) and n-alternative forced-choice tests (e.g., Loftus et al., 1978; Mahé et al., 2015; Wyler & Oswald, 2016; Zhu et al., 2010). In this study, n-alternative forced-choice tests were of interest, particularly two-alternative forced-choice (2-AFC), which have been used in several misinformation studies mentioned above. In this test, there are typically two options: a correct and a misleading option for those details that were misleading, or a correct and a foil option for those details that were not misleading (i.e., control). This test can be considered a robust measure of the impact of misinformation. By providing both the correct and misleading options, it allows for the retrieval of both memory traces, potentially leading to a more accurate memory judgment and evaluation of the effects of misinformation compared to when correct or misleading items are presented in isolation. Therefore, Experiment 3 was interested in employing this test format to determine whether the 2-AFC test can uncover the possible impact of reduced attention on memory for negative and neutral events.

By using a two-alternative forced-choice test, another potential issue can be dealt with concerning the way participants respond to items in recognition tests. According to Jou et al. (2018), participants may adopt a set response criterion in a Yes/No (henceforth True/False) recognition test. The signal detection analysis in Experiments 1 and 2 indicates that there was a tendency for participants to be more liberal in their responses toward misleading details than toward control details. That is, one responds *True* to misleading details more often, thus accepting the misleading information. Discriminability analysis in both Experiments 1 and 2 support this response bias pattern because participants were less able to discriminate the correct detail from the misleading than from the non-misleading (i.e., control) detail. Previous research has shown that exposure to misleading information leads to a more liberal response criterion towards misleading details, which may be due to, for example, responding based on feelings of familiarity (Hekkanen & McEvoy, 2002; Luna & Migueles, 2008). Due to an absence of response bias interaction effects with misinformation, this suggests that the pattern of the liberal bias in the misinformation effect was similar across emotion conditions, attention conditions, and detail type. Furthermore, only in Experiment 2, participants were overall more liberal in their responses to details from the negative/high picture compared to the neutral picture, which is in line with previous research showing a liberal response bias for negative arousing stimuli (e.g., Dougal & Rotello, 2007), though the exact mechanisms behind this pattern are not yet fully clear.

One way to address the issue of response criterion is by using a forced choice test, where participants discriminate between the correct detail and the misleading detail. Jou et al. (2018) argued that 2-AFC tests are *criterion-free*. Not necessarily a complete absence of criterion, but rather a significant reduction of its role in a 2-AFC test compared to a True/False test. In a 2-AFC test, participants must choose either the correct or the misleading details, regardless of whether both details are judged to have met an absolute criterion (a criterion that one sets in a True/False test). As such, in a 2-AFC test, one is not comparing each detail against an individual criterion, but rather comparing the two details to each other and making a final decision based on the relative strength difference between the two items. Since the recognition decisions in a 2-AFC test are based on the difference in strength rather than an absolute criterion, it is considered to be relatively criterion-free. Jou and colleagues tested the role of criterion on the production of false memories in the DRM paradigm. They found a reduction in false recognition when a 2-AFC test was used compared to a Yes/No test, indicating that a restriction in the use of criteria led to a significant drop in false recognition.

So, when participants decide between a correct and a misleading detail by basing their decisions on the difference in strength, or the relative familiarity, between the two options, how might this produce the differences in misinformation endorsement hypothesised in the previous two experiments based on research on emotional memory narrowing and automatic and controlled processing? When participants have more time to encode the pictures, participants may “see” the correct detail to be stronger than the misleading detail, whereas when participants have a very short time to encode the pictures, the misleading detail may feel stronger due to the poor encoding of the picture details. How might this change across picture emotion conditions and for central and peripheral details? For instance, for the negative high-arousing picture, there may be little difference in the endorsement of misleading central details across the presentation duration conditions. Since the central information is part of the arousing event, it may be more likely to benefit from automatic processing, thus, the strength-difference between the correct and the misleading details should remain relatively similar across the presentation duration conditions. However, for both the negative low-arousing and neutral pictures, the need for controlled processes for successful encoding would mean that the false recognition of the misleading central details should increase from the long to the short presentation duration condition. As such, the misleading details should appear stronger than the correct detail among those participants in the short presentation duration condition. Overall, the 2-AFC test may produce the differences that were predicted on theoretical grounds, therefore Experiment 3 set out to explore this.

3.4.1 Method

3.4.1.1 Participants

One-hundred and four participants (age: M = 24.73, SD = 11.51, age range = 18 - 58; sex: 80 females, 21 males, 1 other, & 2 not disclosed) completed the study in return for course credits or a small fee. An a priori power analysis using MorePower 6.0 indicated a required total sample size of between 32 and 80 for a medium to large effect size with Power 0.80. More participants were tested to compensate for the potential loss of data from failed attention checks. Participants had English as their first language, had a normal or corrected-to-normal vision, and were not colour-blind. Participants were recruited via City, University of London's SONA system and the online recruitment platform Prolific. Informed consent was obtained from all participants. The study was ethically approved by the City, University of London's Psychology Research Ethics Committee.

3.4.1.2 Design, Materials and Procedure

The mixed design was similar to Experiment 2, except that the Misinformation variable was now within subjects due to practical reasons. Participants were randomly assigned to the short [1 second; n = 53] or the long [30 seconds; n = 51] presentation duration condition.

The materials and procedure were similar to Experiment 2, except for the following main differences. Since the Misinformation variable became within-subjects, participants received both misleading and control questions in the post-event questionnaire. See Appendix E for all these post-event questions. For example [bold is misleading], "Near the woman's **dark green** skirt, did you see the flower on the ground?". The misleading/control details from Experiment 2 were used, but four additional details were manipulated. Where possible, the consistent details from Experiment 2 became the misleading/control details in this experiment. Therefore, for each picture, there were eight Yes/No post-event questions (24 in total). Of these, four misleading questions suggested inaccurate information and four control questions either omitted the misinformation or described the critical detail in a neutral form. There were two versions of the post-event questionnaire. The misleading and control details were counterbalanced, such that misleading details in Version A were controls in Version B and vice versa.

The recognition test was a two-alternative forced-choice test. For each picture, the test contained 12 questions (i.e. 36 in total). Four questions probed memory for details that were incorrectly suggested to half of the participants in the post-event questionnaire (misleading questions), four questions probed memory for details not previously falsely suggested to half of the participants (control questions), and four questions probed memory for details not previously suggested to *all* participants (non-leading questions). See Appendix E for all the misleading and control test questions. In total, six questions targeted central information and six questions targeted peripheral information. For the misleading questions, the two response alternatives were a correct detail (consistent with the picture), and a misleading detail (consistent with the post-event questionnaire). For example, "What colour was the woman's skirt?" with response alternatives a) Burgundy [correct] and b) Dark green [misleading]. For both the control and non-leading questions, the two response options were a correct detail and a novel foil. In the control questions, the misleading option that was suggested to half of the participants becomes the novel foil.

Due to the significant number of participants failing the RKG comprehension check in Experiment 2, this measure was discontinued due to the concern about repeating the high failure rate from not understanding the R/K/G distinction. Online testing does not allow for the experimenter to present verbal instructions and assurance they have understood the instructions. Instead, for each recognition test question, participants were asked to indicate their level of confidence in their answer on a 5-point scale (1 = "not at all confident", 5 = "very confident"). Confidence ratings are easier to understand for the participant, and research has shown that misleading information can be endorsed with a higher degree of confidence using such ratings (e.g., Mahé et al., 2015; Loftus et al., 1978, Exp. 3; Luna & Migueles, 2009). Considering, from a legal perspective, that a witness's level of confidence in their recall of the event could affect the perception judges and jurors have of the credibility of the witness (Penrod & Cutler, 1995; Wells et al., 1979), confidence ratings were collected.

3.4.2 Results

Only seven participants were removed from the analyses due to failing attention checks [see Experiment 2 for attention check details and exclusion criteria]. The final sample consisted of 97 participants (age: $M = 25.16$, $SD = 11.79$, age range = 18 - 58; Sex: 74 females, 20 males, 1 other, & 2 undisclosed). There were 49 participants in the short presentation duration condition and 48 participants in the long presentation duration condition. Mood ratings were analysed to check for any mood effects. The main analysis included recognition responses to non-leading, misleading, and control questions, and adjusted recognition responses based on confidence scores (i.e., referred to as misinformation resistance). The statistical tests used are mentioned in the relevant sections below. Where the assumption of sphericity was violated, the Greenhouse-Geisser correction was reported. Bonferroni correction was applied to all t-tests and pairwise comparisons to reduce Type 1 errors.

3.4.2.1 Mood Check

Independent-sample t-tests were conducted on valence and arousal ratings separately across the Presentation Duration conditions. Both valence ratings, $t(95) = -.05$, $p = .959$, $d = .01$, and arousal ratings, $t(84.69) = -.50$, $p = .615$, $d = .10$, did not significantly differ across short and long presentation duration conditions, indicating that participants' mood at the start of the experiment was relatively similar across the conditions.

3.4.2.2 Correct Recognition

To be consistent with Experiments 1 and 2, correct recognition of details not suggested to all participants was analysed. The correct responses to non-leading questions were subjected to a 3 (Picture Emotion: Negative/High vs. Negative/Low vs. Neutral) x 2 (Detail Type: Central vs. Peripheral) x 2 (Presentation Duration: Short [1s] vs. Long [30s]) mixed-factors ANOVA, with between subjects on the last factor. Analysis revealed a significant main effect of Detail Type, $F(1, 95) = 24.10$, $p < .001$, $\eta_p^2 = .20$, and significant Picture Emotion x Presentation Duration, $F(2, 190) = 3.45$, $p = .034$, $\eta_p^2 = .04$, and Picture Emotion x Detail Type, $F(2, 190) = 4.05$, $p = .019$, $\eta_p^2 = .04$, interactions. Since the three-way interaction approached significance, $F(2, 190) = 2.92$, $p = .056$, $\eta_p^2 = .03$, this interaction was decomposed below within Picture Emotion.

For the negative/high picture, there was only a significant main effect of Detail Type, $F(1, 95) = 19.84$, $p < .001$, $\eta_p^2 = .17$, whereby central detail accuracy was better ($M = .66$, $SD = .34$) than peripheral detail accuracy ($M = .44$, $SD = .32$). No interaction effect ($p = .276$) suggests that this pattern was similar in each attention condition. For the negative/low picture, there was, again, only a significant main effect of Detail Type, $F(1, 95) = 8.50$, $p = .004$, $\eta_p^2 = .08$, whereby accuracy was higher for central details ($M = .56$, $SD = .35$) compared to peripheral details ($M = .42$, $SD = .34$). There were no further significant effects (Fs < 2.88, ps $> .09$). However, it is worth noting that there was a trend such that accuracy was lower in the short presentation duration condition ($M = .44$, $SD = .25$) compared to the long presentation duration condition ($M = .53$, $SD = .26$), $F(1, 95) = 2.88$, $p = .093$, $\eta_p^2 = .03$, suggesting that, descriptively, memory for both detail types decreased with reduced attentional resources. For the neutral picture, there was *only* a significant interaction, $F(1, 95) = 6.54$, $p = .012$, $\eta_p^2 = .06$. Accuracy for central details unexpectedly increased from long presentation condition ($M = .42$, $SD = .33$) to the short presentation condition ($M = .61$, $SD = .37$), $t(95) = 2.73$, $p = .007$, $d = .55$. There was no change in accuracy for peripheral details across conditions, $t(95) = -.74$, $p = .462$, $d = .15$. Overall, like Experiment 2, a difference in memory for central and peripheral details was found only in negatively valenced events.

3.4.2.3 False Recognition

Incorrect responses to misleading and control questions were analysed using a 3 (Picture Emotion: Negative/High vs. Negative/Low vs. Neutral) x 2 (Detail Type: Central vs. Peripheral) x 2 (Misinformation: Misled vs. Control) x 2 (Presentation Duration: Short [1s] vs. Long [30s]) mixed ANOVA, with between subjects on the last factor. Table 16 provides the descriptive statistics for the endorsement of the misleading and control details.

Analysis revealed the standard misinformation effect, whereby false recognition was higher for misleading details ($M = .51$, $SD = .17$) compared to control details ($M = .34$, $SD = .16$), $F(1, 95) = 54.04$, $p < .001$, $\eta_p^2 = .36$. There was also a significant Picture Emotion x Presentation Duration interaction, $F(2, 190) = 4.22$, $p = .016$, $\eta_p^2 = .04$, and a Picture Emotion x Misinformation x Presentation Duration interaction (see Figure 3), $F(2, 190) = 4.50$, $p = .012$, $\eta_p^2 = .05$. This interaction was decomposed using a Misinformation x Presentation Duration mixed-ANOVA on each level of Picture Emotion.

For the negative/high picture, there was a significant main effect of Misinformation, $F(1, 95) = 17.22$, $p < .001$, $\eta_p^2 = .15$, with more false recognition for misleading details ($M = .51$, $SD = .29$) compared to control details ($M = .36$, $SD = .26$). There were no further significant results (Fs < 1.80, ps $> .18$), indicating that the size of the misinformation effect was similar for both presentation duration conditions. For the negative/low picture, there were significant main effects of Misinformation, $F(1, 95) = 34.34$, $p < .001$, $\eta_p^2 = .27$, and Presentation Duration, $F(1, 95) = 6.74$, $p = .011$, $\eta_p^2 = .07$, which were both qualified by a significant interaction, $F(1, 95) = 4.67$, $p = .033$, $\eta_p^2 = .05$. Independent-Samples t-tests revealed that false recognition for the misleading details increased from the long presentation duration condition ($M = .47$, $SD =$

.26) to the short presentation duration condition (*M* = .64, *SD* = .24), *t*(95) = 3.32, *p* = .001, *d* = .67. There was no change in false recognition for the control details, *t*(95) = -.03, *p* = .977, *d* = .01. Finally, for the neutral picture, there was only a significant misinformation effect, *F*(1, 95) = 12.00, *p* < .001, η_p^2 = .11. From Figure 3, it can be seen that the false recognition of misleading details was similar across the presentation duration conditions but memory errors increased in the short duration condition for control details. Despite these patterns, there was no significant interaction effect, *F*(1, 95) = 3.09, *p* = .082, η_p^2 = .03. Overall, the false recognition data showed that a short picture presentation duration increased the negative impact of misinformation exposure on memory for negative/low picture details, but not for the negative/high picture. Although there also appears to be less of an impact in the short duration condition for neutral picture details, the rise in memory errors for control details may suggest the possible role of guessing (more on this in the general discussion).

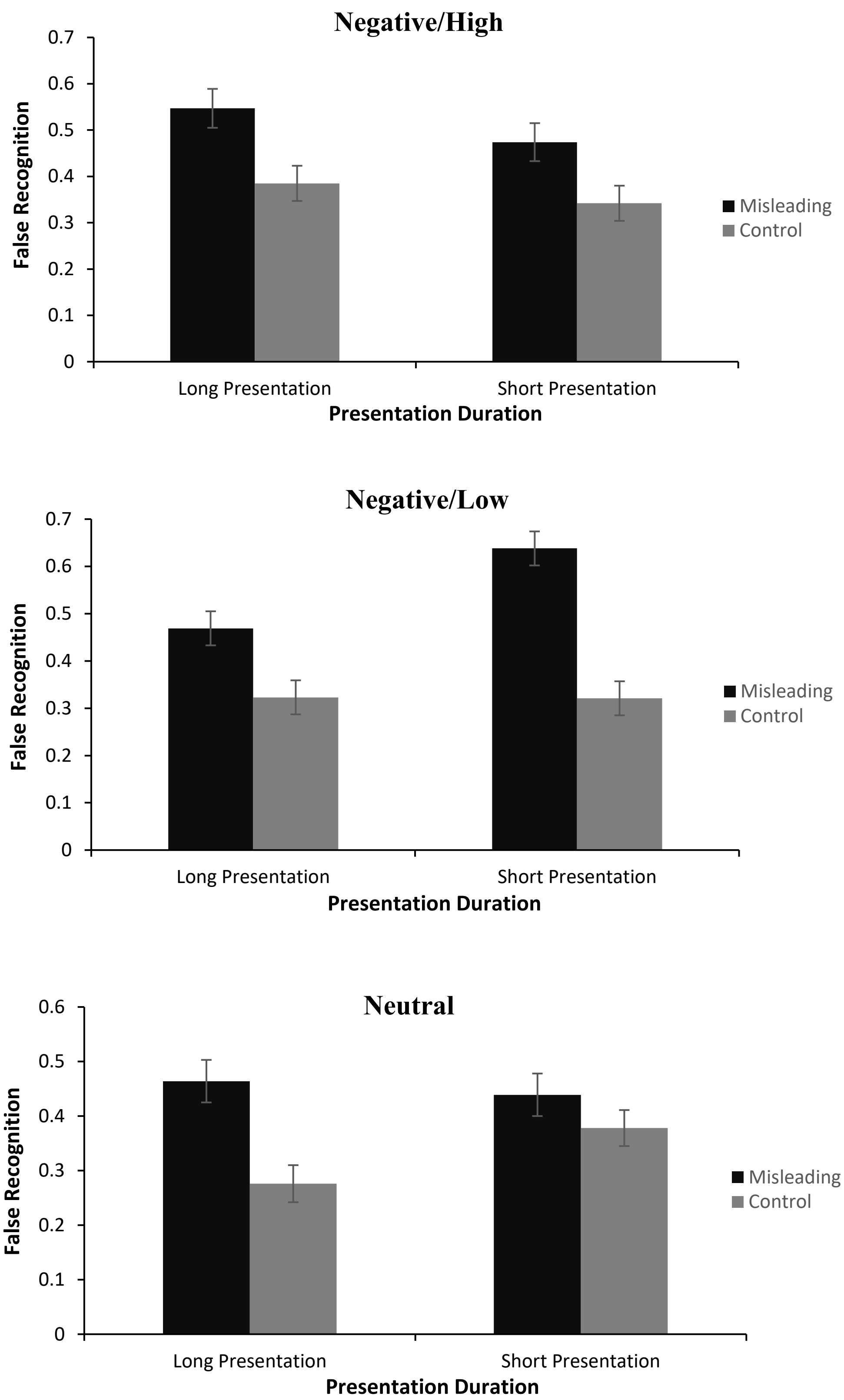


Figure 3. The proportion of false recognition of misleading and control details for each Picture Emotion as a function of Presentation Duration and Misinformation (Error bars represent the standard error).

Table 16. *Mean proportions and standard deviations for the false recognition of the misleading and control details as a function of picture emotion, detail type, misinformation, and presentation duration.*

Presentation Duration	Short Presentation				Long Presentation			
Misinformation	Misled		Control		Misled		Control	
	M	SD	M	SD	M	SD	M	SD
Central Details								
Negative/High	.47	.34	.35	.34	.55	.39	.37	.34
Negative/Low	.64	.32	.37	.36	.52	.36	.32	.33
Neutral	.39	.34	.38	.36	.41	.34	.25	.29
Peripheral Details								
Negative/High	.48	.39	.34	.36	.54	.38	.41	.34
Negative/Low	.63	.34	.28	.34	.42	.33	.32	.35
Neutral	.49	.35	.38	.36	.52	.37	.30	.30

Note. M and SD refer to Mean and Standard Deviation, respectively.

3.4.2.4 Misinformation Resistance

Many participants did not make at least one correct or one incorrect response in one or more of the cells in the design, thus an ANOVA on the confidence scores was not possible since the participants that have at least one empty cell have to be removed. The remaining sample size would be too low to extract meaningful conclusions. Therefore, confidence scores were analysed in the following manner. To gain insight into confidence scores assigned to misleading questions, Dalton and Daneman's[18] (2006; see also Loftus, 1979) procedure was used, where correct and incorrect responses to the misleading and control questions are adjusted according

[18] The procedure was as follows: for the misleading and control questions, participants were first assigned a base score of 5 if they selected the correct answer or a base score of 0 if they selected an incorrect answer. For correct answers, the confidence rating provided by the participant was simply added to the base score (=5). For example, if a participant selected the correct answer in the misleading question and assigned a confidence rating of 5, the misinformation resistance score for that question would be 10 (5 + 5) indicating high resistance to misleading information with high confidence. For incorrect answers, the confidence rating assigned to these answers was first reversed (5=1, 4=2, 3=3, 2=4, 1=5). The reversed rating was then added to the base score (=0). For example, if a participant selected the misleading detail in misleading question and assigned a confidence of 5, the misinformation resistance score for that question would be 1 (0 + 1) indicating very low resistance to misinformation and inappropriately high confidence. Scores around the middle of the scale (i.e. 5) indicated moderate resistance and appropriately low confidence.

to the 1-5 confidence rating. The adjusted scores were a value from 1 to 10. *Misinformation resistance scores* were computed to determine how resistant participants are to endorsing misinformation. Scores approaching 10 indicate high resistance to misinformation and high confidence in the correct detail. Scores approaching 1 indicate low misinformation resistance and inappropriately high confidence in the misleading detail. Table 17 presents the means and standard deviations for the misinformation resistance scores.

Analysis of the misinformation resistance scores revealed that participants were less resistant to falsely recognising misleading details ($M = 5.37$, $SD = .94$) than control details ($M = 6.22$, $SD = .75$), $F(1, 95) = 52.87$, $p < .001$, $\eta_p^2 = .36$. There was also a significant main effect of Picture Emotion, $F(2, 190) = 5.40$, $p = .005$, $\eta_p^2 = .05$. Bonferroni pairwise comparisons revealed that, regardless of prior exposure to misinformation, participants were less resistant to endorsing false details from the negative/high picture ($M = 5.62$, $SD = .97$) compared to the neutral picture ($M = 5.97$, $SD = .78$; $p = .007$). There were no further significant comparisons (*p*s > .22). The analysis also revealed significant interactions: Picture Emotion x Presentation Duration, $F(2, 190) = 5.04$, $p = .007$, $\eta_p^2 = .05$, Picture Emotion x Misinformation, $F(1.85, 175.47) = 4.08$, $p = .021$, $\eta_p^2 = .04$, and Picture Emotion x Misinformation x Presentation Duration interaction (see Figure 4), $F(2, 190) = 4.26$, $p = .016$, $\eta_p^2 = .04$. To aid comparison, the three-way interaction was decomposed in the same way as in false recognition results.

For the negative/high picture, participants were less resistant to endorsing misleading details ($M = 5.24$, $SD = 1.33$) than control details ($M = 6.00$, $SD = 1.17$), $F(1, 95) = 22.91$, $p < .001$, $\eta_p^2 = .19$. There were no further significant results (*F*s < 1.91, *p*s > .17). For the negative/low picture, there were significant main effects of Misinformation, $F(1, 95) = 30.29$, $p < .001$, $\eta_p^2 = .24$, and Presentation Duration, $F(1, 95) = 9.58$, $p = .003$, $\eta_p^2 = .09$. Due to a marginal interaction effect, $F(1, 95) = 3.61$, $p = .06$, $\eta_p^2 = .04$, this was explored further since the pattern of results was similar to false recognition results. Bonferroni-corrected

Independent-Samples t-tests revealed that resistance to misleading details reduced from the long presentation duration condition (*M* = 5.67, *SD* = 1.51) to the short presentation duration condition (*M* = 4.71, *SD* = 1.40), $t(95) = -3.24$, $p = .002$, $d = .66$. There was no change in misinformation resistance scores for the control details, $t(95) = -.42$, $p = .677$, $d = .08$. Finally, for the neutral picture, the results were similar to the negative/high picture, such that there was only a significant misinformation effect, $F(1, 95) = 13.61$, $p < .001$, $\eta_p^2 = .13$. It is worth noting that the main effect of Presentation Duration was marginal ($p = .066$), such that there was greater resistance to false recognition in the long presentation duration condition (*M* = 6.11, *SD* = .89) compared to the short presentation duration condition (*M* = 5.82, *SD* = .63). In sum, the misinformation resistance followed the recognition data, such that participants were less resistant to misinformation associated with the negative/low picture under short presentation duration conditions, whereas no significant change in misinformation resistance across presentation duration conditions was found in the negative/high and neutral pictures.

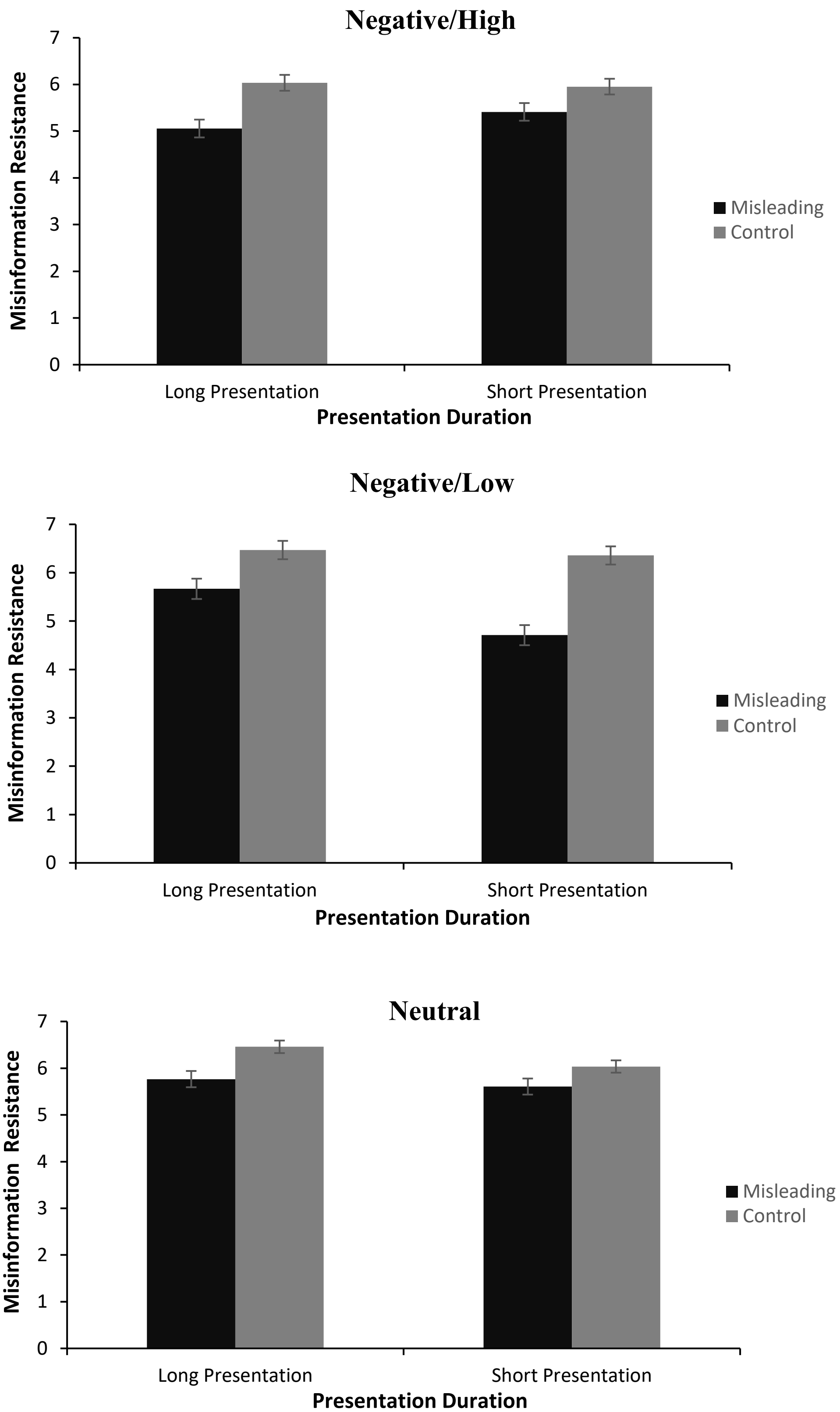


Figure 4. Mean misinformation resistance scores for misleading and control details in each Picture Emotion as a function of Presentation Duration and Misinformation (Error bars represent the standard error).

Table 17. *Mean proportions and standard deviations for the misinformation resistance scores as a function of picture emotion, detail type, misinformation, and presentation duration.*

Presentation Duration	Short Presentation				Long Presentation			
Misinformation	Misled		Control		Misled		Control	
	M	SD	M	SD	M	SD	M	SD
Central Details								
Negative/High	5.55	1.63	6.10	1.47	4.99	2.30	6.38	1.98
Negative/Low	4.77	1.75	6.37	1.60	5.41	2.13	6.31	1.79
Neutral	5.83	1.59	6.11	1.48	6.02	1.57	6.69	1.39
Peripheral Details								
Negative/High	5.28	1.42	5.81	1.29	5.13	1.55	5.70	1.45
Negative/Low	4.65	1.83	6.35	1.83	5.93	1.84	6.63	1.95
Neutral	5.39	1.18	5.96	1.32	5.51	1.85	6.23	1.32

Note. M and SD refer to Mean and Standard Deviation, respectively.

3.4.3 Summary of Experiment 3

Experiment 3 found that for the negative high-arousing event, there was no significant change in the misinformation effect across presentation duration conditions, but misinformation had a significant negative impact on memory for the negative low-arousing event. This highlights the role of automatic and controlled encoding processes. Surprisingly, the neutral event findings were similar to the negative high-arousing event. Overall, unlike Experiments 1 and 2, Experiment 3 demonstrated the differential impact of reduced attention at encoding on suggestibility for negative events. However, as in Experiments 1 and 2, the false recognition finding did not vary with detail type. The misinformation resistance data followed the false recognition patterns. Furthermore, similar to Experiment 2, memory for central details was better than for peripheral details only in the negative pictures, demonstrating a memory narrowing effect with negative valence. Experiment 3 findings are discussed in the General Discussion that follows.

3.5 General Discussion

The detrimental impact of misleading information on memory performance has been demonstrated in a plethora of studies. Research has shown that the endorsement of misleading information increases under limited attentional resources during an event (Lane, 2006). In addition, divided attention studies (e.g., Kang et al., 2014; Kensinger & Corkin, 2004) have also shown that negative arousing information may benefit from automatic encoding processes. However, no research to date has addressed the question of how negative emotion and attention interact to affect suggestibility. Hence, the three experiments aimed to investigate the role of attention on memory for negative and neutral events and susceptibility to post-event misinformation. To summarise, participants were presented with negative high-arousing, negative low-arousing, and neutral pictures. Participants' attention was manipulated by dividing their attention between the pictures and an attention-demanding secondary task (Experiment 1) or by varying the presentation duration of the pictures (Experiments 2 & 3). Thereafter, misleading information about central and peripheral aspects of the scenes were administered via a questionnaire, followed by a recognition test to evaluate memory for the scenes. The recognition tests were similar in Experiments 1 & 2 but changed to a 2-AFC test in Experiment 3. The main findings of interest will now be discussed.

3.5.1 Limited Attention at Encoding and Misinformation Endorsement

In Experiments 1 and 2, there was no evidence of a differential effect of reduced attention on susceptibility to misinformation for negative (arousing and low arousing) and neutral events. Also, there was no significant main effect of Attention/Presentation Duration condition. Thus, unlike Lane (2006), overall false recognition of misleading details did not increase in the divided attention (Expt. 1) and short presentation duration (Expt. 2 & 3) conditions. Methodological differences with previous research may be a possible explanation for the absence of attention effects, such as in the type of secondary task, type of memory test, type of misleading information, and the presentation duration of the pictures. Concerning the type of recognition test, Experiment 3 used a 2-AFC test instead of a True/False test used in Experiments 1 and 2 for two reasons. First, 2-AFC tests are most common in misinformation research and are more powerful due to presenting both the correct and the misleading detail, which may prompt retrieval of both memory traces and/or one detail may appear stronger than the other. Second, Jou et al. (2018) suggested that participants may adopt a liberal response criterion in a True/False test. One way to reduce the role of criterion is by using a 2-AFC test whereby participants make their response based on the relative strength between the response options. Misinformation research has demonstrated the use of a liberal response towards misleading details (e.g., Luna & Migueles, 2008). Indeed, in Experiments 1 and 2, the signal detection analysis showed a clear pattern that a more liberal bias was adopted for details that were misleading than those details that were not previously misled. Further, this response bias pattern did not interact with attention, suggesting that a similar pattern occurred in both attention conditions.

By reducing the role of criterion in Experiment 3 using a 2-AFC test, an effect of attention was found. Behavioural studies employing a divided attention task (e.g., Kang et al., 2014; Kensinger & Corkin, 2004) have demonstrated that negative-arousing information benefits from automatic encoding processes and is thus less reliant on attentional resources for successful encoding, whereas enhanced memory for negative low-arousing information requires controlled and more elaborative encoding processes. Kensinger and Corkin (2004) have shown that the amygdala-hippocampus network seems to be associated with the rapid and automatic processing of negative and arousing stimuli, whereas the prefrontal-hippocampus network is used for more elaborative and controlled processing of negative nonarousing and neutral stimuli. In Experiment 3, the findings from the negative pictures may add further support to the role of automatic and controlled processes. For the negative high-arousing picture, there was no significant change in the endorsement of the misleading details (and in misinformation resistance scores) across long and short presentation duration conditions. This could suggest that participants were able to process the details in the picture even under reduced attentional resources at encoding, indicating automatic processing at play when encoding the picture. As a result, the false recognition of the misleading details did not increase in the short presentation condition. Therefore, the difference in strength between the original and misleading options at test likely remained similar under both presentation duration conditions. The negative/high finding supports previous research demonstrating that the processing of negative arousing stimuli (e.g., Kensinger & Corkin, 2004; Talmi et al., 2007a) may not be dependent on attentional resources. Furthermore, there was no evidence in the present study to suggest that the findings differed with detail type. Indeed, previous research has shown that the recognition of details within negatively arousing contexts may depend less on overt attention (i.e., fixation duration) than in positive and neutral contexts (Kim et al., 2013; Gülçay & Cangöz, 2016). As for the negative low-arousing picture, the endorsement of misleading information increased, and resistance to misinformation decreased, in the short presentation condition. This suggests that participants were unable to process the picture very well in the short presentation duration condition. Due to relatively poor memory for the event details, the misleading details may have been more prominent such that, at test, the strength of the misleading details was stronger than for the original details, thereby increasing false recognition of misleading information. This finding lends support for the need for controlled processes to successfully encode negative low-arousing stimuli.

Although the above findings were explained in terms of the strength of activation of misleading and original details, these findings could further be explained from a source monitoring perspective. Research has demonstrated that source confusions play a critical part in the misinformation effect where participants erroneously misattribute the misleading information to the original event (for a review, see Mitchell & Johnson, 2000). Source confusions commonly arise when there are similarities between the sources (Mitchell & Johnson, 2000). Indeed, the post-event questionnaire was about the original scenes, and so there was an overlap of the semantic content in the post-event information and the pictures (Mitchell & Johnson, 2000). Furthermore, answering the post-event questions likely involves the memory retrieval of the original event and the possible mental visualisation of the suggested information, which can increase source similarity and source misattribution errors (Johnson et al., 1993; Mitchell & Johnson, 2000). Therefore, it is not surprising that a misinformation effect for both negative events was found in the long presentation duration condition. The automatic processing of the negatively arousing picture can suggest that participants were able to retrieve the scene during the post-event questionnaire, and so the degree of source confusion and source misattribution may be less likely to vary significantly with presentation duration, consequently preventing an increase in misinformation susceptibility in the short presentation duration condition. For the negative low-arousing picture, however, the recognition results suggest the possible requirement of controlled processing. So, a disruption to controlled processes impairs memory for the event details and the source information (Lane, 2006). The reduced ability to distinguish between the memories of event details and misleading details consequently increases misinformation susceptibility.

Previous research using a false memory DRM paradigm have demonstrated the role of automatic and controlled processing in false recognition analysis, but not in correct recognition analysis (Hellenthal et al., 2019). So, in the three experiments, was there evidence of automatic processing of the negatively arousing scene and the controlled processing of the negative low arousing scene in the correct recognition analysis? Findings from Experiments 2 and 3 (both experiments being largely similar) lend support for this. In Experiment 2, accuracy did not significantly vary across presentation duration conditions for both the negative/high and negative/low pictures. However, for the negative/low picture, there was a sizeable trend such that accuracy dropped in the short duration condition. This pattern was significant for the neutral picture. The discrimination ability of the correct details from the false details did not vary across presentation duration conditions for the negative/high picture, but for the negative/low and neutral pictures, discriminability reduced in the short duration condition. Despite this evidence in Experiment 2, false recognition did not vary with presentation duration, but a change in the test format in Experiment 3 did. In Experiment 3, accuracy for central and peripheral details showed no significant variation across presentation duration conditions for the negative/high picture. Although non-significant also for the negative/low picture, there was a marginal trend towards reduced accuracy in the short duration condition for both detail types. For the neutral picture, the effect was specific such that accuracy for central details unexpectedly increased in the short duration condition. Overall, there was evidence of differential processing for negatively arousing scenes compared to negatively low arousing scenes in the recognition of original event details. The results from the experiments suggest that the processing of negatively low arousing scenes, but not negative arousing scenes, may be more susceptible to reduced accuracy and discriminability under limited attention conditions.

An unexpected finding in Experiment 3, however, concerned the neutral picture. Like the negative high-arousing picture, there was no significant change in the false recognition of misleading details across the attention conditions. The misinformation resistance data also reflected the same pattern. This cannot be explained by automatic processing since, based on previous research, successful memory for neutral stimuli requires controlled processes (Kensinger & Corkin, 2004). One would expect the neutral picture finding to be similar to the negative low-arousing picture, or alternatively expect the false recognition for both the misleading and control details to significantly increase in the short presentation condition.

There was a pattern such that false recognition for the control details increased from the long to the short presentation duration condition, which can be attributed to the poorer memory for the event details when attentional resources are reduced. Thus, this led to the endorsement rates of misleading and control details to be close to similar levels, descriptively, in the short presentation duration condition. However, there was no significant change in misinformation endorsement. It is not fully clear as to why that might be. Could it be that the misleading information is associated with a weak memory trace? The misinformation associated with the negative pictures may be better stored in memory due to (1) a stronger connection that may be made between the post-event information and the negative event and/or (2) the negative emotion that one experiences when retrieving memory for the negative pictures to answer the post-event questions. This is less likely to influence post-event details for the neutral picture due to the blandness of the picture and the questions, which may lead to a weaker memory of the misleading information. As such, it may be less easy to differentiate between the correct and the misleading details. Although some misinformation may be remembered due to the recency advantage, the misinformation's influence on recognition memory is overall less likely to significantly change across attention conditions. This may also mean that the degree of source confusion is less likely to markedly change across duration conditions. Further research is required to determine, more conclusively, the impact of attention and misinformation on neutral stimuli. For example, future research can use different neutral events to see whether the finding in Experiment 3 is replicated for scenes depicting different events or whether the finding was an artefact of the specific neutral picture used in the experiment.

The false recognition results of Experiment 3 did not vary with central and peripheral details. There was a theoretical motivation to expect a possible difference in memory for central and peripheral misinformation between presentation duration conditions, at least for the negatively arousing picture. This, however, was not found. Previous misinformation studies have reported mixed results regarding the effect of emotion on memory for central and peripheral misinformation (see Sharma et al., 2022, for a review). This could be attributed to methodological variations between the studies (e.g., the type of memory test, and the way central and peripheral details are defined). Experiment 3 findings support Porter et al. (2003), who found no significant difference across emotional and neutral scenes, and this was extended to the role of attention during event encoding. However, future research can determine whether the finding, irrespective of detail type, is a genuine result or an artefact of the study's design/procedure.

3.5.2 Visual Attention and Misinformation

In addition to examining the role of attention by manipulating the attentional resources at encoding, In Experiment 1, overt attention was also measured using eye-tracking technology to explore its relationship to later misinformation endorsement. The correlational analysis did not reveal clear evidence of the link between overt attention and misinformation endorsement. Eye fixations did not predict the later recognition of suggested misleading details in each emotion condition. It could be argued that this indicates automatic processing of the negative high-arousing scenes since negative-arousing stimuli should be less dependent on attentional resources. However, for the negative low-arousing and neutral pictures, a relationship between overt attention and later misinformation endorsement may be expected due to the need for controlled processing, particularly in the divided attention condition. It has been shown that memory performance for emotional stimuli is not related to processing time (Humphreys et al., 2010), and Experiment 1 extends this to false recognition performance for misleading details. It is worth noting that, for the negative low-arousing pictures, eye fixations on central and peripheral details positively led to a decreased recognition of non-suggested (control) false central details regardless of attention condition and non-suggested (control) false peripheral details (within the divided attention condition), respectively. This suggests that the level of visual attention to central details determines later endorsement of non-suggested false details. For the peripheral details, its encoding may be greatly affected by the divided attention condition, thus an increased level of visual attention is needed to reduce errors in recognising non-suggested false details.

It is important to note two key limitations for the eye tracking data. First, the correlations were based on small sample size. Second, visual attention can be covertly shifted and maintained in other parts of a visual scene without requiring a subsequent direct fixation on that specific region (Liversedge & Findlay, 2000). Visual tasks in real-world scenarios usually involve a combination of covert and overt visual attention (Brunyé et al., 2019). As such, this is a limitation of eye tracking because eye trackers can only measure overt visual attention, but they are not intended for tracking covert visual attention (Brunyé et al., 2019). Overall, whether visual overt attention predicts later false recognition, depends on the type of event, detail, and level of recognition. More research is needed to further understand the role of visual attention on the suggestibility of negative and neutral events.

3.5.3 Central and Peripheral Information

Considering that Detail Type was an investigative factor in the experiments and that the experiments uncovered some interesting findings regarding true and false recognition of central and peripheral details, it is thus worthy of some discussion. It is theorised that emotional arousal narrows the attentional scope, resulting in more attention allocated to central and most salient information and less to peripheral information (Easterbrook, 1959; Kaplan et al., 2012). This may lead to an enhanced memory for central information and impaired memory for peripheral information. Attention narrowing can occur for a number of reasons. For example, the emotional nature of the central information may mean that central information benefits from early information processing (e.g., Hulse et al., 2007) and a greater level of attention (e.g., Christianson et al., 1991; Chipchase & Chapman, 2013). Central information may serve as an attention magnet (Laney et al., 2003, 2004). That is, it may be visually salient/shocking (e.g., containing blood), and/or a distinctive feature in the scene, which can capture the attention of an emotionally aroused individual. Furthermore, in terms of a goal-relevance approach (see Levine & Edelstein, 2009), the central information may capture attention because it is relevant to one's currently active goal and is what an individual would be interested in.

In this study, the distribution of eye fixations to central and peripheral areas of the scenes did not fully support the attention narrowing hypothesis. For the negative high-arousing pictures, irrespective of attention condition, participants fixated faster on the central area compared to the peripheral area, indicating that the arousing and salient nature of the central area captured attention faster. Despite this, there was no difference in the TFD between the central and peripheral areas, thus going against the view that arousing aspects of an event holds attention for longer (Easterbrook, 1959). It may be that participants explored the scene more, rather than spending most of the time looking at the central area due to the gruesome elements in the negative-arousing scenes (Peace & Constantin, 2016).

For the negative low-arousing pictures, the peripheral area was fixated on faster under full attention compared to divided attention, whereas the TTFF on the central area did not vary with attention condition. This suggests that the emotional central area attracted attention faster, but the secondary task may have held one's attention for longer and slowed down scene exploration to the peripheral area. For TFD, there were greater fixations on the central area compared to the peripheral area, which could be due to the emotional nature of the event and partly supports the view that negative emotion narrows attention (Van Damme & Smets, 2014). However, it could also be argued that the less detail in the peripheral area led to the central area being fixated on more. This is more plausible considering that, descriptively, participants spent more time on the central area, and less time on the peripheral area, in the negative/low condition compared to the negative/high and neutral conditions.

Finally, for the neutral picture, TTFF data surprisingly revealed similar results as the negative high-arousing pictures. Despite the pictures being rated neutral, some scene elements may be considered positive (e.g., dogs, and men eating outside on a sunny day), thus capturing attention faster to the central area. Furthermore, TFD was higher in the peripheral area. This may be due to (1) more details in the peripheral area and (2) potentially more scene exploration since the central area does not contain strong emotional/salient elements. Like the negative pictures, TFD did not vary with attention condition, possibly due to similar fixation levels on central and peripheral areas across attention conditions since all participants have the full 30 seconds to look at each picture.

As can be seen from the eye-fixation data, there was no clear evidence that central information in an emotionally arousing event captures and holds attention more than peripheral information. However, as mentioned previously, visual attention can be shifted and sustained covertly to other areas of a visual scene without the requirement for overt fixation (Liversedge & Findlay, 2000), which eye tracking did not measure. Thus, attentional narrowing may be explained if both overt and covert attention is considered. Nevertheless, previous research has shown that fixation duration and/or time to first fixation is not necessarily prioritised for emotionally arousing information (e.g., Humphreys et al., 2010).

The recognition memory data provided some evidence of enhanced memory for central details at the expense of memory for peripheral aspects. In Experiment 1, there was no clear valence or arousal effect on central and peripheral memory since memory for central details was better than that for peripheral details for both negative arousing and neutral pictures, with no difference found for the negative low-arousing picture. These patterns were also found in the analysis of Criterion bias, where a liberal bias was adopted for central details in the negative/high and neutral pictures. However, in Experiments 2 and 3, memory was better for central details compared to peripheral details in both the high and low-arousing negative pictures, and no difference between central and peripheral details was found for the neutral picture, consistent with Van Damme and Smets' (2014) findings. This was also revealed in the discrimination ability analysis for Experiment 2. Methodological differences between the studies and the larger sample size in Experiments 2 and 3 may be possible reasons for the different outcome in Experiment 1.

Memory was better for central details compared to peripheral details in the negative pictures for Experiments 2 and 3. One explanation can be related to attention magnets. In both negative pictures, the central area consisted of gruesome (e.g., blood) or death-related (e.g., cemetery) imagery. Since the central details were part of the source of emotion, the central information may be considered attention magnets and highly salient. According to Laney et al. (2003, 2004), attention magnets can grab participants' visual attention and may influence later memory. Another explanation may be that the central information is distinctive relative to peripheral details. Previous research has shown that under relative distinctiveness conditions (i.e., a mixed presentation of emotional and neutral stimuli), emotionally negative items were better remembered (Dewhurst & Parry, 2000). Furthermore, considering a goal-relevance explanation (Levine & Edelstein, 2009), the central information may be relevant to an individual's currently active goal. Previous research has shown that goal-relevant details are better remembered, whereas details irrelevant to the goals are less likely to be remembered (e.g., see Kaplan et al., 2012, for a review; Van Damme et al., 2017). The negative pictures used in the present experiments may have activated the universal goals of survival and health (Van Damme & Smets, 2014) since the events depicted are related to assault and death. Only the central details are relevant to these goals. As a result, this may have led to the enhancement of central memory over peripheral memory in both the negative high- and low-arousing events. It must be mentioned that the accuracy for central details was visibly higher in the negative arousing than the low-arousing pictures. Indeed, in Experiment 2, vivid recollection was greater for the central details in the negative-arousing event. This demonstrates that information from an arousing/salient part of an emotional scene is remembered more vividly due to greater sensory/perceptual attributes, supporting research showing that the retrieval of emotionally arousing information is typically accompanied by vivid recollection (e.g., Humphreys et al., 2010; Kensinger & Corkin, 2004; Sharot et al., 2007).

Regarding false recognition of misleading information, a Picture Emotion x Detail Type x Misinformation interaction was found in Experiment 2. The findings differed from those by Van Damme and Smets (2014). For the negative high- and low-arousing pictures, a misinformation effect for central details was absent for peripheral details, a finding also shown in the discrimination analysis. For the recognition of correct details, memory was better for central details over peripheral details within both negative events. As such, negative valence may have led to a more general decline in memory for peripheral details, whereby errors were produced regardless of prior exposure to misinformation. For the central details, the benefit of negative valence was overruled by prior exposure to misinformation, similar to Van Damme and Smets. The misinformation effect for central details may have occurred due to source confusions. As mentioned previously, source confusions can arise when there is an overlap between the sources, such as in terms of semantic content (Mitchell & Johnson, 2000). This can be further augmented when the misleading information is visualised when answering the post-event questions. Due to the emotional nature of the central event in the pictures, it is likely that the visualisation of the misinformation and its integration into the original event is stronger for the central details, making source monitoring difficult. The misleading information may also have a stronger memory trace. Since negative information has been found to be better remembered than neutral information (e.g., Kensinger and Corkin, 2004), it is also plausible to assume that the post-event (mis)information associated with the negative events, particularly the central details, will be remembered well, and the encoding may be enhanced through imagery and elaboration of the post-event information. As for the neutral picture, the misleading information affected memory performance for both central and peripheral details, again, a finding also revealed in the discrimination analysis. This may be due to a relatively poorer memory for neutral events compared to negative events, thus the misleading information is more accessible to memory and relied upon.

This three-way interaction was only found in Experiment 2, but not in Experiments 1 and 3. Experiment 2 has several similarities to Van Damme and Smets' (2014) study (i.e., misinformation exposure was between-subjects, a True/False test was employed, the misleading information was embedded in the post-event questions rather than being the focus of them, and the misleading details were contradictory). The three-way interaction may only be found with certain methodological elements, suggesting the need for future research to investigate this further. However, with the mixed results from the three experiments and prior studies (e.g., Porter et al., 2003; Van Damme & Smets, 2014), there is currently no consensus regarding the impact of misinformation on central and peripheral memory across emotional events (see Sharma et al., 2022). As such, more research on emotion and misinformation research is needed to further understand the impact of emotional memory narrowing on suggestibility.

3.5.4 Conclusion

Eyewitnesses to a criminal event may be placed in a complex situation whereby their attention may be drawn to different goals. This can result in fewer attention resources available for forensically relevant details (Lane, 2006). Since witnesses may later be exposed to misleading information, understanding how limited attention affects memory for an event when misleading information is introduced is of importance. As such, the main aim of the three experiments was to examine the role of attention and emotion in the false recognition of misleading information. In Experiments 1 and 2, there was no evidence that attention during event encoding plays a significant and differential role in the misinformation effect for negative (arousing and low-arousing) and neutral events. Furthermore, in Experiment 1, the overall evidence from eye fixation data suggests that overt attention does not reliably predict the endorsement of misleading information and suggestibility in negative and neutral events. In Experiment 3, participants were asked to choose between a correct and a misleading detail in a 2-AFC test rather than a True/False test used in Experiments 1 and 2. When the event was negative high-arousing, it was found that the endorsement of, and resistance to, misleading information did not vary with presentation duration, an indication of automatic processing of the negative event. However, when the event was negative low-arousing, misinformation endorsement increased, and misinformation resistance decreased, when the event was presented for a shorter duration, an indication of the need for controlled processing during event encoding. These results have implications for the real world (although note finding for the neutral stimuli in the study). That is, when a witness experiences a negative event, high arousal may protect against a significant increase in misinformation susceptibility when an event takes place quickly compared to when it occurs for a longer time. We appreciate that the findings for the neutral picture were unexpectedly similar to the negative high-arousal picture. More research is required to understand this further. Finally, the three experiments also highlight that, since the impact of attention on suggestibility was found after a change in the type of test, researchers should be mindful of what the impact of experimental design has on misinformation endorsement.

Chapter Four: The Impact of Post-Warnings on Susceptibility to Misinformation for Negative Arousing and Neutral Events

4.1 Introduction

The influential work by Elizabeth Loftus and colleagues demonstrated the damaging effect of post-event misinformation on eyewitness memory (e.g., Loftus, 1979; Loftus et al., 1978). As we know, the robust finding in misinformation research is that individuals report previously suggested misleading information rather than the original information on a memory test about an earlier witnessed event. This was also found in Experiments 1-3 for both negative emotional and neutral events. Eyewitness events tend to be negatively valenced and emotionally arousing, therefore it is important to develop methods to reduce the impact of misinformation on memory for a negatively arousing event. Indeed, one line of investigation that has received much attention is whether the effect of misinformation can be weakened or even eliminated by a warning given *after* one has been exposed to the false information (Blank & Launay, 2014). In real-life, witnesses are less likely to know whether they have been exposed to misinformation, and law enforcement officials may not know of any prior false information that could impact witness statements. Therefore, being able to use (effective) post-event warnings about prior misinformation can be more useful. We do make mistakes in our recollections of events that are forensic-related, and inaccurate recollections have been shown to lead to miscarriages of justice (Howe & Knott, 2015), therefore there is a need to understand if and how we can improve the accuracy of eyewitness reports.

The evidence for the effectiveness of post-warnings (henceforth, warnings) in reducing the effect of misinformation has been mixed. On the one hand, some studies have shown that the impact of misinformation is resistant to warnings (e.g., Belli et al., 1994; Greene et al., 1982; Luke et al., 2017; Zaragoza & Lane, 1994, Experiment 4). For example, Greene et al. (1982) presented participants with a warning about the possible exposure to misinformation, and the warning further mentioned that the post-event source was written by a police cadet who lacked experience at recording crimes. The warning was given either before the slide event, immediately before the narrative, or immediately before completing the recognition test. Focusing on the latter, they found that vulnerability to misinformation did not change between participants who were warned and those who had not been warned. Thus, the warning did not encourage a careful completion of the test. They suggested that their warning was general, and that a more specific warning (e.g., challenges concerning the police cadet such as them being colour-blind) may be more effective. On the other hand, several studies have shown that a warning can reduce the effect of misinformation on memory or even eliminate it (e.g., Chambers & Zaragoza, 2001; Christiaansen & Ochalek, 1983; Blank, 1998; Oeberst & Blank, 2012; Wright, 1993; Zaragoza & Koshmider, 1989). The heterogeneity in the methods and procedures of the warning studies (e.g., the type of memory used, or the type of post-warning given) can account for the mixed results. Nevertheless, Blank and Launay (2014) conducted a meta-analysis of post-warning misinformation studies and found that, compared to no warning, misinformation warnings led to a significant improvement in overall accuracy and a substantial decrease in the endorsement of misinformation.

Blank and Launay (2014) summarised that warnings can vary in how specific they are about prior exposure to misinformation. Some studies alert participants about the *possible* exposure to prior misleading information (e.g., Blank et al., 2013; Greene et al., 1982; Wyler & Oswald, 2016). As mentioned previously, individuals in applied situations (e.g., witnesses, police interviewers) may be unaware of exposure to inaccurate information, therefore a warning operating on the realm of possibility is more ecologically valid. However, several warning studies have *definitively* stated that inaccuracies exist between the event and the post-event information (e.g., Christiaansen & Ochalek, 1983). In a more extreme version of specificity, warnings have also explicitly stated the details that were misleading in the post-event information. Such a warning has been shown to eliminate the impact of misinformation (e.g., Wright, 1993).

Although warnings used in misinformation tend to be quite general (i.e., simply informed participants about prior exposure to misinformation), warnings can also include an element of "*enlightenment*" (e.g., Blank, 1998; Oeberst & Blank, 2012). In an enlightenment warning, participants are informed that they were exposed to misleading information but are also given the reason behind this manipulation. That is, participants are made aware that the study is about the effects of inaccurate post-event information on later memory performance and aims to replicate the process of recalling an eyewitness event (Blank & Launay, 2014). To briefly illustrate a study using an enlightenment warning, Oeberst and Blank (2012) presented participants with an event, followed by misinformation, and then a recognition test to examine the effect of misinformation. Thereafter, participants were "enlightened" about the misinformation manipulation before being asked to complete a final test. In three experiments, they found that the detrimental effect of misinformation was eliminated or even reversed after an enlightenment warning. Indeed, in their meta-analysis, Blank and Launay (2014) found that enlightenment warnings were most effective in that they completely eliminated the misinformation effect.

So, why do warnings reduce the impact of misleading information on memory performance? According to the source monitoring theory (Johnson et al., 1993), the misinformation effect occurs when participants misattribute the source of their memory of the misleading information to the event. When participants fail to engage in source monitoring of their memories, misleading information may pass as memories of the original event (Johnson et al., 1993; Mitchell & Johnson, 2000). Indeed, misinformation research using source memory tests has shown that the impact of misleading information is reduced when participants are required to indicate the source of their recollections (e.g., Lindsay & Johnson, 1989; Zaragoza & Lane, 1994, Experiment 3). By providing warnings, participants are alerted to the fact that discrepancies between the original event and the post-event information may exist. This consequently informs participants about the importance of closely monitoring the origins of their memories. During a memory test, participants may adopt a more critical approach towards the information within the test and apply a thorough and strategic process to monitor the memory traces that are retrieved automatically (Higham et al., 2017). If participants correctly identify the misleading detail as having been part of the post-event source, they may then engage in further memory search in order to find an alternative answer. In addition to warnings improving source discrimination, warnings may also reduce or prevent biased responses towards misleading information or improve task representation by highlighting the crucial need to adopt a search-and-discriminate strategy (Blank & Launay, 2014). As stated by Blank and Launay (2014), different warning mechanisms can work together and be present to varying degrees in different warning types, leading to different levels of their effectiveness (more on this later).

Research has shown that warnings have an impact on misinformation endorsement, but do warnings affect susceptibility to misinformation differently for certain types of details in a witnessed event, more specifically central and peripheral details? Very little research has been conducted to examine this. For example, Wyler and Oswald (2016) showed participants a video of a robbery and were then presented with misleading information about a central and a peripheral aspect of the event. Before testing memory for the event, some participants were informed that they may have been exposed to misinformation. Following this, participants completed a two-alternative forced-choice test, and then a source test whereby participants indicated from which source they based each of their recognition answers (i.e., video, post-event, video and post-event, and I guessed). The researchers included a source test to determine whether the effect of warning in the recognition test persisted in a more conservative source memory test. They found that the warning reduced the endorsement of the misleading central detail compared to misinformed/no-warning, but this warning effect was not found for the peripheral misleading detail. Like the recognition data, the source memory results revealed that the warning reduced source misattribution errors compared to no warning for the central detail and not for the peripheral detail. Wyler and Oswald (2016) explained that the errors associated with the central misleading detail were due to deliberation (i.e., selecting the misleading information despite suspecting it to be inconsistent) and/or recency biases (i.e., the misleading information is endorsed due to it being presented more recently) and that the warning was able to reduce the errors due to a stronger memory trace for the original central detail than the peripheral detail. Since the effect was not eliminated suggests that some participants may have also developed a false belief (i.e., they genuinely believe that misinformation occurred in the event). For the ineffectiveness of the warning on the misleading peripheral detail, it was explained that such details have a weaker memory trace and that susceptibility to peripheral details was due to forming false beliefs and best guesses (i.e., they only have memory for the misleading detail and so endorse this piece of information).

In another study, Leding and Antonio (2019) explored the Need for Cognition (NFC; an individual's tendency to engage in effortful cognitive activities, such as critical thinking, problem-solving, and information processing) in the misinformation paradigm and the impact of warning on misinformation errors among high- and low-NFC individuals. They presented a clip of a burglary from The Pink Panther, followed by a narrative containing misleading central (major) and peripheral (minor) details. Finally, participants completed a three-alternative forced-choice test. Half of the participants received a general warning before the recognition test alerting them that inaccurate details were embedded in the narrative. Overall, high-NFC individuals had better accuracy and were more resistant to misinformation compared to low-NFC individuals, suggesting that individuals with high-NFC may have engaged in effortful discrepancy detection leading to improved accuracy. Regardless of high and low NFC, however, they found that the warning reduced the endorsement of misleading peripheral details, but not misleading central details. This is at odds with Wyler and Oswald's (2016) finding. Instead, Leding and Antonio argued that the ability to detect discrepancies between the event and post-event information is easier for central details, thus false recognition would be lower regardless of a warning. However, for peripheral details, the warning likely increased discrepancy detection, thereby reducing the endorsement of falsely suggested peripheral details.

The studies by Wyler and Oswald (2016) and Leding and Antonio (2019) obtained different results. Could the emotionality of the event used in the studies have led to different findings? In Wyler and Oswald's study, the event could be considered emotionally negative, potentially mid to high arousing. In the video, a man, who was taking cash out of a cash machine, was approached by young men, assaulted, and had his wallet stolen. However, in Leding and Antonio's study, the event could be considered low arousing, potentially of neutral valence despite the negative context (i.e., burglary). A scene taken from The Pink Panther showed a burglar entering a museum and stealing a diamond. It is, of course, unclear what the precise level of valence and arousal of these events are since emotional ratings were not measured. Therefore, a systematic and controlled study examining whether warnings impact misinformation susceptibility differently for a negative-arousing event than for a neutral event is required. Research has shown that we process and retrieve negative information differently from neutral information. For example, studies have demonstrated a memory narrowing effect in negative (arousing) events (see Kaplan et al., 2012, for a review). Indeed, in Experiments 2 and 3, central details were better remembered than peripheral details in the negative scenes. One explanation in the literature is that as arousal increases, our attentional resources are directed to central information in an event, consequently impairing memory for peripheral information (Easterbrook, 1959). Further, negative events appear to be more susceptible to misleading information than neutral events (e.g., Porter et al., 2003; Van Damme & Smets, 2014). It is argued that there is an adaptive benefit to incorporating relevant information concerning negative events to avoid or deal with them in the future, which could give rise to false memories (Porter et al., 2008, 2010). Considering that witnesses are asked to retrieve negative and arousing experienced event(s), it is therefore important to understand whether and how the detrimental impact of misinformation on memory for negatively arousing events can be reduced using warnings.

In addition, both studies (i.e., Leding & Antonio, 2019; Wyler & Oswald, 2016) only used a *general* warning (that is, participants were simply informed about the prior misinformation). The meta-analysis by Blank and Launay (2014) found that a warning with an element of "enlightenment" was most effective at reducing the effect of misinformation. Unlike the general warning, Oeberst and Blank (2012) argued that a warning with an enlightenment element ensures that participants have an optimal and stable representation of the memory task. This is because the 'enlightenment' (1) explicitly emphasises the crucial need to search memory for two contradictory pieces of information and to carefully monitor the sources of those, and (2) adequately explains the purpose of the memory task. Oeberst and Blank argued that general warnings provide an inadequate explanation regarding the extent and motivations behind the discrepant information. Thus, participants may think about the reasons why misinformation was presented and become doubtful about the purpose of the study, potentially diverting participants' focus onto unproductive avenues of thought during the memory task and not engaging in effective source monitoring.

To date, no study has examined the impact of enlightenment warning on the susceptibility to misinformation for central and peripheral details within negative and neutral contexts. This was the purpose of Experiment 4. Participants saw a negative-arousing picture and a neutral picture and then completed a post-event questionnaire with embedded misinformation about central and peripheral details in the scenes. Prior to a three-alternative choice recognition test, participants either received a general warning or an enlightenment warning, or no warning was given about prior exposure to misinformation. Both general and enlightenment warnings were included to explore differences in false recognition between a simple and a more elaborated warning. Following Wyler and Oswald (2016), participants completed a source test immediately after the recognition test to see whether any effects found in the recognition test persist in a more conservative test and to explicitly measure source misattribution errors.

It is acknowledged that previous research, including Experiments 1-3, presents mixed findings regarding the impact of misinformation exposure on memory for negative and neutral events and central and peripheral memory (see Sharma et al., 2022, for a review). Nevertheless, what is clear is that both negative and neutral events have been shown to be vulnerable to misinformation. So, what impact would a warning have on misinformation endorsement rates for such events? In Wyler and Oswald's (2016) study, it seems that the witnessed event was negative and arousing and they found that the warning had a positive impact only on central information, arguing that central information has a stronger memory trace than peripheral information. Previous research has demonstrated a memory narrowing effect specifically for emotional events (see Kaplan et al., 2012, for a review). Indeed, Experiments 1-3 showed a memory narrowing effect for negative arousing events (though note in Experiment 1, this was also unexpectedly found for the neutral event). Thus, a misinformation warning may only have an impact on central information. As for the neutral event, the absence of clear salient features would suggest a broader processing of information. Indeed, in Experiments 2 and 3, there was no difference between central and peripheral memory for the neutral event. However, if the original central details are better retrieved regardless of warning, an explanation that was put forth by Leding and Antonio (2019) for their finding using a neutral event, then the warning effect may be found only for the peripheral details. Furthermore, these predictions may vary with the type of warning, considering that the enlightenment warning has been found to be most effective (Blank & Launay, 2014). Based on the above, the following was hypothesised:

H_1: Compared to no warning, the enlightenment warning would show a greater effect at reducing the endorsement of misinformation overall than a general warning.

H_2: For the negatively arousing event, warnings (compared to no warning) would reduce the endorsement of misinformation for central details, but not peripheral details, with the enlightenment warning producing a bigger effect.

H_3: For the neutral event, warnings (compared to no warning) may reduce the endorsement of both central and peripheral misinformation, or only peripheral misinformation, with a particularly stronger effect found with an enlightenment warning.

4.2 Experiment 4

4.2.1 Method

4.2.1.1 Participants

Two hundred and twenty-three participants (age: $M = 32.75$, $SD = 10.57$, age range = 18 - 60; sex: 114 females, 108 males, & 1 other) completed the study[19] in return for a small fee. An a priori power analysis using MorePower 6.0 indicated a required total sample size of between 66 and 156 for a medium to large effect size with Power 0.80. More participants than this range was tested for two reasons. First, Wyler and Oswald's (2016) main findings were based on an aggregation of data across three experiments, and each experiment consisted of between 160 and 190 participants. Second, data from failed attention/comprehension checks would be removed. All participants had English as their first language and had a normal or

[19] This was the first online experiment conducted during the Covid pandemic.

corrected-to-normal vision. All but three participants indicated that they were not colour-blind. Participant recruitment took place using Prolific. Participants provided informed consent and were debriefed at the end of the experiment. City, University of London's Psychology Research Ethics Committee ethically approved the study.

4.2.1.2 Design

The experiment had a mixed design consisting of three variables. Valence was manipulated within subjects. Each participant saw two pictures, and the order was counterbalanced: one negative high-arousing and one neutral[20]. Detail Type was also a within-subjects variable, whereby participants were questioned on central and peripheral aspects of each scene. Finally, the Warning Condition variable was between subjects. This variable consisted of three groups: general warning, enlightenment warning, and no warning. Participants in each group received misleading information since the main investigation was to examine whether the *presence* of a warning affects false recognition of misleading information. Participants were randomly assigned to one of the Warning Conditions, and the number of participants in each condition was as follows: 66 [general], 60 [enlightenment], and 50 [no warning]. Furthermore, an additional group of control participants was tested for the sole purpose to check whether the misinformation manipulation was overall successful by comparing memory performance between the no warning and the control group. The control condition participants were neither warned nor exposed to misleading information and 47 participants were assigned to this group. The main dependent variables were the correct recognition rates and correct source attribution rates for the original details, the false

[20] A negative low-arousing picture was not included for three reasons: (1) due to practical reasons because testing was moved online and there was an interest to reduce the length of time to complete the experiment considering the number and length of measures, (2) in terms of real-life application, negative high-arousal would be most likely experienced by witnesses, and (3) warning and misinformation studies have not yet included neutral and negative events into one study, so possible differences using an emotionally arousing event was examined first.

recognition rates and source misattribution rates for the misleading details, and misinformation resistance scores (i.e., adjusted recognition responses based on confidence scores).

4.2.1.3 Materials

Picture Characteristics. Two pictures used in the previous experiments were chosen as to-be-remembered events. The negative arousing event was the assault scene (IAPS number: 9254) and the neutral event was the restaurant scene (IAPS number: 2593). Based on the valence and arousal ratings obtained from the Pilot study, paired-sample t-tests revealed that valence was significantly lower for the negative arousing picture compared to the neutral picture, $t(25) = -13.18$, $p < .001$, $d = 3.16$, and arousal was significantly higher for the negative arousing picture compared to the neutral picture, $t(25) = 6.16$, $p < .001$, $d = 1.51$.

Post-Event Questionnaire. The post-event questionnaire (titled "Picture Questionnaire" for the participants) consisted of eight Yes/No questions about each picture (i.e., 16 in total). There were four *misleading questions* (see Appendix F). For participants in the misleading conditions, these questions contained misinformation. For participants in the control condition, the phrasing of the questions was kept as similar as possible except that the misinformation was omitted, or the critical detail was described in a neutral form. For example [bold is misleading], "The man in the foreground sitting on the right wore **black** jeans paired with what kind of shoes, were they formal shoes?" vs. "The man in the foreground sitting on the right wore jeans paired with what kind of shoes, were they formal shoes?". To mask the misleading suggestions and to cover the 'both' option in the source test, participants were also asked four *consistent questions* where correct details were suggested. An example is: "Did the woman in the **floral** dress, who was helping the injured woman on the ground, have brown hair?". The consistent questions were the same for all participants. For both the misleading and consistent questions, two targeted central information and two targeted peripheral information. The central and peripheral information was determined from data collected in the Pilot study. In all questions, the misleading or consistent detail was never the focus of the question but rather presented as extra information. For the details that were the focus of the question (e.g., "…were they formal shoes", "…have brown hair"), participants had to determine whether the detail was in the picture. As such, some of these details were part of the picture and some details were not. This ensured that participants used both the Yes and No response options. Importantly, these details were presented in a non-suggestive manner and did not interfere with the suggested details that were embedded in the questions. Participants were not asked about these details in subsequent tests.

Post-Warnings. Participants in both the general and the enlightenment warning groups were informed prior to the recognition test about the possible presence of misinformation in the questionnaire. Warning participants about the *possibility* of prior misinformation is more realistic since eyewitnesses are unlikely to know whether they had been exposed to misinformation, and law enforcement officials typically would not know of any prior false information that could impact witness statements.

Participants in the general warning condition received the following simple warning (e.g. Christiaansen & Ochalek, 1983; Dodson et al., 2015; Szpitalak & Polczyk, 2010): **"**Please read this carefully. When answering the questions, please be aware that the picture questionnaire you completed earlier [that consisted of Yes/No questions] **may** have contained **some** inaccurate information about the pictures. Therefore, please answer the questions **based on your memory for the pictures**.**"**

The post-warning given to the enlightenment group was a modified version of the warning used by Oeberst and Blank (2012) and was as follows: **"**Please read this carefully. We regret that it was necessary to deceive you about the true purpose of this experiment at the beginning. This experiment is actually about the psychology of eyewitness memory and the influence of discrepant post-event information. Imagine you had witnessed a traffic accident. Later, you might discuss it with other witnesses, be asked some questions about the accident, or read an article about it in a newspaper. Some details of the accident **may** not be mentioned, and other details **may** be outright wrong without you necessarily noticing this at first. In this experiment, we simulated such a situation: You saw two pictures, and after a 10-minute interval, you completed a picture questionnaire [consisting of Yes/No questions] that **may** have contained **some** inaccurate information about the pictures. In the following test, you will be asked a series of questions about the pictures. **Please answer the questions based on your memory for the pictures!"**

Memory Tests. Two tests were constructed. The first test was a 24-item three-alternative forced-choice recognition test (i.e. 12 questions per picture). Unlike Experiment 3, three response options were used because, although participants may avoid selecting the misleading information due to the warnings, this would not lead to the correct answer unless participants have a memory for the original detail (Blank & Launay, 2014). Thus, with three options, participants would still need to determine which is the correct answer rather than simply selecting the remaining alternative option if only two response options were available. Furthermore, three response options have been used in previous (warning) misinformation research (e.g., Frost & Weaver, 2010; Leding & Antonio, 2019; Zhu et al., 2010).

For each picture, there were four misleading questions that probed memory for incorrectly suggested details in the warning conditions (see Appendix F for the misleading test questions), four consistent questions that probed memory for suggested details consistent across the post-event questions and pictures, and four non-leading questions that probed memory for picture details that were not previously suggested to all participants. For the three types of questions, two targeted central information and two targeted peripheral information. For the misleading questions, the three response alternatives were an original detail (consistent with the picture), a misleading detail (consistent with the post-event questionnaire), and a novel foil detail. For participants in the control group, the 'misleading' detail was a novel foil. For example, "What colour were the jeans worn by the man in the foreground sitting on the right?" with response alternatives a) Blue [consistent], b) Black [misleading or control], and c) Grey [novel foil]. For the consistent and non-leading questions, participants were shown the original detail and two novel foils. Participants were instructed to select one of the response alternatives based on their memory for the pictures. If they did not know the answer, they were told to make their best guess. For each question, participants were asked to indicate their level of confidence in their answer on a 5-point scale (1 = "not at all confident", 5 = "very confident"). Research has shown that misleading information can be endorsed with a higher degree of confidence using such ratings (e.g., Mahé et al., 2015; Loftus et al., 1978, Exp. 3). In Experiments 3, confidence ratings were collected, and misinformation resistance scores were calculated (i.e., adjusted recognition responses based on assigned confidence ratings), which revealed a similar pattern to the false recognition data. We were interested to continue exploring misinformation resistance but this time in the presence of a warning; thus confidence ratings were recorded.

The second test examined source monitoring. There were 12 questions for each picture (i.e. 24 in total). For each question, participants were re-presented with the recognition question and the answer they had selected (following the structure by Wyler

& Oswald, 2016; e.g. *You were asked: "What colour were the jeans worn by the man in the foreground sitting on the right?" You answered: "Black"*). Participants were asked to indicate the source(s) of information from which their answer was based on. Four options were provided as follows: 'saw it in the picture only', 'read it in the questionnaire only', 'saw it in the picture **and** read it in the questionnaire, and 'I guessed'. [21]

4.2.1.4 Procedure

Participants were told that they will be shown two pictures for 30 seconds each. They were instructed to "Please look at each picture as if you unexpectedly witness the event". Preceding each picture was a fixation cross for two seconds to ensure as much as possible that all participants began looking at each picture from the same position. Picture presentation order was counterbalanced such that half of the participants saw the negatively arousing picture followed by the neutral picture. Once both pictures had been presented, participants completed unrelated distractor tasks for 10 minutes (i.e., mathematical problems and unrelated anagrams). Thereafter, participants completed the post-event questionnaire which suggested misleading information. Depending on the counterbalancing order during the picture encoding phase, participants answered questions about the negative picture first followed by the neutral picture or vice versa. Before each set of questions, participants were told which picture the questions are referring to.

After another 10-minute interval during which time participants completed reasoning problems, participants read the instructions for the recognition test. For the two warning

[21] Some studies (e.g. Hellenthal et al., 2016; Okado & Stark, 2005; Zhu et al., 2010) also included a fifth option ('*saw it in both and they conflicted with each other*') for participants to indicate that they noticed discrepancies between the event and misinformation phases but are unsure of the exact source-attribution. However, since this fifth option could act as a non-explicit warning and could affect comparisons between warning and no warning groups, a decision was made to not use this option. Source tests without this fifth option have been used in several misinformation studies (e.g. Kiat et al., 2018; Wyler & Oswald, 2016; Zaragoza & Lane, 1994).

groups, participants received the warning alongside the test instructions. To determine whether participants in the warning groups read the warning, immediately after the instructions they were given a warning check that instructed them to write down the warning they had received on the previous page. To maintain consistency across conditions, participants in the no-warning and control groups were asked to write the test instructions they had received on the previous page. The recognition test was followed by the source memory test. Both tests were self-paced. Again, in both memory tests, depending on the counterbalancing order at the encoding phase, participants answered questions about the negative picture first followed by the neutral picture or vice versa. Before each set of questions, participants were told which picture the questions are referring to.

After the memory tests, participants provided demographic information and due to the arousing negative picture used in the study, participants watched a short clip from a wildlife documentary to ensure that they finish the study in a neutral/positive state. Participants received a full debrief explaining the study's true purpose and the use of deception.

4.2.2 Results

Thirty-four participants were removed from all analyses[22]. The final sample consisted of 189 participants (age: M = 32.57, SD = 10.18, age range = 18 - 60; Sex: 105 females, 83 males, & 1 other). The following number of participants remained in each condition: 48 [general warning], 49 [enlightenment warning], 46 [no warning], and 46 [control]. An initial analysis between the no-warning and control groups on overall correct and false recognition

[22] Participants were removed due to one or more of the following reasons:

1. Failed warning check. Two coders (Datin Shah & Lauren Knott) passed or failed the warning comprehension check. The coders were looking for understanding of warning instructions. Any disagreements were resolved through discussion.
2. Failing more than one attention check or failing the post-event questionnaire check. In total, there were seven attention checks (four "click me" buttons during the picture encoding phase, and one each in the post-event questionnaire, recognition test, and source test)
3. Indicated that they were colour-blind.
4. Completing the study twice.

responses to misleading questions was conducted to check for successful misinformation manipulation. The main analysis included, correct (original detail) and false (misleading detail) recognition responses to misleading questions, source attribution of the original and misleading details to the picture, and adjusted recognition responses based on confidence scores (i.e., misinformation resistance). A detailed calculation method of the latter can be found in Experiment 3. The statistical tests used to analyse the data are mentioned in the relevant sections below. Bonferroni correction was applied to all t-tests and pairwise comparisons to reduce Type 1 errors.

4.2.2.1 Misinformation Manipulation

Independent-sample t-tests revealed that the misinformation manipulation was successful. Participants in the no warning condition had lower accuracy (M = .39, SD = .19) compared to the control condition (M = .53, SD = .17), $t(90) = -3.52$, $p = .001$, $d = .73$. Furthermore, misleading details were endorsed significantly more in the no warning condition (M = .42, SD = .18) compared to the control condition (M = .23, SD = .15), $t(86.72) = 5.36$, $p < .001$, $d = 1.12$. These findings indicate that the misinformation paradigm was successful at producing a misinformation effect.

4.2.2.2 Correct Recognition

To determine the effectiveness of warnings on memory accuracy after exposure to misinformation, the proportion of misleading questions to which participants selected the original detail was calculated (see Table 18)[23]. A 2 (Valence: Negative vs. Neutral) x 2 (Detail Type: Central vs. Peripheral) x 3 (Warning Condition: General Warning vs Enlightenment

[23] Similar to Experiments 1-3, this experiment included non-leading details (i.e., details that were not suggested to *all* participants). ANOVA on the proportion of non-leading questions to which participants selected the correct answer produced a significant Valence x Detail Type interaction ($p < .001$). Bonferroni paired-sample t-tests revealed better memory for central details compared to peripheral details only in the negatively arousing picture ($p < .001$). This demonstrates emotional memory narrowing. Since this analysis was not important for this experiment's purpose, it is not reported in the main text.

Warning vs. No-warning) mixed-factors ANOVA with repeated measures on the first two factors was conducted. Analysis revealed a significant main effect of Valence, $F(1, 140) = 7.84$, $p = .006$, $\eta_p^2 = .05$, Detail Type, $F(1, 140) = 19.63$, $p < .001$, $\eta_p^2 = .12$, but not Warning Condition, $F(2, 140) = .82$, $p = .443$, $\eta_p^2 = .01$. The three main effects were qualified by a significant three-way interaction (see Figure 5), $F(2, 140) = 3.66$, $p = .028$, $\eta_p^2 = .05$. The interaction was driven by patterns within each level of Valence. For the Negative picture, there was a significant Detail Type x Warning Condition interaction, $F(2, 140) = 3.91$, $p = .022$, $\eta_p^2 = .05$. The main interest was to examine differences between warning conditions. Thus, One-Way ANOVAs revealed differences for central details, $F(2, 140) = 3.08$, $p = .049$, $\eta_p^2 = .04$, but not for peripheral details, $F(2, 140) = .80$, $p = .450$, $\eta_p^2 = .01$. There was a trend towards greater accuracy for central details in the general warning and the enlightenment warning conditions compared to no warning, with the latter warning showing a stronger trend. However, tests for multiple comparisons did not survive Bonferroni correction (*p*s > .051). Within warning conditions, Bonferroni-corrected (alpha set at .016) t-tests revealed that memory for central details was significantly better than peripheral details only for the enlightenment warning condition ($p < .001$; general: $p = .038$; no warning: $p = .875$). Together, this indicates that the enlightenment warning was able to improve accuracy for central details, but not so much so the peripheral details. For the Neutral picture, memory was better for central details ($M = .43$, $SD = .35$) compared to peripheral details ($M = .33$, $SD = .34$), $F(1, 140) = 7.83$, $p = .006$, $\eta_p^2 = .05$. However, there was no significant main effect of Warning Condition nor interactions (*F*s < .61, *p*s > .54). Overall, *compared* to no warning, the general and the enlightenment warnings did not significantly increase accuracy for both the negative and neutral pictures, but for the negative picture, there was a strong trend that the enlightenment warning improved memory for central details.

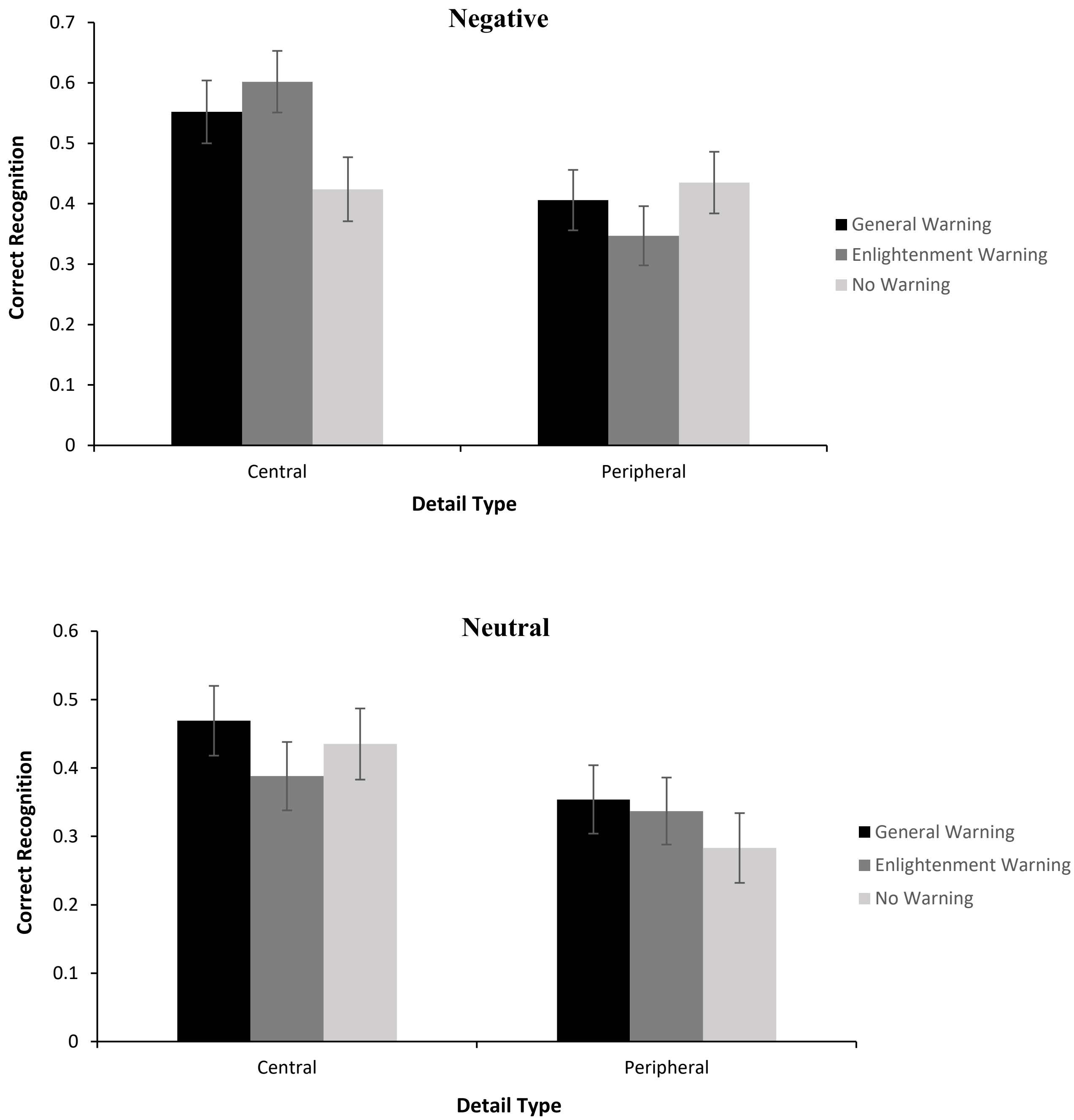


Figure 5. Mean proportion of original details endorsed in the misleading questions for each picture as a function of Detail Type and Warning Condition. Error bars in each figure represent standard errors.

4.2.2.3 False Recognition

Since there were three possible response options to each misleading question, a reduction in correct recognition does not necessarily equate to increased susceptibility to misleading information. Therefore, the proportion of misleading questions to which participants selected the misleading detail was calculated (see Table 18). Analysis using the same 3-way ANOVA as the above revealed no significant main effects (Fs < 1.15, ps > .32), two-way interactions (Fs < 2.96, ps > .08), and a three-way interaction ($F = 2.46$, $p = .089$). This indicates that there is no clear evidence that the warnings are effective at reducing the endorsement of misinformation, regardless of the emotionality of the picture and the type of detail.

Table 18. *Mean proportions and standard deviations for true and false responses to misleading questions as a function of valence, detail type, and warning condition.*

Valence	Negative				Neutral			
Detail Type	Central		Peripheral		Central		Peripheral	
	M	SD	M	SD	M	SD	M	SD
[a] **Correct Recognition**								
General Warning	.55	.39	.41	.34	.47	.38	.35	.39
Enlightenment Warning	.60	.37	.35	.33	.39	.34	.34	.28
No Warning	.42	.32	.44	.37	.44	.33	.28	.36
[b] **False Recognition**								
General Warning	.32	.35	.39	.35	.39	.36	.35	.37
Enlightenment Warning	.32	.33	.44	.38	.48	.31	.37	.30
No Warning	.41	.30	.41	.40	.40	.33	.46	.36

Note. M and SD refer to Mean and Standard Deviation, respectively.
[a] = participants selected the original detail. [b] = participants selected the misleading detail.

4.2.2.4 Source Attribution

Following Zhu and colleagues (2010, 2012), robust recognition responses were examined by calculating the attribution rates of the original and misleading details to the picture. Table 19 presents the full breakdown of the means and standard deviations for these source attributions. As can be seen, the attribution rates were lower than the recognition rates. This can be expected since the source test is a more conservative measure of misinformation whereas the recognition test is a more liberal measure (Wyler & Oswald, 2016).

Source Attribution of the Original Detail. The proportion of misleading questions for which participants had selected the original detail and further attributed it to the picture (i.e., selected 'saw it in the picture only') was calculated and submitted to a 3-way ANOVA as the above. Analysis revealed a significant main effect of Valence, $F(1, 140) = 7.80$, $p = .006$, $\eta_p^2 = .05$, Detail Type, $F(1, 140) = 20.35$, $p < .001$, $\eta_p^2 = .13$, but not Warning Condition, $F(2, 140) = 1.32$, $p = .270$, $\eta_p^2 = .02$. The first two main effects were qualified by a significant interaction, $F(1, 140) = 9.70$, $p = .002$, $\eta_p^2 = .07$. For the Negative picture, correct source attribution rates was higher for central details ($M = .25$, $SD = .31$) compared to peripheral details ($M = .09$, $SD = .20$), $t(142) = 5.05$, $p < .001$, $d = .58$, irrespective of warning condition. This finding likely occurred because the central details are part of the arousing event and have a stronger memory trace than peripheral details, thus are more likely to be correctly attributed to the original event. However, this difference was not significant for the Neutral picture, $t(142) = 1.11$, $p = .269$, $d = .12$. There was also a Valence x Warning Condition interaction (see Figure 6), $F(2, 140) = 3.74$, $p = .026$, $\eta_p^2 = .05$. For the Negative picture, $F(2, 140) = .64$, $p = .527$, $\eta_p^2 = .01$, there were no significant differences between the warning conditions, suggesting that neither providing a simple warning nor an enlightenment instruction was effective at increasing participants' correct source attribution of the original detail. However, for the neutral picture, $F(2, 140) = 4.63$, $p = .011$, $\eta_p^2 = .06$, Bonferroni multiple comparisons revealed that correct source attribution rates were higher in the general warning condition ($M = .17$, $SD = .21$) compared to the no warning condition ($M = .07$, $SD = .14$; $p = .011$), with no further significant comparisons (*p*s > .11). This indicates that only a simple warning was effective at encouraging retrieval of the original detail from the correct source. This will be considered further in the discussion.

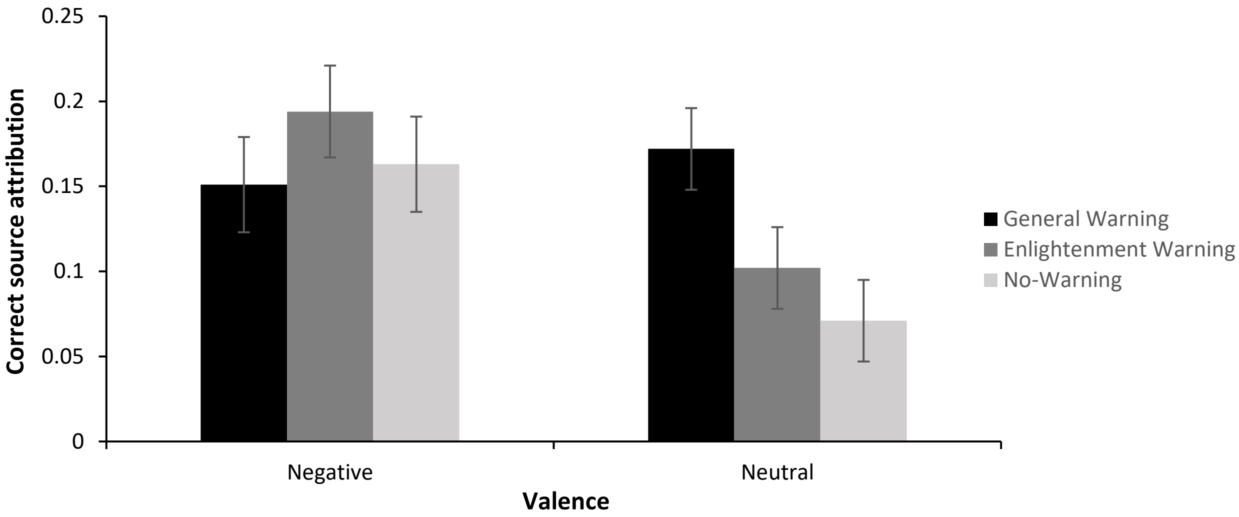


Figure 6. The proportion of original details correctly endorsed and attributed to the picture as a function of Valence and Warning Condition. Error bars in each figure represent standard errors.

Source Misattribution of the Misleading Detail. A calculation was made representing the proportion of misleading questions for which participants had selected the misleading detail and misattributed the source of information as a picture (i.e. selected 'saw it in the picture only' or 'saw it in the picture **and** read it in the questionnaire'). The error rate was lower, which has previously been shown to be the case in the source monitoring test than in a recognition test (e.g., Zaragoza & Koshmider, 1989; Zaragoza & Lane, 1994). Analysis of the source misattribution rates of the misleading details revealed no significant main effect of Valence, $F(1, 140) = 3.27$, $p = .073$, $\eta_p^2 = .023$, but there was a significant main effect of Detail Type, $F(1, 140) = 22.32$, $p < .001$, $\eta_p^2 = .14$, indicating that participants misattributed misleading central details ($M = .18$, $SD = .21$) to the picture more than misleading peripheral details ($M = .08$, $SD = .13$). The main effect of Warning Condition was significant, $F(2, 140) = 3.23$, $p = .042$, $\eta_p^2 = .04$. but pairwise comparisons did not survive Bonferroni correction (*p*s > .078). There were no significant interaction effects in the analysis (*F*s < .77, *p*s > .38). Overall, like the false recognition findings, warnings were not found to be effective at reducing source misattribution errors for the negative and the neutral picture compared to no warning.

Table 19. *Mean proportions and standard deviations for the source attribution of original and misleading details to the picture as a function of valence, detail type, and warning condition.*

Valence	Negative				Neutral			
Detail Type	Central		Peripheral		Central		Peripheral	
	M	SD	M	SD	M	SD	M	SD
[a] **Original Details**								
General Warning	.23	.31	.07	.18	.18	.28	.17	.28
Enlightenment Warning	.30	.34	.09	.20	.12	.22	.08	.19
No Warning	.21	.29	.12	.22	.09	.19	.05	.16
[b] **Misleading Details**								
General Warning	.21	.31	.09	.20	.22	.34	.14	.22
Enlightenment Warning	.13	.22	.03	.12	.18	.26	.08	.19
No Warning	.16	.26	.03	.12	.15	.28	.09	.19

Note. M and SD refer to Mean and Standard Deviation, respectively.
[a] = participants selected the original detail and attributed it to '*saw it in the picture only*'. [b] = participants selected the misleading detail and attributed it to '*saw it in the picture only*' or '*saw it in the picture **and** read it in the questionnaire*'.

4.2.2.5 Misinformation Resistance

Similar to Experiment 3, participants' recognition responses to the misleading questions were adjusted according to the appropriateness of the 1-5 confidence rating. See Experiment 3 for further details. Here, the *misinformation resistance scores* indicate how resistant participants are at endorsing misinformation compared to endorsing the original detail (therefore responses to foil details were not considered when calculating these scores).[24] Table

[24] Due to some participants not selecting either the correct answer or the misleading option for two of any type of misleading questions, this resulted in some empty cells. Therefore, the following number of participants remained in each warning condition: General Warning (39), Enlightenment Warning (44), and No Warning (41).

20 presents the means and standard deviations for misinformation resistance scores. Analysis of the scores revealed a main effect of Detail Type, $F(1, 121) = 5.81$, $p = .017$, $\eta_p^2 = .05$, whereby participants were more resistant to misleading central details ($M = 5.68$, $SD = 1.46$) than misleading peripheral details ($M = 5.29$, $SD = 1.19$). There were no further significant main effects and no interaction effects (*F*s < 2.50, *p*s > .09). Thus, similar to false recognition findings, the presence of warnings did not change participants' resistance to misleading information *compared* to no warning.

Table 20. *Mean and standard deviations for misinformation resistance scores as a function of valence, detail type, and warning condition.*

Valence	Negative		Neutral	
	M	SD	M	SD
Central Details				
General Warning	6.05	1.94	5.90	2.17
Enlightenment Warning	5.98	2.17	5.49	1.50
No-warning	5.37	1.78	5.29	1.88
Peripheral Details				
General Warning	5.30	1.31	5.49	2.24
Enlightenment Warning	5.49	1.32	5.22	1.87
No-warning	5.44	1.68	4.79	2.00

Note. M and SD refer to Mean and Standard Deviation, respectively.

4.2.3 Summary of Experiment 4

The experiment successfully demonstrated the standard misinformation effect. Source misattributions of the misleading detail were also greater for central compared to peripheral details; a difference not found in the recognition data. Since the remember/know measure in Experiments 1 and 2 revealed that participants vividly remembered central false details over peripheral false details, it is not surprising that participants misattributed more of the central misleading details to the picture. More importantly, the experiment revealed that the warnings were not significantly effective *compared* to no warning at reducing the endorsement of misleading information for both negative arousing and neutral events. Also, no differences in the impact of warning exposure on misinformation were found for central and peripheral misleading details, contrary to previous research (Leding & Antonio, 2019; Wyler & Oswald, 2016). There are misinformation studies that have not shown the benefit of a general warning on misinformation endorsement (e.g., Greene et al., 1982; Luke et al., 2017; Zaragoza & Lane, 1994, Experiment 4), and Experiment 4 extended this finding to both a neutral event and a negative high-arousing event. In addition, the enlightenment warning has been hailed as an effective post-warning in a meta-analysis (Blank & Launay, 2014) and in some studies (e.g., Blank, 1998; Oeberst & Blank, 2012). However, Luke et al. (2017) examined whether the impact of bait questions (i.e., questioning suspects on hypothetical evidence) on memory can be lessened but they found that the enlightenment warning was not effective at reducing susceptibility to misinformation. They argued that the bait question evidence may not have been encoded as hypothetical or the hypothetical context may have declined over time.

Warnings were not effective at reducing misinformation endorsement rates in this study. This may be related to warning specificity. First, the warnings used stated the *possible* exposure to prior misinformation instead of a *definite* exposure. Such a warning can be considered ambiguous, and participants may not engage in effortful source monitoring if they feel that they were not exposed to misleading information. Second, Higham et al. (2017) suggested that warnings that state the possible/definite exposure to misinformation are not specific enough in that such warnings do not indicate exactly what information was misleading and how much of the prior information was misleading. Thus, participants may not engage in optimal source monitoring and consequently, misinformation may *slip through the net* (Higham et al., 2017). In the next experiment, the effect of more specific misinformation warnings on memory for negatively arousing and neutral events was investigated by alerting participants to a *definite* exposure to misinformation and by including an item-specific warning (by Higham et al., 2017). Furthermore, there were minor methodological differences which will be addressed in Experiment 5.

4.3 Experiment 5

In Experiment 4, the general and enlightenment warnings did not significantly reduce the endorsement of misleading information compared to no warning for both negatively arousing and neutral events. Also, the effect of warning was not found to vary with central and peripheral misinformation, contrary to previous research (Leding & Antonio, 2019; Wyler & Oswald, 2016). As mentioned in the conclusion of Experiment 4, there was an interest in continuing the investigation set out in Experiment 4 by exploring more specific warnings. There were two reasons for this. First, the warnings in Experiment 4 informed participants of the *possibility* of misleading information in the post-event questionnaire. It may be that such a warning is ambiguous and less effective compared to an unambiguous warning that informs participants of the definite exposure to misinformation. Indeed, previous studies using an unambiguous warning did not find it to be effective at reducing misinformation endorsement when given post-event (e.g., Greene et al., 1982; Luke et al., 2017). Therefore, a more specific warning that explicitly informs participants about the existence of inaccuracies in the post-event questionnaire may be necessary to encourage participants to engage in a thorough memory search for inconsistent information.

Second, Experiment 5 followed Higham et al. (2017) by employing an item-specific warning. In an item-specific warning, participants are clearly made aware of the test questions that contain details that they were misled about and questions that do not contain suggested misleading information[25]. This contrasts with a general and an enlightenment warning, where participants are told that they (may) have been exposed to misinformation, but uncertainties

[25] Oeberst and Blank (2012) also used a similar approach in their third experiment, whereby participants were told whether one or two pieces of information was relevant to a test question. However, this was combined with an enlightenment warning, whereas the current study is interested in examining the warnings in isolation, and their study involved repeated testing.

remain as to the number of details for which they were misled and the particular test questions that the warning applies to. Consequently, this could make source monitoring and memory search less effective.

In the study by Higham et al. (2017), participants were presented with a slide sequence depicting a staged murder (valence and arousal level unknown). After the slide show, participants read a narrative that contained misleading details and control details (i.e., misinformation was either omitted or described in a neutral form). Thereafter, a two-alternative forced-choice recognition test (Experiment 1) or a cued-recall test (Experiment 2) was given targeting the misleading and control details. Before the memory test, however, half of the participants received a general warning that simply stated the presence of misinformation in the narrative, whilst the other half of the participants received the combined general and item-specific warning. Finally, all participants completed a discrepancy detection test whereby they had to indicate the test questions for which they had noticed a discrepancy between the original event and the post-event narrative. This measure was included because discrepancy detection has been found to play a role in the misinformation effect (e.g., Tousignant et al., 1986), and the authors were interested in examining the impact of warnings when discrepancy was not detected. The authors found that the general warning did not reduce the effect of misinformation on memory accuracy, such that the misinformation effect persisted even after the warning. This was largely attributed to discrepancy detection failure that led to poor performance on questions containing misleading details. However, the item-specific warning eliminated misinformation's influence on accuracy. Though, again, discrepancy detection failure did make participants susceptible to misinformation, but much less so than when a general warning was given.

Higham and colleagues (2017) explained their findings in terms of task representation and strategy adoption. That is, the item-specific warnings improve the internal understanding of the memory task by explicitly indicating the need to employ a search-and-discriminate strategy for misleading test questions and a search-and-accept strategy for non-misleading questions. This ensures a more targeted source monitoring and memory search whereby participants may increase their effort to search for the original detail when the misleading detail is correctly attributed to the post-event questionnaire, or search for both the original and misleading details by being aware of the misleading test question. Overall, the endorsement of misleading details should decrease using an item-specific warning and potentially increase memory performance by retrieving the original detail. In contrast, Higham and colleagues explained that general warnings do not indicate what information participants were misled about and how much misinformation was present in the post-event information (which is also applicable to enlightenment warnings). If participants can only retrieve one of the two contradictory details, subsequent source monitoring and effortful memory search may not continue if participants believe that only a small amount of misinformation was present and that the unsuccessful retrieval of two details means that they were not misled on the remembered detail. Consequently, they might disregard further source monitoring to verify the accuracy of the retrieved detail, resulting in some misinformation being endorsed.

Higham et al's. (2017) study did not include a No Warning misinformation condition. Therefore, it is unclear whether receiving an item-specific warning is significantly more effective at reducing misinformation endorsement compared to not providing a warning. The comparison between warning and no warning is important because it helps to assess the effectiveness of warning messages. Their study also did not contain an enlightenment warning to determine whether the item-specific warning is more effective than an enlightenment warning. Moreover, valence and arousal were not measured so it remains unclear whether the item-specific warning will have a positive impact on memory for a negative arousing event. Therefore, a similar experiment to Experiment 4 was conducted by including an item-specific warning to explore (1) whether warnings affect misinformation susceptibility for central and peripheral details differently for the negatively arousing event and for the neutral event (i.e., a three-way interaction effect) now that warning specificity has been altered, and (2) whether the item-specific warning is more effective at reducing susceptibility to misleading details than the general and enlightenment warnings for negative and neutral events. The former was rationalised and hypothesised previously in Experiment 4 (see pages 167-168). In addition, we expect that, compared to no warning, the item-specific warning would lead to a stronger reduction in misinformation endorsement than the general and the enlightenment warnings. Whether the item-specific warning produces the differences hypothesised for negative and neutral events in Experiment 4, and if so, whether the effect is stronger than the original two warnings, remains to be seen.

4.3.1 Method

4.3.1.1 Participants

Two-hundred and seventy-four participants (age: M = 33.24, SD = 12.01, age range = 18 - 60; sex: 170 females, 103 males, & 1 other) completed the study in return for course credit or a small fee. An a priori power analysis using MorePower 6.0 indicated a required total sample size of between 72 and 176 for a medium to large effect size with Power 0.80. Again, more participants than this range were tested to allow for data removal for failed attention and comprehension checks, but also to align with the previous experiments in this thesis so far. All participants had English as their first language and had normal or corrected-to-normal vision. All but four participants indicated that they were not colour-blind. Participants were recruited via City's SONA system and the platform Prolific. Participants provided informed consent and were debriefed at the end of the experiment. City, University of London's Psychology Research Ethics Committee ethically approved the study.

4.3.1.2 Design, Materials and Procedure

The design was similar to Experiment 4, except that the Warning Condition variable consisted of four groups: general warning [*n* = 57], enlightenment warning [*n* = 54], item-specific warning [*n* = 56], and no warning [*n* = 48]. Participants were randomly assigned to the conditions. Once again, a group of control participants [*n* = 59] was included to check for successful misinformation manipulation.

The materials and procedure were similar to Experiment 4 except for the following main differences. The questions in the post-event 'Perception' questionnaire were phrased differently. The phrasing was reverted back to the "Did you see…?" format used in Experiments 1-3 [e.g., "Paired with his **black** jeans, did you see the formal shoes the man in the foreground sitting on the right was wearing?"]. See Appendix G for all the misleading and control post-event and test questions. In Wyler and Oswald's (2016) and Leding and Antonio's (2019) studies, their post-event information was a piece of text that participants had to read. In the text, only the misleading details were the false items; all other details in the text were consistent with the event. In Experiment 4. around half of the details that were the focus of the questions were not part of the picture. As previously mentioned, the focus details do not interfere with the misleading details in the question and the test questions do not target the focus details. Nonetheless, the phrasings of the post-event questions were changed so that only the misleading details remain the false details to be more consistent with previous research.

Item-specific warning: The item-specific warning was a modified version of the warning used by Higham et al. (2017) and was as follows:

> "Please be aware that in the perception questionnaire you completed <u>earlier</u> [that consisted of Yes/No questions], **some** of the questions contained misleading information about the pictures. Therefore, when answering the following test questions, you should **rely exclusively on your own memory of the pictures**.

PLEASE NOTE: There are 12 questions for each picture. Four of these questions relate to details that you were misinformed about in the perception questionnaire you completed earlier, so you must be very careful when answering these questions. For these four questions, one alternative is correct (i.e., it appeared only in the picture), one is the misleading option (i.e., it was mentioned only in the perception questionnaire), and one is new incorrect (i.e., a new detail). The other eight questions relate to details about which you have received no misinformation. For these eight non-misleading questions, one alternative is correct (i.e., it appeared only in the picture, or it appeared in the picture and in the perception questionnaire but it was consistent across both) whereas the other two alternatives are incorrect (i.e., they are a new detail).

To help you answer the test questions correctly, misinformation questions are written in RED, whereas non-misleading questions are written in GREEN."

In addition to the warning check that instructed participants to write down the warning they had received on the previous page, participants in the item-specific warning group were given a multiple-choice question that specifically asked them to indicate what the green and red questions referred to.

For all the warnings used in this study, participants were informed that they were **definitely** exposed to misleading information in the post-event questionnaire. In Experiment 4, participants were told that they **may** have been exposed to misinformation. However, warning participants about the possible exposure to misinformation cannot be applied to an item-specific warning. Therefore, for consistency, both the general and the enlightenment warnings also mentioned a definite exposure to some misinformation.

There were some minor changes to the phrasings and format in both the general and enlightenment warnings. The updated warnings are as follows:

General warning: "Please be aware that in the perception questionnaire you completed earlier [that consisted of Yes/No questions], **some** of the questions contained misleading information about the pictures. Therefore, when answering the following test questions, you should **rely exclusively on your own memory of the pictures**."

Enlightenment warning: "We regret that it was necessary to deceive you about the true purpose of this experiment at the beginning. This experiment is about eyewitness testimony and the influence of misleading post-event information.

Imagine you had witnessed a traffic accident. Later, you might discuss it with other witnesses, be asked some questions about the event, or read an article about it in a newspaper. Some details of the accident may not be mentioned, and other details may be outright wrong without you noticing this at first. After some time, you are then asked to recall what you remember about the accident.

In this experiment, we simulated such a situation: you saw two pictures, and then completed a perception questionnaire [consisting of Yes/No questions] in which **some** of the questions contained misleading information about the pictures. In the following memory test, we are interested in how you can remember the original details from the pictures.

When answering the test questions, you should **rely exclusively on your own memory of the pictures**."

Finally, to be consistent with the recognition test, the questions in the source test were also coloured green or red for participants in the item-specific condition. This was to avoid the possible confounding impact on the data if participants remembered the colour of some questions but not others.

4.3.2 Results

Thirty-four participants were removed from all analyses[26]. The final sample consisted of 240 participants (age: *M* = 33.82, *SD* = 11.82, age range = 18 - 60; Sex: 146 females & 94 males). The number of participants in each condition was as follows: 48 [general warning], 48 [enlightenment warning], 46 [item-specific warning], 48 [no warning], and 50 [control]. The same analyses as in Experiment 4 were conducted and reported below. Bonferroni correction was applied to all t-tests and pairwise comparisons to reduce Type 1 errors.

4.3.2.1 Misinformation Manipulation

Independent-sample t-tests revealed that the misinformation manipulation was successful. Participants in the no warning condition had lower memory accuracy (M = .38, SD = .19) compared to the control condition (M = .50, SD = .19), $t(96) = -3.15$, $p = .002$, $d = .64$. Furthermore, misleading details were endorsed significantly more in the no warning condition (M = .51, SD = .21) compared to the control condition (M = .30, SD = .18), $t(96) = 5.41$, $p < .001$, $d = 1.09$.

4.3.2.2 Correct Recognition

To determine the effectiveness of warnings on memory accuracy after misinformation exposure, a 2 (Valence: Negative vs. Neutral) x 2 (Detail Type: Central vs. Peripheral) x 4 (Warning Condition: General Warning vs Enlightenment Warning vs. Item-specific Warning vs. No Warning) mixed-factors ANOVA with repeated measures on the first two factors was conducted on the proportion of misleading questions to which participants selected the original detail (See Table 21)[27]. Analysis revealed a significant main effect of Valence, $F(1, 186)$ =

[26] Participants were removed due to failing the warning check, failing more than one attention check (out of three, similar to Experiment 2), failing the post-event questionnaire check, or being colour-blind.

[27] Like Experiment 4, ANOVA on the proportion of non-leading questions to which participants selected the correct answer produced a significant Valence x Detail Type interaction (p = .041). Bonferroni-corrected paired-sample t-tests revealed better memory for central over peripheral details only in the negatively arousing picture (p < .001). Once again, this demonstrates emotional memory narrowing.

10.64, $p = .001$, $\eta_p^2 = .05$, whereby memory for details was better from the negative picture ($M = .46$, $SD = .26$) compared to the neutral picture ($M = .38$, $SD = .26$). There was also a significant main effect of Detail Type, $F(1, 186) = 24.25$, $p < .001$, $\eta_p^2 = .12$, with greater memory accuracy for central details ($M = .48$, $SD = .27$) compared to peripheral details ($M = .36$, $SD = .26$). There was no significant main effect of Warning Condition nor interactions (*F*s < 2.40, *p*s > .07). Therefore, warnings were not found to significantly improve accuracy *compared* to no warning, regardless of event emotion and detail type.

4.3.2.3 False Recognition

To examine whether warnings reduce susceptibility to misleading information, the same 3-way ANOVA used for correct recognition was applied to the proportion of recognised misinformation (see Table 21). Analysis revealed a significant main effect of Warning Condition, $F(3, 186) = 5.96$, $p < .001$, $\eta_p^2 = .09$. Bonferroni pairwise comparisons revealed that the enlightenment warning ($M = .40$, $SD = .18$; $p = .035$) and the item-specific warning ($M = .34$, $SD = .23$; $p < .001$) significantly reduced misinformation endorsement compared to no warning ($M = .51$, $SD = .21$). This pattern approached significance for the general warning condition ($M = .40$, $SD = .18$; $p = .05$). Furthermore, there was a significant Warning Condition x Valence interaction (see Figure 7), $F(3, 186) = 2.87$, $p = .038$, $\eta_p^2 = .04$.

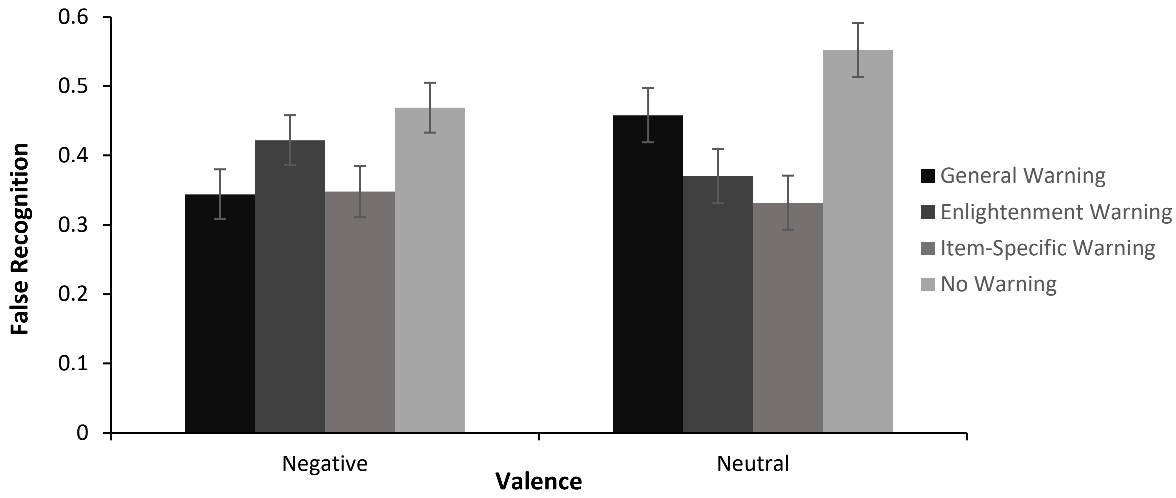


Figure 7. Mean proportions of misleading details endorsed as a function of Valence and Warning Condition (Error bars represent the standard error).

For the negative arousing picture, $F(3, 186) = 2.83$, $p = .04$, $\eta_p^2 = .04$, the significant one-way ANOVA did not survive Bonferroni correction (*p*s > .08), suggesting that the rate of misinformation endorsement did not statistically significantly change across warning conditions. However, for the neutral picture, $F(3, 186) = 6.41$, $p < .001$, $\eta_p^2 = .09$, the enlightenment warning ($M = .37$, $SD = .26$; $p = .006$) and the item-specific warning ($M = .33$, $SD = .29$; $p < .001$) significantly reduced susceptibility to misinformation compared to no warning ($M = .55$, $SD = .26$), whereas this was not the case for the general warning ($M = .46$, $SD = .25$; $p = .525$). Overall, for the negative arousing event, the presence of warnings did not *significantly* reduce susceptibility to misleading information. However, for the neutral event, stronger warnings were effective at reducing the endorsement of misinformation. For both, the findings did not vary with central and peripheral details.

Table 21. *Mean proportions and standard deviations for the true and false responses to misleading questions as a function of valence, detail type, and warning condition.*

Valence	Negative				Neutral			
Detail Type	Central		Peripheral		Central		Peripheral	
	M	SD	M	SD	M	SD	M	SD
[a] **Correct Recognition**								
General Warning	.63	.32	.37	.37	.41	.35	.38	.32
Enlightenment Warning	.45	.36	.41	.37	.43	.37	.38	.35
Item-specific Warning	.54	.38	.45	.35	.42	.36	.36	.36
No Warning	.53	.39	.31	.35	.45	.35	.22	.25
[b] **False Recognition**								
General Warning	.30	.32	.39	.35	.55	.36	.37	.37
Enlightenment Warning	.45	.33	.40	.36	.40	.34	.34	.33
Item-specific Warning	.32	.37	.38	.40	.34	.35	.33	.40
No Warning	.42	.38	.52	.37	.49	.30	.62	.33

Note. M and SD refer to Mean and Standard Deviation, respectively.

[a] = participants selected the original detail. [b] = participants selected the misleading detail.

4.3.2.4 Source Attribution

Following Experiment 4, robust recognition responses were examined by calculating the source attribution rates of the original and misleading details to the picture. See Table 22 for means and standard deviations.

Source Attribution of the Original Detail. Analysis of the proportion of original details correctly attributed to the picture revealed a significant main effect of Valence, $F(1, 186) = 11.31$, $p < .001$, $\eta_p^2 = .06$, and Detail Type, $F(1, 186) = 38.47$, $p < .001$, $\eta_p^2 = .17$, and both were qualified by a significant interaction, $F(1, 186) = 14.59$, $p < .001$, $\eta_p^2 = .07$. The different patterns were found only within Detail Type. For central details, correct source attribution was significantly higher for the negative picture ($M = .24$, $SD = .34$) compared to the neutral picture ($M = .13$, $SD = .26$), $t(189) = 4.35$, $p < .001$, $d = .38$. This may likely be due to a stronger memory trace for central details, particularly in an emotionally arousing event where the central details can be more vividly represented in memory. No significant difference was found for peripheral details, $t(189) = -.29$, $p = .774$, $d = .03$, possibly due to a weaker memory trace in general regardless of the emotionality of the event. There was also a significant Warning Condition x Detail Type interaction, $F(3, 186) = 3.54$, $p = .016$, $\eta_p^2 = .05$. This was driven only by differences *within* the warning conditions, suggesting that correct source attribution rates for central and peripheral details did not significantly vary *across* warning conditions. Bonferroni paired sample t-tests (alpha set at .012) revealed a central-peripheral source memory difference only in the general warning condition, $t(47) = 5.79$, $p < .001$, $d = .98$, and the no warning condition, $t(47) = 2.93$, $p = .005$, $d = .52$, whereby the rates for correct source attribution of the original details were higher for central details (general: $M = .26$, $SD = .27$; no warning: $M = .17$, $SD = .24$) compared to peripheral details (general: $M = .05$, $SD = .13$; no warning: $M = .06$, $SD = .14$). Overall, source attribution of the original central details was better from the negative picture than the neutral picture. However, the presence of warnings were not found to encourage correct source attribution of the original details *compared* to no warning.

Source Attribution of the Misleading Detail. Analysis of the proportion of misleading details misattributed to the picture revealed a significant main effect of Valence, $F(1, 186) = 7.34$, $p = .007$, $\eta_p^2 = .04$, and Detail Type, $F(1, 186) = 17.77$, $p < .001$, $\eta_p^2 = .09$, but not Warning Condition, $F(3, 186) = 2.16$, $p = .094$, $\eta_p^2 = .03$. Unlike the false recognition results, the three main effects were qualified by a significant interaction (see Figure 8), $F(3, 186) = 2.67$, $p = .049$, $\eta_p^2 = .04$. The interaction was decomposed at each level of Valence.

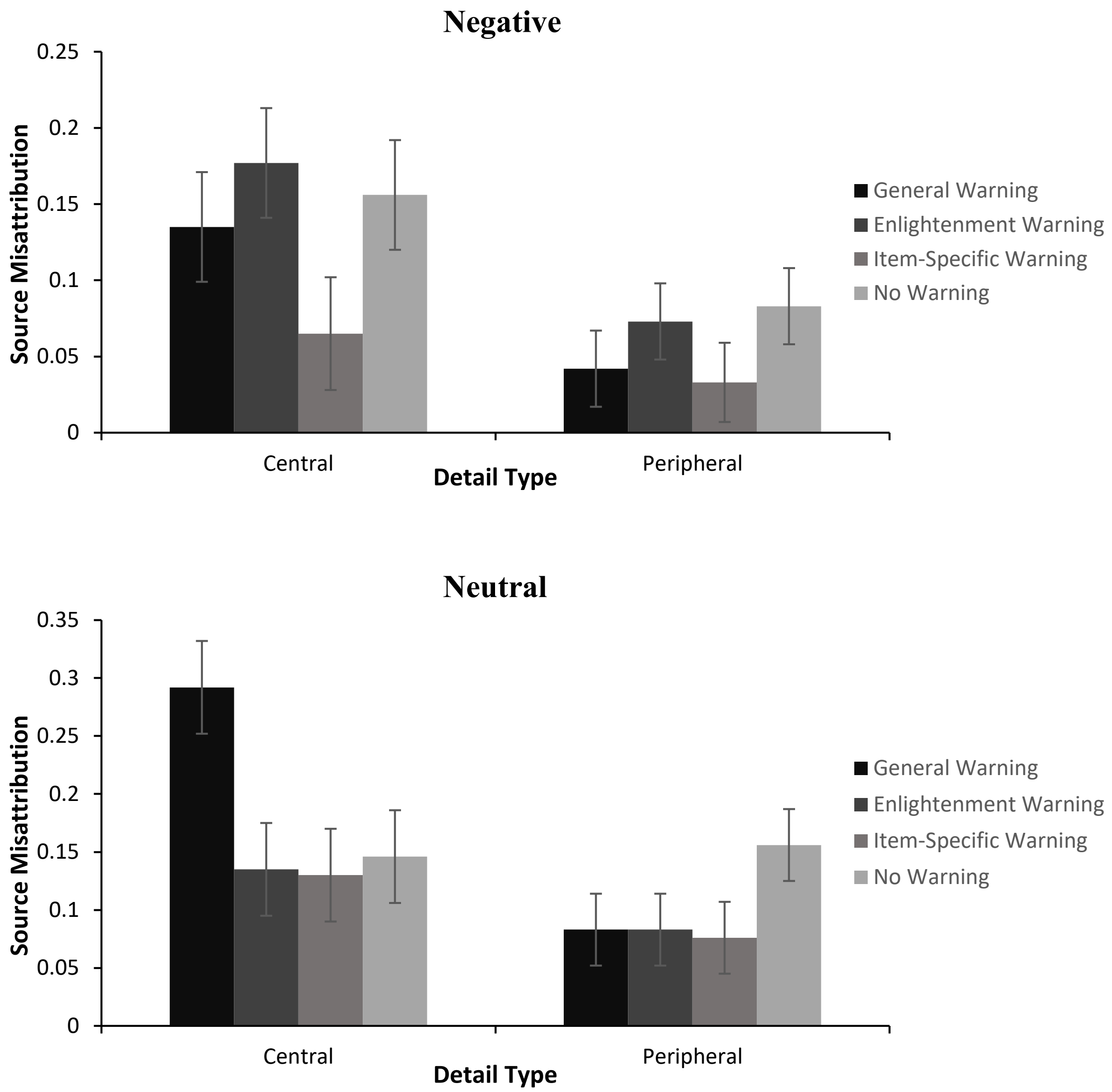


Figure 8. Mean proportions of misattribution errors for the misleading details as a function of Valence, Detail Type, and Warning Condition (Error bars represent the standard error).

For the negative picture, the main effect of Warning Condition was not significant, $F(3, 186) = 2.43$, $p = .066$, $\eta_p^2 = .04$, though Bonferroni-corrected comparisons reveal a pattern that source misattribution errors were lower in the item-specific warning condition compared to the enlightenment ($p = .104$) and no warning ($p = .159$) conditions. There was a significant main effect of Detail Type, $F(1, 186) = 11.96$, $p < .001$, $\eta_p^2 = .06$, whereby source misattribution was greater for central misleading details ($M = .13$, $SD = .25$) compared to peripheral misleading details ($M = .06$, $SD = .18$). An absence of a significant interaction, $F(3, 186) = .51$, $p = .675$, $\eta_p^2 = .01$, suggests that the greater source misattributions for central over peripheral details was similar across warning conditions. For the neutral picture, the Detail Type, $F(1, 186) = 10.82$, $p = .001$, $\eta_p^2 = .06$, and Warning Condition, $F(3, 186) = 2.12$, $p = .100$, $\eta_p^2 = .03$, main effects were qualified by a significant interaction, $F(3, 186) = 4.10$, $p = .008$, $\eta_p^2 = .06$. For central details, $F(3, 186) = 3.82$, $p = .011$, $\eta_p^2 = .06$, Bonferroni multiple comparisons revealed that source misattribution errors were significantly higher for the general warning compared to the enlightenment warning ($p = .035$) and the item-specific warning ($p = .029$), but not the no warning condition ($p = .059$). For peripheral details, there were no significant differences across the warning conditions, $F(3, 186) = 1.51$, $p = .213$, $\eta_p^2 = .02$.

Table 22. *Mean proportions and standard deviations for the source attribution of original and misleading details to the picture as a function of valence, detail type, and warning condition.*

Valence	Negative				Neutral			
Detail Type	Central		Peripheral		Central		Peripheral	
	M	SD	M	SD	M	SD	M	SD
[a] **Original Details**								
General Warning	.35	.37	.05	.15	.17	.30	.05	.19
Enlightenment Warning	.16	.28	.08	.19	.15	.29	.10	.21
Item-specific Warning	.23	.33	.07	.20	.08	.21	.09	.24
No Warning	.22	.34	.07	.21	.12	.24	.05	.15
[b] **Misleading Details**								
General Warning	.14	.29	.04	.14	.29	.35	.08	.19
Enlightenment Warning	.18	.24	.07	.21	.14	.22	.08	.24
Item-specific Warning	.07	.20	.03	.16	.13	.25	.08	.18
No Warning	.16	.26	.08	.19	.15	.25	.16	.23

Note. M and SD refer to Mean and Standard Deviation, respectively.

[a] = participants selected the original detail and attributed it to '*saw it in the picture only*'. [b] = participants selected the misleading detail and attributed it to '*saw it in the picture only*' or '*saw it in the picture **and** read it in the perception questionnaire*'

4.3.2.5 Misinformation Resistance

Similar to Experiment 4, *misinformation resistance* scores were calculated (see Experiment 3 for details), which were analysed using the same ANOVA as the above. Table 23 provides the means and standard deviations for the resistance scores. Analysis[28] to assess whether the warnings affect the degree of resistance to misinformation revealed a main effect of Detail Type, $F(1, 163) = 11.85, p < .001, \eta_p^2 = .07$, whereby participants were more resistant to misleading central details ($M = 5.70, SD = 1.37$) than misleading peripheral details ($M = 5.25, SD = 1.25$). There was a significant main effect of Valence, $F(1, 163) = 5.91, p = .016, \eta_p^2 = .04$, Warning Condition, $F(3, 163) = 4.47, p = .005, \eta_p^2 = .08$, and a significant Valence x Warning Condition interaction (see Figure 9), $F(3, 163) = 3.10, p = .028, \eta_p^2 = .05$.

Similar to false recognition, one-way ANOVAs were conducted on each level of Valence. For the negative arousing picture, $F(3, 163) = 2.61, p = .053, \eta_p^2 = .05$, Bonferroni multiple comparisons revealed no significant differences in misinformation resistance scores across the warning conditions (all *p*s > .082). However, for the neutral picture, $F(3, 163) = 4.98, p = .002, \eta_p^2 = .08$, Bonferroni comparisons revealed that participants were more resistant to misleading information in the enlightenment warning condition ($M = 5.67, SD = 1.40; p = .005$) and the item-specific warning condition ($M = 5.63, SD = 1.27; p = .010$) compared to the no warning condition ($M = 4.72, SD = 1.33$). There were no further significant comparisons (*p*s > .13). Overall, the results follow the false recognition findings.

[28] Due to some participants not selecting either the correct answer or the misleading option for two of any type of misleading questions, this resulted in some empty cells. Therefore, the following number of participants were in each condition for this analysis: General Warning (42), Enlightenment Warning (41), Item-specific Warning (39), and No Warning (45).

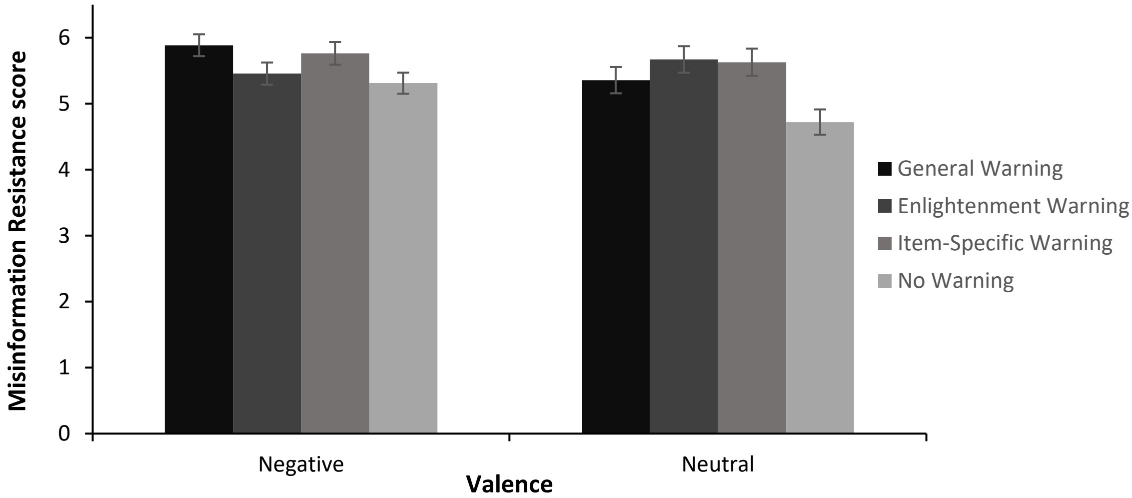


Figure 9. Mean misinformation resistance scores for misleading details as a function of Valence and Warning Condition (Error bars represent the standard error).

Table 23. *Mean and standard deviations for misinformation resistance scores as a function of valence, detail type, and warning condition.*

Valence	Negative		Neutral	
	M	SD	M	SD
Central Details				
General Warning	6.35	1.54	5.31	1.62
Enlightenment Warning	5.54	1.82	5.66	1.79
Item-specific Warning	6.05	1.65	5.86	1.35
No Warning	5.62	1.90	5.22	1.65
Peripheral Details				
General Warning	5.43	1.15	5.41	1.62
Enlightenment Warning	5.38	1.48	5.68	1.72
Item-specific Warning	5.47	1.40	5.40	1.90
No Warning	5.00	1.52	4.22	1.80

Note. M and SD refer to Mean and Standard Deviation, respectively.

4.3.3 Summary of Experiment 5

In contrast to Experiment 4, the presence of warnings in Experiment 5 affected the memory for the neutral event. Specifically, the enlightenment and item-specific warnings were effective in reducing the recognition of misinformation and improving resistance to misinformation, aligning with previous studies that have demonstrated the efficacy of these types of warnings (e.g., Oeberst & Blank, 2012; Higham et al., 2017). Additionally, both warnings were successful in reducing source misattribution compared to the general warning, but only for the central misleading details. It remains unclear why the source misattribution was descriptively markedly higher for the central misleading details when a general warning was given compared to no warning. However, similar to Experiment 4, the warnings did not significantly mitigate the impact of misinformation on recognition and source memory for the negative event, suggesting the enduring influence of misinformation in negative arousing events. The General Discussion section will explore potential explanations for these findings.

4.4 General Discussion

Given the significant real-world implications of being exposed to misleading information, researchers have devoted efforts to exploring strategies that can mitigate its detrimental effects. One promising approach involves the use of post-warnings, where individuals are alerted to the presence of misinformation they have been exposed to. Previous studies have shown the effectiveness of such warnings in reducing or eliminating the impact of misleading information (Blank & Launay, 2014). However, the specific impact of warnings on misinformation related to negative arousing events remains relatively unexplored. Events that eyewitnesses experience are typically negative and arousing. Research has shown that negative emotion can increase susceptibility to misleading information (e.g., Porter et al., 2003, 2010; Van Damme & Smets, 2014) and some types of warnings are more effective at reducing the endorsement of misleading information (Blank & Launay, 2014). The aim of Experiments 4 and 5 was to explore the impact of different warnings on susceptibility to misleading information within negatively arousing and neutral scenes and misinformation for central and peripheral aspects of these scenes. Participants were presented with a negatively arousing scene and a neutral scene, followed by exposure to misleading information via a post-event questionnaire. Before a forced-choice recognition test and a source monitoring test, participants received either a general warning (Expt. 4 & 5), an enlightenment warning (Expt. 4 & 5), or an item-specific warning (Expt. 5).

The experiments revealed different effects of warnings for negatively arousing and neutral scenes. For the negatively arousing scene, warnings did not *significantly* reduce the endorsement rates of misleading information compared to no warning in both Experiments 4 and 5. Misinformation resistance also did not change across warning and no warning conditions. Thus, many participants in the experiments consider the misleading information to be part of the original event. This is in contrast to Wyler and Oswald's (2016) study where they found the general warning to be effective for at least the central item. A possible explanation for this finding may be due to continued source monitoring failures despite the warnings. Warnings inform participants of potential discrepancies between the event and the post-event information and the need to consider the sources of their memories carefully before responding. Based on this, warnings can be successful at reducing the effect of misinformation through correct source attribution. However, it may be that, for the negative arousing picture, participants truly believe the misleading information to be part of the event, resulting in source monitoring failure. The post-event misinformation associated with the negative arousing event may have a strong memory trace and be more integrated into the original event, making source monitoring difficult. Source confusions typically occur when sources or characteristics between sources are similar (e.g., an overlap of the semantic content in the post-event questionnaire and the witnessed event; Mitchell & Johnson, 2000). Processing the post-event questions can accompany the retrieval of the original event, the possible mental imagery and rehearsal of the misleading suggestions, and the reconstruction of the original event by including elements from both sources (Johnson et al., 1993; Mitchell & Johnson, 2000). This can further increase the overlap between the two sources and source confusions. Hyman and Loftus (1998) suggested that the visualisation of new information can lead to the creation of false memories because the detailed and richness of the perceptual and sensory information in vivid images can make the new information seemingly real and the suggested event more detailed, consequently making one more susceptible to misattributing suggested information to the witnessed event. Indeed, empirical evidence (e.g., Dobson & Markham, 1993; Zaragoza & Lane, 1994) has shown that when a post-event task requires reflecting back to the original event or requires imagining misleading details, source misattribution errors can increase due to participants mistakenly believing the misleading information to be part of the original event.

Although mental imagery of the misleading information and event reconstruction are also likely with the neutral event, the negative event is emotional and arousing and it is plausible to assume that the retrieval of the arousing event and the possible visualisation of the post-event information may increase emotional arousal, thereby enhancing the vividness, integrability with the original event, and memorability of the misleading information. Indeed, research has shown that negative memories are remembered and retrieved vividly (e.g., Kensinger & Corkin, 2003; Sharot et al., 2007) and that arousal during encoding enhances memory (e.g., Cahill & McGaugh, 1998). Also, Crombag et al. (1996) and Lommen et al. (2013) found that misleading participants about a dramatic fictious event (e.g., plane crash) led to many participants remembering such events. They argued that high arousing negative events may be more susceptible to misinformation compared to ordinary events because of their ability to create mental images, which disrupts the process of accurately determining the source of information. Lommen and colleagues further argued based on their findings that individuals with high arousal at the time of encoding misinformation may form images of the misinformation more vividly. Overall, source monitoring failure due to source confusions is likely a reasonable explanation for why the warnings did not have a significant impact on misinformation endorsement rates for the negative-arousing event.

Since the warning did not significantly reduce false recognition rates for the negative scene, it is therefore not surprising that warnings did not significantly increase the recognition of the original detail *compared* to no warning. This is in line with Leding and Antonio's (2019) finding whereby the accuracy of the misleading questions (both central and peripheral) did not significantly change across warning and no warning conditions. However, it is worthwhile to note though that for the negative event in Experiment 4, there was a trend such that accuracy for central details increased after a general warning and an enlightenment warning compared to no warning, with the trend being stronger for the latter warning. In line with Wyler and Oswald (2016), central details have a stronger memory trace than peripheral details, thus warnings can be more likely to influence central details. This trend was not found in Experiment 5; thus it remains to be seen whether it is a result of warning specificity (possibility vs. definite) or a one-off observation.

Turning to the neutral scene, Experiment 5 revealed that, compared to no warning, the enlightenment and the item-specific warnings, but not the general warning, significantly reduced the endorsement of misleading information and participants became more resistant to misinformation. Previous research has demonstrated the effectiveness of these two warnings (e.g., Blank, 1998; Higham et al., 2017; Oeberst & Blank, 2012). It is suggested that both the enlightenment and item-specific warnings improve the internal representation of the memory task by clearly emphasising the need to use a search-and-discriminate approach and encouraging effortful memory search and thorough source discrimination (Higham et al., 2017; Oeberst & Blank, 2012). Consequently, the effect of misleading information should be mitigated, as was demonstrated in Experiment 5. The reduction in misinformation endorsement was greater for the item-specific warning. In the enlightenment warning, participants are unaware of how much misinformation is present, so some misinformation may be endorsed if participants do not appropriately engage in source monitoring (Higham et al., 2017). In the item-specific warning, participants are made aware of the exact questions that contain misleading information, thus, a more targeted searching and monitoring approach is utilised for those questions that are misleading (Higham et al., 2017).

Despite the reduction in false recognition in the enlightenment and item-specific warnings, this did not correspond with a significant increase in correct recognition of the original details. Descriptively, there was an increase in correct recognition (at least for peripheral details, supporting Leding & Antonio, 2019) after the enlightenment and item-specific warnings, suggesting that there may have been a successful retrieval of the original detail by some participants. However, this was not significant. Blank and Launay (2014) argued that although warnings to ignore misleading information may qualify as a demand characteristic, correct answers can only be produced if people remember the original details. Therefore, having more than two options in a forced-choice test can help demonstrate whether warnings lead to improved memory performance under different conditions. A possible explanation may be that participants retrieved the misleading details, which may be more likely the first detail that comes to mind (Higham et al., 2017), and correctly identified the source as post-event. However, in most instances, they may have failed to retrieve a contradictory detail, and so were unable to determine which of the two remaining choices is the correct detail. Indeed, it has been shown that memory for neutral information is not as strong as that for emotional information (see Levine & Pizarro, 2004, for a review). Thus, participants could take the failed retrieval as evidence of no misinformation, but considering the reduction in misinformation endorsement, they may have ignored the first, likely misleading, option that came to mind and selected a different response by guessing, which was not always correct. This approach is more fine-grained in an item-specific task as they may do this only for misleading questions, hence the greater reduction. Wyler and Oswald (2016) argued that a reduction in the endorsement of misinformation after a warning is due to the warning undermining deliberation and recency biases. Due to a reduction in false recognition, the endorsement of misinformation may be attributed to such biases. However, even after the warnings, some participants still endorsed misleading details for the neutral picture, and this may be attributed to guessing errors or in some instances a genuine false memory.

It is important to note that, in Experiment 4, the enlightenment warning was not found to be effective at reducing the endorsement of misleading information associated with the neutral picture compared to no warning, but in Experiment 5, the enlightenment was significantly effective. Why might this be? For the neutral picture, the difference between the experiments could be due to the way participants were informed about the suggestive misinformation. In Experiment 4, participants were told of the *possibility* of prior exposure to misinformation, whereas in Experiment 5, participants were informed of the *definite* exposure to misinformation. The findings appear to show that the tentative versus definitive wording likely impacted the enlightenment warning only since the general warning was found to not be effective regardless of wording. It may be that participants who were definitively warned were more likely to engage in effortful source monitoring and source discrimination than those who were tentatively warned. A tentatively worded warning is more realistic in terms of its practical application, but it can be nonetheless perceived as ambiguous. Indeed, a few studies using ambiguous warnings have not found a significant impact of warning in reducing the recognition of misinformation (e.g., Greene et al., 1989; Luke et al., 2017). Of course, there were some methodological differences between the two experiments that one could argue contributed to the difference in results. However, considering the negative picture results and the general warning result for the neutral picture, this may only play a minor role, if any at all. Nevertheless, future researchers using the misinformation paradigm should consider the impact of definitively and tentatively worded warnings to further understand what role this can play.

Finally, the benefits of a warning for the neutral picture did not materialise when the warning was more general (both in Experiments 4 and 5). Although several studies using a general warning did find a significant reduction in the effect of misinformation (e.g., Chambers & Zaragoza, 2001; Christiaansen & Ochalek, 1983), other studies did not reveal its effectiveness (e.g., Greene et al., 1982; Luke et al., 2017). Although heterogeneity between studies can play a role (see the introduction to this chapter), Oeberst and Blank (2012) and Higham et al. (2017) argued that a general warning leaves participants with uncertainty about the reason and extent of the misinformation manipulation, thus it may not adequately provide a clear representation of what is required in the memory task. An enlightenment and item-specific warnings provides a more optimal representation of the task that encourages effortful memory search and source monitoring due to a search-and-discriminate approach being explicitly emphasised. Furthermore, Higham et al. (2017) found that failure to detect discrepancies largely accounted for the ineffectiveness of the general warning. It is unclear whether this was the case in Experiment 5, considering that no significant increase in correct recognition was found for the two stronger warnings. Further research can set out to test this.

It is important to mention that, despite the theoretically based predictions, the false recognition findings in Experiment 5 (and 4) did not significantly vary with central and peripheral details. Therefore there was no evidence that impact of warning on misinformation had different effects on both central and peripheral details. It may be that the above explanations could account for this. For the neutral picture, it is possible that participants may have detected discrepancies for both central and peripheral details through careful source monitoring (at least for the enlightenment and item-specific warnings). This is because there is an absence of salient features and negative emotion in the scene making memory narrowing effects less likely. Thus, participants may engage in a broader processing of the scene. For the negative arousing picture, it can be adaptive to know not only the information relevant to the main event, but also information about the surroundings (e.g., people or objects present in the background) in order to deal with and/or avoid similar future dangers. From a source monitoring viewpoint, both central and peripheral post-event details could be visualised, be better integrated into the original event, and have a stronger memory trace, increasing source confusions. That is because both details are associated with the negative arousing scene, and the negative emotion that one may feel due to the retrieval of the event during the post-event questionnaire may influence memory for the post-event details in general. Despite these possible explanations, it is once again important to reiterate that previous misinformation studies have reported mixed results regarding the effect of emotion on memory for central and peripheral misinformation (see Sharma et al., 2022, for a review), with Porter et al. (2003) finding no significant evidence of the impact of misinformation on central and peripheral memory across emotional and neutral scenes. Thus, future research can aim to test whether the current findings, irrespective of detail type, are genuine or an artefact of the study's methodology.

In addition to the recognition test, a post-recognition source memory test was administered following the procedures of Wyler and Oswald (2016) and Zhu and colleagues (e.g., 2010) to further refine recognition memory performance. To do so and in line with Zhu and colleagues, the degree to which participants believed that they had seen the misleading or correct detail in the original scene was calculated, which Zhu and colleagues refer to as *robust* memory performance. Here, the focus will only be on the impact of the presence of a warning (warning vs. no warning) on source attribution rates. In Experiments 4 and 5 for the negative arousing picture, the misattribution of the misleading details to the picture was not significantly reduced by the presence of a warning compared to no warning, which is in line with the recognition memory performance. This suggests that not only the quantity of misinformation endorsement but also the quality of misinformation endorsement did not change with and without a warning, indicating that participants believe that the misleading information was part of the event. A noteworthy finding was obtained in Experiment 5, whereby participants had a robust false memory (i.e., higher misattribution rates) for central misleading details compared to peripheral misleading details for the negatively arousing event, regardless of warning presence. This could be explained from a source monitoring perspective. Since the central misleading details were directly associated with the arousing event depicted in the scene, it may be that such details have a stronger memory trace than peripheral details, but also that mental imagery of central details when answering the post-event questions are likely to be more vivid and detailed compared to the peripheral misleading details. Thus, there may be a greater overlap, both semantically and perceptually, between the original and post-event sources for the central details, thereby increasing source confusions and making warnings ineffective.

For the neutral picture, however, the results differed from the recognition test, such that the reduction in source misattribution errors of the misleading details for the enlightenment and item-specific warnings continue to highlight the effectiveness of these warnings, but only for central details. It may be that the central misleading details are better remembered due to recent exposure (Peace & Constantin, 2016) and so with stronger warnings participants were able to engage in a more thorough, and possibly strategic, source monitoring to correctly identify the source of the central misleading details. However, this reduction was only significant compared to the general warning, and it is unclear as to why participants committed more source attribution errors when a general warning was given compared to when no warning was given.

Regarding the correct source attributions of the original details, the *overall picture* across both experiments was that warnings largely did not significantly improve the source attribution of the correct details *compared* to no warning for both negative and neutral events. This mirrors the recognition findings. It is important to note some differences between the experiments. First, only the simple warning was effective at increasing correct source attributions in the neutral picture in Experiment 4, but not in Experiment 5. Second, only in Experiment 5, higher source attributions for correct central over correct peripheral details were found in the general and the no warning conditions. Descriptively, it appears that in the enlightenment and item-specific warnings, correct source attribution increased for the peripheral details but decreased for the central details. The explanation for both findings is unclear, and it is also unclear whether warning specificity (i.e., possible vs. definite exposure) could account for the differences in these robust memory findings between the experiments. Further warning and misinformation research could help determine the reliability of these findings, but the source test implications discussed next could have impacted the results.

As can be seen, there are similarities and differences between the recognition and source test results in each experiment, and source test results between the experiments. Differences in the results could be expected since the source test is more conservative than a recognition test and participants are likely to be more critical in their memory on a source test. However, caution needs to be exercised when interpreting and concluding from the source test results, due to limitations in the way that the source test was employed. The source responses may not accurately reflect their recognition response. First, participants may have forgotten what source they used to make their recognition response. Second, the recognition response may have been made due to genuine source confusion. For example, if the memory trace for the misleading and/or original detail is strong, but they have difficulty identifying the correct source, they may guess the source response if they feel obliged to make a response or they may not want to commit to a particular source and select *I guessed* (Blank, 1998). Higham (1998) recommended that the response option "*I know it occurred somewhere in the experiment, but I don't know* *where*" should be included in a source monitoring test to account for source uncertainty and to reduce participants making guess responses for reasons other than genuine guesses. Third, the source test was given to the participants after they completed the recognition test, following Wyler and Oswald (2016). Although not very common, such a procedure has been used in a few studies (e.g., Okado & Stark, 2005; Wyler & Oswald, 2016; Zhu et al., 2010, 2012). Participants during the source test can change their minds regarding the source for which they made their recognition response, thus it cannot be confidently said that the source test responses indicate how the recognition test responses were made. A recommendation could be to conduct two experiments, one with only the recognition test and one with only the source test. The limitations highlighted here hinders firm conclusions to be made regarding the contribution of source attributions in the study and also make the comparison between the recognition and source test results difficult. Therefore, future research should address these limitations to obtain more accurate source responses to better understand the impact of warning on source memory for negative arousing and neutral events.

To summarise, the impact of warnings depended on the specificity of the warning, the type of warning, and the emotionality of the event. When participants were warned about the *possible* exposure to misinformation, warnings had no significant impact on reducing the effect of misinformation for both a negative arousing and a neutral event. Considering that witnesses and investigators are typically unaware if misinformation was encountered, this finding has important implications in real-life settings. However, when participants were made aware of the *definite* exposure to misinformation, this had a reliable effect only for the neutral event. More specifically, an enlightenment and an item-specific warning, but not a general warning, reduced the effect of misinformation and participants showed resistance to misinformation, highlighting important theoretical implications regarding source monitoring, bias, and task representation. For the negative arousing event, however, memory malleability was demonstrated in recognition and source memory such that warnings did not significantly impact misinformation susceptibility. This has serious implications for eyewitness testimony considering that witnessed events are typically negative and arousing. Once again, false recognition findings did not vary with the centrality of the information. The methodology and the classification (in terms of definition and approach) of central and peripheral information differs across studies and could lead to mixed results (see Levine & Edelstein, 2009, for a review; Kaplan et al., 2012; Luna & Albuquerque, 2018). In conclusion, further research is necessary to gain a comprehensive understanding of the resistance of negative arousing events to warnings. This may involve developing post-warnings that effectively address uncertainty regarding the presence, nature, and extent of misinformation.

Chapter Five: The Effect of Delayed Retrieval on Misinformation Susceptibility for Negative and Neutral Events

5.1 Introduction

This thesis concludes with an investigation into the role of retention interval on suggestibility for negative events. Understanding how misinformation affects memory over time has important implications, particularly for forensic settings where the accuracy of eyewitness testimony is paramount. Studies have shown that memory for emotional information remains stable or improves over time but memories for neutral information decrease with time (e.g., Kleinsmith & Kaplan, 1963; Park, 2005; Sharot & Phelps, 2004; Sharot & Yonelinas, 2008; Wang, 2014). For example, using different retention intervals, Wang (2014) showed participants emotionally arousing (negative and positive) and neutral pictures and tested their recognition memory of the pictures either 5 minutes, 24 hours, or 1 week later. Although there was no change in accuracy between the 5-minute and 24-hour delay for all pictures, accuracy dropped in the 1-week delay compared to the 24-hour delay for the positive and neutral pictures, but no change in accuracy was found for the negative pictures. Dolcos et al. (2005) found better recollection of emotionally arousing (positive and negative) pictures compared to neutral pictures even after one year. Furthermore, in a meta-analytic study, Park (2005) investigated whether emotionally arousing events are better remembered after a certain time delay on various types of stimuli (e.g., verbal, visual, etc.). They found that at immediate testing (i.e., 2-min, & 20-min), memory was better with low arousal than with high arousal, whereas at delayed testing (i.e., 45-min., 1 day, and more than 1 day), high arousal represented superior memory. Overall, the research demonstrates that emotionally arousing (negative) information benefits from a slower rate of forgetting over time.

There has been limited research using complex events examining delayed retrieval of central and peripheral details in negative arousing events (for a review, see Christianson, 1992). For example, Christianson and Loftus (1987) presented participants with a slide sequence depicting an emotionally negative or neutral event. They were instructed to write down the most distinctive feature of each slide, thereby only focusing on the central aspects of the slides. Memory for details and the pictures were tested either 20 minutes or 2 weeks later. They found that central details were better remembered from the negative event rather than the neutral event. However, on a picture recognition test that measured memory for peripheral details, recognition was poorer for the negative emotional event compared to the neutral event. These results were found at both 20-minute and 2-week retention intervals. Furthermore, details about the essence of the emotional event continued to be well remembered 6 months later by many participants compared to the central details of the neutral event. Burke et al. (1992) found that memory for central details was better, and memory for peripheral details was poorer, for a negative arousing event compared to a neutral event. Although there was a general decrease in memory performance over time (i.e., after one week) for both details, the benefit of emotional arousal on memory for central details increased over time in comparison to the neutral event. Morover, the disadvantage of emotional arousal on memory for peripheral details found at immediate testing decreased over time. These results suggest that negative arousing events, particularly central details, appear to be more resistant to significant forgetting over time.

So why is the memory for negatively arousing information retained over time? One theory suggests the role of neurohormonal processes, in particular the amygdala (McGaugh, 2000). When one experiences emotional arousal, stress hormones (such as epinephrine and cortisol) are activated, which activates the amygdala (McGaugh, 2018). The amygdala modulates the activity of other brain areas, such as the hippocampus and para-hippocampus, which enhances memory consolidation and influences long-term memory (e.g., Dolcos et al., 2003, 2011; McGaugh, 2002). Additionally, visual, prefrontal, and parietal brain regions are activated when encoding emotional information (Dolcos et al., 2011, 2012; Kensinger & Corkin, 2004). There is empirical support for the role of the amygdala in enhanced memory of arousing information. For example, in an fMRI scanner, Fastenrath et al. (2014) presented participants with emotionally (positive and negative) arousing pictures and neutral pictures. Recall of the pictures was tested approximately 10 minutes after completion of the encoding phase. The emotionally arousing pictures were better remembered than neutral pictures, and interestingly, fMRI data revealed that there was greater strength in the connection between the amygdala and the hippocampus when encoding emotionally arousing pictures. Dolcos et al. (2005) found that emotional pictures were remembered after one year and that increased activation of the amygdala and hippocampus regions at retrieval was related to a greater recollection of negative and positive pictures. As can be seen, the interactions between the amygdala and the hippocampus during the encoding and retrieval of emotionally arousing information appear to benefit long-term memory retention. Furthermore, as the effect of arousal is typically enhanced after a period of delay, this slow consolidation process is argued to serve an adaptive function (McGaugh, 2000). Indeed, from an evolutionary perspective, being able to remember an arousing experience over time can help an individual prepare for similar events, and guide future behaviour to approach or avoid such situations (Porter & Peace, 2007; Porter et al., 2008).

In the misinformation paradigm, researchers have manipulated the interval between the event phase and the misinformation phase (e.g., Loftus et al., 1978; Paz-Alonso & Goodman, 2008; Paz-Alonso et al., 2013) and between the misinformation phase and the memory retrieval phase (e.g., Frost et al., 2002). The current study examines the latter, but the former will be revisited in Chapter 6. Studies investigating the impact of retention interval on the misinformation effect have shown that the size of the misinformation effect increases over a longer retention interval (e.g., Frost, 2000; Frost et al., 2002; Holmes & Weaver, 2010; Mudd & Govern, 2004; Underwood & Pezdek, 1998). Frost et al. (2002) showed a slide sequence depicting a monetary theft in an office by a maintenance man, followed by a narrative containing misleading details about the event. Participants were tested on their recognition and source memory for details either 10 minutes or one week later. They found that, over time, participants were more likely to endorse the misleading information and misattribute it to the slide event. Interestingly, source accuracy declined to a much greater extent than recognition accuracy. Furthermore, Mudd and Govern (2004) presented participants with a video clip from a TV show. Participants then interacted with a confederate who either presented misinformation or unrelated information about the video. Participants' memory was tested three times: immediately after the video, after the confederate interaction, and two weeks later. Over time, it was found that participants who were exposed to misinformation became more susceptible to the suggestion and were more confident in their memory. Source monitoring failure could account for continued or increased susceptibility to misinformation over time. One reason for the endorsement of misleading information is that participants misattribute the source of the misinformation as being part of the original event (Zaragoza & Lane, 1994). Frost et al. (2002) argued that the association between the event details and their source fades over time. Memory for the event contains perceptual characteristics, but over time, these distinctive perceptual characteristics fade, and memory for the event becomes more like the memory of the (verbal) misinformation (Frost et al., 2002). Consequently, the reduced number of source cues available after a longer delay makes participants less resistant to misleading information, thereby increasing misinformation errors. Another explanation put forth by Underwood and Pezdek (1998), called the availability-valence hypothesis, is that the association between misleading information and its source tends to fade away more quickly compared to the misinformation itself. This rapid decay of the source can increase participants' tendency to accept the misinformation as being part of the original event as the retention interval progresses.

The first study to examine the impact of delayed testing on susceptibility to misinformation for emotional events was conducted by Porter et al. (2010; see also Monds et al., 2016). They presented participants with positive and negative emotional picture scenes.

Misinformation was introduced to half of the participants in a series of questions about the pictures. Finally, participants answered open-ended questions about each scene immediately and either 1 week or 1 month later. Regardless of the emotionality of the pictures, they found that accuracy for misinformation questions (i.e., major and minor misleading details combined) was lower for misled participants than for control participants at both immediate and delayed testing and that the decline in accuracy between one week and one month was greater for misled than for control participants. However, misinformation effects were found for the major misleading detail (i.e., a salient peripheral detail that was not present in the picture) in both negative and positive pictures, but the endorsement of major misleading details was greater for negative relative to positive pictures, a pattern that persisted over time. This indicates that negative emotion increases vulnerability to major misinformation.

Why might emotionally negative events continue to be vulnerable to misinformation over time? From an evolutionary perspective, Porter and colleagues (2008, 2010) argued that negative information is better retained in memory over time but is also vulnerable to distortion from misleading information (termed *paradoxical negative emotion* hypothesis; Porter et al., 2008). Remembering information from negative events can help individuals to avoid or deal with future dangers (Porter & Peace, 2007). However, negative events are also susceptible to distortion. This is because there would be an adaptive need to store into memory relevant information concerning negative events from trustworthy sources (e.g., researchers) to ensure one is prepared for future related dangers. To explain their major misinformation finding, Porter et al. (2010) argued that major details indicate a significant change in one's recollection, thus constituting valuable information that may serve a greater benefit in the future. Consequently, at least for Porter et al.'s study, major details associated with negative events were more likely to be incorporated into one's memory reports over time.

Source monitoring failure may also be used to explain these findings. Source misattributions can most often occur when there are similarities between the original information and the post-event information, making accurate source monitoring difficult (Johnson et al., 1993; Mitchell & Johnson, 2000). When participants process the post-event information, they may reconstruct the original event with the new information and engage in active rehearsal, thus further increasing the overlap between the two sources of information (e.g., in sensory/perceptual characteristics) and strengthening the post-event information (Zaragoza and Mitchell, 1996; Mitchell and Johnson, 2000). As mentioned in Chapter 4, the source confusion may be worse for negative high-arousing events than for neutral and emotionally low-arousing events. Negatively arousing events are emotional, and it is plausible to assume that the retrieval of the original event and the visualisation of the post-event information may increase emotional arousal, thereby enhancing the vividness, integrability with the original event, and memorability of the misleading information. Further, arousal has been shown to benefit memory consolidation of negative information through the activation of the amygdala and hippocampus (e.g., Dolcos et al., 2005; McGaugh, 2000). Consequently, misinformation may continue to affect memory for a negative arousing event over time due to source confusion, especially if the availability of source cues fades with time (Frost et al., 2002). It may be assumed that this would not be the case for negative low-arousing events, although this has yet to be examined.

In the present study (Experiment 6), the arousal of the negative emotional images was manipulated, with a neutral image comparison across a period of delay. Negative information regardless of the level of arousal have been shown to be better remembered than neutral information (e.g., Kensinger and Corkin, 2004), but also be susceptible to misinformation (Van Damme and Smets, 2014). The present study aimed to explore whether retention interval and misinformation exposure differentially impacted misinformation for high and low-arousing negative events. In addition, Porter and colleagues did not directly study memory for central and peripheral details. Memory for central details of negatively arousing events may persist over time more than peripheral details (for a review, see Christianson, 1992). Central details from negative events and high-arousing events have shown to be vulnerable to prior exposure to misinformation (Van Damme and Smets, 2014), though its effect over time is yet to be seen. Thus, the aim was to systematically study the impact of delayed retrieval on susceptibility to misinformation for central and peripheral aspects of negative events. Finally, we wanted to replicate Porter et al's (2010) finding but with different memory tests at immediate and delayed testing sessions. This would eliminate any concerns regarding repeat testing with the same memory test (see Porter et al., 2010). This could affect the interpretation of the memory reports if participants contaminate memory for the event images with test responses from a previous test condition. Considering the above, Experiment 6 is believed to be the first to examine the impact of delayed retrieval and exposure to misinformation for central and peripheral details for emotionally negative (both high and low in arousal) and neutral images. Based on previous research, it was hypothesised that:

H_1: For the negatively arousing event, the magnitude of the misinformation effect for central details would be similar over time but the effect would increase for peripheral details, whereas for the negative low-arousing and neutral events, the misinformation effect for both central and peripheral details would increase after one week.

H_2: At both immediate and delayed testing sessions, negatively arousing events would be more susceptible to major (peripheral) misinformation than negative low-arousing and neutral events.

5.2 Method

5.2.1 Participants

Forty-eight participants (age: *M* = 35.35, *SD* = 14.60, age range = 18 - 60; sex: 32 females & 16 males) took part in two sessions of the study in return for course credits or a small fee[29]. An a priori power analysis using MorePower 6.0 indicated a required total sample size of between 32 and 80 for a medium to large effect size with Power 0.80. The participants had English as their first language, normal or corrected-to-normal vision, and were not colour-blind. Participants were recruited via City's SONA system and the participant recruitment platform Prolific. Participants provided informed consent and were debriefed at the end of the experiment. City, University of London's Psychology Research Ethics Committee ethically approved the study.

5.2.2 Design

The experiment consisted of four variables. All variables were within subjects. For Picture Emotion, each participant saw three pictures, and the order was counterbalanced: one negative high-arousing (negative/high), one negative low-arousing (negative/low), and one neutral. For Detail Type, participants were questioned on central and peripheral aspects of the scenes. The presence of Misinformation (misled vs. control) was another variable, whereby there were, in total, five misleading details (two central and three peripheral details) and five control details (i.e., no misinformation was provided for these details; two central and three peripheral details). The misleading and control details were counterbalanced. Finally, for the Retention Interval variable, participants completed a recognition test immediately and one week later. As such, the misleading and control details were split between the immediate and delayed recognition tests and counterbalanced. However, one of the misleading peripheral details and one of the control peripheral details targeted major misinformation (i.e., a salient

[29] Summary data from 12 participants are not included here because they only took part in the first session.

peripheral detail that is not present in the picture). For major misinformation only, Retention Interval was between subjects, with 24 participants in the immediate condition and 24 in the delayed condition. Porter and colleagues (2003, 2010) only had one major misleading detail in each picture. These details are considered to be salient and should be noticeable if present, therefore including more than one could make participants aware of the presence of false information and the purpose of the study. The dependent variable was the false recognition of the incorrect answer in the misleading and control questions.

5.2.3 Materials

Picture Characteristics. The same three IAPS pictures used in Experiments 2 and 3 were taken as to-be-remembered events. That is, the negative high-arousing picture was an assault scene, the negative low-arousing picture was a cemetery scene, and the neutral picture was a restaurant scene. See Experiment 2 for details regarding differences in arousal and valence.

Post-Event Questionnaire. There were two versions of the post-event questionnaire (titled "Perception Questionnaire" for the participants). Each version consisted of 10 Yes/No questions about each picture (i.e., 30 in total). In each version, five misleading questions suggested inaccurate information and five *control* questions either omitted the misinformation or described the detail in a neutral form. The phrasing of the control questions was kept as similar as possible except that the misinformation was omitted. See Appendix H for all the misleading and control questions for each picture. For example [bold is misleading], "The injured man sitting on the right was wearing **light-blue** trousers, but did you see that he was topless?" vs. "The injured man sitting on the right was wearing trousers, but did you see that he was topless?". In total, four questions targeted central information and six questions targeted peripheral information. The central and peripheral details were determined from data collected in the Pilot, with many of the details having been used in prior experiments within this thesis. Following Porter et al. (2003), one of the peripheral details targeted a suggested major detail. A major detail was defined as a person, animal, or a major object that is falsely suggested to be present in the pictures (e.g., "…a large pigeon"; or "…an ambulance"). Although it is not possible to define the size of the detail since the major details do not exist, in a similar manner to Porter and colleagues, it was considered that most, if not all, participants would notice this salient information if present. In each questionnaire version, there was also a control question for the major peripheral detail that was misleading in the other version. The misleading and control details were counterbalanced, such that misleading details in Version A were controls in Version B and vice versa. Participants were told that this was a task about their perception of the scenes.

Memory Test. Two two-alternative forced-choice recognition tests were constructed, one for immediate testing and one for delayed testing. See Appendix H for all the misleading and control test questions. In test one, there were eight questions for each picture (i.e. 24 in total). Three questions probed memory for misleading details, three questions probed memory for control details, and two questions probed memory for non-leading details not previously suggested to all participants. In total, three questions targeted central information and five questions targeted peripheral information. This test included two questions per picture about the major (peripheral) details (one misleading and one control). In test two, there were six questions for each picture (i.e. 18 in total). Two questions probed memory for previously misled details, two questions tested memory for control details, and two questions asked about non-leading details. In total, three questions targeted central information and three questions targeted peripheral information. This test had fewer questions because there were no questions addressing the major details. The order of the tests was counterbalanced, such that half of the participants received test one in the first session and test two in the second session.

For the misleading questions, the two response alternatives were a correct detail (consistent with the picture), and a misleading detail (consistent with the PEI). For example, “What colour were the trousers worn by the injured man sitting on the right?” with response alternatives a) Beige [consistent] and b) Light blue [misleading]. The same response alternatives were used for control questions targeting those details that were misleading for half of the participants. For both the control and non-leading questions, a correct detail and a novel foil were possible answers. In both tests, participants were instructed to select one of the response alternatives based on their own memory for the pictures. The questions and response alternatives were presented in random order. If they did not know the answer, they were told to make their best guess.

Mood Ratings. To measure participants’ mood states at different points during the experiment, the valence and arousal SAM scales were used (see Experiment 1 for details about the SAM scales). Mood was assessed immediately before picture encoding (session 1) and recognition tests (sessions 1 and 2).

5.2.4 Procedure

Participants took part in two sessions. In session one, participants first provided informed consent and then completed the valence and arousal 9-point SAM scales to assess participants’ *current mood*. After completing both scales, participants were told that they will be shown some pictures for 30 seconds each. They were instructed to “Please look at each picture as if you unexpectedly witness the event”. Preceding each picture was a fixation cross for two seconds. The presentation order of the pictures was counterbalanced. Once all three pictures had been presented, there was a 10-minute interval during which time participants completed unrelated filler tasks (i.e., mathematical problems and anagrams). Thereafter, participants completed the post-event questionnaire in which half of the questions suggested misleading information. The participants were not warned about potential discrepancies between the information in the questions and the picture. The order of the sets of questions about each picture followed the picture presentation order at the encoding stage. After the post-event phase, there was another 10-minute interval during which time participants completed reasoning problems. Then all participants completed the SAM questionnaire again and the first recognition test. Whether participants received test one or test two in this session depended on the counterbalancing condition that they were randomly assigned to. After completing the recognition test, participants provided demographic information, and then watched a short clip from a wildlife documentary to ensure that they ended the first session in a neutral/positive mood state. On the final page, participants were falsely told that the second session in one week will involve looking at new pictures and rating each picture on two dimensions of emotion (valence and arousal). This instruction was given to reduce the chances of participants rehearsing the information in the interval.

Exactly one week later, participants were sent a link for the second part of the study. The link was sent in the morning and participants had until 9pm on the same day to complete the second part. They first completed the SAM questionnaire to assess their current mood state. Thereafter, they were given the second recognition test. Participants who received test one or two in session one completed test two or test one in the second session, respectively. After completing the recognition test, they received a full debrief explaining the study's true purpose and the use of deception.

5.3 Results

Two participants were removed from all analyses due to failing more than one attention check (out of a total of three checks like in Experiment 2). The final sample consisted of 46 participants (age: $M = 35.48$, $SD = 14.63$, age range = 18 - 60; sex: 30 females & 16 males). For the analysis of major misinformation, there remained 22 participants in the immediate condition and 24 in the delayed condition. Mood ratings were analysed to check for any mood effects. The main analyses were conducted on the proportion of false responses in misleading and control questions. The statistical tests used are mentioned in the relevant sections below. Where the assumption of sphericity was violated, the Greenhouse-Geisser correction was reported. Bonferroni correction was applied to all t-tests and pairwise comparisons to reduce Type 1 errors.

5.3.1 Mood Check

To check whether there were any significant changes to participants' mood between three points in the experiment (Time 1: start of session one; Time 2: immediately before the recognition test of session one; Time 3: start of session two), One-way ANOVAs were conducted on valence and arousal scores separately. Of interest is the difference between Time 1 and Time 3, and between Time 2 and Time 3, since the former represents the start of each session, and the latter represents participants' mood before each recognition test. No difference in valence scores was found between Time 1 and Time 3 ($p = 1.00$) and between Time 2 and Time 3 ($p = .149$) and no significant differences in arousal were found between Time 1 and Time 3 ($p = .203$) and between Time 2 and Time 3 ($p = .220$).

5.3.2 False Recognition

The false recognition responses to misleading and control details[30] were analysed using a 3 (Picture Emotion: Negative/High vs. Negative/Low vs. Neutral) x 2 (Detail Type: Central vs. Peripheral) x 2 (Misinformation: Misled vs. Control) x 2 (Retention Interval: Immediate vs.

[30] This experiment included non-leading details (i.e., filler test items). An ANOVA on the correct responses to these filler questions revealed no significant interactions (*p*s > .210). Therefore, unlike Experiments 2-5, there was no evidence of an emotion memory-narrowing effect in this experiment. This could be attributed to methodological differences (i.e., only one test item at the immediate and delayed sessions).

Delayed) repeated measures ANOVA. See Table 24 for means and standard deviations. Analysis revealed a significant main effect of Misinformation, $F(1, 45) = 35.83$, $p < .001$, $\eta_p^2 = .44$, and Detail Type, $F(1, 45) = 4.66$, $p = .036$, $\eta_p^2 = .09$. False recognition was significantly higher for misleading details ($M = .48$, $SD = .15$) compared to control details ($M = .30$, $SD = .14$) and for central details ($M = .42$, $SD = .13$) compared to peripheral details ($M = .36$, $SD = .16$). There was also a significant Retention Interval x Misinformation interaction, $F(1, 45) = 10.95$, $p = .002$, $\eta_p^2 = .20$, and a Picture Emotion x Retention Interval x Misinformation interaction (see Figure 10), $F(2, 90) = 3.44$, $p = .036$, $\eta_p^2 = .07$[31]. The three-way interaction was decomposed at on each level of Picture Emotion.

For the negative/high picture, there was only a significant main effect of Misinformation, $F(1, 45) = 9.74$, $p = .003$, $\eta_p^2 = .18$. Due to no interaction effect ($p = .492$), this indicates that there was no change in the pattern of the misinformation effect at both immediate and delayed sessions and no change in the false recognition of misleading and control details over time. For the negative/low picture, there were significant main effects of Retention Interval, $F(1, 45) = 4.81$, $p = .033$, $\eta_p^2 = .10$, and Misinformation, $F(1, 45) = 21.98$, $p < .001$, $\eta_p^2 = .33$, which were both qualified by a significant interaction, $F(1, 45) = 11.67$, $p = .001$, $\eta_p^2 = .21$. Paired-samples t-tests revealed a significant misinformation effect at immediate testing (misleading: $M = .61$, $SD = .39$; control: $M = .21$, $SD = .29$), $t(45) = 6.00$, $p < .001$, $d = 1.16$, but not at delayed testing (misleading: $M = .32$, $SD = .34$; control: $M = .28$,

[31] The data was binary (0 & 1 coded). To be consistent with relevant previous research (e.g., Jobson et al., 2023; Porter et al., 2010; Van Damme & Smets, 2014), an ANOVA was performed on binary data. Previous research has conducted an ANOVA on such data (e.g., Porter et al., 2010 and Peace & Constantin, 2016, on major misinformation data; Sutherland & Hayne, 2001). Furthermore, the significant three-way interaction collapses across central and peripheral details, resulting in two misleading and two control details at each time point. Previous research has performed an ANOVA when each cell of the design has two items (e.g., Forgas et al., 2005; Van Damme and Smets, 2014). However, an alternative analysis was conducted. Since log-linear cannot analyse within-subjects data with complex designs, the data were also analysed using Generalised Estimating Equations (GEE; Liang & Zeger, 1986) with a Binomial distribution and log link function. GEE, an extension of the Generalised Linear Model (GLM), is an approach that allows for the analysis of repeated measurements and non-normally distributed data. The findings from the GEE analysis were similar to those obtained using the ANOVA, thus only ANOVA is reported for comparison to previous data.

SD = .31), *t*(45) = .43, *p* = .667, *d* = .10. This was due to a decrease in false recognition of the misleading details over time. For the neutral picture, there was a significant main effect of Misinformation, *F*(1, 45) = 6.85, *p* = .012, η_p^2 = .13, but not for Retention Interval, *F*(1, 45) = .10, *p* = .752, η_p^2 = .002. However, both main effects were qualified by a significant interaction, *F*(1, 45) = 11.45, *p* = .001, η_p^2 = .20. Similar to the negative/low picture, a significant misinformation effect at immediate testing (misleading: *M* = .54, *SD* = .35; control: *M* = .25, *SD* = .31), *t*(45) = 4.16, *p* < .001, *d* = .89, disappeared when tested one-week later (misleading: *M* = .36, *SD* = .29; control: *M* = .40, *SD* = .36), *t*(45) = -.65, *p* = .522, *d* = .13. Again, this was due to a decrease in false recognition of misleading details over time but also an increase in false recognition of control details. In sum, it appears that misinformation continued to influence memory performance over time for the high-arousing negative event, but for the low-arousing events, there was no significant negative impact of misinformation on memory after one week; in fact, false recognition of the misleading details decreased over time.

Based on Porter et al. (2003, 2010) and Van Damme and Smets (2014), it was investigated whether there were differences in the endorsement of the major misleading details across negative and neutral pictures over time. However, the analysis revealed this to not be the case. There was a significant misinformation effect (misleading: *M* = .43, *SD* = .35; control: *M* = .21, *SD* = .24), *F*(1, 44) = 16.22, *p* < .001, η_p^2 = .27. Furthermore, there was also a significant Misinformation x Retention Interval interaction, *F*(1, 44) = 9.19, *p* = .004, η_p^2 = .17. At immediate testing, accuracy was lower for misleading major details (*M* = .53, *SD* = .35) compared to control major details (*M* = .14, *SD* = .20), *t*(21) = 5.05, *p* < .001, *d* =1.38. However, this misinformation effect was no longer significant at delayed testing (misleading: *M* = .33, *SD* = .33; control: *M* = .28, *SD* = .25), *t*(23) = .70, *p* = .491, *d* = .19. No further main effects or interactions were found in the analysis (*F*s < 1.10, *p*s > .34).

Table 24. *Descriptive statistics for the false recognition of misleading and control details as a function of picture emotion, detail type, misinformation, and retention interval.*

Retention Interval	Immediate Testing				Delayed Testing			
Misinformation	Misleading		Control		Misleading		Control	
	M	SD	M	SD	M	SD	M	SD
Central Details								
Negative/High	.59	.50	.33	.47	.46	.50	.41	.50
Negative/Low	.67	.47	.22	.42	.35	.48	.39	.49
Neutral	.59	.50	.22	.42	.43	.50	.39	.49
Peripheral Details								
Negative/High	.52	.51	.35	.48	.50	.51	.26	.44
Negative/Low	.54	.50	.20	.40	.28	.46	.17	.38
Neutral	.50	.51	.28	.46	.28	.46	.41	.50

Note. M and SD refer to Mean and Standard Deviation, respectively.

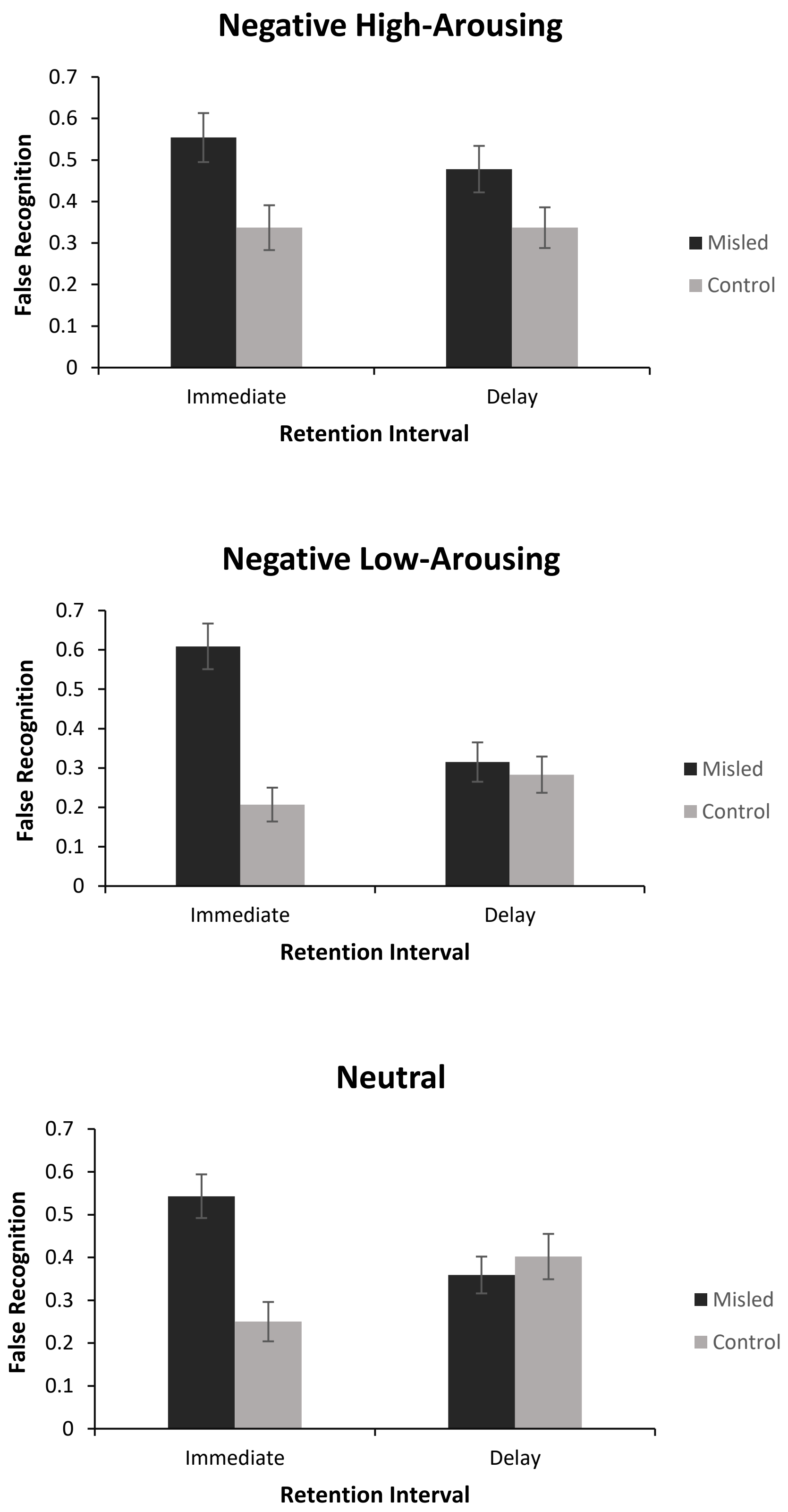


Figure 10. Graphs showing the proportion of false recognition for the misleading and control details for each picture as a function of Retention Interval and Misinformation (Error bars represent the standard error).

5.4 Discussion

This experiment aimed to explore the impact of delayed retrieval and susceptibility to misinformation for negative/high arousal, negative/low arousal, and neutral events, and based on previous emotion memory literature, whether there would be differential effects on memory distortion for central and peripheral details (Kaplan et al., 2012). Research has shown that the endorsement of misleading information increases when memory retrieval is delayed (Frost, 2002) and that negative high arousal makes one susceptible to misinformation both at immediate and delayed testing (Porter et al., 2010). However, we had yet to understand whether misinformation affects memory over time differently for events high and low in arousal and for details that are central or peripheral to the main event. This is what Experiment 6 set out to explore. Participants were presented with a negative high-arousing, negative low-arousing, and neutral scenes, followed by exposure to misleading central and peripheral details about the picture. Recognition memory was measured shortly after misinformation exposure and one week later. The main findings are discussed below.

Frost et al. (2002) argued that the availability of source cues is reduced over time due to the event details losing perceptual information with time and becoming more similar to verbal misleading information, consequently increasing the effect of misinformation on memory performance. In fact, source accuracy declined to a greater extent than recognition accuracy (Frost et al., 2002). Based on this, it could be predicted that the effect of misinformation may increase or remain stable over time. However, for negative and neutral scenes, the present study obtained differences in the misinformation effect. For the negative high-arousing picture, regardless of detail type, misinformation's influence on memory persisted one week later. Such a finding fits with the paradoxical negative emotion (Porter et al., 2008) hypothesis. This predicts that negative information will be remembered well over time, but can be associated with a greater susceptibility to distorting misleading information relative to other emotional events. This is because retaining memory of negative arousing events can help one to avoid or address them in the future (Porter et al., 2008). However, it may also be adaptive to incorporate all relevant information about negative events from trustworthy sources (e.g., researchers, parents) to further prepare for and/or avoid similar "dangerous" events in the future (Porter et al., 2008). Thus, Porter et al. (2008) theorised that memory for negative events is not only remembered well over time but also vulnerable to distortion. Consistent with this, the present study found continued susceptibility to misinformation for the negative arousing event over time.

Considering theoretical explanations for the misinformation effect, the persistence of this effect over time for the negatively arousing picture could be attributed to continued source confusion. When answering the post-event questions, participants are likely to engage in the retrieval and reconstruction of the original event and the mental visualisation and rehearsal of the misleading information (Johnson et al., 1993; Mitchell & Johnson, 2000), further increasing the overlap between the two sources and increasing source confusion. This has been empirically demonstrated in previous research (e.g., Dobson & Markham, 1993; Zaragoza & Lane, 1994). Misleading information about the negative low-arousing and neutral events may also be accompanied by mental imagery and event reconstruction. However, the negatively arousing event is emotional, and arousal has been shown to benefit memory consolidation of negative information through the activations of the amygdala and hippocampus (e.g., Dolcos et al., 2005; McGaugh, 2002). Therefore, it is plausible to assume that the retrieval of an arousing event may increase emotional arousal during post-event questioning, and the mental visualisations of the associated post-event suggestions would be more vivid, better integrated into memory for the original event, and better remembered over time. Consequently, misinformation may continue to affect memory for a negative arousing event over time due to source confusion, especially if the availability of source cues fades with time (Frost et al., 2002).

For the negative low-arousing and neutral events, the effect of misinformation at immediate testing disappeared after a delay. This means that, for the two low-arousing scenes, the misleading information interfered with memory performance when tested immediately but this interference significantly reduced at delayed testing as represented by increased accuracy of the misleading details. Such a finding may suggest a *spontaneous recovery* of the original information. There has been evidence of spontaneous recovery of the original information (e.g., Chandler, 1991; Windschitl, 1996). For example, in a series of experiments, Windschitl (1996) showed participants a series of faces, followed by interpolated faces that were similar to those originally seen. Labels (e.g., Brides) were provided underneath each set of faces, allowing participants to connect the target and interpolated faces. Participants were then given a recognition test, between 10 minutes to 2 weeks later, where they had to choose between the original face or a novel face (i.e., a modified recognition procedure; McCloskey & Zaragoza, 1985a). They found that the interpolated faces interfered with memory performance such that accuracy dropped at 10-minute and 45-minute retention intervals. However, after 48 hours, the detrimental effect of the interpolated faces disappeared. Interestingly, memory accuracy for the original items improved after 48 hours, demonstrating absolute spontaneous recovery.

So for the negative low-arousing and neutral events, why did the endorsement of misleading details decrease over time in favour of the original details? One may argue that participants may have correctly attributed the source of the misleading detail to the post-event questionnaire and thus opted to avoid choosing this detail. However, as commonly stated in previous research (e.g., Frost et al., 2002; Underwood & Pezdek, 2010), source cues fade over time, thus making it difficult to correctly monitor the source of their memories and leading to increased misinformation susceptibility. It can still be that, like the negatively arousing scene, source confusions remained after one week. However, to complement this theory so as to explain the low-arousing scene findings, an activation-based explanation can be used (e.g., Source of Activation Confusion model; Ayers & Reder, 1998). Here, it can be that there is competition between two coexisting memory traces associated with a particular retrieval cue (Windschitl, 1996). When testing after a short interval, misinformation receives more activation relative to the original detail because of its recent exposure and blocking the original detail, thus the original detail is less likely to be retrieved, and the misleading detail may be more likely to be misattributed to the original event. At delayed testing, however, memory traces for both details are weaker, but the strength of the misinformation item is roughly equivalent to or below that of the original item's strength (Ayers & Reder, 1998; Lustig et al., 2004). The misleading information has a less distortive effect on memory at one week because its recency advantage is reduced and is thus less accessible to memory. Therefore, the original details receive more activation overall and is subsequently endorsed, and the level of activation of both the original and misleading details becomes similar to when misinformation was not presented, resulting in an absence of a misinformation effect (Ayers & Reder, 1998).

Lustig et al. (2004) further argued that an increase in accuracy over time can be explained in terms of automatic processes (i.e., recently presented information is more accessible) and controlled processes (i.e., engaging in a memory search for the correct response). Participants were presented with the first list of word pairs, followed by a second list of word pairs where the second word in the pair differed from the first list. Finally, a word fragment test was given immediately after the second list and one day later. Before the test, participants were either given direction instructions (i.e., retrieve the correct response) that utilise both controlled and automatic processes or indirect instructions (i.e., respond based on what comes to mind first) that rely primarily on automatic processes. They found that the greater memory impairment at immediate testing was due to automatic processes and the reduced impairment after one day was due to the weakened recency advantage of the new information and thus the reduced accessibility of the incorrect response.

Overall, the reduction in the endorsement of misleading information associated with the negative low-arousing and neutral scenes after one week may be due to the reduced accessibility of the misleading information and greater activation of the original information over time. Two questions arise from this. First, does the greater activation of the original information at one week truly indicate that the original detail was recovered? In the present study, this cannot be conclusively determined because if participants no longer have a memory for some or most of the misleading information, then they may either select the original detail because that is now most accessible, or they may guess between the original and the misleading detail due to an absence of an original detail memory trace. Considering the latter, it is clear from the data that memory for the negative/low and neutral scenes weakened over time because there was a visible increase in false recognition for control details, which was particularly greater for the neutral scene. Furthermore, Experiment 5 showed a reduction in misinformation endorsement for the neutral picture after a post-warning, but this did not lead to an increase in the recognition of the original detail. Thus, guessing may be contributing to the absence of a misinformation effect at one week to some degree for both the negative/low and neutral pictures. Future replications of the current study should attempt to tease apart the influence of guessing from actual original memory recovery.

Second, why would false recognition not decline over time also for the negative high-arousing event. First, as mentioned earlier, source confusions can arise when there is an overlap between the sources, which can be made worse through the visualisation of the misleading information and its integration into the original event (Johnson et al., 1993). Due to the emotional and arousing nature of the negative event, it is plausible to assume that the mental imagery of the misinformation along with the original event retrieval may make the misinformation more vivid and rich in perceptual information. Second, high arousing information specifically benefits from long-term consolidation (e.g., Kensinger and Corkin, 2004). It may be that the retrieval of the negative-arousing event and the visualisation of the associated post-event information increases emotional arousal, thereby enhancing the encoding and consolidation of the misleading information and memory over time. Together, misleading information continues to interfere with memory for the negatively arousing event, whereby the degree of activation of the misleading information at delayed testing remains similar to immediate testing. This prevents a visible increase in correct recognition after a period of delay.

The reduction in false recognition over time, contrary to previous research, may be due to differences in research methodology. For example, the current study was administered online, thus lacking control of extraneous variables on participants' behaviour and responses, whereas previous research tested participants in a controlled laboratory setting. Also, previous research has used different memory tests, such as a yes/no recognition test (e.g., Underwood & Pezdek, 1998), (cued) recall tests (e.g., Frost, 2000; Horry et al., 2014), or a source-monitoring test (e.g., Frost et al., 2002; Horry et al., 2014). Even n-alternative forced-choice tests differed from the current study, such as Holmes and Weaver (2010) using a 6-AFC test. However, in their study, memory was tested for brands rather than details of a witnessed event. Furthermore, the results have also differed to an extent in previous research. For example, some studies have found that the endorsement of misleading information do not significantly change over time (e.g., Horry et al., 2014; Porter et al., 2010; Underwood & Pezdek, 1998 [in high credibility condition]), whereas others have found the false endorsement does increase with time (e.g., Frost et al., 2002; Holmes & Weaver, 2010; Mudd & Govern, 2004; Underwood & Pezdek, 1998 [in low credibility condition]). Overall, it is difficult to pinpoint the reasons for the different results obtained between the current study and previous research. Thus, future research could attempt to replicate the current study and explore possible methodological elements, such as the type of test.

The effect of retention interval and misinformation on memory for negative and neutral events did not significantly vary for central and peripheral details. Research has shown that negative events in general cause memory narrowing, and that the presence of misinformation (compared to non-exposure) increases susceptibility to central misinformation only in negative events (Van Damme and Smets, 2014). In addition, arousing information, particularly central information in an arousing event, may specifically benefit from long-term consolidation (for a review, see Christianson, 1992). Based on these previous findings, it was rationalised that retention interval could affect memory for central and peripheral misleading details for different emotional events. Although the findings did not support this rationale, past research examining misinformation has yielded conflicting findings when it comes to the impact of emotion on memory for both central and peripheral misinformation (see Sharma et al., 2022, for an overview). This could be attributed to differences in methodology across studies (e.g., variations in the type of memory assessment used and how central and peripheral details are defined). However, further investigation is necessary to determine whether this finding, regardless of detail type, is a genuine outcome or a product of the study's design and procedures.

Finally, turning briefly to major misinformation. Porter et al. (2010) found that major (peripheral) details associated with moderate-to-high arousing negative events were vulnerable to misinformation, which persisted over time. Although a misinformation effect for major misinformation details was found, this disappeared after a period of delay, and did not differentiate across emotional picture conditions. The present study was unable to replicate negative emotion’s specific susceptibility to “major misinformation” details. Two limitations should be mentioned. First, as this was treated as a between-participants factor due to methodological constraints, the sample size was low for analysing major misinformation. Second, there are procedural differences between these studies, including the type of test, definitions for central/peripheral details, images used, and an absence of repeated testing on the same details. The misinformation literature is fraught with procedural differences and understanding the impact of those differences in relation to the impact of emotion on memory distortion is work for future research.

To conclude, the present experiment found that misleading information continued to distort memory for a negatively arousing event over time, whereas memory performance improved for the negative low-arousing and neutral events. Eyewitness events are typically negative and arousing and there can be a delay of a few hours to weeks between experiencing the event and recalling it during a trial (Neubauer & Fradella, 2011). These findings highlight the detrimental impact negative arousing emotion can have on memory for an event even after a long delay. Interestingly though, if the event is low arousing, any impact of misleading information may not have a prolonged effect. Whether this is an artefact of the study or a reliable outcome, is yet to be determined. Future research can explore this through methodological changes (e.g., the type of memory test, presenting more than two response alternatives in a recognition test, using different negative and neutral low-arousing events, exploring different retention intervals, etc.). Furthermore, unlike Porter et al. (2003), the present study was unable to replicate negative emotion's specific susceptibility to major misinformation, though the low sample size for analysing major misinformation is acknowledged. Nevertheless, the present study demonstrates that a highly arousing negative event continued to be vulnerable to misinformation distortion over time.

Chapter Six: General Discussion

The aim of this thesis was to further our understanding on the impact of misleading information on memory for emotionally negative and neutral events. Given that witnesses often experience negative emotions during serious crimes, it is crucial to understand how misinformation and negative emotion interact to influence false remembering. Research has shown that memory for emotional, particularly negatively valenced, information is better remembered than neutral information, both when memory is tested immediately (e.g. Bradley et al., 1992; Kensinger & Corkin, 2004) and after a delay (e.g., Sharot & Phelps, 2004). Research has also shown that emotions can narrow our attention and focus, which can lead to a different pattern of memory effect known as emotional memory narrowing (Kaplan et al., 2012). That is, memory for information that is central to an emotional event has been found to be better remembered than peripheral or irrelevant information. This memory narrowing has been evidenced to potentially be specific to negative emotion (e.g., Van Damme & Smets, 2014; Waring & Kensinger, 2009).

Emotional memory narrowing may contribute to the development of memory distortions. To date, there has been limited research studying the impact of emotion using the misinformation paradigm. There is evidence showing that negative events tend to be vulnerable to misleading information (Monds et al., 2017; Porter et al., 2008; Zhang et al., 2021), particularly "major" misleading details (i.e., salient background details that supplement the event; Peace & Constantin, 2016; Porter et al., 2003, 2010) compared to positive and neutral events. This susceptibility has also been shown to persist over time (Porter et al., 2010). The first investigation into the effects of both valence and arousal on misinformation suggestibility was conducted by Van Damme and Smets (2014). They found that, for peripheral details, a misinformation effect was found regardless of event emotion. For central details, only the negative events (high and low arousing) and the positive high-arousing event were susceptible to suggested misinformation. They explained this finding by simply stating that the benefits of negative emotion and high arousal on central memory were overpowered by previous exposure to misinformation. Overall, the empirical evidence suggests that negative events are susceptible to misleading information.

Despite the previous emotion and misinformation literature, many questions are yet to be answered. In this thesis, three forensically relevant factors were studied that have received little to no empirical examination to date on how they interact with negative emotion and misinformation to influence memory performance. These factors were attention, post-warning, and retention interval. Previous research has shown that limited attentional resources during a witnessed event (e.g., Lane, 2006) and lengthening the retention interval between the misinformation and memory phases (e.g., Frost et al., 2002) increases the effect of misleading information on event memory. In contrast, warning participants prior to a memory test (see Blank & Launay, 2014) has been shown to decrease the detrimental impact of misinformation. The thesis explored three main questions: (1) what is the role of attention on misinformation susceptibility for negative and neutral events, (2) if negative-emotional events are susceptible to misinformation, can post-warnings mitigate its effect on memory, and (3) how does exposure to misinformation affect memory over time for negative and neutral events. Six main experiments were carried out to examine this. By investigating the three factors – attention, warning, and retention interval -, this thesis has advanced our understanding of the effect of misinformation on memory for emotional events, both theoretically and for applied settings. Overall, this thesis demonstrated that misleading information can have serious and stable consequences on memory for emotionally negative events. In this chapter, the main findings and conclusions about misinformation susceptibility from the experimental chapters will be summarised, the broader practical and theoretical implications of the findings will be highlighted, and finally limitations and future directions of the research will be discussed.

6.1 Experimental Chapter Summaries

6.1.1 Chapter 3 – Attention

Chapter 3 investigated the role of attention and susceptibility to post-event misinformation on memory for negative-emotional and neutral events. Previous research has shown that divided attention during the encoding of target stimuli reduces memory performance compared to full attention (e.g., Baddeley et al., 1984; Craik et al., 1996), but also increases susceptibility to misleading suggestions (e.g., Lane, 2006). Regarding the latter, it is argued that divided attention disrupts the encoding of source information, thereby making it difficult to distinguish between memories of event details and misleading details (Lane, 2006). But how does reduced attention at encoding and exposure to misinformation affect memory for *negatively arousing* events? There are two lines of research to rationalise the motivation for this question. First, behavioural studies (e.g., Christianson et al., 1991; Kang et al., 2014; Kensinger & Corkin, 2004) and neuroimaging studies (e.g., Kensinger & Corkin, 2004) have shown that the encoding of negatively arousing stimuli benefit from automatic processes (i.e., are less dependent on attentional resources) whereas other valenced (including negative low arousing) and neutral stimuli require controlled and elaborative processes. Second, studies have shown a memory narrowing for central over peripheral details in emotionally arousing events (see Kaplan et al., 2012, 2016), and eye-tracking studies reveal that memory for negatively arousing events, particularly central details, may depend less on attentional resources (e.g., Gülçay & Cangöz, 2016; Kim et al., 2013).

Both lines of research had not been combined to investigate the effect of reduced attention at encoding on susceptibility to misinformation for central and peripheral details in negative arousing and non-arousing contexts. Therefore, three experiments were conducted to test this. Participants were presented with negative high-arousing, negative low-arousing, and neutral pictures. Prior to beginning the set of studies linked to this chapter (and subsequent chapters), the pictures were piloted to ensure that they were of correct level of valence and arousal and had clear central and peripheral details. Participants' attention was manipulated by dividing their attention between the pictures and an attention-demanding secondary task (Expt. 1) or by varying the presentation duration of the pictures (Expt. 2 & 3). Eye movements during scene presentation were also measured in Experiment 1 to examine the relationship between overt attention and later misinformation endorsement. Thereafter, a questionnaire containing misleading information about central and peripheral aspects of the scenes was administered, followed by a recognition test to evaluate memory for the scenes.

In Experiments 1 and 2, there was no evidence of a differential effect of reduced attention on the false recognition of misinformation for negative (arousing and low arousing) and neutral events. This was also the case with remember and know responses reflecting recollective experience, though in Experiment 2, participants had a vivid memory (i.e., greater remember responses) for false details associated with the negative pictures compared to the neutral picture, regardless of previous exposure to misinformation. However, in Experiment 3, the type of recognition test was changed from a True/False test to a 2-AFC (i.e., choosing between correct vs. misleading answers) test to reduce the role of a potential liberal response criterion (see Jou et al., 2018). For the negative high-arousing picture, there was no significant change in the endorsement of, and resistance to, misleading details across long and short presentation duration conditions. This indicated the automatic processing of the picture details. Here, it was argued that the strength difference between the misleading and original details, but also the degree of source confusion, may be roughly similar across both presentation duration conditions, preventing an observed increase in misinformation endorsement when attentional resources are limited. However, for the negative low-arousing picture, misinformation endorsement increased, and resistance to misinformation decreased, in the short presentation condition. This suggested that controlled encoding processes are required to better encode the picture details but can also highlight the disruption to encoding source information that can subsequently increase misinformation errors (Lane, 2006). For the neutral picture, there was no change in the recognition and resistance of misleading details across the presentation duration conditions. Unlike for the negatively arousing picture, this finding was explained in terms of a possible relatively weaker memory trace for the misleading information and the influence of guessing. Though, more research is required to determine, more conclusively, the impact of attention and misinformation on emotionally neutral stimuli. Furthermore, the false recognition findings in Experiment 3 did not vary with the type of detail (but more on this later).

For the relationship between eye movements and false recognition, the correlational analysis in Experiment 1 showed no clear evidence of the link between eye fixations and the later endorsement of suggested misinformation in each emotion condition. Indeed, it has been found that accuracy for emotional stimuli is not related to processing time (Humphreys et al., 2010), and Experiment 1 extends this to false recognition performance for misleading details.

Finally, the effect of misinformation on false recognition varied with emotion and central/peripheral detail only in Experiment 2, whereby a misinformation effect for central details was found regardless of picture emotion, but a misinformation effect for peripheral details was evident only for the neutral picture. The mixed findings across the three experiments and with prior studies (for a review, see Sharma et al., 2022) indicate that there currently remains no consensus regarding the impact of misinformation on central and peripheral memory across emotional events, a point that will be referred back to later.

6.1.2 Chapter 4 – Post-Warnings

Next, Experiments 4 and 5 explored the impact of different post-warnings on susceptibility to central and peripheral misleading information for negatively arousing and neutral scenes. Past research shows mixed findings regarding the effectiveness of post-warning in reducing the effect of misinformation (e.g., Blank, 1998; Christiaansen & Ochalek, 1983; Greene et al., 1982). Nevertheless, a meta-analysis by Blank and Launay (2014) found that compared to no warning, warnings reduced misinformation susceptibility overall.

Different types of warnings have previously been used. Several studies have simply alerted participants about the (possible) presence of prior misleading information (e.g., Christiaansen & Ochalek, 1983; Greene et al., 1982). However, few studies have attached an element of "enlightenment" to the general warning (e.g., Oeberst & Blank, 2012). Here, participants are made aware of the reason behind the misinformation manipulation. Research suggests that this is the most effective at reducing the misinformation effect (Blank & Launay, 2014). In addition, Higham et al. (2017) used an item-specific warning, whereby participants are aware of exactly which test questions contain previously suggested misleading information. They found that the item-specific warning, but not the general warning, reduced misinformation's influence on memory performance. The main theoretical explanation for the effect of warnings relate to the source-monitoring theory (Johnson et al., 1993). Warnings alert participants about the potential discrepancies between the event and the post-event information, thus effectively informing participants of the need to monitor the source of their memories and test information critically and strategically (Zaragoza & Lane, 1994). This is improved in an enlightenment warning where participants have a better understanding of what is required from the memory task (Oeberst & Blank, 2012), and the source monitoring is more targeted in an item-specific warning since participants know when to use a search-and-discriminate approach and a search-and-accept approach (Higham et al., 2017).

To date, no controlled investigation had examined whether warnings impact misinformation susceptibility differently for a negative-arousing event than for a neutral event. As such, this was the first motivation for this chapter. Furthermore, what warning was most impactful needed to be examined. Thus, general, enlightenment, and item-specific warnings were compared. In brief, participants were presented with a negatively arousing scene and a neutral scene, followed by exposure to misleading information via a post-event questionnaire. Before a forced-choice recognition test and a source monitoring test (following Wyler & Oswald, 2016), participants received either a general warning (Expt. 4 & 5), an enlightenment warning (Expt. 4 & 5), or an item-specific warning (Expt. 5).

For the negatively arousing scene, warnings did not *significantly* reduce the effect of misinformation, or increase misinformation resistance, compared to no warning in both Experiments 4 and 5. This may be due to continued source confusion even in the presence of warnings. When answering post-event questions, participants are likely to retrieve memory for the original event, mentally imagine the post-event suggestions, and reconstruct the original event that binds elements from both sources (Johnson et al., 1993; Mitchell & Johnson, 2000). This increases source confusions and source misattribution errors. Although the visualisation of misleading information and event reconstructions can also occur with the neutral event, the emotional and arousing nature of the negative event makes it is plausible to assume that the retrieval of the original event and the visualisation of the related post-event information may increase emotional arousal, thereby enhancing the vividness, integrability with the original event, and memorability of the misleading information, consequently making source monitoring difficult.

For the neutral picture, compared to no warning, the warnings did not significantly reduce the recognition of misinformation, or increase misinformation resistance, in Experiment 4. However, the enlightenment and item-specific warnings did so in Experiment 5. Participants who were definitively warned (Experiment 5) about previous misinformation exposure were more likely to engage in effortful source monitoring and strategic decision-making than those who were tentatively warned (Experiment 4). Furthermore, in Experiment 5, the general warning was not found to be effective. Enlightenment and item-specific warnings clearly emphasise and encourage the need to use a search-and-discriminate approach and to engage in effortful source monitoring, whereas the general warning leaves uncertainly about the reason and extent of the misinformation manipulation (Higham et al., 2017; Oeberst & Blank, 2012). This reduction in false recognition after enlightenment and item-specific warnings did not correspond to a significant increase in the recognition of the original detail. It may be that the memory traces for the neutral event details are weaker and difficult to successfully retrieve by many participants. Thus, the reduction in the misinformation endorsement may reflect participants' tendency to avoid choosing the misleading detail and opt for an alternative response through guessing, which may not always be correct. However, some participants may have also formed genuine false memories of the misleading details and truly believe that it was part of the original event.

6.1.3 Chapter 5 – Retention Interval

Chapter 5 explored the impact of delayed retrieval and susceptibility to misinformation for emotionally negative and neutral events. Research has shown that memory for emotional stimuli remains stable or improves over time (e.g., Sharot & Phelps, 2004; Wang, 2014), and that central details of arousing events seem to benefit most from a lower rate of forgetting (see Christianson, 1992; Park, 2005). When it comes to emotional stimuli, an enhanced memory effect can serve an adaptive function to help one prepare for similar future dangers and guide behaviour (Porter & Peace, 2007) However, from a neurobiological position, activations of the amygdala and hippocampus can influence long-term memory consolidation of emotional stimuli (LaBar & Phelps, 1998). In addition, the misinformation research shows that the size of the misinformation effect increases over a longer retention interval (e.g., Frost et al., 2002). Frost et al. (2002) argued that the association between the event details and their source fades over time, making participants more susceptible to misinformation errors. A study that examined delayed testing on susceptibility to misinformation for emotional events (Porter et al., 2010) found that negative images were associated with a greater susceptibility to previously suggested major misleading details at immediate and delayed sessions compared to positive images. This finding was explained from an evolutionary perspective.

The rationale for Experiment 6 was based on Porter and colleagues' (2010) study. First, the arousal of negative emotional images was manipulated, with a neutral image for comparison. This was because negative events regardless of the level of arousal have been associated with increased accuracy (e.g., Kensinger & Corkin, 2004) and increased misinformation susceptibility (Van Damme & Smets, 2014) than neutral information. Second, memory for central and peripheral details was assessed, because memory for central details may persist over time more than peripheral details (see Christianson, 1992), and have shown to be specifically susceptible to prior misinformation exposure in negative events than neutral events (Van Damme & Smets, 2014, though its effect over time was yet to be seen). Overall, Experiment 6 examined the impact of delayed retrieval and exposure to misinformation on memory for central and peripheral aspects of negative scenes (high and low arousal) and neutral scenes. Participants were presented with negative high-arousing, negative low-arousing, and neutral scenes, followed by exposure to misleading central and peripheral scene details. Recognition memory was measured 10 minutes after misinformation exposure and one week later.

For the negative-high arousing picture, regardless of the type of detail, the magnitude of the misinformation effect did not change over time. There are two possible explanations for this finding. From an evolutionary perspective, the misinformation's influence on memory over time was consistent with the view that it is adaptive to retain relevant information about negative events from trustworthy sources to prepare for future similar "dangerous" events (Porter et al., 2008). Alternatively, from a source monitoring theoretical perspective, a similar explanation made in Chapter 4 was put forth that the retrieval of the original event during post-event questioning and the potential mental imagery of the suggested information may enhance memory for the misinformation and lead to the reconstruction of the original event with the suggested information, thereby increasing source confusions. For the negative low-arousing and neutral events, the effect of misinformation at immediate testing disappeared after a delay. This was driven by a significant reduction in the recognition of misleading details after one week. It can still be that, like the negatively arousing scene, source confusions remained after one week, particularly due to source cues fading over time (Frost et al., 2002). Thus, participants may have relied upon the strength difference of the original and misleading options. That is, using an activation-based explanation (e.g., SAC; Ayers & Reder, 1998; Lustig et al., 2004), after one week, the misleading information may be less accessible in memory due to the recency advantage fading, and so the original detail may receive more activation and be subsequently endorsed. The level of activation of both original and misleading details becomes similar to when misinformation was not presented; hence, an absence of a misinformation effect (Ayers & Reder, 1998). This was argued to be less likely for the negatively arousing event because high arousing information specifically benefits from long-term consolidation (e.g., LaBar & Phelps, 1998). The retrieval of the negative-arousing event may increase emotional arousal, thereby enhancing the encoding, vividness, and the consolidation of the misleading information and memory over time.

6.1.4 Thesis Summary

This thesis provided compelling evidence for the robust and enduring influence of misleading information on memory for negatively arousing events. More specifically, in Experiment 3, the misinformation effect for the arousing event was not found to be affected by the level of attention during event encoding, whereas misinformation susceptibility for the negative low-arousing event increased with reduced attentional resources. In Experiments 4 and 5, the negatively arousing event was found to be quite resistant to post-warnings varying from a simple warning to an item-specific warning, highlighting the strength and stability of the misinformation once endorsed. Furthermore, in Experiment 6, the misinformation effect persisted over time for the negative-arousing event. However, for the negative low-arousing event (and neutral event), misinformation's influence in memory dropped at one week. These findings add to the growing body of emotion and misinformation research (e.g., Porter et al., 2003; Van Damme & Smets, 2014) by showing that negatively arousing events are uniquely vulnerable to misinformation over time, are resistant to warning, but have a protective barrier against increased misinformation vulnerability under limited attention conditions due to the automatic processing of such events. Furthermore, a key focus of this thesis was to examine the differential impact of central and peripheral misleading details on memory. However, contrary to theoretical expectations, this distinction did not yield main significant results in the conducted experiments. Further research is necessary to validate the findings of false recognition, regardless of the type of details involved.

6.2 Practical and Theoretical Implications

The main findings in this thesis have significant applied implications in real-life settings, in particular, legal/forensic settings where eyewitness testimony is an important part of criminal investigations and may sometimes be the only evidence available. In an eyewitness situation, witnesses/victims experience an event that is primarily emotionally negative. Following the event, witnesses may be exposed to misinformation about the event (e.g., through media and other witnesses), and some of the information may be false. Despite this, witnesses are expected to produce an accurate account of what they have witnessed (Lane, 2006). Yet, this thesis and previous research (e.g., Porter et al., 2003, 2010; Van Damme & Smets, 2014) have shown that negative events are susceptible to post-event misleading information. Therefore, it is crucial to understand the conditions that give rise to false remembering of emotionally negative events.

In Experiments 1-3, investigating the role of attention is an important investigation in practical terms, since eyewitnesses to a criminal event may be exposed to a complex situation where their attention may be directed toward details beyond those that are relevant to a criminal investigation, such as one's thoughts and feelings at the time of the event or towards searching for an escape route (Lane, 2006). As such, there may be limited attentional resources available to process the relevant event details. The results of Experiment 3 indicate that when a witness is exposed to a negative event, high arousal, but not low arousal, may protect against a significant increase in the incorporation of misleading information into memory reports when the witness spends less time processing the event. Feasibility aside, this theoretically suggests that investigators could ascertain the level of event arousal, for how long the event lasted, and for how long a witness was present during the event. However, the effect of misinformation remained under both attention conditions for the negative-arousing event, further warning legal professionals to be mindful of eyewitness testimony associated with negative events. Of course, the results of Experiment 3 were only obtained after a change in the type of recognition test (from True/False to 2-AFC), since in Experiments 1 and 2, there was no evidence that reduced attention at encoding influences the misinformation effect differently for emotional and neutral events. This suggests that researchers should be mindful of the impact of practical design elements of an experiment when examining emotion and misinformation. Lastly, the correlational analysis between eye-tracking measures and the later endorsement of misleading details suggests that legal professionals should not form conclusions about the veracity of eyewitness reports solely based on the amount of attention witnesses may have devoted to processing the event.

In Experiments 4 and 5, the findings have important implications regarding methods for mitigating the detrimental impact of misinformation. First, and most importantly, the warnings did not reduce the effect of misinformation on memory for a negative arousing event in both experiments. This highlights the strength of misinformation's effect on memory for such an event and signals serious consequences for eyewitness reports. Second, although eyewitness events tend to be negatively emotional, some events may be classed as emotionally neutral (Thorley et al., 2016). For example, a person may run past a witness without the witness knowing that the person was involved in a robbery. Since the warnings had an impact on a neutral event only when they definitively stated the prior exposure to misinformation (Experiment 5), this has important implications considering that witnesses and investigators are typically unaware if misinformation was encountered. Also, only the enlightenment and item-specific warnings in Experiment 5 were found to be effective for the neutral event. Although the former warning could be applied in real-life settings (see Oeberst & Blank, 2012), the latter warning is too specific and can be difficult to translate into the legal field. Overall, these findings suggest that more research is needed to establish effective strategies to warn against misinformation that can work in situations where uncertainty exists regarding its presence and magnitude, particularly for negative arousing events.

In Experiment 6, misleading information continued to influence memory performance for the negatively arousing event after one week, whereas memory errors reduced for the negative low-arousing and neutral events. Eyewitnesses typically experience events that are negatively valenced and highly arousing (e.g., a robbery or an assault). Eyewitnesses may be asked to recall the event immediately after experiencing it or a few hours to weeks after the event (Neubauer & Fradella, 2011). Experiment 6 demonstrated that misleading information could have a long-lasting impact on people's memory of a highly arousing negative event. This could lead to inaccurate or incomplete testimony, which could in turn have serious implications for the outcome of a trial. Therefore, legal professionals may need to be cautious when using testimony about an arousing event taken either immediately or after a period of delay. Interestingly though, if the event is low arousing, there was a memorial benefit of retention interval, whereby the effect of misinformation was reduced over time. This is undoubtedly a positive observation, though whether this is an artefact of the study or a reliable outcome, is yet to be determined.

In addition to the practical implications, the main findings from this thesis provide important theoretical implications. One of the most prominent misinformation theories is the source monitoring theory (Johnson et al., 1993). Yet, previous research on (content) emotion and misinformation typically discuss their findings using alternative explanations such as adaptive function (e.g., Porter et al., 2010), the schematic nature of the details (Peace & Constantin, 2016), and misinformation exposure removing the protective influences of negative emotion and high arousal (Van Damme & Smets, 2014). Throughout the thesis, the source-monitoring perspective was used to try and explain the main findings. In brief, it was argued that negatively arousing events may be more vulnerable to greater source confusions compared to negative low-arousing and neutral events, thus making them more susceptible to misinformation. This is because the negative event is emotional and arousing, and the retrieval and reactivation of the negatively arousing event during post-event questioning, along with the potential mental imagery of the associated misleading information, may increase emotional arousal. This can enhance the vividness and memorability of suggested information and increase source overlap to a greater extent. Indeed, research has argued that compared to ordinary/neutral events, dramatic and negative events are more vulnerable to misinformation (e.g., Crombag et al., 1996). This heightened susceptibility is attributed to their ability to generate vivid mental imagery, which consequently disrupts accurate source monitoring. Therefore, this may explain why, (1) post-event warnings did not *significantly* reduce the effect of misinformation for the negative-arousing event (Expt. 4 & 5) but did so for the neutral event (Expt. 5), and (2) the misinformation effect persisted over time only for the negative-arousing event. Furthermore, research has shown that negatively arousing information specifically benefit from automatic processing (e.g., Kensinger & Corkin, 2004). Thus, in Experiment 3, the finding that presentation duration did not change the magnitude of the misinformation effect for the negatively arousing event, likely suggests an automatic processing of information within the negatively arousing scene. As a result, it could be argued that the degree of activation between the original and misleading memory traces, but also the degree of source confusions, would less likely vary significantly between the presentation duration conditions. Thus, no significant change in the misinformation effect with attentional level is observed. However, for the negative low-arousing event, the increase in the misinformation effect in a short presentation condition may suggest that the encoding of item and source information was disrupted. It is worth considering that the similar findings observed between the neutral picture and the negative-high picture may be attributed to different reasons (e.g., a potentially weak memory trace for both the neutral event and associated misleading details, leading to the possible reliance on guessing).

A finding that was difficult to explain using a source monitoring perspective was in Experiment 6 where the effect of misinformation decreased over time for the negative low-arousing and neutral pictures. Previous research suggests that the availability and accessibility of source cues over time are reduced (e.g., Frost et al. 2002), thus a significant increase in the misinformation effect over time would be predicted. Source confusions can indeed be significant after a delay. It may be that due to the fewer source cues available at one week and the possible weaker memory for both the event and misleading details, memory for misleading and control details for these low-arousing pictures became similar. Thus, using an activation-based approach (e.g., Ayers & Reder, 1998), an explanation was that, after a delay, the strength of activation of the original details was similar regardless of prior misinformation exposure. Overall, the source monitoring theory was able explain the impact of attention, warnings, and retention interval on the misinformation effect for negative and neutral events and explain the specific vulnerability of negatively arousing events to misinformation. While some findings were challenging to explain through source monitoring failure, an activation-based approach offered a complementary theoretical explanation.

Apart from Experiments 4 and 5, the participants in the other experiments were not required to provide explicit judgments about the source of the retrieved information, nor were they explicitly warned at test about discrepancies between the original and post-event sources. Therefore, it is reasonable to ask whether participants in these experiments engaged in active source monitoring of their memories. This, according to the source monitoring theory, is one condition that is required to perform accurately on a memory test following misinformation (Johnson et al., 1993). There has been evidence that participants do not engage in source monitoring automatically. For example, Lindsay and Johnson (1989) found that a yes/no recognition test produced a misinformation effect, but this was eliminated in a source monitoring test, arguing that recognition responses are made on the basis of retrieval fluency rather than source monitoring. Also, post-warning studies (Blank & Launay, 2014) have shown that the endorsement of misleading information reduces after an explicit warning that alerts participants to monitor the source of their memories to identify potential discrepancies between the original event and the post-event information. A decision to not include a source monitoring test in some of the experiments was made because (1) the main emotion and misinformation research did not include a source-monitoring test, and (2) previous research has shown that source monitoring can reduce or eliminate the misinformation effect. By asking for source judgements, this may hinder our understanding of how the factor interacts with emotion to increase or decrease the misinformation effect. Some misinformation studies have also not included a source test, yet they have explained their findings using the source monitoring theory (e.g., Frost, 2000; Parker et al., 2009). Although a source monitoring test post-recognition could have been included like in Experiments 4 and 5 (a procedure that was followed from a relevant study investigating post-warnings), there are limitations to this approach which are highlighted below. It could be that participants did engage in source monitoring to some extent since they were instructed during the memory test to answer the questions based on their own memory of the pictures and there was no mention of the post-event questionnaire after the second stage of the paradigm. Furthermore, it appears to be quite clear across the experiments in the thesis that source monitoring failure likely plays a key role in misinformation's influence on memory for negatively arousing events, due to no significant reduction in misinformation endorsement in Experiments 4 and 5 even in the presence of warnings varying in their specificity. Overall, the source monitoring theory can still be considered as a suitable model for the main findings in this thesis. Nevertheless, future research could directly explore the impact of emotion with limited attention and retention interval on source memory.

One might argue that the effects of misinformation within the experiments are attributable to guessing, demand characteristics of the task and/or recency effects (Bowers & Bekerian, 1984; McCloskey & Zaragoza, 1985a). Indeed, the forced-choice recognition tests did not include an explicit guess option nor was the misleading option excluded from the n-AFC tests. Although the possibility that these mechanisms were behind some of the misinformation effects observed cannot be excluded, there are reasons to believe that this may have played only a minor role in the findings, at least for the negatively arousing event. First, at the beginning of each experiment, participants were not informed that the study examined memory performance. Also, no mention was made of the final memory test until it arrived. Thus, issues pertaining to demand characteristics are likely to be at a minimum. Second, the misleading details in the recognition test were embedded in more non-misleading details, which should have made it harder to adopt a response strategy during the test. For the negatively arousing event, the findings suggest that the misinformation effect is more than just an outcome of biased responses. This is because in Experiment 3, the misinformation effect did not change with picture presentation duration, Experiments 4 and 5, the warnings did not significantly reduce the misinformation susceptibility, and in Experiment 6, the misleading information continued to influence memory after one week. Therefore, other explanations such as genuine source monitoring failures and memory impairment are more appropriate, and it can be reasonably concluded that participants may have developed a genuine belief that the misleading information from the post-event questionnaire did exist in the original visual scene. However, for the neutral picture (and possibly to some degree the negative low-arousing picture), deliberation, recency biases and guessing may play more of a role in the misinformation effect. There was a visible increase in memory errors for the control details in the short presentation duration condition (in the neutral picture; Expt. 3) and after one week (both low arousing pictures; Expt. 6), suggesting that memory for the original trace weakened, thus potentially increasing reliance on guesses. In Experiment 5, there was a significant reduction in misinformation errors in the neutral picture after an enlightenment and item-specific warning, indicating that deliberation and recency effects may play a role in misinformation endorsement (see also Wyler & Oswald, 2016). This reduction did not result in a significant increase in the recognition of the original detail, which may suggest that participants have difficult retrieving the original memory trace, thus resorting to possible guessing. Overall, factors like guessing, recency effects, and demand characteristics may have influenced the observed effects of misinformation in the experiments to some degree, though this may be greater for neutral events.

Furthermore, researchers have argued that both the original and misleading details coexist in memory (e.g., Bowers & Bekerian, 1984). One support for this coexistence theory has come from warning studies showing that misinformation warnings reduce false recognition and increase correct recognition (e.g., Higham et al., 2017). However, Experiments 5 did not provide direct evidence of a coexistence effect between the original and misleading details in memory. That is, for the neutral picture, the reduction in misinformation endorsement after the enlightenment and item-specific warnings did not correspond to a significant increase in the retrieval of the original detail. This of course does not mean that the coexistence of both memory traces does not happen. There may be other reasons at play, such as a difficulty in retrieving the original detail due to a weaker memory trace. Nevertheless, it must be pointed out that Leding and Antonio (2019) found that the general warning reduced peripheral misinformation, but this did not correspond to a *significant* increase in the recognition of original peripheral details. Also, Wyler and Oswald (2016) included only two options for each test question, thus a decrease in central misinformation endorsement after a warning inevitably suggests an increase in accuracy for the original detail. Higham et al. (2017) also had two options, but their second experiment addressed this possible concern using a cued-recall test. Although there was no direct evidence of coexistence, there were trends in the data to potentially support the theory. For example, the Experiment 5 neutral findings did reveal an increase in mean correct recognition (for peripheral details) after the enlightenment and item-specific warnings, though whether this is partly due to guessing is yet to be determined. Also, in Experiment 4 for the negative arousing event, the trend that showed an increase in the endorsement of original central details after the general and enlightenment warnings corresponded to a numerical decrease in misleading central detail endorsement.

Turning to memory for central and peripheral details, it was predicted that the effects of each factor on the misinformation effect across negative and neutral events may vary with the type of detail. However, this was not observed in the experiments, despite the theoretical motivations behind these predictions. Research has shown that, in an emotionally arousing event, memory for central information is better remembered than peripheral information (see Kaplan et al., 2012, 2016) due to increased attention directed towards central/salient information (Easterbrook, 1959). When the accuracy of details not previously suggested to all participants was analysed, in Experiment 1, there was no clear valence or arousal effect on memory narrowing (which was also mirrored in remember and know recollective responses). However, memory for central details was better than for peripheral details in the negatively arousing picture in Experiments 2-5 and the negative low-arousing picture in Experiments 2 and 3. These findings add to the viewpoint that negative emotion, rather than arousal per se, narrows attention (Van Damme & Smets, 2014).

Despite evidence of emotional memory narrowing for non-misleading details, this did not translate as one may predict into false recognition of misleading information (i.e., greater susceptibility to peripheral than to central misinformation in negative events) and was not affected by the three experimental factors (i.e., attention, warning, and retention interval). Only in Experiment 2 was there an interaction between emotion, detail type, and misinformation, irrespective of presentation duration condition. However, even in this interaction, the outcome differed from that by Van Damme and Smets (2014), whereby misinformation influenced memory for central details in all pictures, whereas a misinformation effect for peripheral details was only found for the neutral picture. Even an (almost) replication by Jobson et al. (2022) of Van Damme and Smet's study revealed somewhat different results. Overall, Sharma et al.'s (2022) review revealed that there remains no consensus regarding the impact of emotion and misinformation on memory for central and peripheral details. The misinformation literature is fraught with design and procedural differences, such as the type of test, type of misinformation, and the type of central/peripheral definitions, and this heterogeneity may be the main explanation for the mixed results in the thesis experiments and previous research. Future research aiming to further study the investigative factors in this thesis could set out to use a different definition to categorise central and peripheral details, such as a purely conceptual definition (e.g., Heuer & Reisberg, 1990), to determine whether a change in definition results in the central/peripheral differences that were theoretically motivated in the thesis experiments.

Furthermore, one common view in the emotion literature is that attention is biased toward the central information of an arousing experience. However, the eye-tracking results from Experiment 1 do not provide support for this theory. Contrary to the prediction, there was no trade-off in total attention between central and peripheral areas in the negatively arousing pictures. Total attention was greater for the central area than for the peripheral area in the negative low-arousing pictures, which could be attributed to the emotionality of the event and/or the greater level of detail in the central area. Moreover, the total attention was greater for the peripheral area in the neutral pictures, though one may expect no trade-off in attention in the absence of memory narrowing due to greater scene exploration. Other reasons such as the complexity of the picture in terms of the level of detail, the presence of attention magnets, and the size of the central area(s) can additionally play a role in distributing overt attention in a visual scene.

In sum, the findings in this thesis have shown that, under conditions of limited attention, post-warnings, and delayed retrieval, negatively arousing events are vulnerable to prior misinformation exposure. However, it is important to acknowledge the limitations of this research, which will be discussed in the following section.

6.3 Limitations

In this section, a few limitations of the thesis research are briefly presented, with some limitations potentially hindering the generalisability of the findings to real-world situations (e.g., legal/forensic situations). First, the experiments used static visual scenes to examine the misinformation effect. The use of static pictures is typical in previous emotion and misinformation research. However, real-world events are of course dynamic in nature, therefore the experience of studying pictures in a lab is different from experiencing a dynamic event, which would be more stressful and be associated with real consequences (Knott & Thorley, 2014). Though, it may be that the same mechanisms are responsible for the misinformation effects observed in the experiments regardless of the stimulus type (i.e., static vs. real-world dynamic events; see Wade et al., 2007). Nevertheless, future research should attempt to use negative and neutral videos as target stimuli.

Second, the experiments used only one picture (from Experiment 2 onwards) or two pictures (Experiment 1) per emotion condition. Using a limited number of pictures per condition, particularly one picture per condition, has been common practice in misinformation research examining the effects of stimulus emotion (e.g., Peace & Constantin, 2016; Porter et al., 2003, 2010; Van Damme & Smets, 2014). We used this approach to follow previous research and to reduce the duration of the experiments for online data collection. However, a limitation of this approach may be that the outcomes of the experiments are dependent on the scenes/events used and, although this cannot be confirmed without replications, the findings may lack generalisability to other scenes/events. Indeed, this could be one of the reasons for the mixed results in the misinformation and emotion literature. Therefore, future research should aim to use several target events in each emotion category.

Third, recognition tests were used to assess memory performance. In real-life situations, such as in a courtroom or a police investigation, it is less common for eyewitnesses to be forced into responding using a set number of responses (Campbell et al., 2007). Thus, outcomes from recognition tests may not be generalisable to most recollections of real-life events. However, Howe et al. (2010) argued that recognition tests are still a valid memory assessment tool because, in some instances, autobiographical recollection may be cued (e.g., when presented with a visual aid of an event, or indeed when answering forced-choice questions about the event). Aside from this, researchers have highlighted the benefits of recall or cued recall tests over recognition tests. Recall tests offer a range of possible responses which can reduce correct guessing (Loftus et al., 1985) and response biases (Zaragoza et al., 1987) by eliminating written cues. This can also increase the probability of detecting the actual effects of suggested misleading information (Campbell et al., 2007). Overall, future research on emotion and misinformation research should use, when appropriate, recall tests as much as possible.

Fourth, the recognition tests did not include a ‘don’t know’ option. In legal settings, it is more common for witnesses to be allowed to provide a don’t know response. The absence of this option in recognition tests is common in misinformation research (Paz-Alonso & Goodman, 2008), thus making these tests a forced choice. If participants do not know the answer, they are typically asked to make their best guess. Only a few misinformation studies have used an explicit don’t know response option (e.g., Higham et al., 2011; Oeberst & Blank, 2012; Paz-Alonso & Goodman, 2008; Paz-Alonso et al., 2013; Ulatowska et al., 2016). McCloskey and Zaragoza (1985a) argued that the misinformation effects found in studies where a don’t know option was not available may be over-estimated because the misinformation items may be selected at a higher rate. A don’t know option was not included in the thesis experiments for three reasons: (1) relevant previous research (e.g., Van Damme & Smets, 2014; Wyler & Oswald, 2016) using recognition tests did not include such an option; (2) the inclusion of a don’t know option may encourage participants to utilise this option more to avoid effortful thinking to answer the questions, resulting in potentially a significant loss in accurate data (Scoboria & Fisico, 2013). This may be more likely in online studies where the researcher is not present during testing and in delayed retention studies where memory can be weaker after some time; (3) participants may have a hunch or a subconscious memory for a potential answer, but they may simply go with don’t know due to possible low confidence. However, future research should attempt to include don’t-know options in their memory tests to increase the generalisability of misinformation research.

Fifth, misleading information was administered through a questionnaire instead of a written narrative. The findings may not be generalisable to situations where the misinformation is encountered in a narrative form, such as newspaper reports or statements made by other witnesses. Studies comparing the effectiveness of post-event questionnaires and narratives have found that the misinformation effect is much stronger when the misinformation is administered via a questionnaire than a narrative (e.g., Zaragoza & Lane, 1994), particularly for central details (Saunders, 2009). It is argued that, when answering the post-event questions, the misleading details are more likely to be accompanied by a visual mental image when reconstructing and rehearsing the original event, which can increase source confusions Zaragoza & Lane, 1994). This is less likely to occur when passively engaging in a written or auditory narrative. Thus, future research could conduct an (extended) replication of the experiments in this thesis with misinformation administered via a narrative.

Sixth, in Experiments 4 and 5, a source test was included post-recognition. Such a procedure has been used in previous research (e.g., Wyler & Oswald, 2016). There were similarities and differences between the recognition and source test results in each experiment, and source test results between the experiments. However, as mentioned in Chapter 4, caution is appropriate when forming conclusions from the source test findings due to limitations associated with the tests. For example, participants may have changed their minds regarding the source for which they made their recognition response, making recognition-source comparability difficult, they may have forgotten the source used to make their recognition response, or they may use the *I guessed* response for reasons other than genuine guesses (e.g., when unable to retrieve source information for the retrieved memory). A solution for future research may be to test groups using only a source-monitoring test and to include a fifth option "*I know it occurred somewhere in the experiment, but I don't know where*" (Higham, 1998).

Last but not least, Experiments 2-6 were conducted online due to the Covid pandemic. Although misinformation studies tend to be conducted in a controlled laboratory setting, some studies have been administered online, such as misinformation warning studies by Luke et al. (2017) and Freeze et al. (2022). Aside from the obvious benefits of conducting research online (e.g., larger sample sizes, saving time and money), there are concerns about online experiments (see Finley & Penningroth, 2015, for a review of pros and cons of online research). The common concern is that the data collected from online studies may be of poor quality. This could occur if participants' level of attention and motivation is low during the study, or if the environment in which they complete the study is noisy and distracting. To improve the quality of the data, attention checks were included throughout (and comprehension checks for the post-warnings). No obvious issues in the data were identified amongst those who passed the checks, increasing the overall confidence in the data obtained.

6.4 Future Research

This thesis demonstrated that negatively arousing events are vulnerable to prior misinformation exposure. That is, the misinformation's influence on memory (1) remains stable regardless of the level of attention during encoding, (2) is resistant to post-warnings, and (3) persists over time. Thus, along with previous research (e.g., Porter et al., 2003; Van Damme & Smets, 2014), the experiments in this thesis show that misleading information can have a detrimental effect on memory for negative events. However, more research on the effect of emotion and misinformation is still necessary. In addition to dealing with the potential limitations outlined above in future research, the three factors (attention, warning, and retention interval) can be investigated further.

Attention. Attentional resources were manipulated during event encoding. However, future research can investigate the role of encoding processes at other stages of the misinformation paradigm. For example, Zaragoza and Lane (1998, Expt. 2) asked participants to encode misinformation under conditions of either divided or full attention. They found that divided attention during the post-event stage increased misattribution errors of the misleading items. They argued that divided attention impaired the encoding of information surrounding the misinformation's encounter, such as the physical context and the thoughts/reactions. Thus, the impaired source memory for the suggested details increased source misattribution errors.

Warning. Experiments 4 and 5 did not include the highest level of specificity. For example, Wright (1993) explicitly informed participants of the misleading detail (i.e., "…the woman was NOT eating cereal with her breakfast", pp.159). This was found to remarkably increase accuracy. Can susceptibility to misinformation for negatively arousing events be reduced by a highly specific warning? Future research could aim to answer this question. Indeed, such a warning can be considered a correction to earlier misinformation. Research examining the effect of misinformation correction on memory performance, although using a different experimental task to the misinformation paradigm, have demonstrated a phenomenon called the *continued-influence effect* (e.g., Ecker et al., 2010). This is when the earlier exposure to misinformation continues to influence participants' reasoning and beliefs despite the correction and despite participants remembering the correction (Johnson & Seifert, 1994; for a review, see Lewandowsky et al., 2012). Using this paradigm, Guillory and Geraci (2015) showed that participants rely on negative information, more than positive and neutral information, to make inferences about a politician, regardless of whether that information is later corrected. This suggests that negative erroneous information is better remembered and less likely to be disregarded during memory assessment. Therefore, it would be interesting, in both theoretical and practical terms, to see whether the effect of misinformation for negative arousing events continues even after explicit corrections.

Retention Interval. Several future investigations could take place with manipulating the retention interval. First, the retention interval could be longer than one week. Previous studies have used longer intervals, such as one month (Porter et al., 2010) and 1.5 years (Zhu et al., 2012). Thus, future research could determine whether the negatively arousing event finding continues over a much longer period. Second, several studies have imposed a delay between the witnessed event and misinformation (e.g., Loftus et al., 1978; Moore & Lampinen, 2016; Paz-Alonso & Goodman, 2008; Paz-Alonso et al., 2013) and they have shown that the effect of misinformation increases over time, even for a highly negative event (e.g., Paz-Alonzo & Goodman, 2008). Delay can weaken the memory trace for the original event, leading to larger misinformation effects. Third, Experiment 6 showed that the misinformation effect persisted after one week only for a negatively arousing event. Future research could explore whether including a post-warning may reduce the effect of misinformation for such an event. Considering that Experiments 4 and 5 showed that warnings were not *significantly* effective for the negative-arousing event, and that source memory fades over time (e.g., Frost et al., 2002) thus making source monitoring difficult, it can be argued that warnings may not have a beneficial effect even after a longer delay for negative events. An empirical demonstration of this can provide important practical forensic implications.

Mood. The investigation into the role of emotion in the misinformation paradigm was focused on the emotional content of witnessed events. However, researchers have also examined the impact of mood (i.e., the emotional context) on misinformation susceptibility. Although beyond the scope of this thesis, in brief, several studies have induced mood after event encoding (e.g., Forgas et al., 2005; Van Damme & Seynaeve, 2013), which have revealed mixed findings, such as no effect of mood on the misinformation effect or reduced susceptibility to misinformation (for a review, see Sharma et al., 2022). To the best of our knowledge, no mood and misinformation study has yet examined the role of retention interval and post-warning, a necessary investigation considering the findings in this thesis. However, there has been little attention devoted to understanding the effect of mood at the time of event encoding on susceptibility to misinformation, and its interaction with the emotional content of the event. This is important because, in forensic situations, witnesses/victims' experience of an emotionally arousing event can (typically) induce a negative mood (Zhang et al., 2021). Zhang et al. (2021) set out to investigate this using positive, negative, and neutral mood induction and target event scenes, and found that mood affected misleading responses when interacting with scene valence. That is, misleading responses associated with the emotional scenes (positive and negative) was not affected by mood, but with neutral scenes, positive mood increased misinformation responses. Zhang and colleagues' study did not examine the arousal dimension of emotional experience (i.e., arousal was controlled across mood induction videos, and arousal may have varied across target scenes), nor did they assess memory for central and peripheral details. Thus, future research should delve deeper into understanding the impact of mood on misinformation endorsement for emotional events beyond the existing literature.

6.5 Conclusion

The overarching aim of this thesis was to further our understanding on the impact of post-event misleading information on memory for emotionally negative events. To do this, the role of three factors were examined – limited attention during event encoding, warning prior to memory retrieval, and retention interval between misinformation and test. These factors have previously been shown to influence susceptibility to misleading information. The findings of this thesis highlighted the unique vulnerability of negatively arousing events to misinformation over time, their resilience against misinformation warnings, and their relative protection from increased misinformation susceptibility when attentional resources during event encoding is reduced. This thesis contributes to the growing field of research on emotion and misinformation, and along with theoretical implications, it provides important applied implications in real-life settings, particularly legal and forensic settings where eyewitness testimony is a key part of criminal investigations. Despite the limitations to the research outlined above, the current research has demonstrated the strong and lasting influence of misleading information on memory for negatively arousing events.

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Appendices

Appendix A

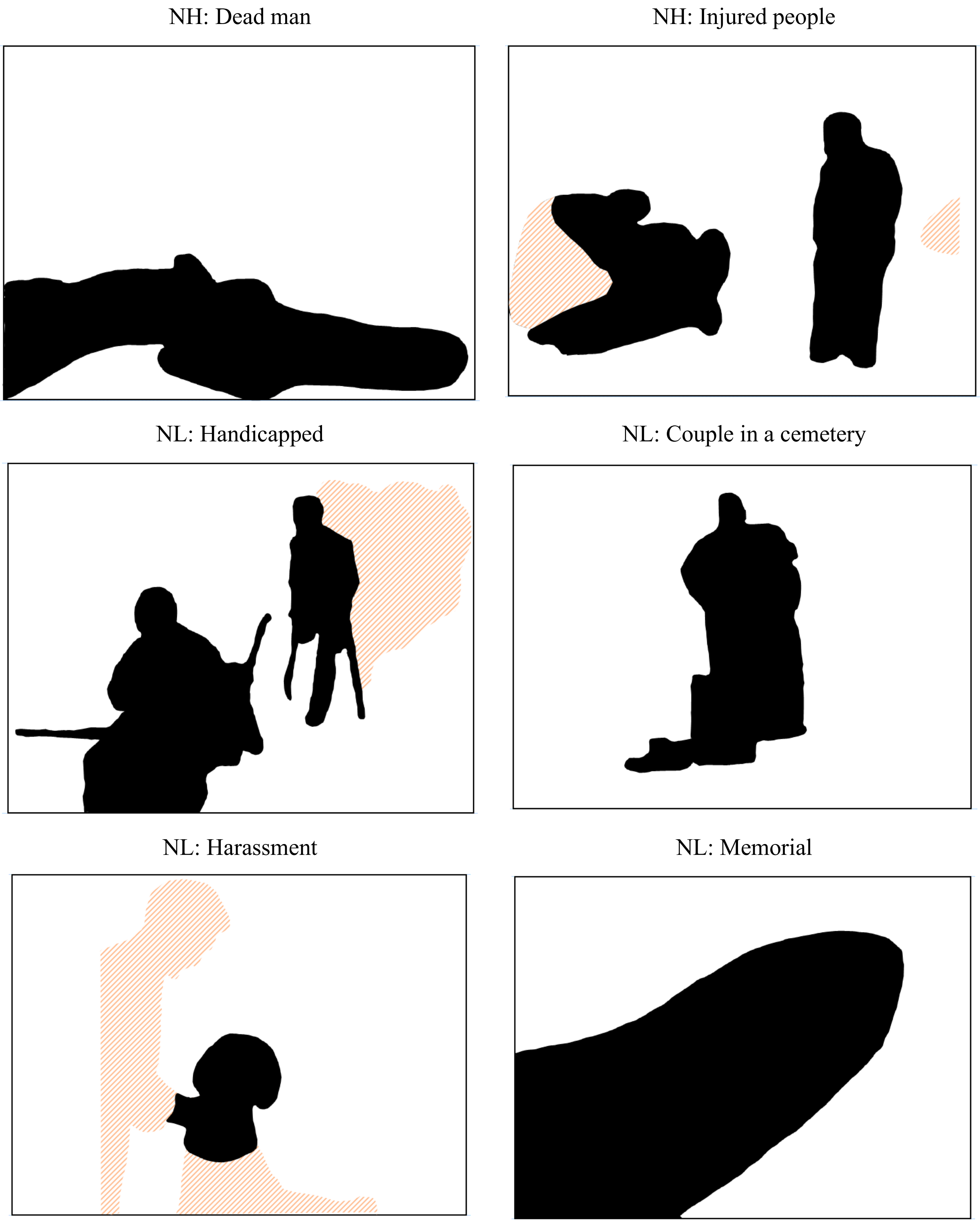

Figure A. An approximate visual representation of the central and peripheral information in each picture indicating the source of the emotion. Black = central information, white = peripheral information, and patterned orange = information having not met the 70% threshold.

Appendix B

Complexity is defined as the amount of detail in the picture. A picture with very few details and with little variety in the details would be less complex than a picture filled with many details and with greater variety in the details. When making your visual complexity judgement, consider the details both in the FOREGROUND and the BACKGROUND of the scene, and consider all kinds of details (e.g., people, objects, colours, patterns). DO NOT make your judgement based on how complex the event in the picture is or based on the emotional properties in the picture. Only focus on how busy the scene is in terms of visual detail.

For the visual complexity rating, the picture will come on the screen again. **Please carefully look at the picture to determine how much detail there is before making your judgement**. To indicate your complexity judgement, **select a number from 1 (indicating low complexity) to 9 (indicating high complexity).**

1	2	3	4	5	6	7	8	9
Low Complexity								High Complexity

Appendix C

*The **bold** detail in each misleading post-event question is the misleading detail*

NEGATIVE/HIGH – DEAD MAN

Q1 [CENTRAL] MISLEADING: Did you see that the man on the ground had **two major cuts** on his right arm?
CONTROL: Did you see that the man on the ground had his right arm across his neck?
TEST: The man on the ground's right arm had two major cuts

Q2 [CENTRAL] MISLEADING: Did you see the **triangle** shape that was on the man on the ground's t-shirt?
CONTROL: Did you see the shape that was on the man on the ground's t-shirt?
TEST: On the man on the ground's t-shirt, there was a triangle shape

Q3 [PERIPHERAL] MISLEADING: Did you see the **white** dog immediately to the right of the people?
CONTROL: Did you see the dog immediately to the right of the people?
TEST: Immediately to the right of the people in the foreground, there was a white dog

Q4 [PERIPHERAL] MISLEADING: Did you see the **horizontal** stripes on the skirt that the woman in the centre of the picture was wearing?
CONTROL: Did you see the stripes on the skirt that the woman in the centre of the picture was wearing?
TEST: The woman in the centre of the picture wore a skirt with horizontal stripes

Q5 [CENTRAL] MISLEADING: Did you see that the blood on the ground **was all dried-up**?
CONTROL: Did you see the blood on the ground?
TEST: The blood on the ground was completely dried-up

Q6 [CENTRAL] MISLEADING: Did you see the **gold** watch the man on the ground was wearing on his left arm?
CONTROL: Did you see the watch the man on the ground was wearing on his left arm?
TEST: The man on the ground wore a gold watch

Q7 [PERIPHERAL] MISLEADING: Did you see the bike that the man **in the jumper** was holding?
CONTROL: Did you see the bike that the man was holding?
TEST: The man holding the bike wore a jumper

Q8 [PERIPHERAL] MISLEADING: Did you see the **three** women walking together in the background?
CONTROL: Did you see the women walking together in the background?
TEST: In the background, there were three women walking together

NEGATIVE/HIGH – INJURED PEOPLE

Q1 [CENTRAL] MISLEADING: Did you see the blue **striped** top the injured woman on the ground was wearing?
CONTROL: Did you see the blue top the injured woman on the ground was wearing?
TEST: The injured woman on the ground wore a striped top

Q2 [CENTRAL] MISLEADING: Did you see that the injured man sitting on the right **bare feet** was looking at the injured woman on the ground?
CONTROL: Did you see that the injured man sitting on the right was looking at the injured woman on the ground?
TEST: The injured man sitting on the right was bare feet

Q3 [PERIPHERAL] MISLEADING: Did you see the **young girl** standing in the background on the very left in the picture?
CONTROL: Did you see the person standing in the background on the very left in the picture?
TEST: Standing in the background on the very left, there was a young girl

Q4 [PERIPHERAL] MISLEADING: Did you see the **blue** advertisement in the background on the left?
CONTROL: Did you see the advertisement in the background on the left?
TEST: In the background, there was a blue advertisement

Q5 [CENTRAL] MISLEADING: Did you see the **polka dot** dress the woman that was helping the injured woman on the ground was wearing?
CONTROL: Did you see the dress the woman that was helping the injured woman on the ground was wearing?
TEST: The woman helping the injured woman on the ground wore a polka dot dress

Q6 [CENTRAL] MISLEADING: Did you see the **navy-blue** trousers that the injured man on the right was wearing?
CONTROL: Did you see the trousers that the injured man on the right was wearing?
TEST: The injured man sitting on the right was wearing navy-blue trousers

Q7 [PERIPHERAL] MISLEADING: Did you see the **three** streetlamps in the background?
CONTROL: Did you see the streetlamps in the background?
TEST: There were three streetlamps

Q8 [PERIPHERAL] MISLEADING: Did you see the white **bowler** hat the bearded man in the background was wearing?
CONTROL: Did you see the white hat the bearded man in the background was wearing?
TEST: In the background, there was a bearded man wearing a white bowler hat

NEGATIVE/LOW – COUPLE IN A CEMETERY

Q1 [CENTRAL] MISLEADING: Did you see the **striped** black top the woman was wearing?
CONTROL: Did you see the black top the woman was wearing?
TEST: The woman wore a striped top

Q2 [CENTRAL] MISLEADING: Did you see the first name read 'Justin' on the **gold** plaque in the middle of the headstone that was in front of the couple?
CONTROL: Did you see the first name read 'Justin' on the plaque in the middle of the headstone that was in front of the couple?
TEST: The headstone in front of the couple had a gold name plaque

Q3 [PERIPHERAL] MISLEADING: Did you see the **pink** flowers that were in front of the headstone in the foreground on the right?
CONTROL: Did you see the flowers that were in front of the headstone in the foreground on the right?
TEST: In front of the headstone in the foreground on the right, there were pink flowers

Q4 [PERIPHERAL] MISLEADING: Did you see the **slanted** headstone on the very left in the foreground?
CONTROL: Did you see the headstone on the very left in the foreground?
TEST: In the foreground on the very left, there was a slanted headstone

Q5 [CENTRAL] MISLEADING: Did you see that the man had a **pencil** moustache?
CONTROL: Did you see that the man had a moustache?
TEST: The man had a pencil moustache

Q6 [CENTRAL] MISLEADING: Did you see the **dark green** skirt the woman was wearing?
CONTROL: Did you see the skirt the woman was wearing?
TEST: The woman's skirt was dark green

Q7 [PERIPHERAL] MISLEADING: Did you see the **heart-shaped** headstone in the background in front of the path on the right?
CONTROL: Did you see the headstone in the background in front of the path on the right?
TEST: In the background on the right in front of the path, there was a heart-shaped headstone

Q8 [PERIPHERAL] MISLEADING: Did you see the name '**Jordan** Wiley Wilcox' marked on the headstone that was in the foreground on the right?
CONTROL: Did you see the name marked on the headstone that was in the foreground on the right?
TEST: Marked on the headstone in the foreground on the right was the name 'Jordan Wiley Wilcox'

NEGATIVE/LOW – FLOWER MEMORIAL

Q1 [CENTRAL] MISLEADING: Did you see the **white** flower bouquet that was against the brick pillar on the very left in the picture?
CONTROL: Did you see the flower bouquet that was against the brick pillar on the very left in the picture?
TEST: Against the brick pillar on the very left, there was a white flower bouquet

Q2 [CENTRAL] MISLEADING: Did you see the **two** light-blue candles on the ledge?
CONTROL: Did you see the candles on the ledge?

TEST: On the ledge, there were two light-blue candles

Q3 [PERIPHERAL] MISLEADING: Did you see the security guard in the upper right of the picture who was wearing an **orange** high-visibility jacket?
CONTROL: Did you see the security guard in the upper right of the picture who was wearing a high-visibility jacket?
TEST: The security guard in the upper right of the picture was wearing an orange high-visibility jacket

Q4 [PERIPHERAL] MISLEADING: Did you see the man in the **t-shirt** standing near the security guard in the upper right of the picture?
CONTROL: Did you see the man standing near the security guard in the upper right of the picture?
TEST: Near the security guard in the upper right of the picture, there was a man wearing a t-shirt

Q5 [CENTRAL] MISLEADING: Did you see the **white** toy bunny in front of the ledge?
CONTROL: Did you see the toy bunny in front of the ledge?
TEST: In front of the ledge, there was a white toy bunny

Q6 [CENTRAL] MISLEADING: Did you see the white card with the **drawing of a rose** that was attached to the black wrapping paper at the front of the pile of flowers?
CONTROL: Did you see the white card that was attached to the black wrapping paper at the front of the pile of flowers?
TEST: At the front of the pile of flowers, attached to the black wrapping paper, there was a white card with a rose drawing

Q7 [PERIPHERAL] MISLEADING: Did you see the suited man with the **briefcase** behind the metal barrier in the background?
CONTROL: Did you see the suited man behind the metal barrier in the background?
TEST: Behind the metal barrier in the background, there was a suited man with a briefcase

Q8 [PERIPHERAL] MISLEADING: Did you see the man in the **short-sleeve** shirt with his arms resting on the metal barrier in the background?
CONTROL: Did you see the man with his arms resting on the metal barrier in the background?
TEST: In the background, the man resting his arms on the metal barrier wore a short-sleeve shirt

NEUTRAL – DOG WALKING

Q1 [CENTRAL] MISLEADING: Did you see the **black** coat the woman in the foreground on the left was wearing?
CONTROL: Did you see the coat the woman in the foreground on the left was wearing?
TEST: The woman in the foreground on the left wore a black coat

Q2 [CENTRAL] MISLEADING: Did you see the **grey and white** dog on the right with its tail down?
CONTROL: Did you see the dog on the right with its tail down?
TEST: The dog on the right was grey and white

Q3 [PERIPHERAL] MISLEADING: Did you see the **metal** slatted bin in the background on the right?
CONTROL: Did you see the slatted bin in the background on the right?
TEST: In the background on the right, there was a metal slatted bin

Q4 [PERIPHERAL] MISLEADING: Did you see the blue banner in the distance on the left, which read '**Action** for Change'?
CONTROL: Did you see the blue banner in the distance on the left?
TEST: In the distance on the left, the blue banner read 'Action for Change'

Q5 [CENTRAL] MISLEADING: Did you see the tied-back **blond** hair of the woman in the foreground on the left?
CONTROL: Did you see the tied-back hair of the woman in the foreground on the left?
TEST: The woman in the foreground on the left had blond hair

Q6 [CENTRAL] MISLEADING: Did you see that the woman in the foreground on the right was holding a pink dog leash and **two books**?
CONTROL: Did you see that the woman in the foreground on the right was holding a pink dog leash?
TEST: The woman in the foreground on the right was holding two books

Q7 [PERIPHERAL] MISLEADING: Did you see the **three** vertical masts on the ship in the background?
CONTROL: Did you see the tall vertical masts on the ship in the background?
TEST: The ship in the background had three vertical masts

Q8 [PERIPHERAL] MISLEADING: Did you see the woman in the **skirt** in the background on the very right of the picture?
CONTROL: Did you see the woman in the background on the very right of the picture?
TEST: In the background on the very right of the picture, there was a woman in a skirt

NEUTRAL – MEN AT A RESTAURANT

Q1 [CENTRAL] MISLEADING: Did you see the two **empty** glasses on the men's table in the foreground?
CONTROL: Did you see the two glasses on the men's table in the foreground?
TEST: On the men's table in the foreground, there were two empty glasses

Q2 [CENTRAL] MISLEADING: Did you see the short-sleeved **black** t-shirt the man in the foreground sitting on the left was wearing?
CONTROL: Did you see the short-sleeved t-shirt the man in the foreground sitting on the left was wearing?
TEST: The man in the foreground sitting on the left wore a black t-shirt

Q3 [PERIPHERAL] MISLEADING: Did you see the name of the restaurant written in **lowercase** letters on the awning in the background on the left?
CONTROL: Did you see the name of the restaurant on the awning in the background on the left?
TEST: On the awning in the background on the left, the restaurant's name was in lowercase letters

Q4 [PERIPHERAL] MISLEADING: Did you see the **wooden** bin in the far background on the right?
CONTROL: Did you see the bin in the far background on the right?
TEST: In the far background on the right, there was a wooden bin

Q5 [CENTRAL] MISLEADING: Did you see the **dotted** shirt that the man in the foreground sitting on the right was wearing?
CONTROL: Did you see the shirt that the man in the foreground sitting on the right was wearing?
TEST: The man in the foreground sitting on the right wore a dotted shirt

Q6 [CENTRAL] MISLEADING: Did you see the **grey** jeans that the man in the foreground sitting on the right was wearing?
CONTROL: Did you see the jeans that the man in the foreground sitting on the right was wearing?
TEST: The man in the foreground sitting on the right wore grey jeans

Q7 [PERIPHERAL] MISLEADING: Did you see the man in the **beanie** hat who was sitting next to his companion under the awning in the background on the left?
CONTROL: Did you see the man who was sitting next to his companion under the awning in the background on the left?
TEST: Sitting under the awning in the background on the left, there was a man in a beanie hat

Q8 [PERIPHERAL] MISLEADING: Did you see the **four** parasols in the picture?
CONTROL: Did you see the parasols in the picture?
TEST: There were four parasols in the picture

Appendix D

*The **bold** detail in each misleading post-event question is the misleading detail*

NEGATIVE/HIGH – INJURED PEOPLE

Q1 [CENTRAL] MISLEADING: The injured man sitting on the right was wearing **navy-blue** trousers, but did you see that he was topless?
CONTROL: The injured man sitting on the right was wearing trousers, but did you see that he was topless?
TEST: The injured man sitting on the right wore navy-blue trousers

Q2 [CENTRAL] MISLEADING: Concerning the injured woman on the ground in the **striped** blue top, did you see that she was lying on her side propped up on one arm?
CONTROL: Concerning the injured woman on the ground in the blue top, did you see that she was lying on her side propped up on one arm?
TEST: The injured woman on the ground wore a striped top

Q3 [PERIPHERAL] MISLEADING: In the background, did you see that the **three** multi-headed lamp posts had lantern-shaped heads?
CONTROL: In the background, did you see that the multi-headed lamp posts had lantern-shaped heads?
TEST: In the background, there were three multi-headed lamp posts

Q4 [PERIPHERAL] MISLEADING: In the background, immediately to the right of the **blue** advertisement, did you see the man in a suit?
CONTROL: In the background, immediately to the right of the advertisement, did you see the man in a suit?
TEST: In the background, there was a blue advertisement

NEGATIVE/LOW – COUPLE IN A CEMETERY

Q1 [CENTRAL] MISLEADING: Did you see that, along with his **pencil** moustache, the man had short black hair?
CONTROL: Did you see that, along with his moustache, the man had short black hair?
TEST: The man had a pencil moustache

Q2 [CENTRAL] MISLEADING: Near the woman's **dark green** skirt, did you see the flower on the ground?
CONTROL: Near the woman's skirt, did you see the flower on the ground?
TEST: The woman's skirt was dark green

Q3 [PERIPHERAL] MISLEADING: Did you see that the headstone in the foreground on the right, with **pink** flowers in front, had a curved top?
CONTROL: Did you see that the headstone in the foreground on the right, with flowers in front, had a curved top?
TEST: In front of the headstone in the foreground on the right, there were pink flowers

Q4 [PERIPHERAL] MISLEADING: On the **slanted** headstone in the foreground on the very left, did you see the name plaque?
CONTROL: On the headstone in the foreground on the very left, did you see the name plaque?
TEST: In the foreground on the very left, there was a slanted headstone

NEUTRAL – MEN AT A RESTAURANT

Q1 [CENTRAL] MISLEADING: Paired with his **grey** jeans, did you see the formal shoes the man in the foreground sitting on the right was wearing?
CONTROL: Paired with his jeans, did you see the formal shoes the man in the foreground sitting on the right was wearing?
TEST: The man in the foreground sitting on the right wore grey jeans

Q2 [CENTRAL] MISLEADING: In the foreground, did you see that the man sitting on the left in a **black** t-shirt was looking at his companion?
CONTROL: In the foreground, did you see that the man sitting on the left was looking at his companion?
TEST: The man in the foreground sitting on the left wore a black t-shirt

Q3 [PERIPHERAL] MISLEADING: Did you see that the **four** parasols were square-shaped?
CONTROL: Did you see that the parasols were square-shaped?
TEST: There were four parasols in the picture

Q4 [PERIPHERAL] MISLEADING: Under the awning in the background on the left, did you see the woman that was sitting next to the man in the **beanie** hat?
CONTROL: Under the awning in the background on the left, did you see the woman that was sitting next to the man?
TEST: Sitting under the awning in the background on the left, there was a man in a beanie hat

Appendix E

*The **bold** detail in each misleading post-event question is the misleading detail*

NEGATIVE/HIGH – INJURED PEOPLE

Q1 [CENTRAL] MISLEADING: The injured man sitting on the right was wearing **navy-blue** trousers, but did you see that he was topless?
CONTROL: The injured man sitting on the right was wearing trousers, but did you see that he was topless?
TEST: What colour were the trousers worn by the injured man sitting on the right?

a) Beige
b) Navy blue

Q2 [CENTRAL] MISLEADING: Did you see that the injured woman on the ground in the **striped** blue top was lying on her side propped up on one arm?
CONTROL: Did you see that the injured woman on the ground in the blue top was lying on her side propped up on one arm?
TEST: How would you describe the blue top worn by the injured woman on the ground?

a) A plain blue top
b) A striped blue top

Q3 [PERIPHERAL] MISLEADING: In the background, did you see that the **three** multi-headed lamp posts had lantern-shaped heads?
CONTROL: In the background, did you see that the multi-headed lamp posts had lantern-shaped heads?
TEST: How many multi-headed lamp posts were there in the background?

a) Two
b) Three

Q4 [PERIPHERAL] MISLEADING: In the background, immediately to the right of the **blue** advertisement, did you see the man in a suit?
CONTROL: In the background, immediately to the right of the advertisement, did you see the man in a suit?
TEST: What colour was the advertisement in the background?

a) Red
b) Blue

Q5 [CENTRAL] MISLEADING: Did you see that the woman in the **polka dot** dress, who was helping the injured woman on the ground, had brown hair?
CONTROL: Did you see that the woman in the dress, who was helping the injured woman on the ground, had brown hair?
TEST: What pattern was on the dress worn by the woman that was helping the injured woman on the ground?

a) Floral
b) Polka dots

Q6 [CENTRAL] MISLEADING: Whilst the injured man on the right sat **looking towards the camera**, did you see the person in a white shirt next to him?
CONTROL: Did you see the person in a white shirt who was next to the injured man sitting on the right?
TEST: Where was the injured man sitting on the right looking?

a) Looking at the injured woman on the ground
b) Looking towards the camera

Q7 [PERIPHERAL] MISLEADING: On the building in the background, did you see the square-shaped windows that were near the **three** round windows?
CONTROL: On the building in the background, did you see the square-shaped windows that were near the round windows?
TEST: How many round windows were there on the building in the background?

a) Two
b) Three

Q8 [PERIPHERAL] MISLEADING: In the background, **two people wore a striped shirt**, but did you see that some people in the background were wearing plain shirts?
CONTROL: In the background, did you see that some people were wearing plain shirts?
TEST: Of the people standing in the background, how many wore a striped shirt?

a) One person
b) Two people

NEGATIVE/LOW – COUPLE IN A CEMETERY

Q1 [CENTRAL] MISLEADING: Did you see that, apart from his **pencil** moustache, the man had no other facial hair?
CONTROL: Did you see that, apart from his moustache, the man had no other facial hair?
TEST: How would you describe the man's moustache?

a) Bushy
b) Pencil

Q2 [CENTRAL] MISLEADING: Near the woman's **dark green** skirt, did you see the flower on the ground?
CONTROL: Near the woman's skirt, did you see the flower on the ground?
TEST: What colour was the woman's skirt?

a) Burgundy
b) Dark green

Q3 [PERIPHERAL] MISLEADING: Did you see that the headstone in the foreground on the right, with **pink** flowers in front, had a curved top?
CONTROL: Did you see that the headstone in the foreground on the right, with flowers in front, had a curved top?
TEST: What colour were the flowers in front of the headstone in the foreground on the right?

a) Yellow
b) Pink

Q4 [PERIPHERAL] MISLEADING: On the **slanted** headstone in the foreground on the very left, did you see the name plaque?
CONTROL: On the headstone in the foreground on the very left, did you see the name plaque?
TEST: How would you describe the headstone in the foreground on the very left?

a) Upright
b) Slanted

Q5 [CENTRAL] MISLEADING: Did you see that the woman's **brown** top was long-sleeved?
CONTROL: Did you see that the woman's top was long-sleeved?
TEST: What colour was the top worn by the woman?

a) Black
b) Brown

Q6 [CENTRAL] MISLEADING: On the headstone in front of the couple, did you see that the name on the **square** plaque was in black?
CONTROL: On the headstone in front of the couple, did you see that the name on the plaque was in black?
TEST: What shape was the name plaque on the headstone in front of the couple?

a) Rectangle
b) Square

Q7 [PERIPHERAL] MISLEADING: Did you see that the **black** path in the background went right across the picture?
CONTROL: Did you see that the path in the background went right across the picture?
TEST: How would you describe the path in the background?

a) Grey
b) Black

Q8 [PERIPHERAL] MISLEADING: In front of the path in the background on the right, did you see the decoration that was over the **heart-shaped** headstone?
CONTROL: In front of the path in the background on the right, did you see the decoration that was over the headstone?
TEST: What was the shape of the headstone that was directly in front of the path in the background on the right?

a) Round top headstone
b) Heart-shaped headstone

NEUTRAL – MEN AT A RESTAURANT

Q1 [CENTRAL] MISLEADING: Paired with his **grey** jeans, did you see the formal shoes the man in the foreground sitting on the right was wearing?
CONTROL: Paired with his jeans, did you see the formal shoes the man in the foreground sitting on the right was wearing?
TEST: What colour were the jeans worn by the man in the foreground sitting on the right?

a) Blue

b) Grey

Q2 [CENTRAL] MISLEADING: Did you see that the **black** t-shirt worn by the man in the foreground sitting on the left had short sleeves?
CONTROL: Did you see that the t-shirt worn by the man in the foreground sitting on the left had short sleeves?
TEST: What colour was the t-shirt worn by the man in the foreground sitting on the left?

a) White
b) Black

Q3 [PERIPHERAL] MISLEADING: Did you see that the **four** parasols were square-shaped?
CONTROL: Did you see that the parasols were square-shaped?
TEST: How many parasols were there in the picture?

c) Three
d) Four

Q4 [PERIPHERAL] MISLEADING: Under the awning in the background on the left, did you see the woman who was sitting next to the man in the **beanie** hat?
CONTROL: Under the awning in the background on the left, did you see the woman who was sitting next to the man?
TEST: The man sitting under the awning in the background on the left wore a hat. What kind of hat was it?

a) Ball cap
b) Beanie hat

Q5 [CENTRAL] MISLEADING: Concerning the man in the foreground sitting on the left, did you see that his **light-grey** hair was styled short?
CONTROL: Concerning the man in the foreground sitting on the left, did you see that his hair was styled short?
TEST: What colour hair did the man sitting in the foreground on the left have?

a) Black
b) Light grey

Q6 [CENTRAL] MISLEADING: Did you see that the man in the foreground sitting on the right had his jacket hanging on the back of his chair instead of wearing it over his **jumper**?
CONTROL: Did you see that the man in the foreground sitting on the right had his jacket hanging on the back of his chair instead of wearing it over his top?
TEST: What top was the man in the foreground sitting on the right wearing?

a) A button shirt
b) A jumper

Q7 [PERIPHERAL] MISLEADING: In the far background on the right, near the **black** bin, did you see the unoccupied table?
CONTROL: In the far background on the right, near the bin, did you see the unoccupied table?
TEST: What colour was the bin in the far background on the right?

a) Green
b) Black

Q8 [PERIPHERAL] MISLEADING: To the right of the **white** wall lantern at the top of the picture, did you see the row of windows?
CONTROL: To the right of the wall lantern at the top of the picture, did you see the row of windows?
TEST: What colour was the wall lantern at the top of the picture?

a) Black
b) White

Appendix F

*The **bold** detail in each misleading post-event question is the misleading detail, whereas the **bold** detail in the test question is the correct detail*

NEGATIVE/HIGH – INJURED PEOPLE

Q1 [CENTRAL] MISLEADING: Along with his **light-blue** trousers, was the injured man sitting on the right also wearing a top?
CONTROL: Along with his trousers, was the injured man sitting on the right also wearing a top?
TEST: What colour were the trousers worn by the injured man sitting on the right?

a) Beige
b) Light blue
c) Dark red

Q2 [CENTRAL] MISLEADING: Concerning the injured woman on the ground in the **striped** blue top, was she lying on her side and propped up on one arm?
CONTROL: Concerning the injured woman on the ground in a blue top, was she lying on her side and propped up on one arm?
TEST: How would you describe the blue top worn by the injured woman on the ground?

a) A plain blue top
b) A striped blue top
c) A checkered blue top

Q3 [PERIPHERAL] MISLEADING: In the background, what kind of heads did the **three** multi-headed lamp posts have, were they oval shaped?
CONTROL: In the background, what kind of heads did the multi-headed lamp posts have, were they oval shaped?
TEST: How many multi-headed lamp posts were there in the background?

a) Two
b) Three
c) Four

Q4 [PERIPHERAL] MISLEADING: In the background, immediately to the right of the **blue** advertisement, did you see a man in a suit?
CONTROL: In the background, immediately to the right of the advertisement, did you see a man in a suit?
TEST: What colour was the advertisement in the background?

a) Red
b) Blue
c) Yellow

NEUTRAL – MEN AT A RESTAURANT

Q1 [CENTRAL] MISLEADING: The man in the foreground sitting on the right wore **black** jeans paired with what kind of shoes, were they formal shoes?
CONTROL: The man in the foreground sitting on the right wore jeans paired with what kind of shoes, were they formal shoes?
TEST: What colour were the jeans worn by the man in the foreground sitting on the right?

a) Blue
b) Black
c) Grey

Q2 [CENTRAL] MISLEADING: Did the man in the foreground sitting on the left wear a jacket over his **polo shirt**?
CONTROL: Did the man in the foreground sitting on the left wear a jacket over his top?
TEST: What was the man in the foreground sitting on the left wearing?

a) T-shirt
b) Polo shirt
c) Jumper

Q3 [PERIPHERAL] MISLEADING: Under the **four** parasols, were there any lights hanging?
CONTROL: Under the parasols, were there any lights hanging?
TEST: How many parasols were there in the picture?

a) Two
b) Three
c) Four

Q4 [PERIPHERAL] MISLEADING: Under the awning in the background on the left, was there a woman sitting next to the man in the **beanie** hat?
CONTROL: Under the awning in the background on the left, was there a woman sitting next to the man?
TEST: One person sitting under the awning in the background on the left wore a hat. What kind of hat was it?

a) Ball cap
b) Beanie hat
c) Beret

Appendix G

*The **bold** detail in each misleading post-event question is the misleading detail, whereas the **bold** detail in the test question is the correct detail*

NEGATIVE/HIGH – INJURED PEOPLE

Q1 [CENTRAL] MISLEADING: The injured man sitting on the right was wearing **light-blue** trousers, but did you see that he was topless?
CONTROL: The injured man sitting on the right was wearing trousers, but did you see that he was topless?
TEST: What colour were the trousers worn by the injured man sitting on the right?

- **a) Beige**
- b) Light blue
- c) Dark red

Q2 [CENTRAL] MISLEADING: Concerning the injured woman on the ground in the **striped** blue top, did you see that she was lying on her side propped up on one arm?
CONTROL: Concerning the injured woman on the ground in the blue top, did you see that she was lying on her side propped up on one arm?
TEST: How would you describe the blue top worn by the injured woman on the ground?

- **a) A plain blue top**
- b) A striped blue top
- c) A checkered blue top

Q3 [PERIPHERAL] MISLEADING: In the background, did you see that the **three** multi-headed lamp posts had lantern-shaped heads?
CONTROL: In the background, did you see that the multi-headed lamp posts had lantern-shaped heads?
TEST: How many multi-headed lamp posts were there in the background?

- **a) Two**
- b) Three
- c) Four

Q4 [PERIPHERAL] MISLEADING: In the background, immediately to the right of the **blue** advertisement, did you see the man in a suit?
CONTROL: In the background, immediately to the right of the advertisement, did you see the man in a suit?
TEST: What colour was the advertisement in the background?

- **a) Red**
- b) Blue
- c) Yellow

NEUTRAL – MEN AT A RESTAURANT

Q1 [CENTRAL] MISLEADING: Paired with his **black** jeans, did you see the formal shoes the man in the foreground sitting on the right was wearing?
CONTROL: Paired with his jeans, did you see the formal shoes the man in the foreground sitting on the right was wearing?
TEST: What colour were the jeans worn by the man in the foreground sitting on the right?

a) **Blue**
b) Black
c) Grey

Q2 [CENTRAL] MISLEADING: Did you see that the **polo shirt** worn by the man in the foreground sitting on the left had short sleeves?
CONTROL: Did you see that the top worn by the man in the foreground sitting on the left had short sleeves?
TEST: What was the man in the foreground sitting on the left wearing?

a) **T-shirt**
b) Polo shirt
c) Jumper

Q3 [PERIPHERAL] MISLEADING: Did you see that the **four** parasols were square-shaped?
CONTROL: Did you see that the parasols were square-shaped?
TEST: How many parasols were there in the picture?

a) **Three**
b) Four
c) Two

Q4 [PERIPHERAL] MISLEADING: Under the awning in the background on the left, did you see the woman who was sitting next to the man in the **beanie** hat?
CONTROL: Under the awning in the background on the left, did you see the woman who was sitting next to the man?
TEST: The man sitting under the awning in the background on the left wore a hat. What kind of hat was it?

a) **Ball cap**
b) Beanie hat
c) Beret

Appendix H

*The **bold** detail in each misleading post-event question is the misleading detail*

NEGATIVE/HIGH – INJURED PEOPLE

Q1 [CENTRAL] MISLEADING: The injured man sitting on the right was wearing **light-blue** trousers, but did you see that he was topless?
CONTROL: The injured man sitting on the right was wearing trousers, but did you see that he was topless?
TEST: What colour were the trousers worn by the injured man sitting on the right?

a) Beige
b) Light blue

Q2 [CENTRAL] MISLEADING: Concerning the injured woman on the ground in the **striped** blue top, did you see that she was lying on her side propped up on one arm?
CONTROL: Concerning the injured woman on the ground in the blue top, did you see that she was lying on her side propped up on one arm?
TEST: How would you describe the blue top worn by the injured woman on the ground?

a) A plain blue top
b) A striped blue top

Q3 [PERIPHERAL] MISLEADING: In the background, did you see that the **three** multi-headed lamp posts had lantern-shaped heads?
CONTROL: In the background, did you see that the multi-headed lamp posts had lantern-shaped heads?
TEST: How many multi-headed lamp posts were there in the background?

a) Two
b) Three

Q4 [PERIPHERAL] MISLEADING: In the background, immediately to the right of the **blue** advertisement, did you see the man in a suit?
CONTROL: In the background, immediately to the right of the advertisement, did you see the man in a suit?
TEST: What colour was the advertisement in the background?

a) Red
b) Blue

Q5 [CENTRAL] MISLEADING: Did you see that the woman in the **polka dot** dress, who was helping the injured woman on the ground, had brown hair?
CONTROL: Did you see that the woman in the dress, who was helping the injured woman on the ground, had brown hair?
TEST: What pattern was on the dress worn by the woman that was helping the injured woman on the ground?

a) Floral
b) Polka dots

Q6 [CENTRAL] MISLEADING: Whilst the injured man on the right sat **looking towards the camera**, did you see the person in a white shirt next to him?
CONTROL: Did you see the person in a white shirt next to the injured man sitting on the right?
TEST: Where was the injured man sitting on the right looking?

a) Looking at the injured woman on the ground
b) Looking towards the camera

Q7 [PERIPHERAL] MISLEADING: On the building in the background, did you see the square-shaped windows that were near the **three** round windows?
CONTROL: On the building in the background, did you see the square-shaped windows that were near the round windows?
TEST: How many round windows were there on the building in the background?

a) Two
b) Three

Q8 [PERIPHERAL] MISLEADING: In the background, **two people wore a striped shirt**, but did you see that some people in the background were wearing plain shirts?
CONTROL: In the background, did you see that some people were wearing plain shirts?
TEST: Of the people standing in the background, how many wore a striped shirt?

a) One person
b) Two people

Q9 [PERIPHERAL] MAJOR MISLEADING: Behind the injured man sitting on the right, did you see the hedge that had **a large pigeon on it**?
MAJOR CONTROL: Behind the injured man sitting on the right, did you see the hedge?
TEST: Was there a pigeon in the picture?

a) No, there was no pigeon
b) Yes, there was a large pigeon

Q10 [PERIPHERAL] MAJOR MISLEADING: In front of the **ambulance** in the background on the left, did you see the tree?
MAJOR CONTROL: In the background on the left, did you see the tree?
TEST: Was there an ambulance in the background?

a) No, there was no ambulance
b) Yes, there was an ambulance

NEGATIVE/LOW – COUPLE IN A CEMETERY

Q1 [CENTRAL] MISLEADING: Apart from the **pencil** moustache, did you see that the man had no other facial hair?
CONTROL: Apart from the moustache, did you see that the man had no other facial hair?
TEST: How would you describe the man’s moustache?

a) Bushy
b) Pencil

Q2 [CENTRAL] MISLEADING: Near the woman's **dark green** skirt, did you see the flower on the ground?
CONTROL: Near the woman's skirt, did you see the flower on the ground?
TEST: What colour was the woman's skirt?

a) Burgundy
b) Dark green

Q3 [PERIPHERAL] MISLEADING: Did you see that the headstone in the foreground on the right, with **pink** flowers in front, had a curved top?
CONTROL: Did you see that the headstone in the foreground on the right, with flowers in front, had a curved top?
TEST: In front of the headstone in the foreground on the right, what colour were the flowers?

a) Yellow
b) Pink

Q4 [PERIPHERAL] MISLEADING: On the **slanted** headstone in the foreground on the very left, did you see the name plaque?
CONTROL: On the headstone in the foreground on the very left, did you see the name plaque?
TEST: How would you describe the headstone in the foreground on the very left?

a) Upright
b) Slanted

Q5 [CENTRAL] MISLEADING: Did you see that the woman's **brown** top was long-sleeved?
CONTROL: Did you see that the woman's top was long-sleeved?
TEST: What colour was the top worn by the woman?

a) Black
b) Brown

Q6 [CENTRAL] MISLEADING: On the headstone in front of the couple, did you see that the name on the **square** plaque was in black?
CONTROL: On the headstone in front of the couple, did you see that the name on the plaque was in black?
TEST: What shape was the name plaque on the headstone in front of the couple?

a) Rectangle
b) Square

Q7 [PERIPHERAL] MISLEADING: Did you see that the **black** path in the background went right across the picture?
CONTROL: Did you see that the path in the background went right across the picture?
TEST: How would you describe the path in the background?

a) Grey
b) Black

Q8 [PERIPHERAL] MISLEADING: In front of the path in the background on the right, did you see the decoration that was over the **heart-shaped** headstone?
CONTROL: In front of the path in the background on the right, did you see the decoration that was over the headstone?

TEST: What was the shape of the headstone that was directly in front of the path in the background on the right?
a) Round top headstone
b) Heart-shaped headstone

Q9 [PERIPHERAL] MAJOR MISLEADING: Did you see that in the background on the left, **next to where the elderly man stood**, there was a headstone with gifts on the ground?
MAJOR CONTROL: Did you see that in the background on the left, there was a headstone with gifts on the ground?
TEST: Was there a man standing in the background?
a) No, there was no man
b) Yes, there was an elderly man

Q10 [PERIPHERAL] MAJOR MISLEADING: At the top of the picture, near the **two crows**, did you see the sunlight on the ground?
MAJOR CONTROL: At the top of the picture, did you see the sunlight on the ground?
TEST: Were there any crows in the picture?
a) No, there were no crows
b) Yes, there were two crows

NEUTRAL – MEN AT A RESTAURANT

Q1 [CENTRAL] MISLEADING: Paired with his **black** jeans, did you see the formal shoes the man in the foreground sitting on the right was wearing?
CONTROL: Paired with his jeans, did you see the formal shoes the man in the foreground sitting on the right was wearing?
TEST: What colour were the jeans worn by the man in the foreground sitting on the right?
a) Blue
b) Black

Q2 [CENTRAL] MISLEADING: Did you see that the **polo shirt** worn by the man in the foreground sitting on the left had short sleeves?
CONTROL: Did you see that the top worn by the man in the foreground sitting on the left had short sleeves?
TEST: What was the man in the foreground sitting on the left wearing?
a) T-shirt
b) Polo shirt

Q3 [PERIPHERAL] MISLEADING: Did you see that the **four** parasols were square-shaped?
CONTROL: Did you see that the parasols were square-shaped?
TEST: How many parasols were there in the picture?
a) Three
b) Four

Q4 [PERIPHERAL] MISLEADING: Under the awning in the background on the left, did you see the woman who was sitting next to the man in the **beanie** hat?

CONTROL: Under the awning in the background on the left, did you see the woman who was sitting next to the man?
TEST: The man sitting under the awning in the background on the left wore a hat. What kind of hat was it?

a) Ball cap
b) Beanie hat

Q5 [CENTRAL] MISLEADING: The man in the foreground sitting on the left had **light-grey** hair, did you see that he had a short hairstyle?
CONTROL: Did you see that the man in the foreground sitting on the left had a short hairstyle?
TEST: What colour hair did the man sitting in the foreground on the left have?

a) Black
b) Light grey

Q6 [CENTRAL] MISLEADING: Did you see that the man in the foreground sitting on the right had his jacket hanging on the back of his chair instead of wearing it over his **jumper**?
CONTROL: Did you see that the man in the foreground sitting on the right had his jacket hanging on the back of his chair instead of wearing it over his top?
TEST: What top was the man in the foreground sitting on the right wearing?

a) A button shirt
b) A jumper

Q7 [PERIPHERAL] MISLEADING: Did you see that the **black** bin in the far background on the right was fixed to the wall rather than on the floor?
CONTROL: Did you see that the bin in the far background on the right was fixed to the wall rather than on the floor?
TEST: What colour was the bin in the far background on the right?

a) Green
b) Black

Q8 [PERIPHERAL] MISLEADING: To the right of the **white** wall lantern at the top of the picture, did you see the row of windows?
CONTROL: To the right of the wall lantern at the top of the picture, did you see the row of windows?
TEST: What colour was the wall lantern at the top of the picture?

a) Black
b) White

Q9 [PERIPHERAL] MAJOR MISLEADING: On the very right of the picture, **next to the waiter who was carrying plates**, did you see the people sitting at the table?
MAJOR CONTROL: On the very right of the picture, did you see the people sitting at the table?
TEST: Was there a waiter in the picture?

a) No, there was no waiter
b) Yes, the waiter was carrying plates

Q10 [PERIPHERAL] MAJOR MISLEADING: Did you see that the two unoccupied tables on the right, **with the cat resting on the floor in-between**, had pieces of cutlery on them?
MAJOR CONTROL: Did you see that the two unoccupied tables on the right had pieces of cutlery on them?

TEST: Was there a cat in the picture?

a) No, there was no cat
b) Yes, there was a cat