The Impact of Emotional Salience and Scene Duration Exposure on Susceptibility to Misinformation

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Word count: 4325 (excluding the abstract, references, tables, and figure)

Conflict of Interest statement: The authors declare that the research was conducted in the absence of any conflict of interest.

Data availability statement: The data that support the findings of this study are available from the corresponding author upon request.

Funding statement: This research received no external funding.

Ethics Statement: This study was approved by the Ethics Review Committee of City, University of London. Written informed consent was obtained from all participants prior to their involvement in the study.

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Abstract

Accuracy in eyewitness testimony is shaped by factors affecting attention to event details. While research has explored attention's role in memory accuracy, less is known about its effect on the recollection accuracy for emotion events. This study investigates how emotional arousal and scene presentation duration influence susceptibility to misinformation. Participants viewed high-arousing negative, low-arousing negative, and neutral scenes, with either short or long presentation times. Participants then answered questions about the event, which included misleading information, and completed a forced-choice recognition test. Results showed a misinformation effect under both long and short presentation durations for the negative emotional images, but the effect disappeared for the neutral scene presented for a short duration. These findings suggest that negative emotional content is more susceptible to misinformation under limited viewing conditions, potentially highlighting the need for caution when relying on eyewitness accounts of briefly experienced emotional events.

Keywords: Misinformation Paradigm, Presentation Duration, Memory, Emotion, Arousal

Introduction

In eyewitness statements, it is imperative that memory-based accounts are as accurate as possible. Unfortunately, evidence suggests that this is not always the case. Research has shown over the past several decades that memory can be distorted by misleading information. In laboratory-based settings, Loftus and colleagues (e.g., Loftus et al., 1978) demonstrated the impact of misleading information on memory distortions for an originally experienced event. This phenomenon, commonly known as the misinformation effect, has since been replicated in numerous studies across a variety of contexts (for a review, see Loftus, 2005; Frenda et al., 2011). The misinformation effect is typically examined using three-stages. Participants first observe an event, such as a theft or a car accident, followed by exposure to misleading details about the event. Finally, their memory is tested, often through an n-alternative forced-choice recognition task. The misinformation effect is evident if participants exposed to the misleading information are significantly more likely to endorse this information as part of the original event compared to those in a control group.

There is increasing consensus that eyewitness suggestibility errors stem from source misattributions (e.g., Belli & Loftus, 1995; Chambers & Zaragoza, 2001; Zaragoza et al., 2013). The Source Monitoring Framework (SMF; Johnson et al., 1993) suggests that the likelihood of source misattribution errors, where individuals mistakenly attribute information from a post-event source to the originally witnessed event, depends on two main factors. First, the greater the similarity between the characteristics of the event and the post-event information, the more likely individuals are to confuse the two sources. Second, the more people rely on ambiguous or weak memory traces - such as vague, incomplete, or hard-to-evaluate recollections - to judge whether they witnessed something, the greater the chance of misattribution. Therefore, when post-event details are similar to those of the witnessed event, or it becomes difficult to evaluate the memory evidence, errors in source identification become more probable.

Considerable research has focused on understanding the factors that contribute to, or aid in the decrease of, false eyewitness reports (see Loftus, 2005; Zaragoza et al., 2013). For instance, delays between the event and misinformation (Frost et al., 2002) and between misinformation and test (Higham, 1998) typically increase susceptibility to suggestion, so too does perceived source credibility (Pena et al., 2017). In comparison, warnings about potential exposure to misinformation can reduce susceptibility to suggestion (Blank & Launay, 2014) and encouraging source monitoring can help witnesses discriminate between genuine memories and post-event (mis)information (Zaragoza & Lane, 1994).

Research has also attempted to address characteristics that are representative of real-life eyewitness situations (Ihlebaek et al., 2003). In typical misinformation studies, participants encounter conditions that are relatively free of distraction during the encoding of the witnessed event and the events in question are usually low in emotional arousal. Yet, real-world witnesses are typically recalling details of events that are highly stressful and emotionally salient (i.e., events that capture attention and provoke strong feelings, such as fear and sadness), often with multiple competing goals or limited time to attend to key details. Since real-world events can vary in the attentional demands placed on a witness, it is crucial to understand how these demands affect the witness's susceptibility to suggestion.

Research indicates that our ability to encode information depends on the degree to which we attend to it (Cowan, 1988; Muzzio et al., 2009). Dividing attention between the experimental stimuli and a secondary task, restricts the encoding of detailed recollective information, making accurate retrieval more difficult. Findings show that when a weapon is present, witnesses tend to focus on it, diverting attention from other details (Steblay, 1992). However, few studies have explored how divided attention affects suggestibility. In a notable study, Lane (2006) found that participants who divided their attention during a theft sequence were more likely to misattribute post-event misinformation to the original event than those who were able to give their full attention. These findings suggest that divided attention disrupts memory for event details and the necessary source information, thereby making it difficult to distinguish between memories of event details and misleading details.

Further support comes from research showing that inattentional blindness and misinformation negatively impacts eyewitness memory. Inattentional blindness occurs when an individual fails to notice an unexpected event or stimulus that falls outside of their scope of attention (Rivardo et al., 2011). In Rivardo et al.'s (2011) study, participants watched a video of a theft in a shopping mall while either performing a task (e.g., counting shoppers wearing blue) or passively viewing the clip. After reading a narrative containing misinformation, they completed a recall task. Participants who missed the theft (due to inattentional blindness) were less accurate in their memory recall and more likely to remember the misleading details than those who noticed the theft. Similarly, Cullen et al. (2022) had participants watch a video of a physical assault while completing an attention-demanding task (counting the number of swimming laps). Following exposure to misleading information, participants who failed to notice the crime due to inattentional blindness were less accurate in their memory recall, expressed lower confidence in their recollections, and reported more misinformation than those who noticed the crime. These findings suggest that reduced attention during encoding impairs memory accuracy and increases susceptibility to false suggestions.

Real-life witnesses may have limited time to process the event. To this end, research has also examined the impact of reducing the duration of time available to process stimuli. This approach has been employed in research on word recognition (e.g., Clark-Foos & Marsh, 2008), semantic false memory (e.g., Knott et al., 2018), and face-scene recognition

(Green & Naveh-Benjamin, 2023). In Green and Naveh-Benjamin (2023), participants viewed face–scene pairs for varying lengths of time (0.75, 1.5, or 4 seconds) and then categorised them as exact (same face and scene), related (slightly altered but similar), or unrelated (completely different face and scene). Results showed that recognition of exact pairs improved with longer viewing times, while recognition of related pairs stayed strong even at shorter exposures, indicating the resilience of generalised memory. This suggests that while detailed memory benefits from extended exposure, generalised memory can form with less exposure. Fuzzy Trace Theory (Brainerd & Reyna, 2005) offers an explanation: emotionally charged stimuli promote the rapid formation of gist-based memory traces, which capture the meaning or essence of an event but lack detail. When verbatim traces are weak or unavailable, individuals may rely on gist to interpret or recall an event, increasing the likelihood of accepting misinformation that aligns with the general theme (Bookbinder & Brainerd, 2016; Reyna et al., 2021). Thus, emotional arousal may heighten vulnerability to misinformation by encouraging reliance on simplified, yet compelling, memory representations.

Researchers recognise that emotional experiences can be described along two key dimensions: valence and arousal (Bradley et al., 1992). Valence reflects the positivity or negativity of an experience (e.g., happiness as positive, anger as negative), while arousal indicates the level of emotional intensity, ranging from calm (low arousal) to excited (high arousal). Previous research has explored how attentional resources during encoding affects memory for both emotional and neutral stimuli. Clark-Foos and Marsh (2008; see also Kang et al., 2014) investigated the impact of presentation speed on recognition memory, while also varying the emotional salience of words (negative high-arousal, negative low-arousal, and neutral words[1]). They found that negative emotional words were generally better recognised than neutral words, but that negative high-arousing words were better recollected than negative low-arousing words, even under limited attention. While previous research suggested that valence effects require conscious processing and that arousal effects stem from automatic amygdala activation (Kensinger & Corkin, 2004), Clark-Foos and Marsh argued that their findings indicate an automatic component in both arousal and valence effects on memory compared to neutral stimuli. Perhaps, counterintuitively, false memory rates for negative emotional stimuli are also higher than for neutral stimuli under limited attention conditions (Hellenthal et al., 2019; Knott et al., 2018). Knott et al. (2018) argued that reduced presentation duration prevented associative activation for neutral stimuli, but negative emotional stimuli—processed more automatically—still activated associations, leading to greater false recognition. A fuzzy trace explanation further supports these findings. Bookbinder and Brainerd (2016) argued that negative emotional stimuli are more likely to induce gist-based false memories, as emotional arousal activates a generalised memory trace that emphasises the experience's core meaning rather than its precise elements. Given that gist memory is available earlier than verbatim memory, this explanation fits with the findings from limited presentation duration and greater false memory formation for negative emotional over neutral stimuli.

Furthermore, negative emotional events have also been shown to be vulnerable to misinformation. Porter et al. (2003) examined whether the effects of misinformation exposure varied with the emotionality of photographic scenes. They found that participants were twice as likely to be influenced by misinformation for negative images compared to positive or neutral ones. This was further observed even after one week and one month (Porter et al. 2010). Moreover, Van Damme and Smets (2014) found that participants endorsed fewer correct peripheral details and more false peripheral details for negative scenes (both high- and low-arousal) than for positive and neutral scenes, regardless of prior exposure to misinformation. This suggests that negative valence narrows attention. High arousal improved memory for correct central details, and both negative valence and high arousal reduced control participants' tendency to endorse false central details. This indicates that central aspects of negative scenes act as attention magnets and are perceived as most relevant to the viewer's goals (see Laney et al., 2004; Laney et al., 2003). However, this protective effect disappeared when participants were previously exposed to misinformation. More recently, Jobson et al. (2022) adapted the procedure used by Van Damme and Smets onto an online platform to assess emotion and arousal's influence on memory distortions (Study 1). They found that, regardless of prior misinformation exposure, memory for peripheral details was poorer for negative (particularly the high-arousing scene) and neutral scenes than for positive scenes. As for central details, they found that the misinformation effect was similar across all scenes. This contrasts with Van Damme and Smets, where the misinformation effect was significant only for high-arousing or negatively valenced scenes. Differences in findings may be due to methodological variations (e.g., the testing environment, study design, encoding instructions), which is a common issue across research on emotion and misinformation (see Sharma et al., 2023). Nevertheless, much research on emotion and misinformation indicate that negative events may be particularly susceptible to misleading suggestions.

While previous research has explored how negative emotion impacts susceptibility to misinformation and how reduced attention affects memory performance, no study has yet examined whether reduced presentation duration of emotionally salient scenes, compared to neutral scenes, might increase vulnerability to misleading information. Previous studies (e.g., Hellenthal et al., 2019; Knott et al., 2018; Van Damme & Smets, 2014) suggest that negatively high-arousing information is attention-grabbing and more automatically processed than less arousing or valenced stimuli (although see arguments by Clark-Foos & Marsh, 2008). Additionally, emotionally negative stimuli rely more on gist processing for memory formation, which occur more quickly than verbatim processing (Bookbinder & Brainerd, 2016). Taken together, these findings suggest that memory for negative scenes may be more vulnerable to misinformation, even under conditions of reduced scene exposure. The present study aimed to examine how emotional salience (high-arousing negative, low-arousing negative, and neutral scenes) and scene presentation duration (short vs. long exposure) influence susceptibility to misinformation. Using a within-subjects design for scene emotion and a between-subjects manipulation for presentation duration, participants viewed three scenes, followed by a post-event questionnaire that included misleading and control details. Memory was then assessed using a two-alternative forced-choice recognition test. By integrating emotional valence and arousal with attentional constraints, the study sought to investigate whether limited exposure disproportionately affects memory accuracy and susceptibility to suggestion for negatively emotional compared to neutral events.

Method

Participants

A total of 104 participants (*M*age = 24.73, *SD* = 11.51, range = 18–58; 80 females, 21 males, 1 other, 2 undisclosed) took part for course credits or a small fee. An a priori power analysis was conducted using MorePower 6.0 to determine the minimum sample size required to detect a medium-sized interaction effect ($\eta^2 = .06$) with power 0.80, at an alpha level of .05. This estimate was based on a 3-way interaction between scene emotion, critical detail (misled vs control), and presentation duration, which represented the primary interaction of interest. A medium effect size was chosen due to comparable studies examining misinformation and emotional salience having observed medium or larger interaction effects (e.g., Van Damme & Smets, 2014; Jobson et al., 2022; Peace & Constantin, 2015). The power analysis indicated that a sample size of 80 participants would be sufficient. The analysis output is available on Open Science Framework: https://osf.io/rysj4/?view_only=ae687ce9d7cf46b4b10f49d4ed4ea291. We oversampled to allow for exclusions due to failed attention checks and to ensure balanced group sizes across the between-subjects conditions. All participants had English as their first language and had normal or corrected-to-normal vision. Recruitment was conducted through City St George's, University of London's SONA system (N = 78) and Prolific (N = 26)[2].

Design

This study used a 3 (scene emotion: negative high-arousing vs. negative low-arousing vs. neutral) x 2 (detail location: central vs. peripheral) x 2 (critical detail: misled vs. control) x 2 (presentation duration: short vs. long) mixed design, with presentation duration as a between-participants factor. Participants were randomly assigned to either the short (1 second; n = 53) or long (30 seconds; n = 51) presentation duration condition. We chose 30 seconds for the long duration to align with the scene duration used by Van Damme and Smets (2014). For the short presentation speed, we selected one second because (1) it has been used in previous scene recognition research to assess memory performance (e.g., Ahmad et al., 2016; Szolosi et al., 2014), and (2) we deemed it sufficiently fast for participants to still be able to extract the theme of the events, which was crucial for answering questions in later stages. Misinformation was introduced with four critical misleading details and four control details (no misinformation), with half of each focused on central details and half focused on peripheral details. All participants viewed all three scene types, with scene order and detail type (misled vs. control) fully counterbalanced.

Materials

Scene Characteristics

Three images from the International Affective Picture System (IAPS; Lang et al., 2008) were selected: a high-arousal negative assault scene (IAPS: reference 9254, Valence = 2.03, Arousal = 6.04; Pilot: Valence = 1.92, Arousal = 6.77), a low-arousal negative cemetery scene (IAPS: reference 9220, Valence = 2.06, Arousal = 4.00; Pilot: Valence = 2.81, Arousal = 3.92), and a neutral restaurant scene (IAPS: reference 2593, Valence = 5.80, Arousal = 3.42; Pilot: Valence = 5.77, Arousal = 3.46). The scenes were pilot tested (with 30 participants) for scene emotion and detail type. For details on the procedure to identify central and peripheral information in the scenes, see Shah and Knott (2023). To check that the scenes appropriately fit into the intended emotion categories, we used the Self-Assessment Manikin (SAM; Bradley & Lang, 1994) valence and arousal 9-point scales (see below for more details). The neutral and negative scenes differed in valence such that valence was significantly lower for both negative scenes compared to the neutral scene (negative high-arousing – $p < .001$; negative low-arousing – $p < .001$). Arousal was significantly higher for the negative high-arousing scene compared to the negative low-arousing ($p < .001$) and neutral ($p < .001$) scenes, but the neutral and negative low-arousing scenes did not differ in arousal ($p = 1.00$). Using one scene per emotion condition is in line with previous emotion and misinformation research (e.g., Forgas et al., 2005; Peace & Constantin, 2016; Porter et al., 2003; Van Damme & Smets, 2014).

Post-Event Questionnaire

The main purpose of this questionnaire was to introduce misleading information. The questionnaire consisted of eight Yes/No questions per picture, presented individually and in random order. Each scene featured four central and four peripheral critical details, selected from the pilot study (Shah & Knott, 2023). For each critical detail, there was a misleading question (introducing incorrect information) and a control question (neutral phrasing). For example, a misleading question about a woman's top might read, "Did you see that the woman's **brown** top was long-sleeved?" (the top was actually black, and the **bold** detail was omitted in the control question). For each participant, half of the critical details (two central and two peripheral) were misleading, and the remaining details were controls. Overall, the questionnaire contained four misleading questions and four control questions. To counterbalance the combination of detail type and misinformation, two questionnaire versions were created. Misleading details in Version A were control details in Version B, and vice versa. Both versions of the questionnaires are available on Open Science Framework: https://osf.io/rysj4/?view_only=ae687ce9d7cf46b4b10f49d4ed4ea291.

Memory Test

A two-alternative forced-choice test with 12 questions per scene assessed memory for central and peripheral details. Each question was presented individually in random order. 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 suggested to half of the participants (control questions), and four questions probed memory for details not previously suggested to *all* participants (filler questions). For the misleading questions, the two response alternatives were a correct detail and a misleading detail. For example, "What colour was the top worn by the woman?" along with response alternatives a) Black [correct] and b) Brown [misleading/control]. For the filler questions, the two response alternatives were a correct detail and a novel foil. For example, "What was the man in the foreground sitting on the right holding?" along with response options a) Phone [correct] and b) Wallet [novel foil]. For both the control and filler questions, the two response options were a correct detail and a novel foil. The novel foil in the control questions were the misleading options suggested to half of the participants. The recognition test is available on Open Science Framework: https://osf.io/rysj4/?view_only=ae687ce9d7cf46b4b10f49d4ed4ea291.

Mood Ratings

Research indicates that mood (positive or negative) can influence susceptibility to suggestion (e.g., Forgas et al., 2005). To ensure there were no confounding mood effects, we collected participants' mood ratings at the start of the experiment using the SAM valence and arousal scales. SAM is a non-verbal, pictorial tool that uses a 9-point Likert scale to assess emotional responses. It includes one valence and one arousal scale. On the valence scale, lower scores indicate a more negative mood, while higher scores reflect a more positive mood. For the arousal scale, higher scores correspond to greater arousal levels.

Procedure

The study was conducted online, and participants were all tested individually. They 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. After consent, they filled the SAM questionnaire to assess current mood. Depending on their group, they were told that the pictures would appear briefly for one second or for a longer 30-second duration. They were instructed to view each scene as if they unexpectedly witnessed the event. A 2-second fixation cross preceded each scene. The presentation order of the pictures was counterbalanced.

Following picture presentation, there was a 10-minute interval of unrelated tasks (mathematical problems and anagrams). Thereafter, participants completed the post-event questionnaire without being alerted to possible discrepancies between the questions and the scenes. The questionnaire was presented as a 'Perception Questionnaire', and participants were told the following: "*You are now going to answer a series of questions about your perception of the three pictures you saw earlier. For each question, please select Yes or No*". After the post-event stage, there was another 10-minute interval of unrelated tasks (reasoning problems).

All participants then read the instructions for the two-alternative forced-choice recognition test. The recognition test instructions were as follows: "*You will now complete a recognition test for the three pictures you saw at the beginning of the study. Please answer the questions based on your own memory of the pictures. For each question, there will be* ***two*** *alternative answers. Please select the correct answer. If you do not know the answer, please make your best guess. For each chosen answer, you will also indicate your level of confidence in your answer on a 5-point scale (1 = "not at all confident", 5 = "very* *confident").*" In both the post-event questionnaire and recognition test, the order of questions matched the initial scene presentation sequence. Following each recognition question, participants were asked "How confident are you that your answer is correct?" and subsequently provided a rating between 1 (not at all confident and 5 (very confident) as past research indicates misleading information may be endorsed with higher confidence relative to control information (Mahe et al., 2015).

Finally, participants provided demographic information, watched a neutral video clip (to ensure participants leave the study in a neutral/positive mood state due to the negative pictures included in the study), and received a debrief.

The ensure data quality by identifying participants who are not fully engaged, attention checks were included in the experiment. The scene presentation stage had two attention checks. A 'click me' button appeared immediately after the first and the second scenes. Participants had 3 seconds to click on the button. Additionally, one question in the post-event questionnaire asked participants to select 'Yes' to pass this attention check. As 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.

Results

Seven participants were removed from the analyses due to failing attention checks. The final sample consisted of 97 participants (long presentation: 48, short presentation: 49). Independent-sample t-tests were conducted on valence and arousal SAM ratings, with no significant difference in both valence ratings (p = .959) and arousal ratings (p = .617) for participants across long and short presentation duration conditions. Below, two main analyses are reported[3]. False responses to misleading and control questions were analysed using a 3 (scene emotion: negative high-arousing vs. negative low-arousing vs. neutral) x 2 (detail location: central vs. peripheral) x 2 (critical detail: misled vs. control) x 2 (presentation duration: short vs. long) mixed ANOVA, with between subjects on the last factor. Correct responses to filler questions (scene details not previously suggested) were analysed using a 3 (scene emotion: negative high-arousing vs. negative low-arousing vs. neutral) x 2 (detail location: central vs. peripheral) x 2 (presentation duration: short vs. long) mixed ANOVA. Where the assumption of sphericity was violated, the Greenhouse-Geisser correction was reported. Mean and Standard Deviation for the endorsement of critical and correct details can be found in Tables 1 and 2.

Misinformation Effect

Analysis revealed a strong misinformation effect, whereby false recognition was higher for misleading details (M = .51, SE = .02) compared to control details (M = .34, SE = .02), $F(1, 95) = 54.04$, $p < .001$, $\eta_p^2 = .36$. There were no further significant main effects, and no significant interactions associated with detail location (all $ps > .05$). There were however two significant interactions, scene emotion x presentation duration, $F(2, 190) = 4.22$, $p = .016$, $\eta_p^2 = .04$, and a scene emotion x critical detail x presentation duration interaction, $F(2, 190) = 4.50$, $p = .012$, $\eta_p^2 = .05$. The three-way interaction was decomposed by conducting a critical detail x scene emotion repeated-measures ANOVA at each level of presentation duration (see Figure 1). For the short presentation duration condition, there was a significant main effect of critical detail, $F(1, 48) = 29.34$, $p < .001$, $\eta_p^2 = .38$, but not scene emotion, $F(1.73, 83.00) = 2.67$, $p = .083$, $\eta_p^2 = .05$. However, there was a significant interaction effect, $F(2, 96) = 6.81$, $p = .002$, $\eta_p^2 = .12$. Pairwise comparisons with Bonferroni corrections showed that the misinformation effect (false recognition of misleading details vs false recognition of control details) was present for the negative high-arousing scene (p = .010; misled: M = .47, SE = .04, control: M = .34, SE = .04) and the negative low-arousing scene (p < .001; misled: M = .64, SE = .03, control: M = .32, SE = .04), but not the neutral scene (p = .248; misled: M = .44, SE = .04, control: M = .38, SE = .04). In addition, the false recognition rates were highest for misleading details in the negative low-arousing scene compared to the negative high-arousing scene (p = .005) and the neutral scene (p < .001). There were no significant differences in the false recognition of control details across scene emotions (all *ps* > .720). For the long presentation duration condition, there was a significant main effect of scene emotion, $F(2, 94) = 4.12$, $p = .019$, $\eta_p^2 = .08$, and critical detail, $F(1, 47) = 24.89$, p <.001, $\eta_p^2 = .35$, but no interaction effect, $F(2, 94) = .17$, $p = .840$, $\eta_p^2 = .004$. This suggests that the misinformation effect was similar across all scenes, and indeed, Bonferroni-corrected pairwise comparisons revealed a significant misinformation effect in all scene emotions (all *ps* < .016).

Correct Recognition

For the correct responses to details not manipulated in the post-event questionnaire, there was a significant main effect of detail location, $F(1, 95) = 24.10$, $p < .001$, $\eta_p^2 = .20$, whereby correct recognition was higher for central details (M = .57, SE = .02) than for peripheral details, (M = .45, SE = .02), Detail location also significantly interacted with scene emotion, $F(2, 190) = 4.05$, $p = .019$, $\eta_p^2 = .04$. A central-peripheral difference was only found for the negative high-arousing scene (p <.001; central: M = .66, SE = .03, peripheral: M = .44, SE = .03) and the negative low-arousing scene (p = .004; central: M = .56, SE = .04, peripheral: M = .42, SE = .04), but not for the neutral scene (p =.690; central: M = .51, SE = .04, peripheral: M = .50, SE = .04). There was one additional significant presentation duration x scene emotion interaction, $F(2, 190) = 3.45$, $p = .034$, $\eta_p^2 = .04$. Pairwise comparisons with Bonferroni correction revealed only one significant comparison, with correct recognition higher for negative high-arousing scene (M = .57, SE = .03) compared to the negative low-arousing scene (M = .44, SE = .04) during the short presentation condition (p = .024). All other comparisons were not significant (*p*s > .130). There were no further significant main effects or interactions (*p*s > .05).

Discussion

Eyewitness testimony is an important part of criminal investigations and may sometimes be the only evidence available. Therefore, it is crucial to understand the conditions that give rise to false remembering of emotionally negative events. In the present study, we examined the impact of emotional salience, exposure duration, and susceptibility to misinformation in the context of eyewitness memory. We found that while misinformation susceptibility was present for negative scenes at both short and long presentation durations, it only emerged for neutral scenes at the longer duration. Further, there was evidence of differential processing for negative high-arousing scenes compared to negatively low-arousing scenes.

For the negative high-arousing scene, misleading details were falsely recognised at similar rates across both durations. Such a finding is in line with the suggestion that automatic processing (Kensinger & Corkin, 2004) supports the rapid formation of a generalised or "gist" memory trace for emotionally salient negative information. According to fuzzy trace theory, this gist memory emphasises the core theme of an event while sacrificing precise details (Bookbinder & Brainerd, 2016). This quick formation of gist-based memory for the negative high-arousing scene allowed participants to incorporate misleading information that fit with the overarching gist or emotional context into the generalised memory trace, regardless of whether event exposure time was short or long. This, consequently, resulted in misattributing the source of the misinformation to the original event.

The misinformation effect was also present for the negative low-arousing scene with short and long exposure, although unlike the high-arousing scene, the misinformation effect (endorsing misleading details) was greater for the shorter compared to longer duration condition. Although gist memory traces are generally strengthened by negative emotional valence regardless of arousal level (Bookbinder & Brainard, 2016), certain factors may explain this heightened susceptibility in low-arousing scenes. In the context of the specific scenes used in this study, it is possible that high-arousing stimuli prompted more automatic processing that stabilised source attribution across durations, while the low-arousing scene may have required more controlled processing, which was more vulnerable under brief exposure. When controlled processing is disrupted, as in short exposure times, memory for event details and source information deteriorates (Lane, 2006). This vulnerability may lower participants' threshold for accepting misleading information. Our findings align with Kang et al.'s (2014) study, which reported higher false alarms for low-arousing negative stimuli under divided attention, supporting the idea that such scenes promote the incorporation of misleading details into memory.

For the neutral scene, we found the typical misinformation effect for the long duration condition, but now the misinformation effect disappeared for the short duration condition. Compared to the long duration condition, our short duration condition showed similar recognition rates for misleading details, but an increase in false responses to control details. This suggests that divided attention may not limit scene processing as much as a one-second exposure does. The neutral scene lacks emotional salience, resulting in a weaker or absent gist memory. In the absence of a strong gist, participants depend more on verbatim memory (i.e., memory for precise details), which is sensitive to presentation duration. With only brief exposure, participants likely do not encode enough detail to form a substantive memory trace. Consequently, when misinformation is introduced, there is no robust memory trace to misattribute it to, leading to random guessing at test rather than genuine misattribution, as indicated by the high rate of false responses to control details. As such, there is little distinction between errors from misleading details and errors from non-misled details.

Our findings likely support those from Lane (2006). They used a theft scenario in which a person steals money and a calculator—an event that may carry an element of emotional salience. This raises the possibility that emotional content could have contributed to the increased susceptibility to misleading details under divided attention in Lane's study. These findings highlight the need for further investigation into how attention manipulations interact with emotional salience in influencing susceptibility to misinformation, as emotional content may play a greater role than previously recognised in shaping memory under limited attention.

Although we found no differences in misinformation effects for central versus peripheral details, central details (not subject to misinformation) were more accurately recalled than peripheral ones, particularly in negative emotional scenes. This supports the "cue-utilization hypothesis" (Christianson, 1992), which suggests that emotional arousal narrows attention toward central, salient aspects of an event. This narrowing effect acts as a "spotlight," enhancing encoding of key details of the main emotional event while leaving fewer cognitive resources available for peripheral information. In negative emotional scenes, this "attention magnet" effect makes central details more memorable, while peripheral details are encoded less effectively, leading to poorer recognition/recall (Laney et al., 2004).

Caution is needed when attempting to generalise the findings to real-world situations. The study used a single event in each emotion condition, which one could argue may limit the extent to which the findings can be applied to other types of events. Also, we employed static visual scenes. This differs from the experience of witnessing an actual crime, which are dynamic and typically characterised by greater emotional arousal and perceived consequences (Knott & Thorley, 2014). However, Wade et al. (2007) argued that alterations in memory should reflect underlying processes of memory construction, irrespective of the specific circumstances in which they arise. Moreover, research using different stimuli and events have demonstrated the detrimental impact of reduced attention during event encoding on suggestibility (e.g., Cullen et al., 2022; Lane, 2006; Rivardo et al., 2011) and negative events' susceptibility to misinformation (e.g., Hess et al., 2012; Peace & Constantin, 2016; Porter et al., 2003; Van Damme & Smets, 2014). Therefore, overall, it can be reasonably speculated that the misinformation findings may, to some extent, be similar across stimulus types and outside of the laboratory. The use of a forced-choice recognition test may also not reflect real-life memory recall in situations where eyewitnesses are not limited to set response options. However, the validity of using recognition tasks for memory assessment is supported by Howe et al. (2010), who argued that they may approximate real-world autobiographical situations where memory is externally cued - for example, through visual prompts or structured questioning. While the above methodological considerations are noteworthy, they are common in emotion and misinformation research. Replications incorporating more dynamic stimuli, different event types, and recall-based memory assessments would provide important extensions of the current work. Furthermore, while our a priori power analysis justified a sample size sufficient to detect medium-sized interaction effects, the study may have been underpowered to detect smaller effects that could still be theoretically meaningful (e.g., Lane, 2006). This is particularly relevant when interpreting null or marginal effects. Although we oversampled to accommodate exclusions, future research with larger samples and pre-registered analysis plans would help improve replicability.

Eyewitnesses may encounter a criminal event briefly or be preoccupied with other priorities, such as looking for an escape route (Lane, 2006). As a consequence, eyewitnesses may attend to the event details only for a limited time. The findings of the present study have important implications for the reliability of eyewitness testimony. The processing of negatively low-arousing scenes, but not negative high-arousing scenes, appear more susceptible to misleading information under limited attention conditions. This suggests that high arousal may protect against a significant detrimental influence of misleading information on memory reports when the witness has 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 attended to the event. However, misinformation's influence on memory for negative scenes persisted at both short and long presentation durations, further warning legal professionals to be mindful of eyewitness testimony associated with negative events. This is the first study to show the detrimental impact of limited processing time at study on memory for emotionally salient stimuli in the presence of misinformation, and further work is needed to fully understand its potential impact on memory distortion.

References

Ahmad, F. N., Moscovitch, M., & Hockley, W. E. (2016). Effects of varying presentation time on long-term recognition memory for scenes: Verbatim and gist representations. *Memory & Cognition*, *45*, 390-403. doi: 10.3758/s13421-016-0672-1

Belli, R. F., & Loftus, E. F. (1995). The pliability of autobiographical memory: Misinformation and the false memory problem. In D. C. Rubin (Ed.), *Remembering our past* (pp. 157–179). New York, NY: Cambridge University Press.

Blank, H., & Launay, C. (2014). How to protect eyewitness memory against the misinformation effect: A meta-analysis of post- warning studies. *Journal of Applied Research in Memory and Cognition*, *3*(2), 77–88. doi: 10.1037/h0101798

Bookbinder, S. H., & Brainerd, C. J. (2016). Emotion and false memory: The context–content paradox. *Psychological Bulletin*, *142*(12), 1315–1351. doi: 10.1037/bul0000077

Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The self-assessment manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry*, *25*(1), 49–59. doi: 10.1016/0005-7916(94)90063-9

Bradley, M. M., Greenwald, M. K., Petry, M. C., & Lang, P. J. (1992). Remembering pictures: pleasure and arousal in memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *18*(2), 379-390. doi: 10.1037//0278-7393.18.2.379

Brainerd, C. J., & Reyna, V. F. (2005). *The science of false memory*. New York, NY: Oxford University Press

Chambers, K. L. , & Zaragoza, M. S. (2001). Intended and unintended effects of explicit warnings on eyewitness suggestibility: Evidence from source identification tests. *Memory & Cognition*, *29*, 1120–1129. doi: 10.3758/bf03206381

Christianson, S. A. (1992). Emotional stress and eyewitness memory: A critical review. *Psychological Bulletin*, *112*(2), 284–309. doi: 10.1037/0033-2909.112.2.284

Clark-Foos, A., & Marsh, R. L. (2008). Recognition memory for valenced and arousing materials under conditions of divided attention. *Memory*, *16*(5), 530–537. doi: 10.1080/09658210802007493

Cowan, N. (1988). Evolving conceptions of memory storage, selective attention, and their mutual constraints within the human information-processing system. *Psychological Bulletin*, *104*(2), 163-191. doi: 10.1037/0033-2909.104.2.163

Cullen, H. J., Paterson, H. M., & van Golde, C. (2022). Does experiencing inattentional blindness for crime influence eyewitness recall? *Memory*, *30*(2), 206–216. doi:10.1080/09658211.2021.2002906

Forgas, J. P., Laham, S. M., & Vargas, P. T. (2005). Mood effects on eyewitness memory: Affective influences on susceptibility to misinformation. *Journal of Experimental Social Psychology*, *41*(6), 574–588. doi: 10.1016/j.jesp.2004.11.005

Frenda, S. J., Nichols, R. M., & Loftus, E. F. (2011). Current issues and advances in misinformation research. *Current Directions in Psychological Science, 20*(1), 20–23. doi: 10.1177/0963721410396620

Frost, P., Ingraham, M., & Wilson, B. (2002). Why misinformation is more likely to be recognised over time: A source monitoring account. *Memory*, *10*(3), 179-185. doi: 10.1080/09658210143000317

Greene, N. R., & Naveh-Benjamin, M. (2023). The formation of specific and gist associative episodic memory representations during encoding: Effects of rate of presentation. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 49*(7), 1099–1118. doi: 10.1037/xlm0001173

Hellenthal, M. V., Knott, L. M., Howe, M. L., Wilkinson, S., & Shah, D. (2019). The effects of arousal and attention on emotional false memory formation. *Journal of Memory and Language*, *107*, 54-68. doi: 10.1016/j.jml.2019.03.010

Hess, T. M., Popham, L. E., Emery, L., & Elliott, T. (2012). Mood, motivation, and misinformation: Aging and affective state influences on memory. *Aging, Neuropsychology, and Cognition*, *19*(1-2), 13-34. doi: 10.1080/13825585.2011.622740

Higham, P.A. (1998). Believing details known to have been suggested. *British Journal of Psychology. 89*(2)*,* 265–283. doi: 10.1111/j.2044-8295.1998.tb02684.x

Howe, M. L., Candel, I., Otgaar, H., Malone, C., & Wimmer, M. C. (2010). Valence and the development of immediate and long-term false memory illusions. *Memory*, *18*(1), 58–75. doi: 10.1080/09658210903476514

Ihlebaek, C., Love, T., Eilertsen, D. E., & Magnussen, S. (2003). Memory for a staged criminal event witnessed live and on video. *Memory*, *11*(3), 319–327. doi: 10.1080/09658210244000018

Jobson, L., Wade, K. A., Rasor, S., Spearing, E., McEwen, C., & Fahmi, D. (2022). Associations between the misinformation effect, trauma exposure and symptoms of posttraumatic stress disorder and depression. *Memory*, *31*(2), 179–191. doi: 10.1080/09658211.2022.2134422

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological bulletin*, *114*(1), 3-28. doi: 10.1037/0033-2909.114.1.3

Kang, C., Wang, Z., Surina, A., & Lü, W. (2014). Immediate emotion-enhanced memory dependent on arousal and valence: The role of automatic and controlled processing. *Acta Psychologica*, *150*, 153–160. doi: 10.1016/j.actpsy.2014.05.008

Kensinger, E. A., & Corkin, S. (2004). Two routes to emotional memory: Distinct neural processes for valence and arousal. *Proceedings of the National Academy of Sciences*, *101*(9), 3310–3315. doi: 10.1073/pnas.0306408101

Knott, L. M., & Thorley, C. (2014). Mood-congruent false memories persist over time. *Cognition & Emotion*, *28*(5), 903-912. doi: 10.1080/02699931.2013.860016

Knott, L. M., Howe, M. L., Toffalini, E., Shah, D., & Humphreys, L. (2018). The role of attention in immediate emotional false memory enhancement. *Emotion*, *18*(8), 1063-1077. doi: 10.1037/emo0000407

Lane, S. M. (2006). Dividing attention during a witnessed event increases eyewitness suggestibility. *Applied Cognitive Psychology*, *20*(2), 199–212. doi: 10.1002/acp.1177

Laney, C., Campbell, H. V., Heuer, F., & Reisberg, D. (2004). Memory for thematically arousing events. *Memory & Cognition*, *32*(7), 1149–1159. doi: 10.3758/BF03196888

Laney, C., Heuer, F., & Reisberg, D. (2003). Thematically-induced arousal in naturally-occurring emotional memories. *Applied Cognitive Psychology, 17,* 995–1004. doi:10.1002/acp.951.

Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (2008). *International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-8*. University of Florida, Gainesville, FL.

Loftus, E. F. (2005). Planting misinformation in the human mind: A 30- year investigation of the malleability of memory. *Learning & Memory*, *12*(4), 361–366. doi: 10.1101/lm.94705

Loftus, E. F., Miller, D. G., & Burns, H. J. (1978). Semantic integration of verbal information into a visual memory. *Journal of Experimental Psychology: Human Learning and Memory*, *4*(1), 19-31. doi: 10.1037/0278-7393.4.1.19

Mahé, A., Corson, Y., Verrier, N., & Payoux, M. (2015). Misinformation effect and centrality. *European Review of Applied Psychology*, *65*(3), 155–162. doi: 10.1016/j.erap.2015.03.001

Muzzio, I. A., Kentros, C., & Kandel, E. (2009). What is remembered? Role of attention on the encoding and retrieval of hippocampal representations. *The Journal of Physiology, 587*(12), 2837–2854. doi: 10.1113/jphysiol.2009.172445

Peace, K. A., & Constantin, K. M. (2016). Misremembering Events: Emotional Valence, Psychopathic Traits, and the Misinformation Effect. *Journal of Police and Criminal Psychology*, *31*(3), 189–199. doi: 10.1007/s11896-015-9178-1

Pena, M. M., Klemfuss, J. Z., Loftus, E. F., & Mindthoff, A. (2017). The effects of exposure to differing amounts of misinformation and source credibility perception on source monitoring and memory accuracy. *Psychology of Consciousness: Theory, Research, and Practice*, *4*(4), 337-347. doi: 10.1037/cns0000137

Porter, S., Bellhouse, S., McDougall, A., Ten Brinke, L., & Wilson, K. (2010). A prospective investigation of the vulnerability of memory for positive and negative emotional scenes to the misinformation effect. *Canadian Journal of Behavioural Science*, *42*(1), 55–61. doi: 10.1037/a0016652

Porter, S., Spencer, L., & Birt, A. R. (2003). Blinded by emotion? Effect of the emotionality of a scene on susceptibility to false memories. *Canadian Journal of Behavioural Science*, doi: *35*(3), 165–175. doi: 10.1037/h0087198

Reyna, V. F., Broniatowski, D. A., & Edelson, S. M. (2021). Viruses, vaccines, and COVID-19: Explaining and improving risky decision-making. *Journal of Applied Research in Memory and Cognition, 10*(4)*,* 491–509. doi: 10.1016/j.jarmac.2021.08.004

Rivardo, M. G., Brown, K. A., Rodgers, A. D., Maurer, S. V., Camaione, T. C., Minjock, R. M., & Gowen, G. M. (2011). Integrating inattentional blindness and eyewitness memory. *North American Journal of Psychology*, *13*(3), 519–538

Shah, D. & Knott, L. (2023). The Detrimental Effects of Delay on the Endorsement of Misleading Details for Emotionally Salient Events. *Frontiers in Psychology*, *14*, 1212709. doi: 10.3389/fpsyg.2023.1212709

Sharma, P. R., Wade, K. A., & Jobson, L. (2023). A systematic review of the relationship between emotion and susceptibility to misinformation. *Memory*, *31*(1), 1–21. doi: 10.1080/09658211.2022.2120623

Steblay, N. M. (1992). A meta-analytic review of the weapon focus effect. *Law and Human Behavior*, *16*(4), 413-424. doi: 10.1007/BF02352267

Szolosi, A. M., Watson, J. M., & Ruddell, E. J. (2014). The benefits of mystery in nature on attention: Assessing the impacts of presentation duration. *Frontiers in Psychology*, *5*, 1360. doi: 10.3389/fpsyg.2014.01360

Van Damme, I., & Smets, K. (2014). The power of emotion versus the power of suggestion: Memory for emotional events in the misinformation paradigm. *Emotion*, *14*(2), 310–320. doi: 10.1037/a0034629

Wade, K. A., Sharman, S. J., Garry, M., Memon, A., Mazzoni, G., Merckelbach, H., & Loftus, E. F. (2007). False claims about false memory research. *Consciousness and Cognition*, *16*(1), 18–28. doi: 10.1016/j.concog.2006.07.001

Zaragoza, M. S., & Lane, S. M. (1994). Source misattributions and the suggestibility of eyewitness memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*(4)*,* 934–945. doi: 10.1037/ 0278-7393.20.4.934

Zaragoza, M. S., Belli, R. F., & Payment, K. E. (2013). Misinformation effects and the suggestibility of eyewitness memory. In *Do Justice and Let the Sky Fall*: Elizabeth F. Loftus and her Contributions to Science, Law, and Academic Freedom (pp. 35-63). Taylor and Francis. doi: 10.4324/9780203774861

Table 1. *Mean proportions and standard deviation for the false recognition of the misleading and control details as a function of scene emotion, detail location, critical detail, and presentation duration.*

Presentation Duration	Short Presentation				Long Presentation			
Critical Detail	Misled		Control		Misled		Control	
	M	SD	M	SD	M	SD	M	SD
Central Details								
Negative/High-Arousing	.47	.34	.35	.34	.55	.39	.37	.34
Negative/Low-Arousing	.64	.32	.37	.36	.52	.36	.32	.33
Neutral	.39	.34	.38	.36	.41	.34	.25	.29
Peripheral Details								
Negative/High-Arousing	.48	.39	.34	.36	.54	.38	.41	.34
Negative/Low-Arousing	.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.

Table 2. *Mean proportions and standard deviation for the correct recognition of scene details not previously suggested as a function of scene emotion, detail location, and presentation duration.*

Presentation Duration	Short Presentation		Long Presentation	
	M	SD	M	SD
Central Details				
Negative/High-Arousing	.71	.34	.60	.33
Negative/Low-Arousing	.49	.35	.63	.35
Neutral	.61	.37	.42	.33
Peripheral Details				
Negative/High-Arousing	.44	.33	.44	.32
Negative/Low-Arousing	.40	.37	.44	.32
Neutral	.47	.34	.52	.34

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

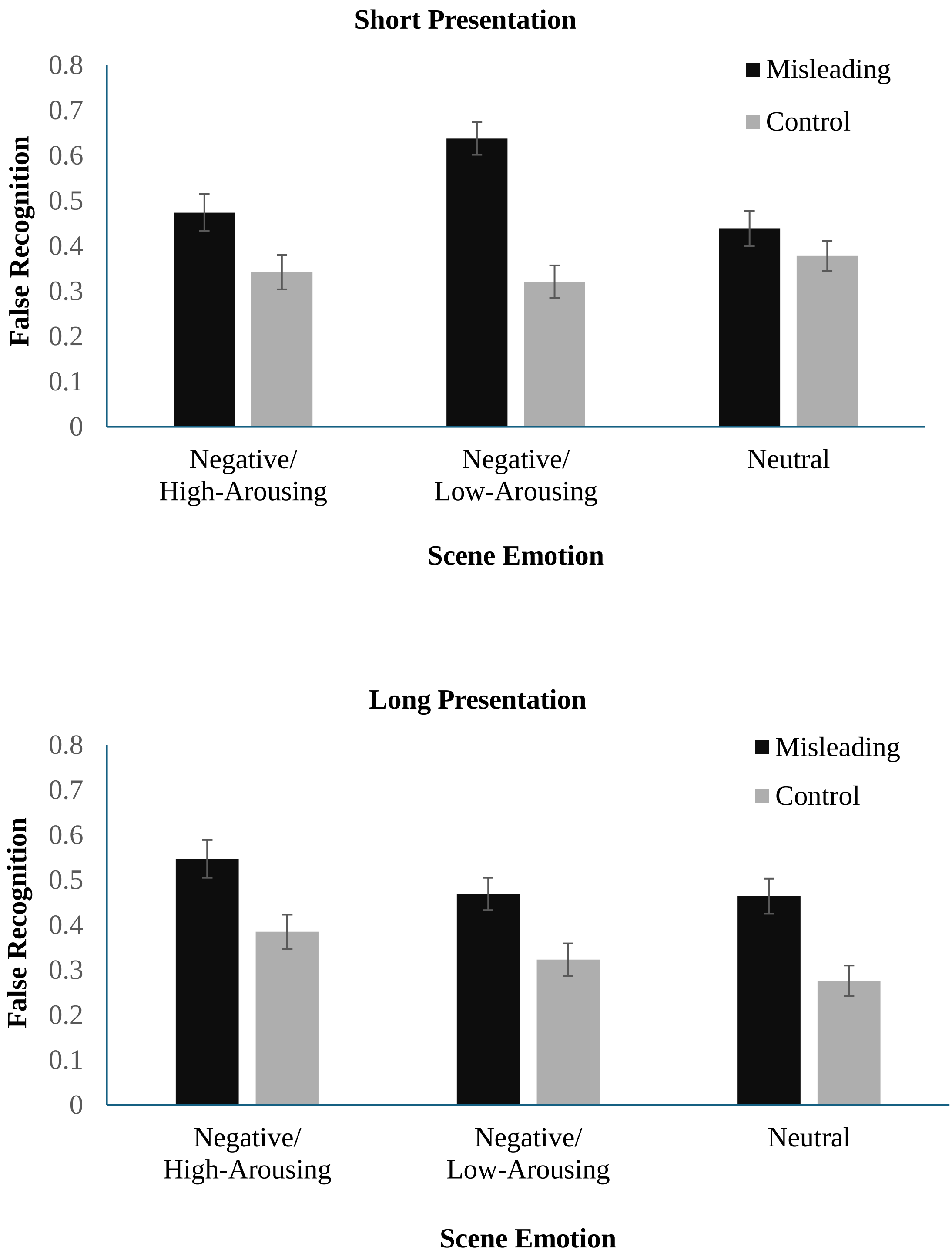

Figure 1. Graphs representing the proportion of false recognition of misleading and control details for each Presentation Duration condition as a function of Scene Emotion and Critical Detail (Error bars represent the standard error).

Footnotes

1. Although Clark-Foos and Marsh (2008) do not provide the experimental words used in their study, examples of words that can fall into the three categories are as follows: negative high-arousing – anger, bomb, danger; negative low-arousing – alone, trash, sad; neutral – cup, chair, paper. These words were taken from Hellenthal et al. (2019).
2. The breakdown of participant demographics across the recruitment platforms were as follows:

   SONA system - Age: $M = 18.79$, $SD = 1.83$, range = 18-32; Gender: 1 male, 74 females, 1 other, 2 undisclosed.

   Prolific - Age: $M = 42.54$, $SD = 9.76$, range = 22-58; Gender: 20 males, 6 females.
3. When analysing confidence ratings, we identified numerous instances of missing data, where participants lacked at least one correct or incorrect response to a specific question type (e.g., a central misleading question for the negative high-arousing picture). Consequently, we computed misinformation resistance scores by integrating recognition responses and confidence ratings to evaluate participants' resilience to misleading information. The results mirrored those obtained in the recognition analysis and are detailed in the supplementary materials, including the calculation methodology.