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The Effects of Context Pre-Exposure and Emotionality on Memory for Context

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Abstract

Individuals vividly remember emotional information (Kensinger, Piguet, Krendl, & Corkin, 2005). However, not all details of an emotional event are remembered accurately to the same extent. Prior research has shown that central details of emotionally arousing events are better remembered than central details of neutral events, while emotionality negatively impacts memory for peripheral details (e.g., Kensinger, Garoff-Eaton, & Schacter, 2007; Kensinger et al., 2005). How emotionality affects the binding of an emotionally arousing event to its spatial context is less clear. Prior findings have demonstrated that the way in which context and item are presented may lead to enhancement and impairment for particular features of an event (Mather, 2007; Mather & Nesmith, 2008; Schmidt, Patnaik, & Kensinger, 2011). Across two experiments, I studied whether pre-exposure to context enhances memory for context and context-item binding when negatively arousing stimuli were presented in neutral contexts. In Experiment 1, pre-exposure to context enhanced context memory for both negatively arousing and neutral stimuli, but it also caused source memory difficulties, reflected in high false alarm rates. In Experiment 2, I attempted to circumvent this source discrimination problem by asking participants to indicate which item was presented with a given context. Now, context pre-exposure significantly enhanced the binding of negatively arousing items to their contexts. These data show that context pre-exposure allows for the encoding of context and the subsequent binding of context and item, and suggest that context-item binding is a relatively automatic process that requires few attentional resources.

Keywords: memory, emotion, context, recognition

The Effects of Context Pre-Exposure and Emotionality on Memory for Context

Until twenty years ago, emotion and cognition were seen as two independent entities. Although cognition and emotion could cause differences in the other such as cognition eliciting an emotional response and emotional processing influencing cognition, they were seen as opposing processes (Kensinger, 2009). Emotions were thought to take over cognition resulting in irrational thought and behavior while cognition diminished the effects of emotional processing. Research has changed the view of emotion and cognition as separable processes. One area of research that focuses specifically on the interconnection between emotion and cognition is memory for emotional events.

Although many factors may contribute to what we remember and forget about particular events, the emotionality of an experience is central to what details are later retained. Emotions affect how much information is later remembered, and it has the potential to vary the quality and variety of details an individual can accurately recall from a past experience (Kensinger & Schacter, 2008). Generally, emotional events are better remembered than everyday experiences. Arousing experiences are assumed to trigger an emotional response that signifies that the event should be encoded and stored (Kensinger & Corkin, 2003). Although emotion has the capability to enhance memory for an event (Levine & Edelstein, 2009), it is not completely understood how emotion affects different aspects of a memory.

Investigations of memory for past real-life emotional events

A line of research that is important for the present experiments is the investigation of the so-called flashbulb memories (Brown & Kulik, 1977). These memories for the conditions under which someone learned about a public traumatic event are often remembered with vivid detail, although the occurrence of the event is often unexpected (Brown & Kulik, 1977). The events are often publicized by the media, and therefore encoded by many individuals, such as the assassination of John F. Kennedy or the September 11th attacks on the Twin Towers. In the original study, Brown and Kulik (1977) found that two features in the accounts written by participants were constant when recalling traumatic public events. First, all written accounts included the circumstances under which the event was first heard. The six central details most remembered by participants included place, ongoing activity, informant, own affect, other affect, and aftermath (Brown & Kulik, 1977). Secondly, participants also included idiosyncratic content such as articles of clothing that were worn while hearing the news. In the original study, over fifty percent of participant accounts reported details that fell within the six prevalent categories of information when asked to recall details of first hearing news of the assassination of John F. Kennedy (Brown & Kulik, 1977). Of importance is that the authors suggest that a high level of surprise and consequentiality underlie the enhanced memory for the six canonical categories of a flashbulb memory.

However, further investigations of flashbulb memories have suggested that recall of the circumstances under which these events occurred is in fact not as enhanced as Brown and Kulik (1977) had first indicated. Talarico and Rubin (2003) suggest that the emotional arousal experienced when one hears about the event causes an increased

subjective confidence. Participants strongly believe that their recall of the occasion is accurate, but when the memory is assessed multiple times, many inconsistencies are revealed. In a study investigating memories of the September 11th attacks on the Twin Towers, participants were more prone to inconsistencies when reporting details of an emotionally arousing than an everyday event occurring in close proximity to the attacks. The authors suggest that overconfidence may lead to the assumption that these particular memories are more accurate. The high confidence of participants' in their accurate recall of surrounding events may be the result of the consistency with which central features of the attacks themselves are retrieved (Talarico & Rubin, 2003).

Similarly, the phenomenon known as the "weapon-focus effect", illustrated that only particular details of an emotionally arousing event are enhanced in memory (Loftus, Loftus, & Messo, 1987). Central details of a negatively arousing event are much better remembered than peripheral details. For instance, a crime witness focuses attention on the weapon of the perpetrator rather than other features of the environment, leading to impaired encoding and memory for surrounding details of the crime (Loftus et al., 1987). In fact, Loftus et al. (1987) found that items appearing in the same slide as the weapon were remembered the least. The ability to correctly recall items presented before the introduction of the weapon was unaffected. Therefore, the results demonstrate an inability to encode and/or bind details of an event that co-occur with the emotionally arousing stimulus.

The motivation for the current experiments was derived from prior research conducted regarding flashbulb memories and the weapon-focus effect. Are participants unable to encode the contextual features of an emotional event due to the attentional

focus on emotionally arousing stimuli? Consequently, does this focus of attention lead to an impaired ability to bind contextual features to the emotionally arousing central components of an event? The memory for a particular event does not only include the "what" but also the "when" and the "where" of its occurrence (Tulving, 1983). Importantly, successful remembering requires the binding of all the details of an event.

Laboratory investigations of memory for emotional events

Studies assessing the effect of emotionality on event memory have indicated two main findings. First, memories involving emotional content are better remembered than memories containing neutral content. Second, peripheral details, such as details not closely related to the central component of a scene, seem to be less well remembered when the scene contains a central emotionally arousing object compared to a neutral object (e.g, Kensinger et al., 2007; Kensinger et al., 2005). Specifically, people show exceptional memory for the central components of an emotional event such as the weapon held by a perpetrator, but details in the periphery such as the color of the perpetrator's shirt are remembered with much poorer quality (e.g., Loftus et al., 1987). These findings illustrate that emotion impairs and enhances certain components of an event. The differences in memory for components of negatively arousing and neutral events become apparent when separately assessing context and object memory. Participants may feel confident in their memory, but when context and object memory for an event are tested separately people demonstrate better memory for negatively arousing central components compared to peripheral details. When the memory is tested for neutral events, central and peripheral components are remembered with equivalent

accuracy. However, studies differ with regard to what is considered a central, and what is considered a peripheral component.

Different paradigms have been developed to study which aspects of emotional memories are remembered. Many use narrative slideshows that switch the presentation of emotional and non-emotional slides (e.g., Loftus et al., 1987; Laney, Campbell, Heuer, & Reisberg, 2004). Others present emotional and non-emotional pictures from standardized databases (e.g, Kensinger, et al., 2007; Kensinger et al., 2005; Mather, Gorlick, & Nesmith, 2009). Those databases, such as the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008) have been developed and proven to evoke a variety of emotional responses in individuals. Depending on the procedure used, central components may range from the gist of a narrative (Laney et al., 2004), an attention-grabbing object within a visual scene (Kensinger et al., 2007), to a feature in spatial or perceptual proximity to an event (Mather & Nesmith, 2008). Peripheral details tend to be defined as details not essential to comprehending the gist of a narrative or scene. For instance, the color of an individual's shirt in a slideshow narrative or items in the background of a visually arousing image may not be integral to the plot. The predominant finding is that central information of an emotional memory is likely to be preserved in memory while peripheral information is less likely to be encoded and therefore not retained (e.g., Levine & Edelstein, 2009).

For instance, Kensinger et al. (2007) presented participants with visually complex scenes depicting a nonemotional background with either a negatively arousing or neutral object. Participants rated each scene as to whether they would approach or move away from it. In a later recognition task participants were more likely to remember negatively

arousing objects than neutral objects. In contrast, backgrounds that had been paired with a negatively arousing object were less likely to be remembered than backgrounds that had been presented with a neutral object. The authors suggest that participants "zoom- in" on the emotional components of a scene leading to better memory for central components. Attention is allocated equally between objects and backgrounds when the stimuli are neutral.

Theoretical explanation of the differential effects of emotionality on different memory components

Many of the current theories specifically focus on the effect of negative arousal on memory because evoking a reaction to negatively arousing stimuli is a much easier task within a laboratory setting (Kensinger, 2009). Although this may be true, emotionality is composed of both valence (positive or negative affect) and arousal (a feeling of excitation or calm) components. Much of the research using emotionally arousing items presented within a neutral context has demonstrated enhanced memory for components of the image that are a central feature of the item and impaired memory for details presented in the periphery of the central component (Levine & Edelstein, 2009). This finding (as well as the above mentioned weapon-focus effect) has been explained with the Easterbrook hypothesis (Easterbrook, 1959; Mather et al., 2009; Kensinger et al., 2007; Kensinger et al., 2005). Easterbrook argued that arousal determines the number of features that an organism can attend to at a given time. Highly arousing stimuli narrow the attention leading to the exclusion of peripheral cues that are also presented (Easterbrook, 1959; Mather et al., 2009). This narrowing of attention allows the

organism to focus on the central components and enhances memory for the event's emotionally arousing details while sacrificing an individual's ability to recall details in the periphery. The attentional focus given to emotional stimuli during encoding leads to enhanced later retrieval of these components in comparison to neutral stimuli (Easterbrook, 1959). Individuals are more apt to attend to stimuli that are of self-importance, such as information central to an emotional stimulus. These central components may consist of spatial features, conceptual meaning, or even temporal occurrence (Levine & Edelstein, 2009).

The object-based framework put forth by Mather (2007) also suggests that emotional items may be vividly remembered by an individual, but the process of binding involves different processes. Emotionally arousing items attract the attention of an individual and increase the binding of within-object features but neglect the between-object binding of an item and contextual details. The ability to remember the associations between particular features of an event relies upon the functioning of the hippocampus and prefrontal cortex. Due to the high levels of stress upon the presentation of a negatively arousing item, hippocampal and prefrontal functioning is disrupted leading to the impaired ability to bind between-object components of an emotional event (Mather, 2007).

In addition, the interplay between the strength of activation in the amygdala and the hippocampus has been shown to affect the consolidation of emotional experiences (Kensinger, 2009). Research on rodents has also demonstrated a neuromodulatory influence of the amygdala on the further consolidation of emotional events in comparison to neutral events (McGaugh, 2004). Through the interaction of stress hormones elicited

during an emotional event, the amygdala further affects the consolidation processes in the memory regions of the medial temporal lobe. It is the processes specific to emotion (e.g., contributions from the amygdala) that further influence hippocampal memory mechanisms (Kensinger, 2007). Specifically, the amygdala plays an important role in determining how threatening a stimulus is when encountered in an environment. The release of adrenal stress hormones is dependent upon mediation by the amygdala that affects memory strength through the activation of adrenergic receptors. Through the process of consolidation, the neurohormonal effect of being presented with a negatively arousing stimulus serves an adaptive function which allows for a slower rate of forgetting. Thus, negatively arousing events have a higher likelihood of being consolidated into a stable memory trace as delay intervals lengthen in comparison to a nonemotional event (Sharot & Phelps, 2004).

Ecological validity and the importance of context

Laboratory investigations provide excellent control over different factors that might influence memory, such as the novelty of the information presented, semantic relatedness, and the visual complexity of stimuli. However, the use of visually shocking stimuli that appear in an unknown context may not easily map onto the emotional events experienced by individuals outside of the laboratory (Laney et al., 2004). In our day-to-day lives, events unfold gradually within a continuously occurring context, but most research on the effects of emotion on memory utilizes a sudden onset of both context and shocking entity. Therefore, the effects of attention narrowing on later memory observed in typical laboratory experiments may not generalize to emotional events that occur in the

real world. Hence, it remains an open question whether memory for context or peripheral details would also be impaired for emotional stimuli if the onsets of context and arousing stimulus were decoupled. The present research attempts to investigate how we process, encode, and retrieve details of emotionally arousing events compared to neutral events when contextual features of the experience are familiar prior to the presentation of both context and emotionally arousing stimulus.

The environment in which an event occurs is an important feature of memory but the sudden onset of an emotionally arousing stimulus may affect the encoding of contextual features due to the narrowing of attention (e.g., Mather et al., 2009; Kensinger et al., 2007). The importance of context familiarity prior to stimulus onset when investigating emotion and memory has also been demonstrated in animal studies (Fanselow, 1990; Matus-Amat, Higgins, Barrientos, & Rudy, 2004). When a rat receives a foot shock in a specific spatial context, the rat will exhibit a freezing response if it is again placed within that environment. However, this effect is dependent upon contextual pre-exposure, i.e., the animal needs time to explore the environment before the foot shock is applied in order to learn the association between the context and the foot shock. If the shock is administered immediately upon placing the rat into the spatial context, the rat is unable to encode the features of the environment where the shock occurs, and the rat will not establish a connection between shock and context, i.e., no conditioning will result (Fanselow, 1990). These findings demonstrate that contextual features need to be encoded beforehand in order to establish an association between the shock and the environmental context. As stated above, human studies on emotional memory commonly do not pre-expose participants to context prior to the onset of context and emotionally

arousing stimulus, which might prevent the binding of the stimulus to the context. At the time of later recall, individuals are unable to recall associations between context and stimulus due to the lack of an opportunity to encode the features of the context before the presentation of an emotionally arousing item. In the current experiments, I test whether pre-exposure to context enhances memory for contextual details (Experiment 1) and allows participants to successfully bind context and item in memory (Experiment 2).

The binding of contextual details and an item has been shown to be an automatic process with neutral stimuli but emotional stimuli may be further dependent upon the formation of a meaningful association between context and item. For instance, Schmidt, Patnaik, & Kensinger (2011) asked participants to view scenes containing a neutral background along with three objects which belonged to the same emotional category. Backgrounds and items were matched so that the items presented could realistically be found in the context portrayed. During the study phase, participants viewed a background which included three emotionally arousing or neutral objects in the scene. For instance, a background depicting a forest scene included a squirrel, chipmunk, and cardinal as a neutral image. A scene of an airport lobby with a policeman, bomb, and a crying woman was used as a negatively arousing image. Participants were instructed to create a short story about the scene that would aid in the retention of the scenes and objects. Afterwards, a cued recall test was administered in which participants had to list the objects that accompanied each background. Under these circumstances, emotional items were remembered better than neutral items. These results demonstrate that if emotionally arousing items are presented within a context where the event could likely happen, people are better able to remember the context-item associations.

For neutral events, the encoding of context and subsequent binding to an item has been demonstrated to be relatively automatic and dependent upon the hippocampus (Hayes, Nadel, & Ryan, 2007). This stands in contrast to a number of findings suggesting impaired encoding of contextual information (i.e., peripheral components) in emotional memories (e.g, Kensinger et al., 2005; Kensinger et al., 2007). Hayes et al. (2007) presented participants with pictures of neutral objects while manipulating the presentation of contextual features accompanying the object. During study, participants viewed an object either in a visually rich realistic setting, or on a white background. In both cases, participants were told to solely focus on the object. During a surprise yes-no recognition test, all objects were presented on a white background. Objects that had been presented on a rich background at study were recognized significantly less than pictures that did not change between study and test. This shows that participants could not intentionally ignore the binding of context and object during the study phase.

Brain correlates of emotional memories

As mentioned previously, memory alterations occurring in the medial temporal lobe as a result of emotional arousal are dependent upon the functioning of the amygdala and the hippocampus. Recent studies have uncovered the important relationship between the amygdala and the hippocampus for the consolidation of emotional memories. For instance, Strange, Hurlemann, and Dolan (2003) instructed participants to learn word lists, each of which contained an emotionally aversive noun among a group of neutral nouns. In a later memory test, neutral words that were presented before an emotionally arousing word were less likely to be remembered, but memory for neutral nouns

following an emotionally arousing word was unaffected. The authors suggest that the release of norepinephrine that occurs when participants are presented with an emotionally aversive word leads to a memory enhancement for the emotional word while impairing memory for the neutral word directly preceding its presentation. Critically, damage to the amygdala or administration of β-adrenergic blockers prior to word list encoding has been shown to deplete the memory-enhancing effects of emotionality (Strange et al., 2003). Thus, these findings have been explained by an enhancement for emotional targets as the result of an adrenergic release mediated by the amygdala. The norepinephrine release at the presentation of an emotional target subsequently impairs the consolidation of the preceding neutral target (Strange et al., 2003).

Additional support for the specific role of the amygdala for encoding and later retrieval of emotional memories comes from studies of patients with amygdala pathology. Individuals diagnosed with Urbach-Wiethe syndrome, a condition in which 50% of patients demonstrate selective bilateral damage to the amygdala do not show the enhanced memory for emotionally arousing words compared to neutral words (LaBar & Cabeza, 2006). As a result of amygdala damage, the orienting of attention to emotionally arousing words is impaired resulting in impaired memory for emotionally arousing words both immediately and after long-term delays (1 hour to 1 month). Healthy adults in the same exact word learning studies show greater advantages for memory of emotionally arousing words compared to neutral words after long (1 hour to 1 day) than after short (immediate) delay intervals. The finding that healthy adults remember emotionally arousing words better than neutral words after an extended period of time suggests that

emotional arousal leads to memory enhancement by facilitating the consolidation process (LaBar & Cabeza, 2006).

As addressed earlier, the neuromodulatory effect of the amydala may further contribute to what components of an emotional event are later bound and consolidated (Kensinger, 2007; LaBar & Cabeza, 2006). Laboratory investigations with humans in which propranolol was administered have shown a reduction in activity of the amygdala (LaBar & Cabeza, 2006). When amygdala activity is reduced by propranolol this leads to a reduced ability to encode emotional stimuli. This reduction in amygdala activity later results in a reduction of hippocampal activity when retrieving the same stimuli. Additionally, the hippocampal memory system plays a crucial role in binding the different components of an event into a coherent episodic memory (Hayes et al., 2007). The hippocampus is not only involved in the retrieval of contextual information, but also facilitates the binding of separate pieces of information together in the neocortex and aids in the further storage of contextual information (Hayes et al., 2007).

Current studies

The current studies investigate whether context pre-exposure will affect the recognition of context when it is later paired with a negatively arousing or neutral item. Familiarity to context prior to item onset may lead to the successful binding of context and item and result in better memory for both contextual features and associated item. The ability to remember contexts in which an emotionally disturbing event was encountered allows organisms to avoid environments that threaten survival. As seen in both studies with humans and animals, when context is not pre-exposed prior to onset of

the item this can result in memory impairment for contextual features of an emotionally arousing event. Alternatively, animal studies with rats have demonstrated that when context is pre-exposed, memory for both central components of an event and contextual features form a bound representation (Fanselow, 1990; Matus-Amat et al., 2004).

Specifically, by allowing extra time for contextual encoding, the current experiments sought to assess whether the impaired context memory for emotional images is due to narrowed attention (i.e., Easterbrook hypothesis) leading to difficulties in maintaining bound representations of emotional events (Mather, 2007), or whether emotionality impairs the storage and retrieval of contextual memory. It is predicted that with contextual pre-exposure, context encoding will suffer less from the attention grabbing quality of the emotionally arousing stimulus. Most importantly, an opportunity to encode context in isolation might allow for the successful binding of context and item memory. This would be evident if an individual is able to immediately recognize the context in which a negatively arousing item was presented. Alternatively, if emotionality only enhances the consolidation of an emotional event, the effects of pre-exposure would only be evident if context recognition improved after a long delay. This would result in the same memory impairment for contextual features when tested immediately as in previous studies even when pre-exposed to context.

Pilot Study

The aim of the pilot study was to obtain valence and arousal ratings for stimuli selected to be used in Experiments 1 and 2. In addition, the pilot study also incorporated a yes/no background recognition task. The recognition task was administered to establish a replication of previous findings for impaired context memory for backgrounds paired

with a negatively arousing item compared to a neutral item (Mather et al., 2009; Kensinger et al., 2005).

Methods

Design and Participants. Nineteen (10 female) undergraduate students at Lehigh University between the ages of 17-21 (M = 18.72, SD = 1.26) participated in the experiment. They received course credit for their participation. The study used a one-factorial design with type of rating as the only independent variable that was manipulated between subjects. Participants were randomly assigned to the valence or arousal rating condition. After rating images on either valence or arousal, subjects underwent an old/new background recognition task.

Materials. Eighty backgrounds, 80 negatively arousing pictures, and 80 neutral pictures were created by modifying images from the International Affective Picture System (IAPS; Lang et al., 1998) and through internet image searches. Backgrounds were comprised of images taken outdoors in rural and urban settings, indoors, underwater, and in desert settings. The negatively arousing and neutral pictures consisted of photos of people, animals, and objects. Images were altered so that the same background could be used with either a negatively arousing or a neutral picture (e.g., a scene of a jungle could be used with a negatively arousing attacking snake or a neutral bird). The negatively arousing and neutral images were isolated from their original backgrounds so that they could be placed into identical contexts using Adobe® Photoshop® CS5 software. The rating scales used were taken from the IAPS Self-Assessment Manikin (SAM) affective rating system (Lang, 1980). Instructions on how to use the SAM scale for arousal ratings stated, “at one extreme of the excited versus calm

scale is when you felt completely stimulated, excited, frenzied, jittery, wide-awake, or aroused. The other end of the scale is when you felt relaxed, calm, sluggish, dull, sleepy, or unaroused." For valence ratings, the SAM scale stated, "at one extreme of the happy versus unhappy scale, you felt happy, pleased, satisfied, contented, or hopeful. The other end of the scale is when you felt completely unhappy, annoyed, unsatisfied, melancholic, despaired, or bored."

Procedure. Participants were presented with an image for 2 seconds and were then prompted to rate on a scale of 1 to 5 the valence (1 = positive, 3 = neutral, 5 = negative) or the arousal (1 = highly arousing, 3 = moderately arousing, 5 = not arousing) of the image. Nine participants were asked to rate the arousal of the presented images after a brief description of the SAM scale presented on the computer. The remaining ten participants rated the valence of the same images.

After a brief distracter task, a computerized old/new recognition test of backgrounds was administered. Each of the 80 backgrounds previously viewed and 80 novel backgrounds were presented in a randomized order for 2 seconds and participants were instructed to indicate whether or not they had previously seen the background or if the context was novel. Prior to the start of the recognition test, the experimenter explained that buttons would appear below the presented backgrounds labeled "old" and "new" on the computer screen. The participants were told to select "old" if they saw the background while completing ratings of valence or arousal, or to select "new" if they had not seen the background during the experiment.

Results and Discussion

Two repeated-measures ANOVAs were conducted to investigate the effect of emotionality (negatively arousing or neutral images) on ratings of valence and arousal. For arousal ratings, a significant main effect of emotionality was found, indicating that negative images (M = 2.61) were judged as significantly more arousing than neutral images, M = 4.38, $F(1,8) = 95.05$, MSE = 14.14, $p < .001$. The results of the repeated measures ANOVA on valence ratings also revealed a significant main effect, $F(1,9) = 200.29$, MSE = 11.04, $p < .001$. Negatively arousing images (M = 4.26) were rated as more negative than neutral images (M = 2.77).

The results from the old/new recognition test during the pilot study were examined to see what effect emotionality had on participants' abilities to discriminate between old and new backgrounds (Figure 1). Accuracy scores for the recognition test were calculated by taking correct responses to old backgrounds (hits) and subtracting incorrect responses to new backgrounds (false alarms). A repeated measures ANOVA with emotionality of image (negatively arousing vs. neutral) as a within-subjects factor revealed a significant effect, $F(1,18) = 38.29$, MSE = .20 $p < .001$. Backgrounds paired with neutral items (M = .45) were recognized better than backgrounds paired with negatively arousing items (M = .31). This replicates previous findings of impaired context memory for negatively arousing images compared to memory for backgrounds paired with a neutral item (e.g., Kensinger, et al., 2007).

The arousal and valence ratings given to images during the pilot study were used to create stimuli sets for both Experiment 1 and 2. Of the 160 negatively arousing and neutral items, 104 were selected for Experiment 1 and 2 based on the following criteria.

Arousal ratings for negative images were stronger, less than 3.73 (*M* = 2.61) on a 5-point scale, than for neutral images which ranged from 3.41 to 4.93 (*M* = 4.38). Negative images had valence ratings greater than 4.02 on a 5-point scale (*M* = 4.26), and neutral images had mean valence ratings ranging from 2.10 to 3.05 *(M* = 2.77).

Experiment 1: The influence of context-pre-exposure on memory for context for neutral and negative events

Previous research has shown that the context and peripheral details of an event are less well remembered when images contain a negatively arousing central element than when they contain a neutral central element (e.g., Mather et al., 2009; Kensinger et al., 2005). Experiment 1 sought to investigate whether prior exposure to the context in which an individual encounters an emotionally arousing event leads to better memory for context in which the emotional stimulus occurred. Familiarization to context offers participants the opportunity to encode contextual details before an attention-grabbing object is presented. It was predicted that participants would demonstrate better context memory for emotionally arousing pictures when context is familiar prior to the study phase than when context and stimulus onset coincide during the study phase. This would indicate that the memory impairment seen in previous research is the result of attention impairment due to the sudden onset of a visually shocking stimulus. In the control condition of non pre-exposure to context, it was hypothesized that contexts paired with negatively arousing items would be less well remembered than contexts paired with neutral items, as shown in previous studies.

Experiment 1 utilized a separate phase in which participants were exposed to contexts that were later paired with neutral and negative central elements. Importantly, the overall duration of context exposure was kept the same for both pre-exposed and non pre-exposed items (see Methods for details).

Methods

Participants. Thirty-two (17 females) Lehigh University undergraduates enrolled in introductory psychology between the ages of 17-21 years (M = 19.13, SD = 1.29) participated in the experiment. In return for participation, students received course credit.

Design and Materials. The experiment used a 2 x 2 within-subjects design. The independent variables were context exposure, either pre-exposed or not pre-exposed, and emotionality of the central item, either negatively arousing or neutral. The dependent variables were the accuracy scores on an old/new recognition task for items and backgrounds. 26 negatively arousing and 26 neutral items were selected from ratings given by participants in the pilot study to be used in the study phase of Experiment 1. Each of the items was paired with a neutral background in the experiment for a total of 52 backgrounds. Of those 104 context-item images, 52 were presented in the study phase (26 paired with a neutral, and 26 paired with a negative item), and 52 were used as novel backgrounds in the recognition task. Across participants, each of the 52 backgrounds that were presented in the study was equally often paired with a negative or neutral item. This was accomplished by creating two stimulus sets, e.g., in Set 1, Background 1 was paired with a neutral item while in Set 2, Background 1 was paired with a negative item. Categories for backgrounds (desert, rural, urban, indoor, and water) were equally distributed among both sets of stimuli. Furthermore, within each set, half of the items

had their corresponding context pre-exposed while the remaining items had a non pre-exposure to context presentation creating four individual sets of stimuli (see Figure 2). Thus, a total of 26 backgrounds were selected for context pre-exposure. An additional 26 backgrounds were also presented during the context pre-exposure phase, but these backgrounds were not presented in the context-item study phase. All of the negatively arousing and neutral items were used in the recognition task along with an additional 52 items (26 negatively arousing and 26 neutral). No background was presented for both a negatively arousing and neutral item during the same session for a participant. The order of negative and neutral images was randomized for each participant.

Procedure. The procedure is depicted in Figure 3. During the pre-exposure phase, participants were presented with 52 backgrounds. Participants were instructed to decide whether the image was taken indoors or outdoors (in order to maintain attention). After a 2-second delay, two buttons appeared below the image labeled "indoor" and "outdoor" while the image remained onscreen. After the participants responded with a mouse click on the button, a 1-second inter-stimulus interval (ISI) was incorporated before the next image was presented. This was repeated until all 52 backgrounds were presented.

Following the pre-exposure phase, the experimenter informed participants that in the next phase of the experiment they would be asked to decide whether they would avoid or approach the image that appeared onscreen. Participants were instructed to choose "avoid" if they would want to walk away from the image presented and "approach" if they would walk towards the image presented. Two buttons appeared below the image after the 2s presentation labeled "approach" and "avoid" while the

image remained onscreen. Participants then viewed a series of 52 context-item images (26 negatively arousing and 26 neutral). Context-item images where context had been previously viewed (i.e., 13 backgrounds now paired with negative and 13 backgrounds now paired with neutral items) were presented for 3 seconds. The non pre-exposure to context images (another 13 negative and 13 neutral items) were viewed for a total of 5 seconds, to ensure that context was presented for the same total duration in both the pre-exposure and the non pre-exposure to context condition. After participants selected whether they would approach or avoid the image presented, a new image was presented after a 1-second ISI. This was repeated until all 52 images had been presented.

All participants completed a 15-minute distracter task of a Sudoku puzzle before proceeding to the recognition task. The recognition test consisted of two blocks, a context recognition phase and an object recognition phase. Context recognition was always administered before object recognition. Context recognition consisted of 104 backgrounds. Fifty-two of the backgrounds had been viewed during the study phase (13 pre-exposed negative, 13 pre-exposed neutral, 13 non pre-exposure to context negative, and 13 non pre-exposure to context neutral. The remaining 52 backgrounds consisted of 26 context images only viewed during the pre-exposure phase and 26 novel contexts. Each context image was presented for 5 seconds, and the participant was prompted afterwards to decide whether the context had been seen during the context-item study phase or was not viewed during this phase. Object recognition consisted of a block of 52 previously studied items (26 negative and 26 neutral) and 52 novel items (26 negative and 26 neutral). During the item recognition task each item was presented for 5 seconds, and participants were instructed to indicate whether the item had been viewed during the

context-item study phase or was new. Two buttons appeared below the image after the 5s presentation labeled “old” and “new” while the image remained onscreen for participants to select an answer before presenting the next context or item image after a 1-second ISI.

Results

Context recognition. Figure 4 shows the hit and false alarm rates of the background recognition test. The hit rates suggest that pre-exposure to context improved context recognition for backgrounds appearing with a negatively arousing item. However, the pattern of false alarms shows that participants often identified pre-exposed backgrounds that had not been part of the study phase as being presented during the context-item study phase. In contrast, false alarm rates for novel backgrounds only presented during the context recognition task and not during the context-item study phase were much lower. In order to account for hit and false alarm rates simultaneously in the statistical analysis, accuracy scores were calculated by subtracting the number of false alarms from hits (see Figure 5). Specifically, for backgrounds that were pre-exposed, scores were calculated by subtracting the number of positive responses (false alarms) to pre-exposed backgrounds that had not been presented during the context-item phase from correct responses (hits) to pre-exposed backgrounds that were paired with an item. Accuracy scores for backgrounds with non pre-exposure to context were calculated by subtracting the number of incorrect responses to novel backgrounds from correct responses to non pre-exposed backgrounds. Therefore, analysis of the data using corrected scores resulted in better context recognition for neutral context-item images.

A 2(context exposure: pre-expose vs. non pre-exposure to context) x 2(emotion: negatively arousing vs. neutral) repeated measures ANOVA was conducted on the

accuracy scores for background recognition. This ANOVA using corrected scores from the background recognition task showed that the main effect of context exposure was significant, $F(1,31) = 12.64$, $MSE = .52$, $p = .001$): non pre-exposure to context ($M = .41$) resulted in better context recognition accuracy than pre-exposure to context ($M = .29$). In addition, the ANOVA revealed a significant main effect of emotionality, $F(1,31) = 36.74$, $MSE = .76$, $p < .001$. Recognition performance for backgrounds paired with neutral items ($M = .43$) was better than for backgrounds paired with negatively arousing items ($M = .27$). A significant interaction between context exposure and emotionality was also revealed, $F(1,31) = 5.81$, $MSE = .11$, $p = .02$. For pre-exposed items context was better recognized for neutral items ($M = .33$) than for negative items ($M = .24$; $F(1,31) = 7.75$, $MSE = .15$, $p = .01$). For backgrounds with a non pre-exposure to context, backgrounds paired with a neutral item ($M = .52$) were more accurately recognized than backgrounds paired with a negatively arousing item ($M = .31$; $F(1,31) = 36.07$, $MSE = .72$, $p < .001$). Mode of presentation did not make a difference for negative items $F(1,31) = 2.75$, $MSE = .08$, $p = .11$; context pre-exposure: $M = .24$, non pre-exposure to context: $M = .31$. In contrast, mode of presentation affected background recognition for neutral items ($F(1,31) = 17.63$, $MSE = .55$, $p < .001$) with non pre-exposure to context leading to better recognition ($M = .52$) than pre-exposed backgrounds ($M = .33$). Overall, the context recognition results indicate that participants were better able to recognize the context of a neutral image in comparison to a negatively arousing image regardless of context presentation.

Item recognition. An analysis was conducted to investigate whether my study replicates previous findings of improved item memory for negatively arousing central

items in comparison to neutral central items. A 2(context exposure: pre-expose vs. non pre-exposure to context; within) x 2(emotion: negatively arousing vs. neutral; within) repeated measures ANOVA was conducted on the accuracy scores for object recognition. Accuracy scores were calculated by subtracting the number of false alarms from hits (Figure 6). No significant differences were found for negatively arousing and neutral items ($F < 1$). Participants were able to accurately recognize whether objects were seen during the approach-avoid phase or were completely new regardless of emotionality (negative or neutral) and exposure (non pre-exposure to context or pre-exposed), with recognition accuracy at ceiling ($M > .90$).

Discussion

The current experiment investigated whether pre-exposure to context improves context memory for negatively arousing events. When considering the hit rates in the background recognition test, it is clear that the manipulation was successful to some degree: Hit rates for pre-exposed contexts far exceeded hit rates for contexts that were not pre-exposed, suggesting that my manipulation was successful. However, a more nuanced picture presents itself when additionally considering the false alarm rates and accuracy scores. Here, a disadvantage for the pre-exposed items is revealed: false alarm rates are higher for pre-exposed than for non-pre-exposed contexts, and accordingly, accuracy scores are also lower for the former. I suspect that this is due to the specific study design and assessment of background memory. Specifically, in the recognition test participants were asked to identify backgrounds that had been paired with an item during the study phase. In the non pre-exposure to context condition, participants had to simply discriminate between previously seen and new backgrounds. In contrast, in the pre-

exposure conditions, participants had to additionally discriminate at what phase of the experiment a background was viewed before indicating whether the background was old or new. This makes the task a rather difficult source discrimination task, which cannot be readily compared to the non pre-exposure to context condition. Indeed, participants' low false alarm rates for novel backgrounds in the non pre-exposure to context condition but high false alarm rates in the pre-exposure condition signify that the two tasks were not comparable in their demands. Further investigation of the source discrimination difficulties should clarify if participants were unable to identify at what phase a particular background was presented. This could be done by giving participants clearer instructions that fully explain the response alternatives of 'old' and 'new' in the recognition task. Instructing participants that a response of 'old' should only be chosen if the background was paired with a negatively arousing or neutral item during the context-item study phase may enable participants to discriminate between backgrounds presented in the pre-exposure phase versus the study phase. Another possible change to the context recognition task would be to provide participants with more than two response alternatives, and instead, allow them to choose between 'pre-exposure only', 'context-item study phase' and 'new'. To summarize, participants benefited from the pre-exposure to context phase, but it was difficult for participants to differentiate between backgrounds that had only been viewed during the pre-exposure phase and backgrounds that had been presented during both the pre-exposure and the study phase.

The current experiment replicated previous findings of better background memory for neutral in comparison to negatively arousing images (e.g., Kensinger et al., 2007). Contrary to my hypothesis, this also occurred for pre-exposed backgrounds. This shows

that pre-exposure does not fully alleviate the memory-impairing effects of negative emotionality.

Unlike prior findings, object recognition in the current experiment does not indicate that participants were able to more correctly identify whether an item was old or new depending on emotionality. A possible explanation for this difference may be dependent upon the number of items presented during the study phase and the duration of item presentation. Although previous studies have utilized a similar number of backgrounds during the study phase, presentation rates for context-item images ranged from 1.5 to 2 seconds and the number of items presented with each background also ranged from one to three central items (e.g., Kensinger, et al., 2007; Schmidt et al., 2011). Ceiling effects for object recognition in the current experiment may be a result of presenting context-item images for a total of 5 seconds while only presenting one central item with each background. Thus, object recognition may have been too easy. Therefore, the aim of Experiment 2 was to investigate the combined memory of contextual information to a negatively arousing or neutral item by utilizing a recognition task that assessed participants' binding of context and item.

Experiment 2: Contextual pre-exposure and context-item binding

The aim of Experiment 2 was to investigate the role of context pre-exposure for the binding of emotional items to context in contrast to separate memory assessments of context and item recognition as conducted in Experiment 1. In Experiment 2 the same pre-exposure and study phase were used as Experiment 1, but a new recognition task was administered to examine participants' ability to bind contexts and items. Experiment 2

specifically investigated how well participants bound the contexts to negatively arousing versus neutral items when pre-exposed to context. By not only assessing context memory, but by presenting a selection of items among which the participant has to select the one that was paired with the context during the study phase, Experiment 2 specifically assesses the accurate binding of context and item. Only old contexts from the context-item study phase were presented during the recognition task of Experiment 2. Therefore the recognition task solely assessed the binding of context and item while eliminating any difficulties in source discrimination. It was hypothesized that with context pre-exposure, participants would be able to encode context prior to the onset of a negatively arousing item. Thus, the attention allocation given to an emotionally arousing item would not fully impair memory for context when paired with a negatively arousing item. It was predicted that context-item recognition would be improved for negatively arousing images when context was pre-exposed. For non pre-exposed contexts, it was predicted that the deficit for negative items would be replicated, because the central components of the image should be encoded with relatively little regard to context. Moreover, no differences were predicted for neutral items as a function of context pre-exposure.

Methods

Participants. Thirty-nine (26 female) Lehigh University undergraduates between the ages of 18-23 years (M = 19.38, SD = 1.25) enrolled in introductory psychology participated in the experiment. Five participants were excluded from analyses due to failure to follow the instructions leaving a final sample of 34 participants. In return for participation, students received course credit.

Materials. The same stimuli used in the pre-exposure and study phase in Experiment 1 were also used for Experiment 2. The context-item recognition task used the same 52 backgrounds, 26 negatively arousing, and 26 neutral items presented to the participant during the study phase. In addition, 52 novel items (26 negatively arousing and 26 neutral) were also presented in the context-item recognition task. Each background during the study phase was paired with both a negatively arousing and neutral item, but each participant only viewed either the negatively arousing or neutral image. Within the 52 context-item images, 26 images had context pre-exposed, and 26 images had no pre-exposure to context.

Design. The experiment used a 2 x 2 within-subjects design. The independent variables were context exposure, either pre-exposed or not pre-exposed, and emotionality of the context-item image, either negatively arousing or neutral. Responses by participants on a context-item recognition task were recorded. Each background was presented with three items. One item was the correct context-item match, another was an item seen during the study phase but matched with another context image, and the third was a novel item not seen in the study phase

Procedure. Experiment 2 followed the same procedure as Experiment 1 with the exception of the administration of a context-item recognition task instead of 2 separate blocks of background and object recognition as in Experiment 1 (for design and procedure, see Figure 7). The context-item recognition task employed the 52 backgrounds from the study phase. Each background was presented along with three items. Participants were instructed to select the item that was paired with the presented background during the study phase. All items shared the same emotionality as the correct

context-item pair (negatively arousing or neutral). Novel items were presented once throughout the context-item recognition task while items viewed during the study phase were presented twice (one time with the correct context match and one time with the incorrect context match). Items were counterbalanced so that distracter items matched the item of the correct context-item pair (e.g., animals, objects, or people).

Results

Two accuracy scores were calculated. One score was calculated as the difference between the number of correctly chosen targets and the number of incorrect targets, including both items from the study phase that had been paired with a different context and new items. Another score was calculated as the difference between the number of correct targets and the number of incorrect targets excluding new items (see Figure 8). Since participants chose new targets very infrequently, both calculations led to the same results. Therefore only the analysis of the scores that calculated the difference between correctly chosen and incorrectly chosen targets are reported in detail. A 2(emotion: negatively arousing vs. neutral; within) x 2(context exposure: pre-exposure vs. non pre-exposure to context; within) ANOVA was conducted on the accuracy of context-item matches in the intact pair recognition task. The ANOVA revealed a significant main effect of context exposure, ($F(1,33) = 35.81$, $MSE = .66$, $p < .001$), as pre-exposure to context ($M = .91$) resulted in better context-item recognition than non pre-exposure to context ($M = .85$). In addition, the ANOVA revealed a significant main effect of emotionality, $F(1,33) = 7.94$, $MSE = .10$, $p = .01$. Recognition of context-item pairs was better for neutral ($M = .95$) than for negatively arousing items ($M = .81$). A significant interaction between context exposure and emotionality was also obtained, $F(1,33) = 9.93$,

MSE = .20, $p = .003$. For pre-exposed and non pre-exposed backgrounds, neutral items were recognized better than negative items [pre-exposed: $F(1,33) = 4.61$, *MSE* = .07, $p = .04$; non pre-exposed: $F(1,33) = 10.60$, *MSE* = .28, $p < .003$]. For negative items, pre-exposure resulted in better memory (*M* = .88) than non pre-exposure (*M* = .75; $F(1,33) = 33.75$, *MSE* = .79, $p < .001$), whereas there was no significant effect of presentation for neutral items, $F(1,33) = 1.70$, $p = .201$. Taken together, the interaction of context exposure and emotionality demonstrates that pre-exposure to context aids in the binding of context and negatively arousing item. Pre-exposure to context allows participants to become familiar with a particular background that subsequently enhances the binding of context and item.

Discussion

Experiment 2 tested whether contextual pre-exposure would enhance the accuracy of binding emotional items to context compared to contexts presented with an emotional item but without any prior exposure to context. Accuracy scores in the non pre-exposed condition align with previous findings that neutral item-context pairings are remembered better than negatively arousing item-context pairings. However, as reflected in the significant interaction between pre-exposure and emotionality, this difference was much smaller in the pre-exposure than the non pre-exposure condition. As in Experiment 1, negative emotionality effects were not fully eliminated by pre-exposing participants to the contexts. Prior research regarding the binding of central items to contextual details suggests that binding is dependent upon the formation of meaningful associations between the two components of the event (Novak & Mather, 2009). They suggest that meaningful associations between negatively arousing items and contextual details are

usually not established without explicit instruction to form them. The present experiment tested whether this binding is indeed dependent upon the deliberate formation of meaningful associations, or whether it can be established rather unintentionally by exposing participants to the backgrounds before negatively arousing items are placed onto these backgrounds. The most important result from Experiment 2 is that while pre-exposure to context had no effect on neutral images, it significantly enhanced memory for context-item pairs for negatively arousing images. Viewing the context in isolation allowed participants to effectively encode context before attentional focus was placed on the item presented. This was sufficient to form a bound representation between context and item when presented together during the context-item study phase. Having participants encode context prior to the presentation of a negatively arousing item allowed for the familiarization of contextual features which allowed for the binding of context and item. This suggests that when context is pre-encoded, the binding of context and item requires relatively little attention.

In contrast to previous studies where context and item are presented together with no prior familiarization with context (e.g., Kensinger et al., 2007), context memory for negatively arousing images resulted in below chance accuracy while context memory for neutral images was above chance. Context memory for negatively arousing items only exceeded chance performance when participants, prior to the presentation of context-item images, were instructed that they would later need to describe the images to an artist (Kensinger et al., 2007). In my experiment, some binding of context and negative item even occurred without context pre-exposure, although to a lesser extent than for pre-exposed context-negative item images. Thus, the accuracy scores for context-item

binding of non pre-exposure to context items demonstrates that the binding of context and item is not completely impaired but that it is more difficult when context is not familiar. Unlike previous research, incorporating a context pre-exposure phase prior to the context-item study phase may have made participants implicitly aware of the importance of context in the current experiment. During the context-item study phase participants were aware that the presentation of the item was important but that the context in which it was presented was also of significance. Thus, the binding of context and item is not an all-or-none process, but pre-exposure to context significantly improves binding for negative items.

General Discussion

The present experiments sought to investigate how pre-exposure to context before the onset of a negatively arousing item would affect how memory of the experience is encoded and later retrieved. In particular, it was hypothesized that prior exposure to the context in which an emotionally arousing event was to occur would affect memory for context. The binding of context and item was also hypothesized to benefit from contextual pre-exposure. Experiment 1 shows that context memory is enhanced by pre-exposure, but the results are limited in interpretation due to the different types of false alarms committed by participants depending on whether the item was pre-exposed or not. Discrimination of backgrounds posed a much harder task for pre-exposure backgrounds than novel backgrounds during the recognition task. It cannot be ruled out that participants were merely recognizing backgrounds previously seen from novel backgrounds instead of correctly identifying whether a background was viewed during

the pre-exposure phase or the study phase. Possible changes to the methodology and design of Experiment 1, such as changes to the responses available for participants to choose, so that participants fully understand task instructions may help to further clarify these results. Instructing participants to recall at what specific phase of the experiment a background was presented would allow further insight into whether participants remember viewing a particular background solely from the pre-exposure phase or from both the pre-exposure and context-item study phase. Allowing for this specific source discrimination would enable an accurate assessment of context memory for pre-exposed, pre-exposed and context-item paired, and novel backgrounds.

Results from Experiment 2 replicate previous findings of impaired item-context binding for negatively arousing images when both contexts and items are novel. Importantly, Experiment 2 shows that context-item memory is enhanced when participants are familiarized with the context before a negatively arousing item is paired with it. Thus, by utilizing a procedure where context and item occurrence were uncoupled, memory for both central and peripheral components of an event was retained, and most importantly, bound together. Findings from Experiment 2 confirmed that context pre-exposure aids in the retention of contextual features by allowing the binding of context and item. Even when the corresponding item was negatively arousing, contextual pre-exposure allowed for the encoding of contextual features before the onset of a visually arousing item. Results from the non pre-exposure condition indicate that disruptions at the time of encoding lead to the decreased ability to recognize contexts presented with an emotionally arousing item in comparison to neutral context-item images. By altering the onset of context and item, the present experiments demonstrated

that when context is familiarized individuals are able to bind this information to a negative event.

To remember the occurrence of an event accurately, one must be able to bind features of the event and to create a bound representation in memory. For example, in order to correctly recall an event such as a shooting one must be able to remember features of the weapon, the individual holding it, and the surroundings of the shooting. As demonstrated in prior research when an individual is asked to recall details of the event, memory for peripheral details is impaired while memory for the weapon and perpetrator is enhanced (Loftus et al., 1987). What is not considered is the familiarity of the context to the individual. In contrast, research on flashbulb memories has demonstrated that location is an important component often remembered when asked to recall the circumstances under which an individual first heard about an emotionally arousing event (Brown & Kulik, 1977). Thus, memory for context is effectively encoded when it bears some significance to the participant such as the occurrence of emotionally arousing events in real life or as demonstrated in the current experiments, when attention is drawn to context prior to the onset of an emotionally arousing item. In addition, the object-based framework put forth by Mather (2007) suggests that emotional arousal enhances perceptual processing which in turn enhances the binding of features that are associated with the item. Findings from both of these studies demonstrate that associations between features of an event and subsequent binding is dependent not only on the emotional arousal experienced but it is also influenced by factors such as prior knowledge and attentional demands.

The current experiments used a specific type of emotional events, thus another point worth investigating is how other types of emotional events are encoded. The current experiments specifically utilized negatively arousing and neutral items, but prior research has suggested that variations in valence and arousal result in dissimilar findings (eg., Kensinger, Garoff-Eaton, & Schacter, 2007a; Kensinger, 2008). Specifically, items that are positively arousing are often remembered better than negatively arousing items (Schmidt et al., 2011). The enhanced item memory when the item is of positive emotionality may reflect differences in the processing of items due to emotionality. It has also been shown that positive emotionality enhances memory for the gist-like characteristics of an experience that are subsequently related to an increased feeling of familiarity with the event (Levine & Bluck, 2004). The induction of positive emotions when presented with an image promotes the use of relational knowledge leading individuals to remember the broad relations of an event rather than specific details (Levine & Edelstein, 2009).

Further studies will be required to explore how emotionality specifically affects the process of consolidation for context and item memories and for the bound memories of context and item. The current experiments assessed the accuracy of context and item memory shortly after the images were first presented. It was possible to explore how pre-exposure affected the encoding of backgrounds and background/item binding in the present experiments, but different results may be found when a delay is inserted between the study phase and the recognition tasks. It has been shown that people demonstrate emotion-induced impairment or enhancement depending on when a recognition test is administered (immediately or with a delay of one week, Knight & Mather, 2009). In a

previous study, Knight and Mather (2009) presented participants with lists of six neutral photographs or computer-generated images of everyday items (e.g., a picture of a real brush or a computer generated brush). Additionally, one more item, either an emotional (e.g. an emotionally arousing photo of people taken from the IAPS) or a neutral (e.g., a picture depicting people performing an everyday activity) "oddball" was incorporated into each list. Participants either took an immediate or a one-week delayed recognition test in which pairs of similar images were shown (e.g., both images were of spoons) and they had to indicate whether one of the items was exactly what was presented during the study phase ("old") or if neither of the items was seen during the study phase ("new"). In the immediate recognition test participants had better memory for items presented with a neutral "oddball" as compared to items presented with an emotional "oddball." The moderately short duration of the impairment for items presented with an emotionally arousing stimulus in both studies suggests that emotion may impair immediate retrieval through prioritizing attention to threatening components of a scene. In contrast, in the one-week delay recognition test participants showed the reverse in that recognition scores were higher for items presented with an emotional "oddball" than items presented with a neutral "oddball." The authors suggest that participants were able to encode both the emotional "oddball" and the items appearing in the set, but that only through further consolidation does memory become enhanced for items appearing with an emotional "oddball" (Knight & Mather, 2009). With the incorporation of an emotionally arousing "oddball," the association of the items presented within the set along with the emotional "oddball" was strengthened through further consolidation and rehearsal. The arousal-modulated storage of an emotional memory could suggest that the interplay between the

amygdala and hippocampus only benefits memory for central and peripheral details after a delay. The authors suggest that this result is the outcome of the rehearsal of items and high focus of attention on all items in the set due to the presentation of an emotionally arousing item. The process of consolidation leads to a memory enhancement for the entire set of photographs presented rather than solely the emotionally arousing "oddball."

The evidence from Knight and Mather (2009) suggests that emotional arousal differentially affects what can be retrieved immediately after a study phase and after a longer delay. Items appearing with an emotionally arousing stimulus due to the high level of activation at encoding were encoded and later remembered better than items appearing with a neutral photograph. By incorporating a delay into the current experiments, the results of a context-item pair recognition task may demonstrate that context pre-exposure further enhances context-item binding specifically for negatively arousing images in comparison to neutral images. Pre-exposure to context along with the presentation of a negative item may lead to a higher level of activation and encoding of both context and item with results only being evident after a delay. Improved context-item recognition for negative images would indicate that the emotional arousal of the item enhances memory for both the item and the context in which it was presented.

Questions have been raised as to what exactly is being investigated in studies that use visually arousing stimuli to represent emotionally arousing events within the laboratory. Previous findings may not fully apply to how emotional events are experienced and remembered and might be rather atypical and specific to visually appalling or gruesome stimuli. When participants are presented with an event that incorporates a visually striking target, only then do findings suggest that attention

narrowing impairs memory for items appearing in the periphery. The current experiments incorporated a phase in which participants were familiarized with context prior to the onset of a visually arousing or neutral item. My findings align with studies looking at the influence of prior knowledge on the ability to encode contextual details of an episodic memory (DeWitt, Knight, Hicks, & Ball, 2012). The authors suggest that if knowledge already exists about a to-be remembered item this allows for a fast and efficient encoding process that directs attentional focus towards episodic details that have yet to be encoded (DeWitt et al., 2012). Therefore, highly similar items are able to be distinguished because focus of attention can be directed towards discriminating distinct details of the specific item. The dependence on prior knowledge allows for the construction of relationships between items and details.

The present experiments provide evidence that the use of pre-exposure to context affects not only the process of encoding but the binding of features presented within an image. Participants were able to bind context and a negatively arousing item with better accuracy when pre-exposed to context in comparison to non pre-exposure to context presentation. These findings further extend previous studies while also demonstrating that results from previous studies cannot be generalized to contexts that are familiar to participants. Thus, familiarizing participants to contexts before the onset of an item identified an important boundary condition to prior investigations (e.g., Kensinger et al., 2007; Kensinger et al., 2005). Although attentional focus was not manipulated in the current experiments, the administration of a pre-exposure phase allowed for an enhancement in the binding of context and item. Findings from the current experiments demonstrate that context familiarity affects what aspects of an emotional event are

initially encoded and later remembered. In Experiment 2, results demonstrate that binding requires less attentional resources when participants are first familiarized with context. This shows that other conditions than requiring participants to form meaningful relations between context and item (Schmidt et al., 2011) can improve memory for contextual details for emotional events. Familiarization to context in the present experiment was sufficient in enhancing context-item binding. This aligns well with studies in the animal domain, which have demonstrated that contextual fear conditioning in rats is dependent on rats' encoding of context before the foot shock is administered (Fanselow, 1990; Matus-Amat, Higgins, Barrientos, & Rudy, 2004). The present results emphasize that pre-exposure to context and the subsequent familiarity with these details allows for the enhanced binding of context and item even when the item may draw attentional focus due to its emotionality.

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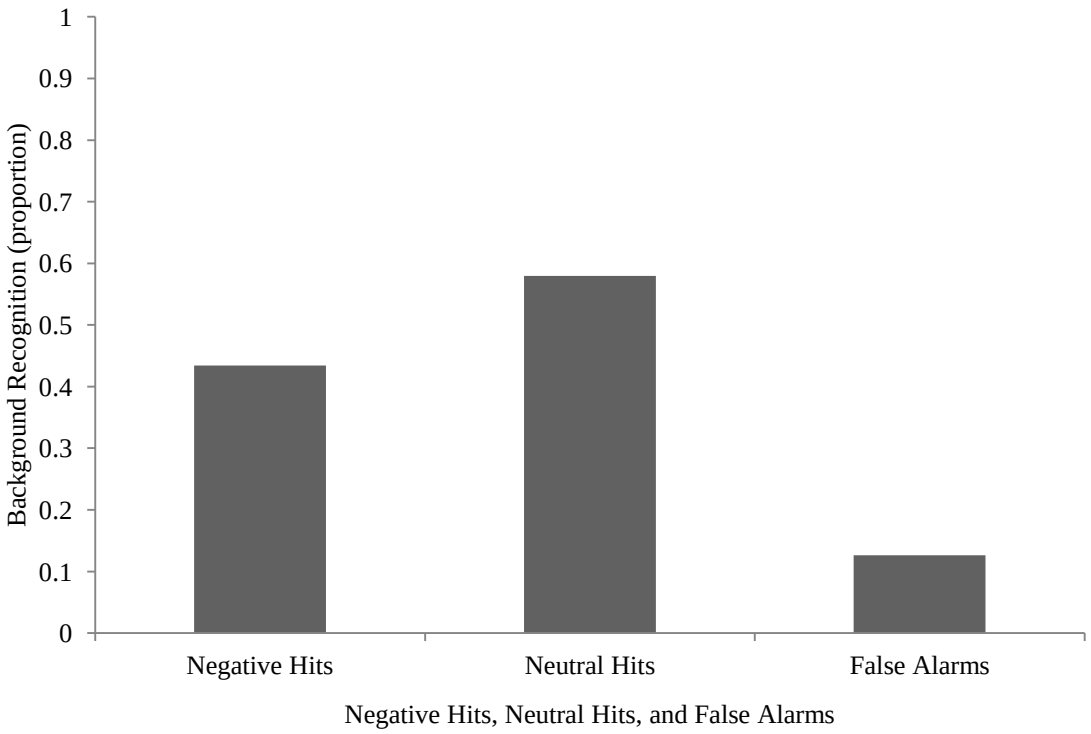

Figure 1. Background recognition in pilot study. For correctly recognized backgrounds (hits), it is further specified whether the background appeared with a negative or neutral image during the study phase. False alarms were responses to novel backgrounds as being presented during the context-item study phase.

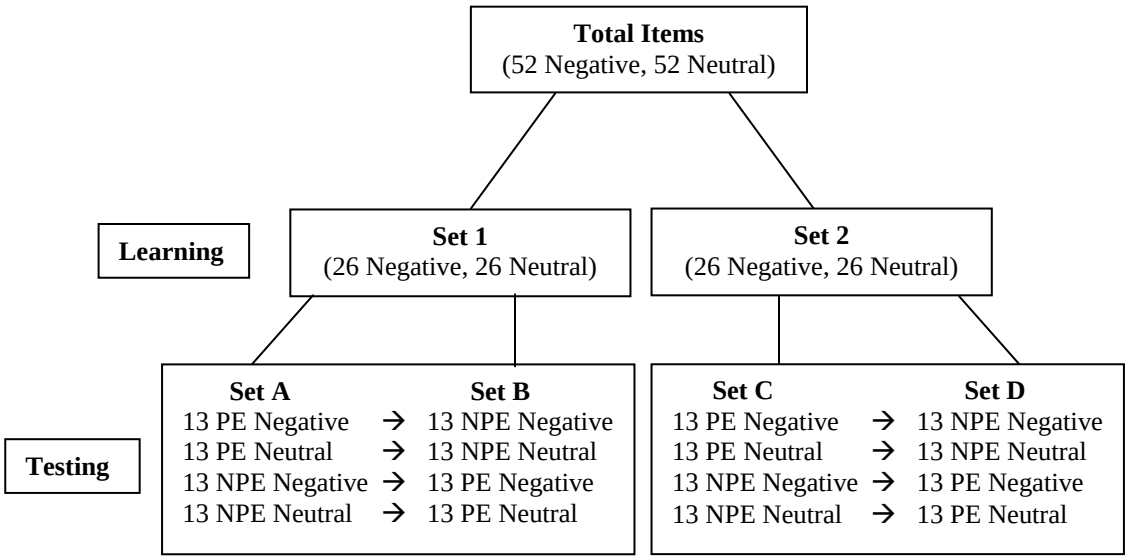

Figure 2. Item selection for Experiment 1 and 2, and the method of counterbalancing stimuli. Stimuli were selected from the pilot study (52 negatively arousing and 52 neutral items) and were further divided randomly into two sets of stimuli each containing 26 negatively arousing and 26 neutral images. Within each of these sets, two stimuli subsets were created; context was pre-exposed (PE) or not (NPE). Context pre-exposure images in Set A were presented as non pre-exposure images in Set B.

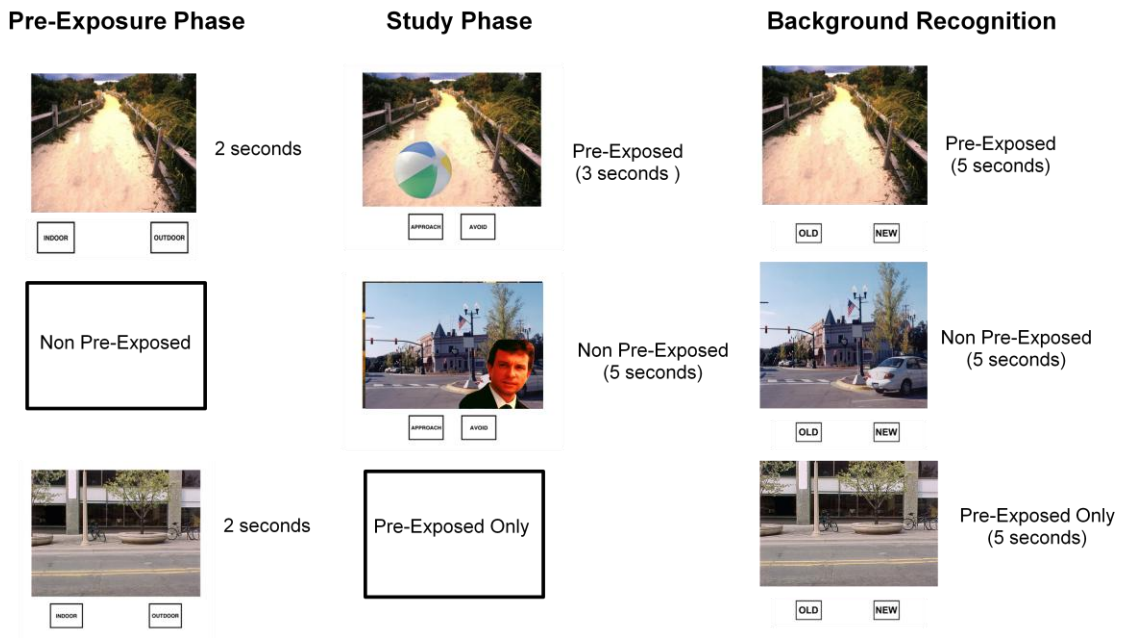

Figure 3. Procedure used in Experiment 1 for the context pre-exposure phase, the context-item study phase, and the old/new background recognition task. Participants first underwent a context pre-exposure phase that presented 52 backgrounds: participants were instructed to select whether the picture was taken indoors or outdoors. After completion of the pre-exposure phase, participants completed the study phase where 26 of the pre-exposed backgrounds were paired with an item and 26 non pre-exposed backgrounds were paired with an item. For images where context was pre-exposed, participants were presented with the image for 3 seconds before instructed to select whether they would approach or avoid the image whereas non pre-exposed images were presented for 5 seconds. Therefore, exposure to context for both pre-exposed and non pre-exposed images was kept constant at 5 seconds. After a brief distracter task, participants completed a background recognition task where all 52 backgrounds that had been presented in the study phase were presented along with 26 backgrounds that had been viewed in the pre-exposure phase only (i.e., not paired with an item) and 26 novel backgrounds. Participants were shown each background for 5 seconds before instructed to select "old" if the background had been presented during the study phase or new if the background had not been presented in the study phase.

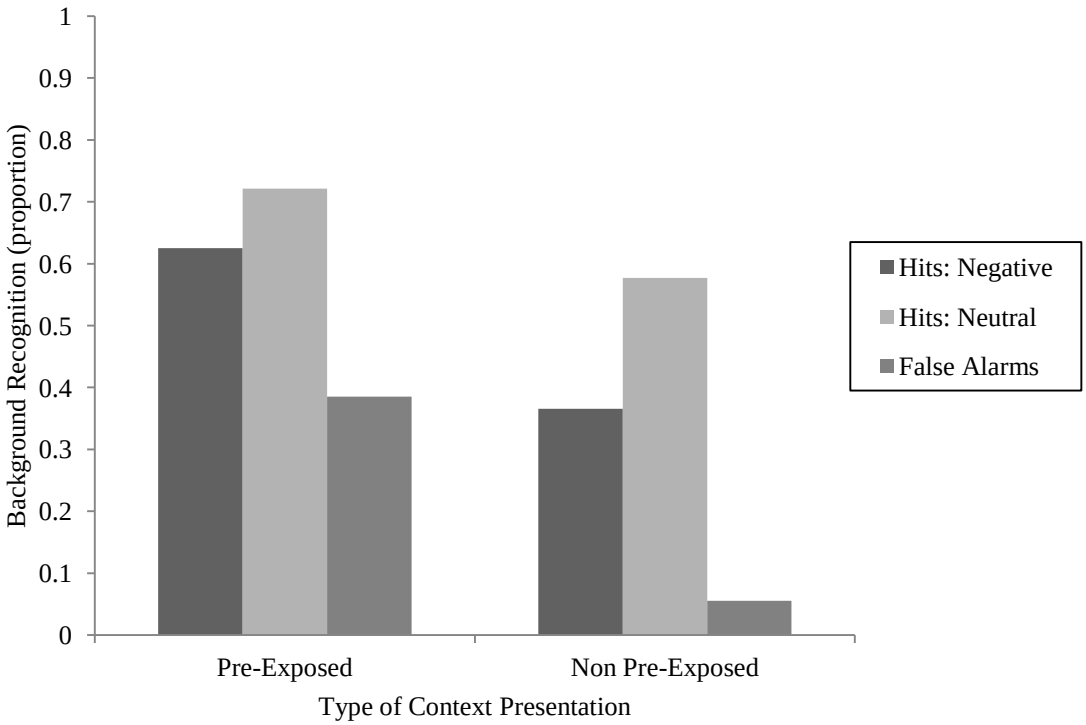

Figure 4. Experiment 1: Positive background recognition responses for backgrounds viewed in the context-item study phase with negative or neutral items (hits), and for novel backgrounds or backgrounds presented in the context pre-exposure phase only (false alarms).

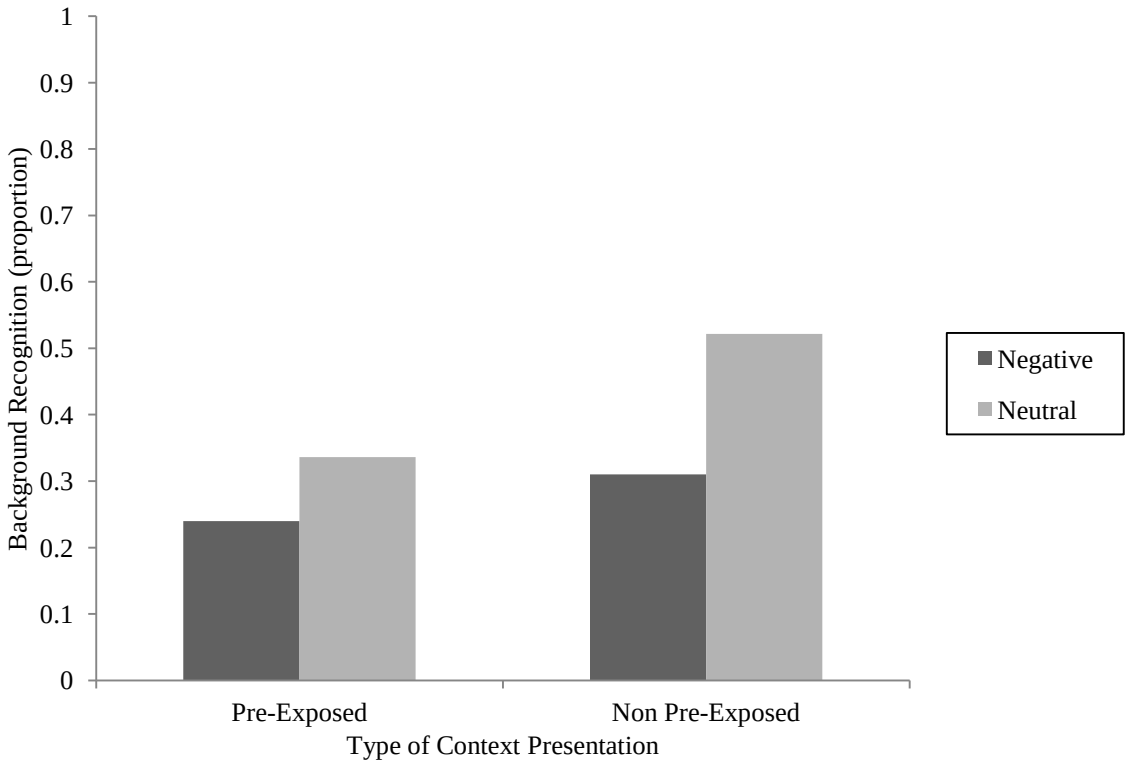

Figure 5. Experiment 1 corrected background recognition scores, calculated by subtracting the number of false alarms from the number of hits. Corrected scores were used in the data analysis of background recognition.

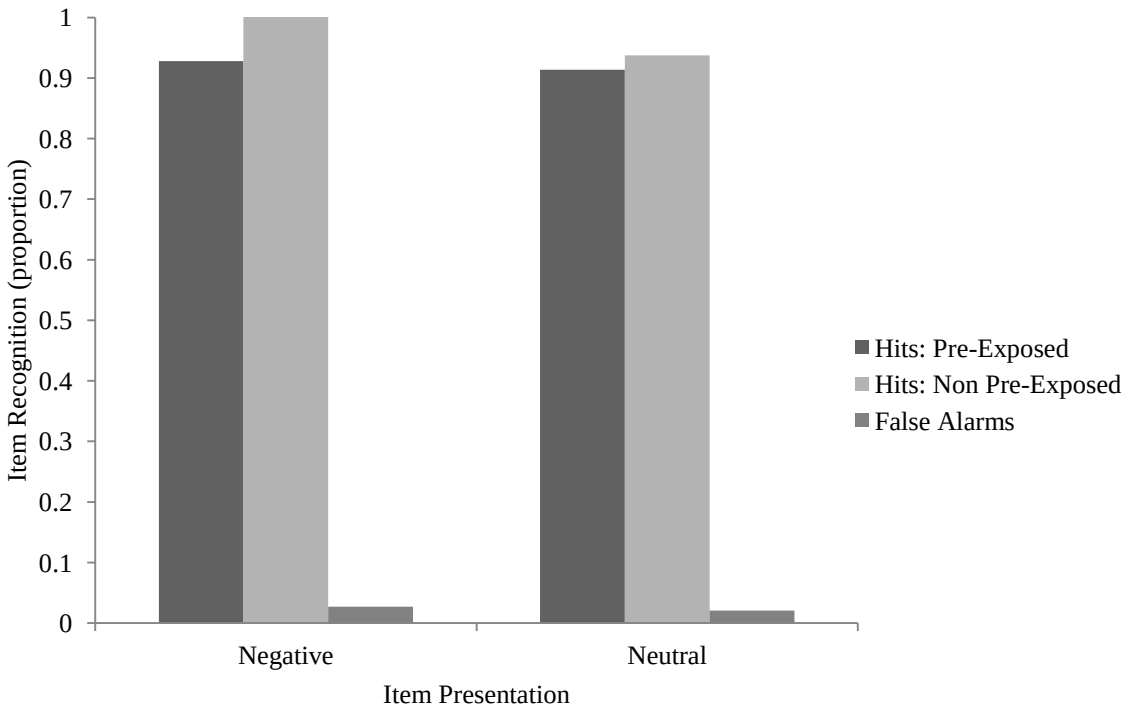

Figure 6. Experiment 1 item recognition scores (hits and false alarms) for negative and neutral items with pre-exposure to context and no pre-exposure to context.

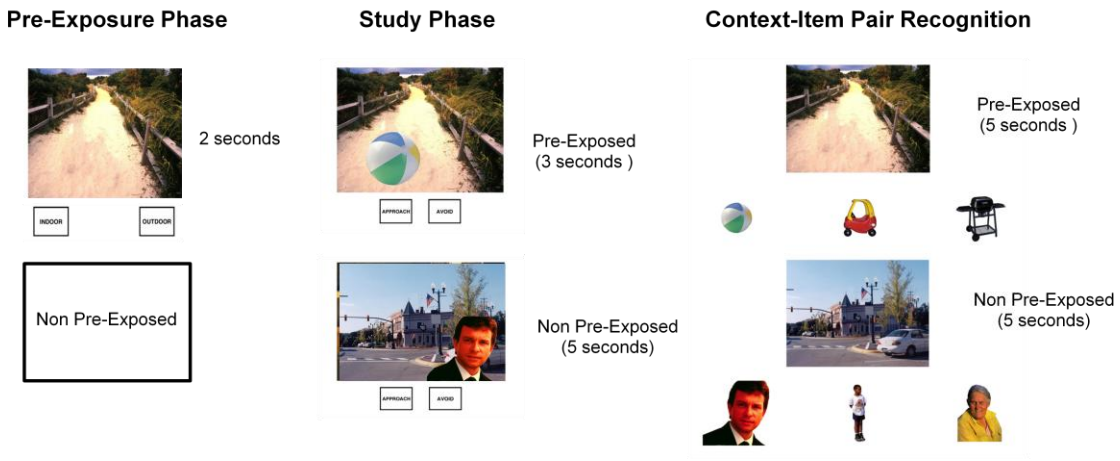

Figure 7. Procedure used in Experiment 2 for the context pre-exposure phase, the context-item study phase, and the context-item pair recognition task. Both the pre-exposure phase and study phase are identical to the one used in Experiment 1. After a brief distracter task after the study phase, participants completed a context-item pair recognition task. Participants were presented with the 52 backgrounds viewed in the study phase along with 3 items. One of the items was the correct context-item match, another item was viewed in the study phase with a different background, and another was a novel item. Participants were instructed to select the correct item that was presented with the background during the study phase.

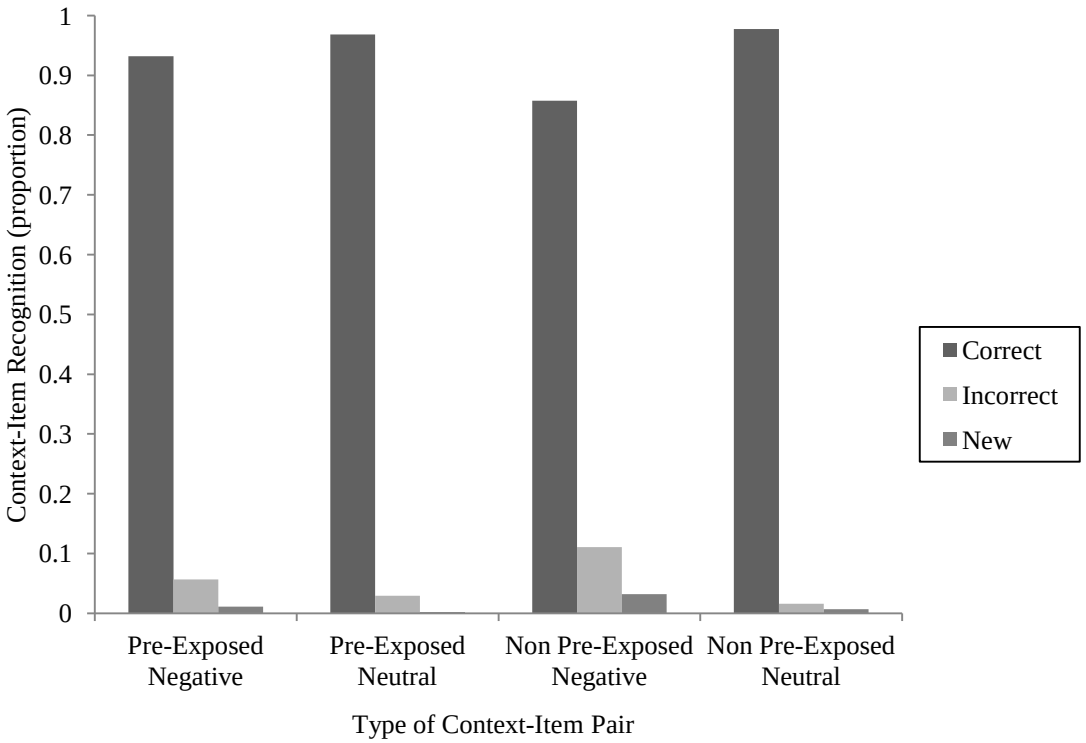

Figure 8. Experiment 2 item recognition scores. Incorrect responses indicate selection of an item previously seen in the approach/avoid phase, but with a different background. New responses reflect selection of a novel item never presented with a background.

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Publication

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