Notice: This is the author's version of a work that was accepted for publication in *Psychological Research.* A definitive version was subsequently published in *Psychological Research.* DOI: 10.1007/s00426-019-01215-0

The Devil is in the Details:

Investigating the Influence of Emotion on Event Memory Using a Simulated Event

Adam R. Congleton

and

Dorthe Berntsen

Center on Autobiographical Memory Research, Aarhus University, Denmark

Author Note

This research was supported by a grant from the Danish National Research Foundation (DNRF89). Special thanks to Niels Peter Nielsen for constructing the video clips used as part of the experimental paradigm, as well as to Sinué Salgado for helping manage data collection via Amazon Mechanical Turk.

Correspondence concerning this article should be addressed to: Adam R. Congleton, Center on Autobiographical Memory Research (CON AMORE), Department of Psychology and Behavioural Sciences, Aarhus University, Denmark. E-mail: congleton@psy.au.dk. Phone: +45 8716 6117.

Abstract

In our everyday lives, the negative events we experience sometimes include powerful, salient details which are ultimately responsible for us interpreting the events as negative (i.e., they drive our interpretation of the emotional valence of the event). Here we examined how the presence of such details within an event shapes our memory for that event. Research on the role of emotion in memory suggests that negative events are often remembered more accurately than positive ones, and this advantage is especially pronounced for the emotion-defining details of the events. However, research rarely separates retrieval effects from effects of attention and information processing during encoding. Here we used a simulated event to examine (1) whether negative events are remembered more accurately than positive events, (2) whether this effect is more pronounced for the emotion-defining detail of the event, (3) whether participants display enhanced accuracy for all aspects of an event (i.e., general memory enhancement) or for only certain aspects of the event (i.e., selective memory enhancement), and (4) whether any enhancement effects for central aspects of the event occur at the expense of contextual information (i.e., memory narrowing). Across three experiments, participants showed superior memory accuracy for the central details of the event in general, while those who interpreted the event as emotionally negative also displayed selective enhancement of the peripheral details. The results further suggested that it was the unexpectedness and/or salience introduced by the emotion-defining detail that was essential to enhancing memory accuracy, and not its goal relevance.

Keywords: event memory, emotional valence, emotional arousal, memory enhancement effects, salience

Disclosure of Interest

The authors report no conflicts of interest.

The Devil is in the Details:

Investigating the Influence of Emotion on Event Memory Using a Simulated Event

Emotion experienced during an event is known to influence memory (e.g., Levine & Bluck, 2004; Levine & Pizzaro, 2004). Whether an event is interpreted as emotionally positive or negative, as well as the degree of emotional arousal elicited, appear to influence what details people later remember. Specifically, emotion can influence whether people exhibit enhanced memory for certain aspects of an event (i.e., memory enhancement for either central or peripheral information), and whether that enhancement is accompanied by a corresponding detriment for other aspects of the event (i.e., a memory-narrowing effect; e.g., Reisberg & Heuer, 2004; Kensinger, 2009; Levine & Edelstein, 2009; Talarico, Berntsen, & Rubin, 2009; Gable & Harmon-Jones, 2010; Mather & Sutherland, 2011).

Importantly, in our everyday lives the negative events we experience sometimes include powerful, salient details that may determine whether we interpret the events as negative (i.e., they drive our interpretation of the emotional valence of the event). For example, receiving a bad grade in red ink on an exam paper, or, more dramatically, seeing a knife in the hand of someone who stopped you to ask for directions, can be the driving force behind how you ultimately come to view the event. In the present series of experiments, our interest was in understanding how the presence of these types of details within a naturally unfolding event shapes our memory for that event.

Memory for Emotional Events Studied in Naturalistic Settings

Much of the research examining the role of emotion on memory has been conducted using simple, laboratory stimuli in an effort to maintain experimental control (e.g., Kensinger & Schacter, 2006b). However, the question remains as to whether certain factors, such as

emotional valence or arousal, shape memory in the same way for our personal, autobiographical event memories. Problematically, the majority of research on such personal memories for emotional events has been unable to examine what happens when people initially experience events (e.g., Berntsen, 2002). Studies investigating these types of personal event memories have instead asked people to recall their memories, with little to no experimental control being exerted over what information was encountered by the participants, even in cases where the events were public and some information was known (i.e., in studies of flashbulb memory; e.g., Brown & Kulick, 1977; Luminet & Curci, 2009).

Some naturalistic studies of personal event memories have used quasi-experimental designs to investigate the effects of emotional valence and arousal. Kensinger and Schacter (2006a) assessed participants' memories for the details of the final game of the 2004 Boston Red Sox-New York Yankees American League playoffs, with the participants being self-divided into those who viewed the event as highly positive (in the case of this game, Red Sox fans), highly negative (Yankees fans), or neutral (fans of neither team). Participants in the negative valence condition remembered more event-related details (i.e., the central or core aspects of the game), and displayed greater consistency in their memory reports across time (i.e., they were less prone to memory distortions or intrusions), compared with those in the positive valence condition. At the same time, participants in both emotional conditions remembered more event-related details than those in the neutral condition, suggesting a general benefit of experiencing the event with some degree of emotional arousal. Similar results were found in Bohn and Berntsen's (2007) study of East and West German participants' memories of the fall of the Berlin Wall, where again participants were self-divided into those who viewed the event as highly positive or highly negative. Participants who rated the event as highly negative were more accurate regarding the

events surrounding the fall compared with those who rated the event as highly positive. However, not all naturalistic studies using quasi-experimental designs have found an accuracy advantage associated with negative valence (e.g., Breslin & Safer, 2011; see Van Bergen & Salmon, 2011 for a different empirical strategy in developmental research).

Present Series of Studies and the Simulated Event Paradigm

In the present series of studies, we introduce the *Simulated Event* paradigm. This paradigm systematically controls the manner in which participants emotionally interpret an event (i.e., emotional valence), the level of emotional arousal they experience (through the use of specific story instructions), as well as the manner in which their emotional interpretation is triggered (through the use of emotion-defining details). At the same time, the paradigm uses naturalistic stimuli in a way commensurate with how participants would experience events, and the emotion that arises from them, as they would for any other event in their daily lives (i.e., through a first-person perspective which involves movement through space and time). Specifically, participants watch film clips depicting a first-person perspective view of going through a scenario while imagining themselves as the protagonists. Previous research has used real-life film clips to examine memory for complex events, such as traumatic events (e.g., Holmes & Bourne, 2008) and how people segment events into episodes (e.g., Zacks & Swallow, 2007). In contrast, here we used computer-simulated films to allow greater research flexibility and to create a first-person perspective of sufficient quality.

This paradigm and its stimuli satisfy the conceptual requirements that define an "event" according to recent theoretical developments within the memory literature (e.g., Rubin & Umanath, 2015). The first-person perspective films we use as part of this paradigm simulate the natural unfolding of a real-life event as viewed from a first-person perspective, whereby the

films engage the viewer as a 'virtual self' who experiences the event as if it were happening to him or her at the present moment. The films depict the perceptual flow of this virtual 'self' as that 'self' goes through the scenes of the event (for example, moving from one spatial location to the next). The scenes have realistic visual and auditory sensations and are always viewed from a first-person perspective, ensuring that the location of the virtual 'self' relative to its surrounding environment is always clear to the viewer. The films were designed such that the pace and direction of the perceptual flow of the event always indicates to the viewer when their virtual 'self' is slowing down, looking around, speeding up, entering a room, exiting, and so forth. As such, these films simulate real-life events much as the viewer would experience them in his or her daily life. The theme of the event and the goals of the virtual 'self' during the event are indicated by a narrative presented to the viewer before the films are played.

Experiment 1

Our aim in this experiment was to examine whether we would observe a memory-narrowing effect when participants interpret an event as emotionally negative and when said interpretation is induced through the presence of an emotion-defining detail, or whether we would observe a memory enhancement effect for certain details without a corresponding detriment in memory for other details. Importantly, as previous research has often confounded the role of attention during encoding with the effects of valence at retrieval, we hoped here to gain a better understanding of the manner in which emotion shapes memory by parsing out the influence of emotional valence through the presentation of the emotion-defining detail only at the end of the event.

We examined participants' accuracy regarding the details of an event they experienced during the experiment, as well as their free recall of those details. The event in question

involved having the participants view a novel film clip from a first-person perspective while imagining themselves in the role of the film's protagonist. The participants were provided with overarching goals they were to keep in mind while watching the film. The goals and instructions provided to participants were inspired by a classic experiment in psychology (Anderson & Pitchert, 1978), and were as follows:

"You are about to see a video that shows a first-person perspective view of walking through a house. ***While watching this video, imagine that you are a thief who is going through this house.*** You know that there is a safe with rare currency located somewhere inside the house and you are searching for it in the various rooms. You know that once you find the safe and take the currency, you will immediately leave the house."[1]

Importantly, participants viewed films that varied only in the nature of the emotion-defining detail that occurred at the very end of the films (see Method). As there were no other differences between the clips, we predicted participants would ascribe an emotional interpretation to the event on the basis of what this final detail told them about the likelihood they would either attain a goal associated with the event or be prevented from attaining that goal (see Method). Specifically, we predicted participants would interpret the event as emotionally negative if the final detail obstructed their goal, while they would interpret the event as emotionally positive if the detail intimated they would attain their goal (e.g., Levine & Burgess, 1997; Ochsner, 2000; Compton, 2003; Levine & Pizzaro, 2004; Reisberg & Heuer, 2004; Mather, 2007). Given the presence of this goal, we predicted that participants would experience some degree of emotional arousal throughout the event, but their arousal levels would be comparable across conditions (see Experiment 2 for a systematic manipulation of emotional

arousal levels). We also predicted that participants who experienced the negatively-valenced event would display improved performance on a forced-choice accuracy test, as well as superior memory for the emotion-defining detail of the event, compared with participants who experienced the positively-valenced event. Overall, we expected central (i.e., emotion- and gist-related) details to be better retained than peripheral event details, but it remains an open question whether we would also observe poorer memory for the peripheral event details (i.e., a memory-narrowing effect) or whether the peripheral details would be unaffected across conditions (i.e., a selective memory enhancement effect) or even enhanced.

Method

Participants and design. Participants were recruited from the Amazon Mechanical Turk online subject pool. They were informed the purpose of the study was to investigate the influence of perspective-taking on the comprehension of details about an experience in which they would be participating. There were 200 participants altogether drawn from the subject pool, randomly assigned to either a positive or negative event condition (with 100 participants per condition). Based on previous research (e.g., Berntsen, 2002), this number of participants was deemed appropriate to detect effects of valence on central and peripheral event memory details for a naturalistic event.

Materials

Online survey. The structure of the study was composed of an online survey created using Survey Monkey, an online survey generation database. The study itself was advertised through the Amazon Mechanical Turk online subject pool (as described above), and a web link was provided to the survey hosted on the Survey Monkey website for participants.

First-person perspective films. Two novel video clips were developed. These clips depicted first-person perspective views of walking through a computer-generated house. This house was developed for the purpose of the present work using Garrys Mod programming software and Hammer Editor to construct the virtual layout map of the house. Recordings were then made of a first-person perspective walkthrough of the computer-generated house, creating the video clips that acted as the experimental stimuli for the study. All of the components of the house seen in the videos, including objects and sounds, were specifically incorporated into the virtual map from scratch. Thus, we had complete control over, and knew *a priori*, what details participants would encounter, as well as where and when those details occurred, in these event video clips.

In both videos, the participants were asked to imagine themselves in the role of the protagonist, and both videos showed the layout and movement through the house from a perspective as if the viewer actually were the protagonist moving in physical space. The protagonist began the event in a garden located outside of the house. The protagonist then entered the house through a set of French windows into the living room. After looking around the living room, the protagonist briefly entered into the bathroom. Afterwards, the protagonist went into the kitchen where the phone rang. The protagonist then moved into the utility area where s/he was further exposed to an alarm beep. The protagonist then proceeded up the stairs to the second floor and entered into a child's bedroom. Next, the protagonist went into an office located across from the child's bedroom before proceeding into the master bedroom at the end of the hall. Once inside the master bedroom, the protagonist located and opened a safe, removed some currency, and proceeded down the stairs to exit via the back door. At this point, the videos differed depending upon the condition. For participants in the Positive Valence condition, the

protagonist opened the door and was heading toward the garden gate when the video ended, while for participants in the Negative Valence condition the protagonist opened the door and subsequently ran into a man in their attempt to leave the house (the video ended at this point; see Figure 1 for an overview of the video clips). The videos were equivalent in length (approximately 2 minutes long) and differed only in the perceived outcome of the event with regard to the participants' currently-active goals as intimated by this final detail (see Procedure for more information).

Central and peripheral details. We classified all details within the video clips into those that were central, or core, to the event itself and those that were peripheral, or contextual, in nature. The exact definition of central versus peripheral details has been extensively debated, and it is impossible to satisfy all definitions in one paradigm (see Levine & Edelstein, 2009 for a review). To keep our research in line with prior investigations of emotion and autobiographical memory, we chose definitions adopted from previous work in this area (i.e., Heuer & Reisberg, 1990; Berntsen, 2002; Moyer, 2002).

In accordance with previous studies (e.g., Heuer & Reisberg, 1990; Berntsen, 2002; Moyer, 2002), a detail was defined as *Central* if it was related to the key emotional experience during the event and if it could not be left out or replaced without a major change in the content of the event. In other words, central details should be related to the specific goal of the experience, as this has been argued to provide the initiation of emotional processes in the first place (see Levine & Edelstein, 2009 for a review); in the present event, searching for the safe and rare currency and escaping successfully (see Procedure section). Otherwise, the details were classified as *Peripheral*. Three independent raters coded all possible details included in the films and classified them as either central or peripheral according to the above definition. Based on

this coding, it appears there were approximately 20 central details and 120 peripheral details. We selected only those details on which all raters were in 100% agreement as being central to use for coding participants' recall and in designing the recognition questions assessing Central Detail accuracy. Similarly, we selected only those details on which the raters were in 100% agreement as being peripheral to use in designing the questions assessing Peripheral Detail accuracy. Based on this analysis, seven details were conclusively identified as Central to the goals of the study. Of those seven details, one detail occurred within the first 30 seconds of the movie, two details occurred between 30 and 60 seconds, two occurred around 90 seconds, and the final two details occurred within the last few seconds of the movie (at approximately the 120 second mark). Examples of central details included the act of entering the house, the sound of the telephone, and the safe, while examples of peripheral details included a white hamper basket, chairs around the dining room table, and soda pop bottles in the kitchen.

Procedure. After providing informed consent, participants were asked to listen to an audio file and report the name of the animal sound they heard in this file (as a way of ensuring they were completing the survey with their audio speakers turned on). Afterwards, participants were informed they would be watching a first-person perspective video clip. In accordance with previous research on the importance of active goals at the time of an event in eliciting emotion (see Levine & Edelstein, 2009 for a review; Rubin & Umanath, 2015), and in order to ensure immersion in the experience, participants were asked to imagine themselves in the role of the film's protagonist and were provided with overarching goals to keep in mind while watching the clips (see above). Based on the instructions, we can say there were two interrelated goals for the participants in experiencing the virtual events in the videos: (1) finding the safe and taking the

rare currency, and (2) successfully escaping from the house. They then watched the video clip, in which only the ending differed across the conditions (cf. Figure 1).

Following the video, participants were asked to solve a series of multiplication problems to introduce a delay before the memory tasks. This distracter task took participants on average five minutes to complete. Afterwards, participants were asked to freely recall as many details about the video as they could possibly remember in whatever order they preferred. A detail was defined for the participants as "any unit of information that you can remember from any part of the video (e.g., any objects you remember seeing, any actions you performed, any sounds you heard, etc.)." We ensured participants would actually generate details by preventing them from advancing in the survey until they had produced at least five details (though they could have generated as many as twenty in the space provided). Recall was scored by calculating the number of central and peripheral details that were produced by the participants, and then dividing their recall by the total number of possible central and peripheral details to obtain proportional recall scores. If the same detail was recalled more than once, it was only counted as occurring one time. All inaccurate responses, which occurred only very rarely, were not included in the final total.

Participants were then asked to complete a forced-choice accuracy test. Specifically, they were asked to answer four-alternative, forced-choice questions about specific central and peripheral details of the video clip they saw, including the critical final detail, as well as questions about critical lures (i.e., questions about events that did not happen during the videos). Questions were asked about seven central details, seven peripheral details, and seven critical lures, for a total of 21 questions altogether. An example of a question regarding a central detail would be: "How many times did the alarm beep?" In terms of a question about a peripheral

detail, an example would be: "In what room was the white hamper basket?" Finally, an example of a question regarding a critical lure would be: "What object did you knock over in the kitchen?"[2] This accuracy test was included as a means of assessing the influence of emotional valence (and other variables in Experiments 2 and 3) on participants' memory for event details they may not have otherwise freely recalled (i.e., it was an assessment of event detail availability in contrast to free recall's assessment of event detail accessibility).

At the end of the experiment, participants were asked a series of questions designed to assess their phenomenological experience during the video clip by assigning values on a 7-point (1-7), Likert-type scale. See Table 1 for specific questions and anchor points.

Because of the high correlation between the anxiety and heart rate variables ($r = .671$, $p < .001$), these two variables were combined together to produce a composite, sum score variable of "arousal." The internal consistency of this arousal score, measured by Cronbach's α, was .802.

Manipulation checks. To ensure participants were actively keeping the overarching goals of the experiment in mind, as well as making sure they were following instructions, three manipulation checks were included throughout the survey. For example, we asked participants questions about the instructions to ensure they were always aware of the overarching goals.

If participants failed to answer any of the manipulation check questions correctly, including if they failed to correctly identify the animal sound they heard as part of the audio check, they were excluded from any further analysis. Participants were also excluded if they failed to recall at least five details during the free recall portion of the experiment, or they attempted to bypass the recall portion by entering irrelevant information into the space provided (e.g., by putting random numbers/letters into five spaces in order to advance in the survey).

However, participants who recalled erroneous, but plausible, event details were included (e.g., recalling the presence of a lawnmower in the garden, when no such detail was present in the videos). Thus, the results below, for all three experiments, are based only on participants who answered all manipulation and audio check questions correctly and recalled relevant details. We continued recruiting participants until we had achieved approximately 100 valid ones in each condition in order to be commensurate with the sample size used in previous research (e.g., Berntsen, 2002).

Results

Participants in the Negative Valence condition reported the experience as significantly more negative compared with those in the Positive Valence condition (see Table 1), indicating our manipulation was successful.[3] Importantly, there was no difference between the two conditions in terms of the level of arousal they reported experiencing during the event. The only other difference observed between the conditions (beyond valence) was a higher incidence of startle response reported by participants in the Negative Valence condition. We will return to this finding in Experiment 3. Overall, the descriptive statistics of all variables assessed by the phenomenological questionnaire showed the participants in both the positive and negative valence conditions to be highly immersed and engaged in the video clips, suggesting these clips were quite efficient at simulating real-life events (see Table 2)

Forced-choice accuracy of details. The results of a 2 x 2 Mixed Analysis of Variance (ANOVA), with Emotional Valence (Positive vs. Negative) as the between-subjects factor and Accuracy Type (Central vs. Peripheral) as the within-subjects factor, revealed a significant effect of Accuracy Type, in which participants were more accurate regarding Central Details (*M* =

5.19) compared to Peripheral Details (M = 3.19), $F(1, 198) = 211.77$, $p < .001$, $\eta^2_p = 0.52$, 95% CIs [5.01, 5.37], [3.00, 3.38]. There was also a significant main effect of Emotional Valence, where participants in the Negative Valence condition (M = 4.38) were significantly more accurate about the details compared with those in the Positive Valence condition (M = 4.00), $F(1, 198) = 9.02$, $p = .003$, $\eta^2_p = 0.04$, 95% CIs [3.82, 4.18], [4.20, 4.56]. No interaction effect was observed.

We next wanted to determine if participants experienced enhanced memory accuracy with regard to the critical final detail of the videos. As this detail constituted the sole difference between the conditions, and was selected as the only detail that intimated the outcome of the event, it was regarded as the one that ultimately drove the valence interpretation participants made about the event (i.e., it acted as the emotion-defining detail). Thus, we examined the accuracy data to determine whether there was a difference in the likelihood that participants would correctly answer the question regarding this final detail (i.e., the man in the Negative Valence condition, and the garden gate in the Positive Valence condition). Consistent with expectations, the results of a Chi-square test of independence revealed a significant interaction [$\chi^2(1) = 49.82$, $p < .001$]. Participants in the Negative Valence condition (84%) were more likely to be accurate regarding the final detail than those in the Positive Valence condition (35%).

In order to determine whether the overall advantage of the negative condition on accuracy was driven by participants' accuracy for this critical final detail, we removed the final detail from their overall Central Detail accuracy score. We then repeated the 2 x 2 Mixed Model ANOVA, with Emotional Valence (Positive vs. Negative) as the between-subjects factor and Accuracy Type (Central vs. Peripheral) as the within-subjects factor. The results again revealed a significant effect of Accuracy Type, in which participants were more accurate regarding Central

Details (M = 4.60) compared to Peripheral Details (M = 3.19), $F(1, 198) = 115.95$, $p < .001$, $\eta^2_p = 0.37$, 95% CIs [4.43, 4.76], [3.00, 3.38]. There was also a marginally significant interaction between Accuracy Type and Emotional Valence, $F(1, 198) = 3.53$, $p = .062$, $\eta^2_p = .02$. However, there was no main effect of Emotional Valence alone (F = 1.21). See Figure 2 for means and standard errors across conditions.

Further unpacking the marginal interaction effect, a follow-up t-test revealed a (marginally) significant difference between participants in the Negative Valence (M = 3.38) compared to the Positive Valence condition (M = 3.00) with regard to the accuracy of Peripheral Details, $t(198) = 1.97$, $p = .051$. However, there was no significant difference between the conditions with regard to the accuracy of Central Details (p = .50).

Free recall of details. Based on the role played by the critical final detail in the forced-choice accuracy results, we first removed the recall of this final detail from participants' Central Detail recall scores before conducting any further analyses, in order to ensure that its presence did not artificially boost the recall of central details. The results of a 2 x 2 Mixed Analysis of Variance (ANOVA), with Emotional Valence (Positive vs. Negative) as the between-subjects factor and Detail Type (Central vs. Peripheral) as the within-subjects factor, revealed a significant effect of Detail Type, in which participants recalled proportionately more Central Details (M = .24) compared to Peripheral Details (M = .06), $F(1, 198) = 783.28$, $p < .001$, η^2_p = .80, 95% CIs [.23, .25], [.06, .07]. There was also a significant interaction between Emotional Valence and Detail Type, $F(1, 198) = 4.43$, $p = .04$, $\eta^2_p = .02$, reflecting that participants in the Negative Valence condition recalled more Central Details while simultaneously recalling fewer Peripheral Details compared to those in the Positive Valence condition. However, there was no significant effect of Emotional Valence alone (F = 1.49, p = .22).

When examining the interaction between Emotional Valence and Detail Type, it appears that participants in the Negative Valence condition were recalling more Central Details (M = .25) and fewer Peripheral Details (M = .06) compared to those in the Positive Valence condition ($M\_Central$ = .23; $M\_Peripheral$ = .07). However, follow-up comparisons revealed there was only a marginal difference between the Negative Valence (M = .25) and Positive Valence conditions (M = .23) in terms of the recall of Central Details (p = .08), while there was no difference between the two conditions in terms of the recall of Peripheral Details (p = .28).

Summary and Discussion

In this experiment, we found that central details were better retained than peripheral details, that participants in the negative valence condition overall were more accurate than participants in the positive valence condition, and that this effect was especially pronounced for the critical, emotion-defining detail. However, when removing the emotion-defining detail from the analyses, the enhanced accuracy in the negative valence condition was reduced to a trend for peripheral details only. We found a similar result in the free recall data, where participants were recalling more central details compared to peripheral details. Despite the presence of a small interaction effect in the recall data, the follow-up comparisons revealed only marginal differences in the recall of central details with no corresponding difference in the recall of peripheral details that would be indicative of a memory narrowing effect.

Experiment 2

In Experiment 2, we wanted to replicate and extend Experiment 1 by assessing how the manipulation of levels of emotional arousal, or the degree of urgency or importance of a situation to an individual (ranging from a state of relaxation to excitement; e.g., see Kensinger, 2009; Levine & Edelstein, 2009 for reviews), would influence participants' memory. In Experiment 1,

arousal levels had been equated across the conditions in order to assess the influence of emotional valence operating at a comparable level of emotionality (since, in both conditions, participants did report arousal to some degree, as opposed to experiencing an emotionally-neutral situation; e.g., Kensinger & Schacter, 2006a). Here, we manipulated arousal, along with the valence of the films, in order to observe the influence of differing levels of arousal on participants' memory. We manipulated arousal by providing additional story instructions that altered the urgency of the situation to the participants, and thus the goal relevance associated with the event details (especially the critical final detail). Thus, we examined the separate and interacting influences of emotional valence and arousal across four conditions: High Arousal-Negative Valence, High Arousal-Positive Valence, Low Arousal-Negative Valence, and Low Arousal-Positive Valence.

Method

Participants and design. There were 384 participants altogether drawn from the Amazon Mechanical Turk online subject pool who were included in the final analysis (out of 675 initially drawn), with 96 participants per condition. This was a 2 x 2 between-subjects design, with Emotional Valence (Positive vs. Negative) and Emotional Arousal (High vs. Low) acting as the variables.

Materials. See Experiment 1 for specific materials used. Given the high correlation between the two variables ($r = .788$, $p < .001$), we once again combined the anxiety and heart rate variables from the phenomenological questionnaire to generate a sum score for "arousal." The internal consistency, as measured by Cronbach's α, was .881.

Procedure. See Experiment 1 for specific procedure used. As in Experiment 1, the Positive and Negative Valence conditions differed only in the ending of the video clip

participants saw (see Figure 1 for an overview of the videos). Levels of Emotional Arousal were manipulated through the inclusion of additional instructions following the general manipulation instructions that provided the overarching goals of the experiment. Specifically, participants in the High Arousal conditions were informed: "You also know that the owner of the house may be back any moment. The owner is a tough man who could be dangerous if he catches you stealing from him. If you run into a person, it is most likely the owner". On the other hand, participants in the Low Arousal conditions were told: "You also know that the owner of the house will be gone for days. This house is located in a neighborhood that is known to be frequented by many travelling salesmen. If you run into a person, it is most likely a salesman". The number of words in these instructions was equated across the High and Low Arousal conditions.

Results

Table 3 shows that our manipulation generally worked. Participants in the Negative Valence conditions rated the films as significantly more negative compared to those in the Positive Valence conditions. Similarly, the results revealed a significant main effect of Emotional Arousal, where participants in the High Arousal conditions reported significantly greater levels of arousal compared with those in the Low Arousal conditions.

As in Experiment 1, participants in the Negative Valence conditions reported significantly more Startle Responses compared with those in the Positive Valence conditions. There was also a significant interaction effect between arousal and valence for this measure, reflecting that participants in the Low Arousal-Negative condition had higher startle ratings than those in the Low Arousal-Positive condition, with no similar difference observed between the two high arousal conditions (Table 3). A number of other effects were observed, suggesting the arousal manipulation increased the overall immersion and intensity felt by participants while watching

the films. As in Experiment 1, the phenomenological ratings were quite high across all conditions, suggesting the films were quite efficient at simulating actual events unfolding in time.

Forced-choice accuracy of details. As in Experiment 1, participants in the Negative Valence conditions (M = .86) were more accurate regarding the assessment of the final detail compared to those in the Positive Valence conditions (M = .33), $F(1, 380) = 160.10$, $p < .001$, η^2_p = .30, 95% CIs [.81, .91], [.27, .40]. In addition, we also found that participants in the Low Arousal conditions (M = .68) were significantly more accurate regarding this final detail than those in the High Arousal conditions (M = .52), $F(1, 380) = 15.08$, $p < .001$, η^2_p = .04, 95% CIs [.61, .74], [.44, .59]. There was no interaction effect observed.

Based on the role of the critical final detail on participants' accuracy in Experiment 1, we first removed the final detail from their overall Central Detail accuracy score. We then conducted a 2 x 2 x 2 Mixed Analysis of Variance (ANOVA), with Emotional Valence (Positive vs. Negative) and Emotional Arousal (High vs. Low) acting as the between-subjects factors and Accuracy Type (Central vs. Peripheral) as the within-subjects factor. The results revealed a significant effect of Accuracy Type, in which participants were more accurate regarding Central Details (M = 4.65) compared to Peripheral Details (M = 3.13), $F(1, 380) = 320.68$, $p < .001$, η^2_p = 0.46, 95% CIs [4.54, 4.76], [2.99, 3.26]. There was also a significant effect of Emotional Valence, with participants in the Negative Valence conditions (M = 3.99) being more accurate compared to those in the Positive Valence conditions (M = 3.79), $F(1, 380) = 4.99$, $p = .03$, η^2_p = .013, 95% CIs [3.86, 4.12], [3.66, 3.92]. There was also a significant effect of Emotional Arousal, with participants in the High Arousal conditions (M = 4.00) being more accurate compared to those in the Low Arousal conditions (M = 3.78), $F(1, 380) = 6.05$, $p = .014$, η^2_p =

.02, 95% CIs [3.88, 4.113], [3.65, 3.90]. Finally, there was a significant interaction between Accuracy Type and Emotional Valence, $F(1, 380) = 11.55$, $p = .001$, $\eta^2_p = .03$. Specifically, participants in the Negative Valence conditions ($M = 3.38$) were more accurate regarding Peripheral Details compared to those in the Positive Valence conditions [$M = 2.88$; $F(1, 380) = 12.97$, $p < .001$, $\eta^2_p = .033$], while there was no difference between the valence conditions in terms of participants' accuracy regarding Central Details (*M_Negative* = 4.61; *M_Positive* = 4.69; $p = .46$). See Figure 3 for means and standard errors across all conditions.

Free recall of details. As in Experiment 1, we first removed the recall of the critical final detail from participants' Central Detail recall scores before conducting the following analysis.

The results of a 2 x 2 x 2 Mixed Analysis of Variance (ANOVA), with Emotional Valence (Positive vs. Negative) and Emotional Arousal (High vs. Low) acting as the between-subjects factors and Detail Type (Central vs. Peripheral) acting as the within-subjects factor, revealed a significant effect of Detail Type, in which participants recalled proportionately more Central Details ($M = .25$) compared to Peripheral Details ($M = .06$), $F(1, 380) = 1678.29$, $p < .001$, $\eta^2_p = .82$, 95% CIs [.24, .26], [.058, .064]. There was also a significant three-way interaction among Emotional Valence, Emotional Arousal, and Detail Type, $F(1, 380) = 4.01$, $p < .05$, $\eta^2_p = .01$. There were no other significant effects observed (all F's < 2.4).

When examining the three-way interaction, it appears that participants in the Low Arousal-Negative condition were recalling more Central Details ($M = .269$) and fewer Peripheral Details ($M = .057$) compared to those in the Low Arousal-Positive condition (*M_Central* = .247; *M_Peripheral* = .069), whereas there was no difference between the High Arousal-Negative and High Arousal-Positive conditions regarding the recall of Central or Peripheral Details. While these results might suggest the presence of a slight memory narrowing effect for participants who

experience a negatively-valenced event in a state of low arousal, the lack of a significant two-way interaction between Emotional Valence and Detail Type does not support such a conclusion.

Summary and Discussion

Across Experiments 1 and 2, we have found that the presence of a detail inducing negative emotional valence through the obstruction of the protagonists' goals leads to selective memory enhancement of the participants' accuracy for the peripheral details of the event (after the emotion-defining detail was excluded from the analysis), compared to a condition where this detail is absent. We have shown this effect is present even when varying the level of arousal.

However, these findings do not clarify the underlying mechanism for this effect. Based on previous research, there are at least two possible explanations. One explanation for the effect is the goal-relevancy associated with this critical detail, specifically the fact that its presence obstructs the goal-pursuit of the protagonist (e.g., Levine & Edelstein, 2009). Another possible mechanism is the saliency and unexpectedness of this detail and its ability to potentially cause surprise and startle for the perceiver (Laney, Campbell, Heuer, & Reisberg, 2004). Study 3 was undertaken with the aim of separating these mechanisms.

Experiment 3

The results of Experiment 2 demonstrated that the effects of emotional valence we observed in Experiment 1 held even when emotional arousal levels were systematically manipulated. Thus, the results supported the idea of a selective memory enhancement effect for the peripheral details of the film (when the emotion-defining detail was excluded from analysis). These results seemed to occur because of the negative emotional valence interpretation of the event induced through an emotion-defining detail at the end of the event, whose presence

obstructs the goal-pursuit of the protagonist. However, an alternative explanation might be the saliency and attention-capturing nature of this detail.

To examine this possibility, we needed to systematically unpack the influences of the goal congruency associated with the emotion-defining detail (that is, whether its presence obstructs or aids in the protagonist's goal-pursuit), a variable representing positive versus negative outcomes; in other words, "valence" according to common definitions (e.g., Levine & Edelstein, 2009). We included four conditions that were designed to do just that: Goal Incongruence-High Salience (where the final detail was a man whom participants were told was the owner of the house), Goal Incongruence-Low Salience (where the final detail was the garden gate, which participants were warned to avoid), Goal Congruence-High Salience (where the final detail was a man whom participants were told was their partner helping them escape), and Goal Congruence-Low Salience (where the final detail was the garden gate, which participants were told to seek out).

Method

Participants and design. There were 400 participants altogether drawn from the Amazon Mechanical Turk online subject pool who were included in the final analysis (out of 572 initially drawn), with 100 participants per condition. This was a 2 x 2 between-subjects design, with Goal Congruency (Congruent vs. Incongruent) and Salience (High: Man vs. Low: Garden Gate) acting as the variables.

Materials. See Experiment 1 for specific materials used. As in the previous two experiments, given the high correlation between the two variables (r = .71, p = .000), we once again combined the anxiety and heart rate variables from the phenomenological questionnaire to generate a sum score for "arousal." The internal consistency, as measured by Cronbach's α, was .827.

Procedure. See Experiment 1 for specific procedure used. As in Experiment 1, participants saw a video in which only the ending varied depending upon the goal congruence of the condition, with participants in the Goal Incongruent conditions experiencing an undesirable outcome at the end of the video, and participants in the Goal Congruent conditions experiencing a desirable outcome at the end of the video (see Figure 1 for an overview of the videos). The outcome of the video was determined by the relevance of the critical final detail to their currently-active goals, which was shaped by the instructions provided to the participants prior to viewing the video. Specifically, in addition to the basic manipulation instructions that provided the overarching goals of the experiment, participants in the Goal Incongruent-High Salience condition were also told: "You also hope that the owner of the house will not return soon. It is essential that you DO NOT meet the owner. If you run into a person, it is most likely the owner and you know that you are caught." Participants in the Goal Congruent-High Salience condition were told: "You also hope that your partner will be coming soon to help you escape. It is essential that you DO meet your partner. If you run into a person, it is most likely your partner and you know that you are successful." Participants in the Goal Incongruent-Low Salience condition were told: "You also hope you will not be seen. Therefore, it is essential you DO NOT leave by the garden gate, which is exposed to neighboring houses. If you leave by the garden gate, you will most likely be seen and will be caught." Finally, participants in the Goal Congruent-Low Salience condition were told: "You also hope you will not be seen. Therefore, it is essential you DO leave by the garden gate, which is not exposed to neighboring houses. If you leave by the garden gate, you will most likely not be seen and will escape." As in Experiment 2, the number of words in these instructions was equivalent across all four conditions.

Thus, to reiterate, participants in the High Salience conditions always saw a video in which they ran into a man at the end (which was described as either a positive or negative outcome), while participants in the Low Salience conditions always saw a video in which they left the house and were headed for the garden gate (which, again, was described as either a positive or negative outcome). All four outcomes were framed by the narrative as being of central importance for the success (or failure) of the protagonist in order to keep them equally arousing and engaging.

Results

Consistent with our manipulation, participants in the Goal Incongruent conditions rated the video clips as significantly more negative compared with those in the Goal Congruent conditions (see Table 4). As in Experiments 1 and 2, participants in the High Salience conditions reported significantly greater startle responses compared with those in the Low Salience conditions. There was also a significant interaction effect, where participants in the Goal Incongruent-High Salience condition reported the greatest startle response, while those in the Goal Incongruent-Low Salience condition reported the least. As in Experiment 1 and 2, the phenomenological ratings were quite high across all conditions, suggesting the films were efficient at simulating actuals events (Table 4).

Forced-choice accuracy of details. In terms of participants' accuracy regarding the critical final detail, the results revealed that participants in the High Salience conditions (M = .83) were more accurate regarding the assessment of the final detail compared to those in the Low Salience conditions (M = .28), $F(1, 396) = 180.57$, $p < .001$, $\eta^2_p = .32$, 95% CIs [.77, .88], [.22, .33]. In addition, we also found that participants in the Goal Incongruent conditions (M = .63) were significantly more accurate than those in the Goal Congruent conditions (M = .48),

$F(1, 396) = 13.43$, $p < .001$, $\eta^2_p = .03$, 95% CIs [.57, .68], [.42, .53]. There was no interaction effect observed.

Based on the role of the critical final detail on participants' accuracy in Experiments 1 and 2, we first removed the final detail from their overall Central Detail accuracy score. We then conducted a 2 x 2 x 2 Mixed Analysis of Variance (ANOVA), with Goal Congruency (Goal Congruent vs. Goal Incongruent) and Stimulus Salience (High vs. Low) acting as the between-subjects factors and Accuracy Type (Central vs. Peripheral) as the within-subjects factor. The results revealed a significant effect of Accuracy Type, in which participants were more accurate regarding Central Details ($M = 4.69$) compared to Peripheral Details ($M = 3.11$), $F(1, 396) = 336.93$, $p < .001$, $\eta^2_p = 0.46$, 95% CIs [4.58, 4.79], [2.97, 3.25]. There was also a significant effect of Stimulus Salience, with participants in the High Salience conditions ($M = 4.13$) being more accurate compared to those in the Low Salience conditions ($M = 3.67$), $F(1, 396) = 23.35$, $p < .001$, $\eta^2_p = .06$, 95% CIs [4.00, 4.26], [3.53, 3.80]. There was also a significant interaction between Accuracy Type and Stimulus Salience, $F(1, 396) = 5.71$, $p = .02$, $\eta^2_p = .014$.

Specifically, participants in the High Salience conditions ($M = 3.45$) were significantly more accurate regarding Peripheral Details compared to those in the Low Salience conditions ($M = 2.78$; $F = 22.11$, $p < .001$, $\eta^2_p = .057$). A similar, but less pronounced difference was seen for the Central Details, where participants in the High Salience conditions ($M = 4.82$) also were significantly more accurate compared to those in the Low Salience conditions ($M = 4.56$; $F = 5.55$, $p = .02$, $\eta^2_p = .014$). In short, the High Salience condition had higher accuracy, but most markedly for Peripheral Details, when the central, emotion-defining detail was removed from the analyses. Importantly, there was no effect of goal congruency/emotional valence ($p > .16$). See Figure 4 for means and standard errors across all conditions.

Free recall of details. As in Experiments 1 and 2, we first removed the recall of the critical final detail from participants' Central Detail recall scores before conducting the following analysis.

The results of a 2 x 2 x 2 Mixed Analysis of Variance (ANOVA), with Goal Congruency (Goal Congruent vs. Goal Incongruent) and Stimulus Salience (High vs. Low) acting as the between-subjects factors and Detail Type (Central vs. Peripheral) acting as the within-subjects factor, revealed a significant effect of Detail Type, in which participants recalled proportionately more Central Details (M = .25) compared to Peripheral Details (M = .06), $F(1, 396) = 1901.43$, $p < .001$, $\eta^2_p = .83$, 95% CIs [.24, .26], [.06, .07]. There were no other significant effects observed (all F's < 2.76).

Summary and Discussion

The results of this experiment indicate that valence, defined in terms of the congruency of the emotion-defining detail with participants' goals, did not have an effect on the accuracy or recall of participants' memory when goal congruency was balanced with the salience associated with that detail. Regardless of whether the participants interpreted the final detail as congruent or incongruent with their goals (and, thus, emotionally positive or negative), it was ultimately the level of salience associated with this final detail that drove their performance downstream. In this experiment, the goal congruency of the final detail did induce emotional valence ratings consistent with previous work on the influence of negative emotional valence on memory (e.g., Levine & Edelstein, 2009). However, our results support the idea that it is the salience associated with the emotion-defining detail that may drive the selective memory enhancement effects we observed, rather than the emotionality, or goal congruency, associated with that detail.

General Discussion

Across three experiments, we used our *Simulated Event* paradigm to investigate how emotional variables shape event memory. We uncovered four main findings in the process that broaden our understanding of the interaction between emotion and memory. First, we observed that participants were significantly more accurate about, and freely recalled more, Central Details compared to Peripheral Details, and this effect occurred across conditions and experiments.[4] Second, we found that interpreting an event as emotionally negative resulted in selective memory enhancement of the accuracy of participants' memory regarding the peripheral details (when the emotion-defining detail was excluded from the analysis). This effect was clearly present in Experiment 2 and a trend in Experiment 1.

Third, when we subsequently investigated in Experiment 3 whether it was the goal-relevance/emotionality of the emotion-defining detail that produced these effects, or rather the salience associated with such details, we found that it was actually the salience that mattered. This result calls into question the previously assumed important role of emotional valence/emotionality (resulting from goal-relevance) in shaping event memory, especially in situations in which the emotional valence/emotionality of an event is triggered through the presence of such unexpected stimuli, as is the case in much previous research on the memory narrowing effect and the weapon focus effect (Burt, Watt, Mitchell, & Conway, 1998).

Fourth, all of these results emerged even though the emotion-defining detail that presumably led to their occurrence was placed at the end of the event videos. As such, the results revealed that this detail, and its subsequent influence upon emotion/emotional interpretation, affected the participants' memory retroactively. This suggests that some of the effects observed in prior studies may have been partly due to memory-based mechanisms

operating beyond the effect of attention and information processing that occurs during encoding. Relatedly, Loftus and Burns (1982) found that a shocking detail (a boy being shot in his head) presented by the end of a film led to greater retrograde forgetting of preceding details than a condition with no violent ending. The fact that no retroactive memory enhancement was seen in Loftus and Burns' (1982) violent condition may reflect the use of a more gruesome detail in their study, in contrast to the more harmless, computer-generated emotion-defining detail in the present study, as well as the fact that both their violent and non-violent conditions were negative (in some of the experiments).

The results of all three experiments revealed that participants have superior memory for the central details of an event compared to the peripheral details. While we did observe a weak interaction effect between Emotional Valence and Detail Type in the free recall data of Experiment 1, indicating the potential presence of a small memory narrowing effect, this interaction (and potential narrowing effects) did not replicate in the subsequent experiments. The fact that we observed clearer effects in the forced choice than free recall measure likely reflects the fact that the former is a more sensitive measure of participants' memory.

Broader Implications of Results

Overall, the results of this study have revealed a complicated relationship among several variables with regard to shaping the accuracy and content of event memories. When people experience an event, they may have goals or expectations that are active during the event, resulting in the experiencing of emotion (e.g., Levine & Burgess, 1997; Reisberg & Heuer, 2004; Mather, 2007). In such cases, any event details which provide information about the likelihood of a goal being attained or obstructed should contribute to the interpretation of the event as emotionally positive or negative, respectively. However, whether the resultant emotional

valence influences the accuracy and content of event details seems to largely depend on whether the valence interpretation occurs because of salient and potentially surprising emotion-defining details. Any observable memory effects may be limited to, or at least most pronounced for, situations where such details are present, especially with regard to the accuracy and content of these details themselves.

One important question is whether such emotion-defining details produce memory effects due to influences on attentional or memory-based mechanisms, or through a combination of both. Previous research has extensively demonstrated how the presence of such stimuli influences attention and subsequent information-processing strategies (e.g., Schwarz & Clore, 1983; Levine & Bluck, 2004; Kensinger, Garoff-Eaton, & Schacter, 2006; Mather, 2007; Gable & Harmon-Jones, 2010, 2011; Chipchase & Chapman, 2013). However, the results of our study indicate that at least part of the memory effects observed in previous research may also be due to memory-based mechanisms operating beyond attentional and information-processing modulations during encoding. Specifically, the presence of the emotion-defining detail in our experiments occurred only at the end of the films, with no other difference existing between the clips prior to the ending. As such, the stimulus should not have been able to influence the accuracy or content of the other central or peripheral details of the event prior to its presence if this effect were solely due to attentional processes. Future research should examine whether such retroactive memory enhancement effects also occur for naturalistic events, in line with neurobiological research on "synaptic tagging" and long-term potentiation (e.g., Frey & Morris, 1997; Dunsmoor, Murty, Davachi, & Phelps, 2015).

These results have important implications for researchers interested in the role of emotion on event memory in naturalistic settings. Researchers have argued that many of the memory

effects observed in studies of emotional valence, both for personal and non-personal event memories, often contain emotion-defining details that ultimately drive the participants' valence interpretation of the event (Laney, Heuer, & Reisberg, 2003). As our results revealed how apparent valence/emotionality effects may actually be due to the salient presence of emotion-defining details, future research that involves asking participants to produce selected autobiographical memories in response to emotion probes should also code the content produced for the presence of such salient stimuli, and whether any observable memory effects can be explained by their presence. Further, if we also claim that the effects of emotional valence we observed in Experiment 2 were actually due to the saliency of the emotion-defining detail (as the results of Experiment 3 seem to indicate), then these results intimate that saliency may have an effect beyond that associated with emotional arousal as well. This is an intriguing finding that should be further investigated.

Limitations and Conclusion

In spite of these strengths, the present work has a number of limitations. First, we used a simulated event that satisfied many requirements of a real event by involving a first-person perspective and realistic movement through space in an ordinary environment. The films were associated with high subjective ratings indicative of immersion and involvement. Nonetheless, such simulated events differ from real-life events by being considerably less self-relevant and less sensory-rich. In addition, we used computer-simulated movies rather than homemade movies, which might consequently have provided a less-realistic experience for the participants. However, if we had used video records of real life events, we would have achieved a greater degree of realism at the cost of research flexibility, and the introduction of unnecessary and confounding novelty, and likely reduced quality of the first-person perspective view.

Second, we used goal instructions that created a more-extreme scenario than participants typically experience during their daily lives. Nevertheless, this was necessary in order to ensure the participants felt engaged with the movie, and thus had an increased likelihood of experiencing a valence/an emotional response in order to test the predictions of this study. If there were any participants who secretly refused to identify with the thief, it is likely they were evenly distributed across conditions, and thus any confounding effects resulting from their presence would be equally distributed.

Third, we acknowledge that our use of the garden gate as the less salient stimulus was not the most effective means of manipulating valence in Experiment 3, as participants did not perceive the gate as negatively as the man even when so instructed. Nonetheless, we still obtained significantly different results between the Negative Valence-Low Salience and Positive Valence-Low Salience conditions, indicating the participants could interpret the gate as either positive or negative based on the instructions provided. In addition, our choice to define the effect of the man as a more "salient" stimulus is not the only possible explanation for the driving difference between the man and the gate. It could also be the case that the man was a more "unexpected" rather than a salient stimulus. We chose to describe the effect as one of salience, but we acknowledge that other possible explanations exist. Future research should continue to unpack the role of salience from expectancy.

Fourth, we used subjective measures of valence and arousal to establish the effectiveness of our manipulations. Obviously, such measures may introduce noise, and it can be debated how such subjective dimensions should be more adequately probed. Nonetheless, we believe these measures overall formed a reliable validity check for our manipulations. Still, more objective

arousal measures, such as measures of heart rate or galvanic skin response, should be considered in future research.

Finally, the use of online experiments might be seen as a limitation. Our decision to conduct the study online was based on previous research demonstrating that experimental methods conducted online to be just as effective and reliable as those conducted within a laboratory environment (e.g., Grysman, 2014; Grysman, Prabhakar, Anglin, & Hudson, 2014; Berntsen, Rubin, & Salgado, 2015; see Mason & Suri, 2011 and Buhrmester, Talaifar, & Gosling, 2018 for reviews)

In conclusion, the Simulated Event paradigm used in this series of studies provides critical insight into the complex role of emotional variables on event memory. The results revealed the important role of the effect of salience associated with emotion-defining details in mitigating previously documented effects of emotional valence/emotion in naturalistic research. Future research should examine additional emotional variables and components of emotion-defining details (such as the role of visual surprise) in shaping event memory.

Ethical Standards

The manuscript does not contain clinical studies or patient data. This study was approved by the ethics committee of the Center on Autobiographical Memory research at the Department of Psychology and Behavioural Sciences at Aarhus University, and, as such, is in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. All participants gave their informed consent prior to their inclusion in the study.

References

Anderson, R.C. & Pichert, J.W. (1978). Recall of previously unrecallable information following a shift in perspective. *Journal of Verbal Learning and Verbal Behavior, 17*, 1-12.

Bartlett, F.C. (1932). *Remembering: A study in experimental and social psychology*. London: Cambridge University Press.

Berntsen, D. (2002). Tunnel memories for autobiographical events: Central details are remembered more frequently from shocking than from happy experiences. *Memory & Cognition, 30*, 1010-1020.

Berntsen, D. & Rubin, D. (2012). *Understanding autobiographical memory: Theories and approaches.* Cambridge: Cambridge University Press.

Berntsen, D., Rubin, D.C., & Salgado, S. (2015). The frequency of involuntary autobiographical memories and future thoughts in relation to daydreaming, emotional distress, and age. *Consciousness and Cognition, 36*, 352-372.

Bluck, S. (2003). Autobiographical memory: Exploring its functions in everyday life. *Memory, 11*, 113-123.

Bluck, S., Alea, N., Habermas, T., & Rubin, D.C. (2005). A tale of three functions: The self-reported uses of autobiographical memory. *Social Cognition, 23*, 91-117.

Bohn, A. & Berntsen, D. (2007). Pleasantness bias in flashbulb memories: Positive and negative flashbulb memories of the fall of the Berlin Wall among East and West Germans. *Memory & Cognition, 35*, 565-577.

Breslin, C.W. & Safer, M.A. (2011). Effects of event valence on long-term memory for two baseball championship games. *Psychological Science, 22*, 1408-1412.

Brown, R. & Kulick, J. (1977). Flashbulb memories. *Cognition, 5*, 73-99.

Buhrmester, M.D., Talaifar, S., & Gosling, S.D. (2018). An Evaluation of Amazon's Mechanical Turk, Its Rapid Rise, and Its Effective Use. *Perspectives on Psychological Science, 13*, 149-154.

Burt, C.D.B., Watt, S. C., Mitchell, D.A., & Conway, M.A. (1998). Retrieving the sequence of autobiographical event components. *Applied Cognitive Psychology, 12*, 321-338.

Chipchase, S.Y. & Chapman, P. (2013). Trade-offs in visual attention and the enhancement of memory specificity for positive and negative emotional stimuli. *The Quarterly Journal of Experimental Psychology, 66*, 277-298.

Compton, R. J. (2003). The interface between emotion and attention: A review of evidence from psychology and neuroscience. *Behavioral and Cognitive Neuroscience Reviews*, *2*, 115-129.

Conway, M.A. (2005). Memory and the self. *Journal of Memory and Language, 53*, 594-628.

Dunsmoor, J.E., Murty, V.P., Davachi, L. & Phelps, E.A. (2015). Emotional learning selectively and retroactively strengthens memories for related events. *Nature*. doi: 10.1038/nature14106

Fredrickson, B. L. & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought action repertoires. *Cognition and Emotion, 19*, 313-332.

Frey, U. & Morris, R.G.M. (1997). Synaptic tagging and long-term potentiation. *Nature, 385*, 533-536.

Gable, P. & Harmon-Jones, E. (2010). The motivational dimensional model of affect: Implications for breadth of attention, memory, and cognitive categorization. *Cognition and Emotion, 24*, 322-337.

Gable, P.A. & Harmon-Jones, E. (2011). Attentional consequences of pregoal and postgoal

positive affects. *Emotion, 11*, 1358-1367.

Grysman, A. (2014). The roles of gender and temporal distance in the recall of dissonant self-related memories. *Consciousness and Cognition, 29,* 10-22.

Grysman, A., Prabhakar, J., Anglin, S. M., & Hudson, J. A. (2014). Self-enhancement and the life script in future thinking across the lifespan. *Memory, 22.*

Heuer, F. & Reisberg, D. (1990). Vivid memories of emotional events: The accuracy of remembered minutiae. *Memory & Cognition, 18,* 496-506.

Holmes, E.A. & Bourne, C. (2008). Inducing and modulating intrusive emotional memories: A review of the trauma film paradigm. *Acta Psychologica, 127,* 553-566.

Kensinger, E.A. (2007). How negative emotion affects memory accuracy: Behavioral and neuroimaging evidence. *Current Directions in Psychological Science, 16,* 213-218.

Kensinger, E.A. (2009). Remembering the details: Effects of emotion. *Emotion Review, 1,* 99-113.

Kensinger, E.A., Garoff-Eaton, R.J., & Schacter, D.L. (2006). Memory for specific visual details can be enhanced by negative arousing content. *Journal of Memory and Language, 54,* 99-112.

Kensinger, E.A. & Schacter, D.L. (2006a). When the Red Sox shocked the Yankees: Comparing negative and positive memories. *Psychonomic Bulletin and Review, 13,* 757-763.

Kensinger, E.A. & Schacter, D.L. (2006b). Amygdala activity is associated with the successful encoding of item, but not source, information for positive and negative stimuli. *Journal of Neuroscience, 26,* 2564-2570.

Laney, C., Campbell, H.V., Heuer, F., & Reisberg, D. (2004). Memory for thematically arousing events. *Memory & Cognition, 32,* 1149-1159.

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

Levine, L. J. & Bluck, S. (2004). Painting with broad strokes: Happiness and the malleability of event memory. *Cognition and Emotion, 18*, 559-574.

Levine, L.J. & Burgess, S.L. (1997). Beyond general arousal: Effects of specific emotions on memory. *Social Cognition, 15*, 157-181.

Levine, L.J. & Edelstein, R.S. (2009). Emotion and memory narrowing: A review and goal-relevance approach. *Cognition and Emotion, 23*, 833-875.

Levine, L. J. & Pizarro, D. A. (2004). Emotion and memory research: A grumpy overview. *Social Cognition, 22*, 530-554.

Loftus, E.F. & Burns, T.E. (1982). Mental shock can produce retrograde amnesia. *Memory & Cognition, 10*, 318-323.

Luminet, O. & Curci, A. (2009). *Flashbulb memories: New issues and new perspectives*. Hove: Psychology Press.

Mason, W. & Suri, S. (2012). Conducting behavioral research on Amazon's Mechanical Turk. *Behavioral Research Methods, 44*, 1–23.

Mather, M. (2007). Emotional arousal and memory binding: An object-based framework. *Perspectives on Psychological Science, 2*, 33-52.

Mather, M. & Sutherland, M.R. (2011). Arousal-biased competition in perception and memory. *Perspectives on Psychological Science, 6*, 114-133.

Ochsner, K. N. (2000). Are affective events richly recollected or simply familiar? The experience and process of recognizing feelings past. *Journal of Experimental Psychology: General, 129*, 242-261.

Pillemer, D. B. (1992). Remembering personal circumstances: A functional analysis. In E. Winograd & U. Neisser (Eds.), *Affect and accuracy in recall: Studies of "flashbulb" memories* (pp. 236-264). New York: Cambridge University Press.

Reisberg, D. & Heuer, F. (2004). Memory for emotional events. In D. Reisberg & P. Hertel (Eds.), *Memory and emotion* (pp. 3-41). New York: Oxford University Press.

Rubin, D.C. (2005). A basic systems approach to autobiographical memory. *Current Directions in Psychological Science, 14*, 79-83.

Rubin, D.C. (2006). The basic-systems model of episodic memory. *Perspectives on Psychological Science, 1*, 277-311.

Rubin, D.C. & Umanath, S. (2015). Event memory: A theory of memory for laboratory, autobiographical and fictional events. *Psychological Review, 122*, 1-23.

Schwarz, N. & Clore, G.L. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality & Social Psychology, 45*, 513-523.

Talarico, J. M., Berntsen, D., & Rubin, D. C. (2009). Positive emotions enhance recall of peripheral details. *Cognition and Emotion, 23*, 380-398.

Van Bergen, P. & Salmon, K. (2011). Attachment and emotion knowledge in development. In J. Low & P. Jose (Eds.), *Lifespan development: New Zealand perspectives*. Auckland: Pearson.

Zacks, J. M. & Swallow, K.M. (2007). Event segmentation. *Current Directions in Psychological Science, 16*, 80-84.

Footnotes

1. The choice of this story as part of our materials did not reflect any sympathy with burglars or thieves, or any other illegal activity. Rather, the story was chosen to create an emotional event that was not offensive (e.g., through the use of highly upsetting scenes or images). We followed the example of Anderson and Pichert (1978), who likewise asked the participants to view a story from the point of view of a potential burglar.
2. As there was never a significant difference across conditions in any of the experiments with regard to critical lures, we will not be discussing them further. Since the participants were demonstrating near-ceiling effects of accuracy regarding these questions, we can consider them as another manipulation check demonstrating that participants were indeed paying careful attention to the video during encoding.
3. In order to determine if our Positive Valence condition was positive with respect to the neutral rating on the scale used in this study to assess emotional valence, we conducted one-sample *t*-tests for both the Positive and Negative Valence conditions, where we compared the mean of participants' self-reported emotional valence of each condition to the neutral rating of the scale. The results of these tests demonstrated that both conditions significantly differed from the neutral rating point (i.e., the midpoint of 4 on a 7 point Likert-type scale) in their respective directions on the rating scale (Positive Valence Condition: $M = 5.02$, $SD = 1.48$, $t(99) = 6.87$, $p < .001$; Negative Valence Condition: $M = 2.75$, $SD = 1.70$, $t(99) = -7.37$, $p < .001$).
4. Of course, one cannot rule out the possibility that the central details included in this study were remembered better because of potentially greater inherent saliency of (some of) these details. However, many of the details identified as "central" would most likely not have been

considered salient if they were not relevant to the goal of being a thief (e.g., the flat-screen TV in the living room, which was not particularly unique, but could be considered a desirable object for a thief to steal). Of course, distinguishing between the effects of the inherent saliency of details and their increased salience as a result of being goal-relevant is beyond the scope of this study.

5. In order to ensure that the only difference between the saliency conditions was participants' accuracy regarding the critical final detail of the man/gate, we examined participants' accuracy regarding the final detail (man vs. gate) compared to the mean of their accuracy for all of the other central detail questions combined (excluding the final detail question). The results revealed there were no differences between the conditions in terms of participants' accuracy for all of the central detail except for the man and gate (*M_Positive* = .66, *M_Negative* = .65). However, as previously reported, participants in the Negative Valence condition were significantly more accurate regarding the final detail of the man (*M* = .84) compared to those in the Positive Valence condition regarding the final detail of the garden gate (*M* = .35).

Notice: This is the author's version of a work that was accepted for publication in *Psychological Research.* A definitive version was subsequently published in *Psychological Research.* DOI: 10.1007/s00426-019-01215-0

Table 1

Phenomenological questions with rating scale/anchor points

---

1. (Imagine) How easy was it to imagine yourself as a thief? (1 = *Very difficult*, 7 = *Very easy*).
2. (Immersion) How immersed did you feel in the situation while watching the video? (1 = *Very disengaged*, 7 = *Very immersed*).
3. (Identify) How much did you identify with the role of the thief? (1 = *Did not identify at all*, 7 = *Identified completely*).
4. Arousal
    a. (Anxiety) How much anxiety did you feel during the video? (1 = *Very little anxiety*, 7 = *Extreme anxiety*).
    b. (Heart Rate) How much did your heart race during the video? (1 = *Not at all*, 7 = *The entire time*).
5. (Valence) Imagining yourself in the role of the thief, how would you describe the emotional state of the thief at the end of the video? (1 = *Very negative*, 7 = *Very positive*).
6. (Startle) How often did you experience a startle moment during the video (e.g., where you jumped slightly)? (1 = *Never*, 7 = *Very often*).

Note. Arousal = A composite variable consisting of the anxiety and heart rate variables combined together.

Table 2

Experiment 1 means, (standard deviations), t-*values, and (degrees of freedom) of phenomenological questionnaire variables*

Variable	Negative Valence	Positive Valence	*t*-values (*df*)
Imagine	5.67 (1.35)	5.62 (1.38)	0.26 (198)
Immersion	5.95 (1.09)	5.93 (1.11)	0.13 (198)
Identify	4.35 (1.88)	4.24 (1.89)	0.41 (198)
Arousal	6.80 (3.62)	6.21 (3.43)	1.18 (198)
Valence	2.75 (1.70)	5.02 (1.48)	10.07*** (198)
Startle	3.07 (1.74)	2.30 (1.60)	3.26*** (198)

Note. * = p < .05, ** = p < .01, *** = p < .001

Table 3

Experiment 2 means, (standard deviations), and F-*values of phenomenological questionnaire variables*

Variable	HA-Negative	HA-Positive	LA-Negative	LA-Positive	Valence	Arousal	Interaction
	M SD	M SD	M SD	M SD	F(1,380)	F(1,380)	F(1,380)
Imagine	5.42 (1.45)	5.67 (1.40)	5.34 (1.62)	4.90 (1.63)	0.40	7.30**	5.00*
Immersion	5.97 (1.02)	5.92 (1.18)	5.74 (1.17)	5.66 (1.27)	0.32	4.23*	0.02
Identify	4.53 (1.64)	4.49 (1.90)	4.17 (1.80)	3.91 (1.91)	0.66	6.52*	0.35
Arousal	8.40 (3.36)	8.33 (3.71)	7.35 (3.91)	6.28 (3.87)	2.24	16.62***	1.77
Valence	1.80 (1.19)	5.34 (1.52)	2.77 (1.45)	5.28 (1.44)	444.65***	9.97**	12.91***
Startle	3.17 (1.76)	3.22 (1.82)	3.50 (1.87)	2.30 (1.62)	10.08**	2.61	12.00***

Note. HA = High Arousal, LA = Low Arousal, Negative = Negative Valence, Positive = Positive Valence; * = $p < .05$, ** = $p < .01$, *** = $p < .001$

Table 4

Experiment 3 means, (standard deviations), and F-*values of phenomenological questionnaire variables*

Variable	Incon-High	Incon-Low	Con-High	Con-Low	Congruent	Salience	Interaction
	M SD	M SD	M SD	M SD	F(1,396)	F(1,396)	F(1,396)
Imagine	5.36 (1.58)	5.44 (1.59)	5.38 (1.56)	5.07 (1.77)	1.16	0.50	1.44
Immersion	5.72 (1.36)	5.87 (1.19)	5.54 (1.31)	5.52 (1.33)	4.17*	0.25	0.43
Identify	4.03 (1.94)	4.26 (1.98)	4.20 (1.86)	3.75 (1.95)	0.77	0.32	3.10
Arousal	7.57 (3.46)	6.39 (3.51)	6.21 (3.78)	7.25 (3.84)	0.47	0.04	9.24**
Valence	1.88 (1.17)	4.36 (1.73)	4.40 (1.84)	5.16 (1.70)	103.82***	98.88***	27.87***
Startle	3.36 (1.81)	2.32 (1.71)	2.59 (1.75)	2.57 (1.57)	2.31	9.59**	8.88**

Note. Incon = Incongruent, Con = Congruent, High = High Salience, Low = Low Salience; * = $p < .05$, ** = $p < .01$, *** = $p < .001$

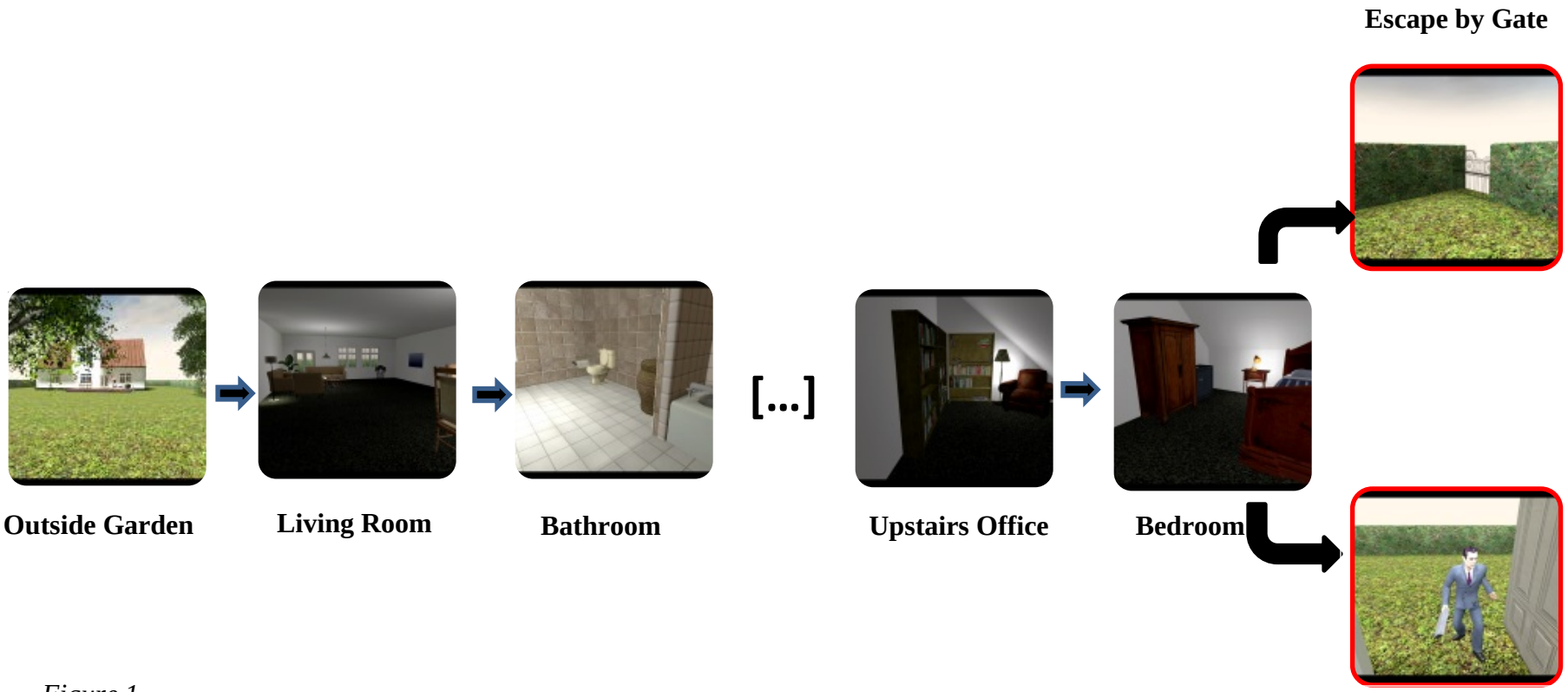

Figure 1.

A schematic representation of the progression of the first-person perspective film. The two film versions are identical, except for the last scene, Escape by Gate (positive condition in Studies 1 and 2, low salience condition in Study 3) and Meet Man (negative condition in Studies 1 and 2, high salience condition in Study 3).

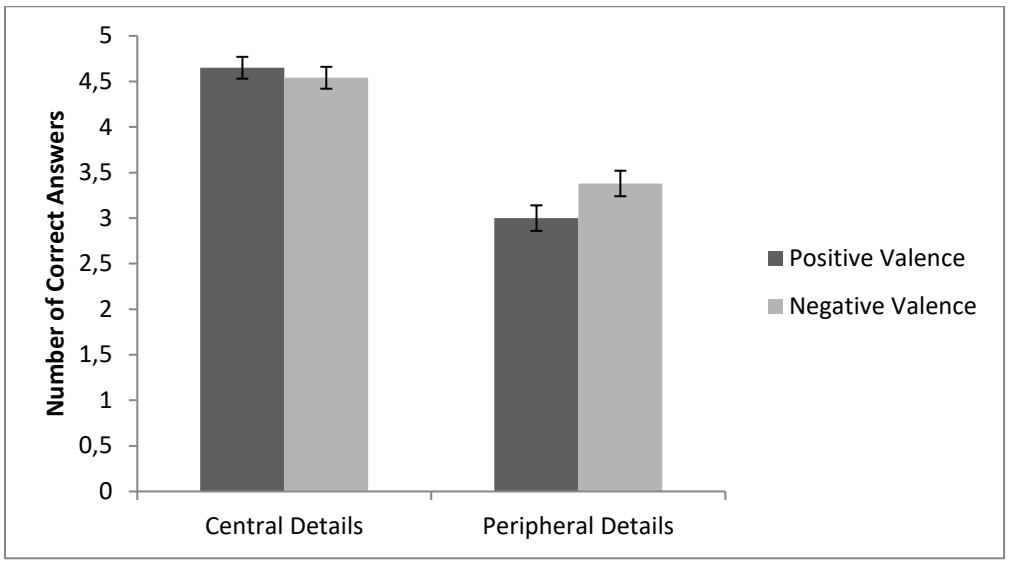

Figure 2. Experiment 1 accuracy of central and peripheral details.

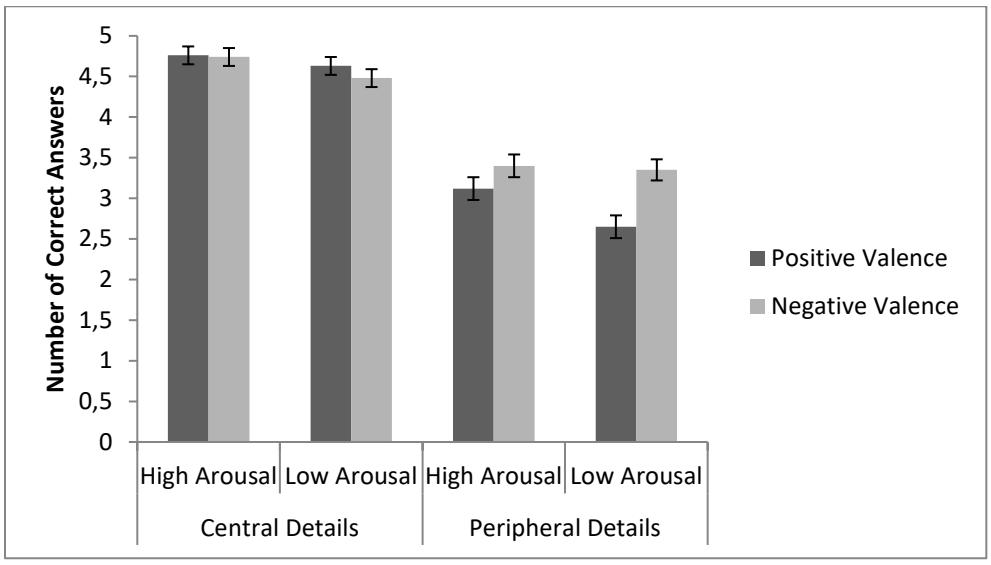

Figure 3. Experiment 2 accuracy of central and peripheral details.

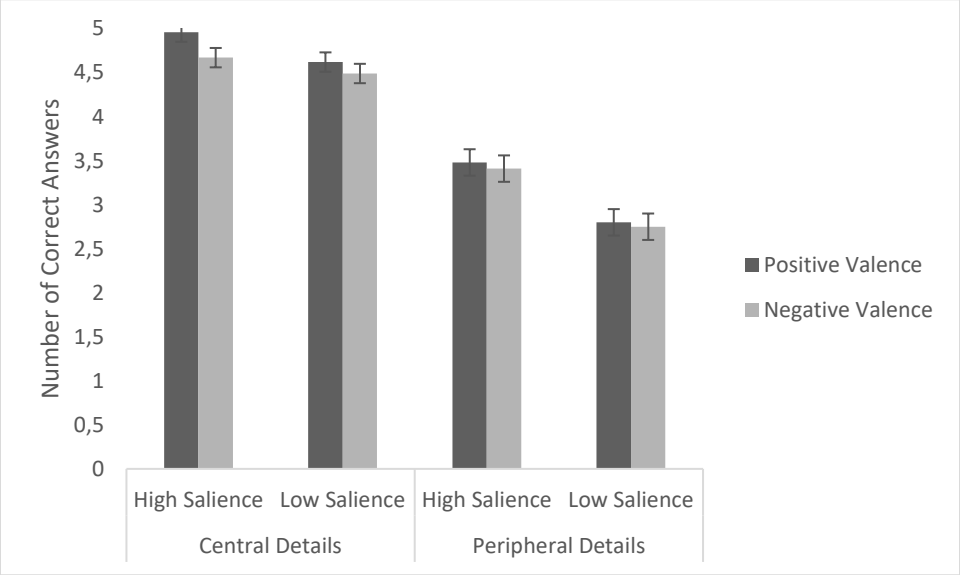

Figure 4. Experiment 3 accuracy of central and peripheral details. Note that '*Positive Valence'* refers to the Goal Congruent conditions, while '*Negative Valence'* refers to the Goal Incongruent conditions.