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Reality monitoring and memory distortion: Effects of negative, arousing content

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Although individuals often claim to vividly remember negatively arousing information, few studies have been performed to examine whether this emotional information is remembered more accurately than nonemotional information. In the present study, we investigated whether the emotional content of items modulates the accuracy with which individuals make reality-monitoring decisions. Participants (young adults, 18–35 years of age) distinguished imagined from seen words (Experiments 1 and 3A) or objects (Experiments 2 and 3B). Half of the items studied in each condition (presented and imagined) were negative and arousing, and half were neutral. The participants mistook imagined items for presented ones, but the number of reality-monitoring errors was lower for the arousing items than for the neutral items. Negative, arousing items appear to be remembered with contextual detail more frequently than are neutral items, leading memory for this emotional information to be less prone to distortion than is memory for neutral information. Thus, negative arousal can enhance not only the subjective vividness of a memory, but also a memory's accuracy.

It is often difficult to distinguish between instances in which an item was imagined and those in which it was actually presented. *Reality monitoring* refers to the set of processes that allow this discrimination of external and internal sources of events (Johnson & Raye, 1981). In everyday life, this ability is critical for answering nagging questions such as the following: Did I lock the door behind me? Or did I only imagine locking it? In the laboratory, such distinctions must be made when individuals experience some events and imagine others and then, later, must attribute each event to the proper source (see, e.g., Finke, Johnson, & Shyi, 1988; Henkel, Johnson, & De Leonardis, 1998). The task is a difficult one because both event types are familiar: To successfully discriminate the event types, individuals must determine the source of an item's familiarity (internally generated vs. externally presented).

To accurately assign information to an internal or external source, individuals appear to take advantage of the fact that different types of information tend to be differentially remembered for actual and imagined events. Experienced events often include more sensory, contextual, and semantic information, whereas imagined events contain more information regarding cognitive operations (Johnson & Hirst, 1993; Johnson & Raye, 1981). Remembering these characteristics (e.g., the sensation of holding the key while locking the front door) typically is associated with accurate memory attributions, but reality-monitoring errors sometimes can occur. Evidence to support this framework has come from a number of lines of research. For one, manipulations that narrow the gap with regard to the details associated with experienced versus imagined events (e.g., vividly imagining an event, so that the event includes rich perceptual information, or generating an imagined item automatically, so that limited cognitive operations are employed) tend to increase the likelihood of reality-monitoring errors (see, e.g., Henkel et al., 1998; Johnson, Foley, & Leach, 1988; Johnson, Raye, Foley, & Foley, 1981; Mammarella & Cornoldi, 2002). In contrast, manipulations that enhance differences between imagined and experienced events (e.g., including object use as part of a performed action) reduce the frequency of reality-monitoring errors (Sussman, 2001). Second, individuals who have difficulties remembering event details (e.g., older adults) make reality-monitoring errors with greater frequency than do individuals who do not have such difficulties (e.g., younger adults; Chalfonte & Johnson, 1996; Hashtroudi, Johnson, & Chrosniak, 1990; Johnson, De Leonardis, Hashtroudi, & Ferguson, 1995). Third, memory distortions are reduced when retrieval orientation promotes a response on the basis of item-specific information, rather than on the basis of familiarity alone (see Johnson, Hashtroudi, & Lindsay, 1993; Schacter, Norman, & Koutstaal, 1998). Therefore, the ability to remember contextual details of the encoding episode appears to be critical for reality-monitoring performance.

The goal of the present experiment was to examine what effect the emotional salience of information would

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have on reality-monitoring ability. Individuals often claim to remember arousing events vividly and in great detail. *Flashbulb memories* are an extreme example, with individuals believing that they remember specific contextual details of a surprising and arousing event, such as where they were and what they were wearing, even years after the event occurred (e.g., R. Brown & Kulik, 1977). Even in laboratory settings, however, emotional content increases the vividness of memory: Individuals are more likely to state that they vividly *remember* pictures and words if they have negative content than if they are void of emotional meaning (Dewhurst & Parry, 2000; Kensinger & Corkin, 2003; Ochsner, 2000).

Although it is clear that emotional experiences seem to be remembered richly, there can be dissociations between the subjective vividness and the objective accuracy of a memory for an arousing event. For example, individuals often change their reports about how they first learned of an emotional event, while retaining high confidence in their memory. In fact, there often is little correlation between an individual's confidence in a memory and the consistency of that memory (Neisser & Harsch, 1992; Schmolck, Buffalo, & Squire, 2000; Talarico & Rubin, 2003). In the laboratory, enhanced *remember* responses, indicating a subjectively vivid memory for an item, often occur without an enhancement in *old–new* discrimination of emotional items (Ochsner, 2000; Sharot, Delgado, & Phelps, 2004), leading some researchers to propose that the negative, arousing content of information increases primarily the subjective richness associated with a memory, but not its objective accuracy (e.g., Sharot et al., 2004).

In some instances, however, memories for emotional information (and in particular, negatively emotional information) are more likely to contain contextual details. For example, individuals are more likely to remember the color of font or the spatial location of an emotional word, as compared with a neutral word (D'Argembeau & Van der Linden, 2004; Doerksen & Shimamura, 2001). Contextual information presented in a sentence also can be more likely to be remembered if the sentence is negative, as opposed to when it is neutral (Kensinger, Anderson, Growdon, & Corkin, 2004; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002; but see Maratos & Rugg, 2001).

Given the reliance of reality-monitoring ability on the ability to remember contextual information (e.g., sensory, perceptual, and semantic information for presented events and information about cognitive operations for imagined events; Johnson & Raye, 1981), it would follow that stimuli that are more likely to be remembered with contextual details would be less prone to misattribution. Thus, if contextual elements present at encoding are more likely to be remembered for negative, arousing items, this should boost an individual's ability to distinguish internally generated from externally generated information. If, in contrast, arousal primarily enhances the subjective vividness of a memory but does not influence the accuracy of the contextual details remembered, reality-monitoring performance should not be better for the arousing words than for the nonarousing words.

The couple of studies in which memory distortion for emotional and neutral information has been looked at have supported the conclusion that emotional information is less likely to be falsely remembered than is neutral information. When participants study words related to nonpresented neutral lures (e.g., *sink*, *pink*, and *wink*, related to *rink*) or emotional lures (e.g., *cape*, *tape*, and *nape*, related to *rape*), they are less likely to falsely recognize (Pesta, Murphy, & Sanders, 2001) or falsely recall (Kensinger & Corkin, 2004a) the emotional lures than the neutral lures. However, in these studies, the majority of the studied items were neutral. Thus, the design did not allow a distinction between effects of emotional salience and effects of conceptual incongruence: The fact that the lures were emotional also made them conceptually inconsistent with the words presented at study (see Kensinger & Corkin, 2004a, for further discussion). It is possible that when similar proportions of emotional and neutral items are studied, there is no memory accuracy benefit for the emotional items.

The present experiments were designed so that half of the studied items were negative, arousing items and half were neutral. Therefore, differential illusory memory rates should not result from a conceptual incongruence of the arousing items but, instead, should stem from the arousing nature of the items. The present study addressed whether the negative, arousing content of items would reduce the frequency with which an individual would misremember information, using reality-monitoring paradigms with viewed or imagined words (Experiments 1 and 3A) or objects (Experiments 2 and 3B). We focused on negative, arousing stimuli for several reasons. First, in the bulk of the research on memory for contextual details of emotional events, negative public events (e.g., *flashbulb memories*) or real-life experiences (e.g., the *weapon focus* effect) have been focused on. Similarly, negatively valenced stimuli have been used in the laboratory (e.g., Kensinger et al., 2002; Kensinger & Corkin, 2003). Second, the studies in which memory for negative and positive stimuli has been compared have shown that the two valences may differentially affect the processes related to memory formation (Dolcos & Cabeza, 2002) and the frequency with which information is vividly remembered (Ochsner, 2000). Third, we wanted to select emotional stimuli relatively high in arousal, and it is easier to find high-arousal negative words and objects than high-arousal positive words and objects.

EXPERIMENT 1

In the first experiment, the participants performed a letter height decision task (adapted from H. D. Brown, Kosslyn, Breiter, Baer, & Jenike, 1994): They indicated whether the first letter of a word was shorter than the last letter. Half of the words were presented both aurally and visually. The other words were presented aurally but not visually, requiring the participants to form a mental image of the word to perform the letter height task. At retrieval, the participants were asked to indicate which items had been visually presented. Thus, they had to distinguish the words that had been externally presented (on the computer screen) from those internally generated (mentally imagined). Reality-monitoring errors occurred when the individuals mistakenly said that an item that they had imagined had been visually presented. By manipulating the emotional content of the words, we could investigate whether this likelihood of misattribution was affected by whether or not the information was arousing.

Experiment 1 also included two encoding conditions: an incidental one, in which the participants were not instructed that their memory would later be tested, and an intentional one, in which the participants were informed that they would be required to indicate whether words had been externally presented. This instruction manipulation allowed investigation of the effects of negative arousing content on memory when individuals did and did not know that the ability to discriminate internal from external sources would be tested. We reasoned that if relatively automatic processes influence the ability to remember the source (internal or external) of a negative arousing item's presentation, memory accuracy should differ for the emotional and the neutral items on the incidental task. In contrast, if voluntary engagement of attentional processes modulates memory accuracy for the arousing items, memory for those items might be disproportionately altered with the intentional encoding task. This manipulation of encoding instructions seemed important, given recent evidence that for some types of contextual information (color of font), the memory benefit for emotional words can be greater with incidental encoding instructions than with intentional ones (D'Argembeau & Van der Linden, 2004). We wanted to examine whether this influence of encoding instructions would exist within a reality-monitoring paradigm.

Method

Participants

The participants were 32 native English-speaking Harvard University undergraduate or graduate students (18 females and 14 males;[1] age range = 18–30 years; mean age = 21.3). Half of the participants were given the incidental encoding task, and half were given the intentional encoding task. No participant had a history of depression or was currently depressed, and no one was taking centrally acting medications. Participation required approximately 45 min, and the participants were compensated with $7 or course credit. The participants provided informed consent in a manner approved by Harvard University's Committee on the Use of Human Subjects.

Materials and Design

The stimuli were 128 words. Half were negative and arousing, and half were neutral. The words were selected from the Affective Norms for English Words database (ANEW; Bradley & Lang, 1999) and from words used in a prior investigation (Kensinger & Corkin, 2003). Negative words (e.g., *rape* or *slut*) had an average valence rating of 3.0 (SD = 1.1) and an average arousal rating of 6.2 (SD = 1.0). Neutral words had an average valence rating of 5.8 (SD = 0.96) and an average arousal rating of 3.9 (SD = 0.67).[2] Valence and arousal rating scales ranged from 1 to 9 (lower numbers indicate *more negative* and *less arousing*, respectively). Negative and neutral words were all four letters in length and did not differ significantly in word frequency, familiarity, or concreteness (Coltheart, 1981).

The stimuli were divided into two sets of 64 words each (32 arousing and 32 neutral). The set used was counterbalanced across participants. The two sets did not differ significantly in word frequency, familiarity, or concreteness (Coltheart, 1981), and the emotional words from the two sets did not differ significantly in valence or arousal ratings.

Of the 64 words, 48 (24 arousing and 24 neutral) were presented at study. The remaining 16 words (8 arousing and 8 neutral) were used as foils on the recognition test. The words presented at study, versus those used as foils at recognition, were randomized across participants. At study, all the words were presented aurally (via headphones). Concurrent with the auditory presentation, the participants saw either the word written in lowercase letters (e.g., *bomb*) or a line (_____) indicating that they should imagine what the word would look like if written in lowercase. The condition in which the words were presented (visual presentation or mental imagery) was counterbalanced across participants.

Because the participants performed a letter height decision task, we counterbalanced the letter heights of the emotional and the neutral words. For each emotion–modality category, six items had first letters that were shorter than the fourth letter (e.g., *slut*), two had first and fourth letters that were both short (e.g., *rape*), two had first and fourth letters that were both tall (e.g., *fish*), and two had a first letter that was taller than the fourth letter (e.g., *toes*). The participants responded *yes* only to items for which the first letter was shorter than the last and *no* to all the other items. Thus, six items in each emotion–modality combination required a *yes* response, and six required a *no* response. Four buffer items (two requiring a *yes* response and two a *no* response; not included in the number tallies above) were placed at the beginning and end of the study list.

Procedure

Incidental study phase. The participants were told that they would be performing a task of visual imagery ability. They were informed that some of the items would be emotional, because we were interested in how the emotional content of items affected cognitive processing. The participants heard a series of 48 words (24 arousing and 24 neutral) pronounced over a headset. Simultaneously, they saw either the word written on the screen (e.g., *rape*) or a blank line (___). The words were evenly divided between the two presentation conditions (visual presentation and mental imagery) in such a way that 12 arousing and 12 neutral words were studied in each condition. The words were pseudorandomly intermixed, so that no more than 4 words of a given presentation or emotion condition were presented together. The participants had a maximum of 6 sec to indicate whether the height of the first letter of the word was lower than the height of the fourth letter of the word (if written in lowercase). They pressed a key labeled "Y" when the first letter was lower in height and a key labeled "N" when the first letter was of a height equal to or greater than that of the last letter of the word. As soon as the participant made his or her response, a fixation cross (+) was presented until the start of the next trial. Reaction times to make the letter height decision were measured.

Test phase. Immediately after completion of the study phase, the participants were given a surprise recognition test, in which they indicated whether or not the words had been visually presented at study. Thus, both heard/imagined words and new words received the same response. They were presented with 64 words (the 48 studied words, 8 new arousing words, and 8 new neutral words).

Intentional study and test phases. The procedure for the intentional study and test phases was identical to that for the incidental ones, with the exception that the participants were warned before the study phase that a memory test would follow and that they would be required to indicate which words had been visually presented.

Data Analysis

The memory measures of interest were the proportions of correct attributions (i.e., correctly indicating that an item had been visually presented) and misattributions (i.e., incorrectly attributing an imagined item to visual presentation). To analyze the effects of emotion on these attribution rates, an ANOVA was conducted with item type[3] (negative arousing or neutral) and response type (correct attribution or misattribution) as within-subjects factors. The critical questions were whether an interaction between item type and response type would emerge and whether that interaction would result from enhanced accuracy for the arousing items (i.e., increased rates of correct attribution to visual presentation and decreased rates of misattribution to visual presentation) or from reduced accuracy for arousing items. Encoding instruction (incidental or intentional) was included as a between-subjects factor in order to examine whether this variable would influence the interaction between item type and response type.

Results

The ANOVA revealed an effect of response type [$F(1,30) = 43.04$, $p < .001$; partial $\eta^2 = .59$], due to the fact that correct attribution rates were higher than misattribution rates, along with the critical interaction between item type and response type [$F(1,30) = 24.05$, $p < .001$; partial $\eta^2 = .45$]. This interaction emerged because the participants showed lower misattribution rates for negative arousing words than for neutral words [$t(15) = 2.47$, $p < .05$, with incidental encoding; $t(15) = 2.38$, $p < .05$, with intentional encoding] and higher correct attribution rates for negative arousing words than for neutral words [$t(15) = 2.97$, $p < .01$, with incidental encoding; $t(15) = 2.33$, $p < .05$, with intentional encoding; see Table 1]. There was an interaction between encoding instruction and response type [$F(1,30) = 6.35$, $p < .05$; partial $\eta^2 = .18$]: Misattributions were lower and correct attributions were higher with the intentional encoding instructions than with the incidental encoding instructions (see Table 1). The instructions did not, however, interact with the effects of item type. There was no interaction between instruction and item type and no three-way interaction between instruction, item type, and response type.

The effect of negative arousal on memory accuracy did not stem from differences in processing time at encoding: An ANOVA conducted on the reaction times during the encoding phase indicated no effect of item type and no interactions with item type ($p > .2$). The effect also was not due to a general bias in memory: Misattribution rates did not differ for new arousing and new neutral items ($p > .2$; see Table 1).

Table 1
Experiment 1: Reality Monitoring as a Function of Encoding Condition and Emotional Content

Emotion	Correct Attribution *M*	Correct Attribution *SE*	Misattribution *M*	Misattribution *SE*	Baseline False Alarm *M*	Baseline False Alarm *SE*
Incidental Encoding						
Negative arousing	.58	.06	.41	.06	.08	.03
Neutral	.45	.05	.55	.05	.08	.02
Intentional Encoding						
Negative arousing	.66	.06	.31	.06	.08	.03
Neutral	.57	.06	.41	.06	.08	.03

Note—Correct attribution rates reflect assignment of a *viewed* response to a visually presented word. Misattribution rates indicate assignment of a *viewed* response to a mentally imagined word. Baseline false alarm rates signify assignment of a *viewed* response to a nonstudied word.

Discussion

The results of Experiment 1 support the conclusion that reality-monitoring errors occur less frequently for negative arousing items than for neutral ones. Although individuals did make some errors with negative items, believing that they had seen a word that, in reality, they mentally imagined, such errors occurred more frequently for neutral words.

The finding that memory for negative arousing items is less prone to distortion than is memory for neutral items is consistent with results from an associate list paradigm used to elicit false memories (Kensinger & Corkin, 2004a; Pesta et al., 2001), suggesting that the effect holds across a range of paradigms. Furthermore, the effect does not appear to result only when the emotional items are conceptually incongruent with the items present at study: In the present design, half of all the studied words were negative. Thus, the enhanced accuracy for these items could not be due to general differences in expectations about how many emotional items were imagined or presented.

The data from the present experiment also are consistent with prior data suggesting that individuals are more likely to remember contextual elements present during encoding of emotional, as compared with neutral, verbal stimuli (D'Argembeau & Van der Linden, 2004; Doerksen & Shimamura, 2001). Presented items that are remembered with contextual details (such as the visual percepts present at encoding) may be more easily distinguished from imagined items (Johnson et al., 1993). Similarly, remembering information present during an imagined event (e.g., the cognitive operations performed) should assist in rejecting the item as a presented one. Thus, the enhanced reality monitoring for the negative items is consistent with the improved source-monitoring ability shown in these prior studies. These data indicate that negative arousal does not merely enhance subjective vividness, while having no effect on memory accuracy; rather, across a range of paradigms, arousing words appear to be less prone to memory distortion than are nonarousing words.

The encoding instructions (incidental or intentional) did not affect the interaction between emotion and response type. In both conditions, correct attribution rates were higher and misattribution rates were lower for the negative arousing words than for the neutral words. This finding suggests that the ability to remember contextual details of negative information may occur even when intentional strategies are not engaged. There may be relatively automatic processes that facilitate the encoding of contextual details (see, also, Bush & Geer, 2001; Kensinger & Corkin, 2004b). It is also plausible that retrieval strategies are particularly important in mediating the effect. Prior studies have shown that when participants require retrieval of source information before determining whether an object was presented, reality-monitoring errors occur less frequently than in conditions in which participants may be more likely to make assignments on the basis of familiarity (Johnson et al., 1993; Schacter et al., 1998). Perhaps individuals are more likely to adopt a source retrieval strategy when retrieving information about negative arousing words, as compared with neutral words.

Regardless of the exact mechanisms, the results of Experiment 1 indicated that reality-monitoring performance was better for negative arousing words than for neutral words. An open question was whether this finding would generalize to another type of stimulus. The studies that have shown better source memory for emotional information have used single words (Doerksen & Shimamura, 2001; Kensinger & Corkin, 2003) or sentences (Kensinger et al., 2002). Perhaps there is something particular about verbal emotional stimuli (e.g., the fact that they must be processed to a relatively high level before their emotional salience can be ascertained) that leads to the source memory enhancement. To examine whether the findings of Experiment 1 would generalize to a different paradigm, using a different type of stimulus, Experiment 2 assessed reality-monitoring ability for negative and neutral objects.

EXPERIMENT 2

In Experiment 2, we used a design (adapted from Gonsalves & Paller, 2000) that would assess reality-monitoring ability for single objects. Object names (e.g., *cabbage*) were presented, and the participants were asked to form a mental image of the object in order to decide whether it would fit inside a shoebox. Half of the named objects were then visually presented. At retrieval, the participants distinguished items that had been visually presented from those that had not.

Method

Participants

The participants (12 women and 8 men) were native English speaking Harvard undergraduate or graduate students (age range = 19–25 years; mean age = 21.5). Task completion required two sessions, each lasting approximately 0.5 h, and the participants were remunerated at $10/h for their participation. The methods were approved by the Harvard University Committee on the Use of Human Subjects.

Materials

Materials included 450 concrete words (half negative and arousing and half neutral) and 450 photo object depictions of the named objects. Images were taken from a photo clip art package (Hemera Co.) and from www.clipart.com and depicted a single object (e.g., a frog or a snake) void of any background. Images were formatted using PicStationX, so that they were 300 pixels in their longest dimension.

Words and pictures were judged for arousal by a group of 20 young adults (10 men; 18–35 years of age). Half of the words and objects were high in arousal, receiving scores greater than 2.5 (mean for words = 2.96, mean for pictures = 3.07) on a scale of −5 to +5 (negative values indicated that an item was *calming* or *soothing*, and positive values indicated that an item caused *excitement* or *agitation*). The other half of the words and objects were neutral, receiving arousal ratings lower than +1 (mean for pictures = 0.67, mean for words = 0.59).

Numerous dimensions were controlled between the negative and the neutral items, in order to lessen the concern that factors aside from the negative, arousing content could underlie performance differences. Negative and neutral images were matched for category membership so that they contained similar numbers of people, animals, or buildings/landscapes. Negative images were taken primarily from the categories of *animals*, *clothing*, *weapons/crime*, *funeral*, *hospital/medical*, and *professions*. Neutral images were taken primarily from the categories of *animals*, *clothing*, *tools*, *holiday*, *restaurant*, and *professions*. Items were selected so that a similar number of items were taken from each category. Category membership was ascertained on the basis of the listing in the clip art package. Negative and neutral words were matched pairwise for word length, word frequency, and word imageability (Coltheart, 1981), so that there were no overall differences on any of these dimensions.

Design

Study phase. The participants were instructed that they were performing a task assessing mental imagery ability and emotional processing. At study, 300 words (150 emotional and 150 neutral) were presented on the computer screen, each for 2 sec. Half of the words (75 emotional and 75 neutral) were followed by a blank square for 2 sec (*word-only* trials), and half of the words were followed by their corresponding photo object for 2 sec (*word-plus-picture* trials). The items shown on word-only versus on word-plus-picture trials were counterbalanced across participants.

The participants made a buttonpress to indicate whether each word named an object that was bigger or smaller than a shoebox (the participants were shown the shoebox prior to the start of the study phase). They were told that the task was assessing mental imagery performance and that they should, therefore, use mental imagery to perform the size judgment task. Subsequent debriefing indicated that all the participants successfully formed mental images of the objects within the allotted time. No response was required to the pictures or rectangles.

Test phase. After a 2-day delay,[4] the participants returned to the laboratory and performed a surprise recognition test. Debriefing indicated that no participant believed that his or her memory would be assessed. The participants were presented with words via a headset (auditory word files were downloaded from www.ldc.upenn.edu/cgi-bin/aesl/aesl) and were asked to make buttonpresses to indicate whether they had seen a picture corresponding to the item. Thus, new items and items that had only been mentally imagined required a *no* response. The recognition test included all 300 studied items, plus 50 novel arousing items and 50 novel neutral items from the same categories as the items studied and 25 novel arousing and 25 novel neutral items from unstudied categories. The items included as categorical lures versus as studied items were randomized across participants. The recognition test was self-paced.

Results

An ANOVA was computed with response type (false alarm to an unrelated item, false alarm to a categorically related item, misattribution of a word-only item, or correct attribution of a word-plus-picture item) and item type (negative or neutral) as within-subjects factors. This ANOVA revealed a significant effect of response type [$F(3,57) = 71.74$, $p < .001$; partial $\eta^2 = .79$], stemming from the participants' higher rates of correct attribution, as compared with misattributions [for negative items, $t(19) = 8.49$, $p < .001$; for neutral items, $t(19) = 5.74$, $p < .001$]. There was no effect of item type [$F(1,19) = 0.23$, $p > .6$; partial $\eta^2 = .01$], but there was a significant interaction between response type and item type [$F(3,57) = 9.42$, $p < .001$; partial $\eta^2 = .33$]. The interaction resulted because misattribution rates (to word-only items) were significantly higher for neutral items than for negative arousing items [$t(19) = 3.4$, $p < .01$], whereas correct attributions (to word-plus-picture items) were significantly higher for arousing than for neutral items [$t(19) = 4.02$, $p < .001$; see Table 2]. There was no effect of item type on the baseline false alarm rates for items that were unrelated to those presented at study [$t(19) = 0.17$, $p > .8$] or for items that were categorically related [$t(19) = 0.48$, $p > .6$].

Discussion

The results of Experiment 2 replicated and extended the critical findings of Experiment 1. The participants showed improved reality-monitoring ability for objects with emotional content, as compared with those devoid of emotional salience. Thus, memory for emotional items appears to be less prone to at least some types of memory distortion. This finding is not constrained to tasks including only verbal stimuli but also extends to a task in which reality-monitoring ability is assessed for single objects.

A potential drawback of Experiments 1 and 2 was that the participants were given only two options at retrieval: The item was presented, or the item was not presented. This design prevents separation of item recognition from source attribution (presented or imagined) scores (see Murnane & Bayen, 1996, for a discussion). In order to distinguish item recognition from source recognition rates, we carried out variations of Experiments 1 and 2 in which the participants were given three choices at retrieval: The item was presented, the item was imagined, or the item was never studied.

EXPERIMENT 3A

Method

Participants

The participants in Experiment 3A (8 women and 8 men) were native English speaking Harvard University undergraduate or graduate students (age range = 20–28 years; mean age = 21.9).

Materials and Design

The materials and design were identical to those described in Experiment 1, with the exception that the participants were given the three choices at retrieval. Because the encoding instructions had not influenced the effect of emotion on memory performance in Experiment 1, only the incidental encoding instructions were administered.

Results

To examine whether Experiment 3A would replicate the main finding of Experiment 1, an ANOVA was conducted on the response rates uncorrected for item recognition. This analysis considered the effects of response type (correct attribution or misattribution), item type (negative arousing or neutral), and condition type (presented or imagined) as within-subjects factors, revealing significant effects of item type [$F(1,15) = 9.56$, $p < .01$; partial $\eta^2 = .39$] and response type [$F(1,15) = 31.66$, $p < .001$; partial $\eta^2 = .68$]. The ANOVA also showed the critical interaction between item type and response type [$F(1,15) = 36.6$, $p < .001$; partial $\eta^2 = .71$], due to the fact that correct attribution rates were higher and misattribution rates were lower for the negative arousing words than for the neutral words (see Table 3). An interaction also was present between item type and condition type [$F(1,15) = 8.37$, $p < .05$; partial $\eta^2 = .36$], with a greater effect of item type for the imagined items than for the presented items (see Table 3).

The three-choice recognition decision allowed computation of source memory performance conditional upon item recognition (a *conditionalized source identification measure*; see Durso, Reardon, & Jolly, 1985; Marsh & Bower, 1993; Murnane & Bayen, 1996). It was important to examine this measure because item recognition rates were higher for the negative arousing items than for the neutral items [$t(15) = 3.21$, $p < .01$]. An ANOVA conducted on the conditional source measures with item type (negative or neutral) and condition (presented or imagined) as within-subjects factors indicated a significant effect of item type [$F(1,15) = 24.6$, $p < .001$; partial $\eta^2 = .62$] and no effect of condition or interaction between item type and condition. The effect of item type resulted because source memory was more accurate for the negative arousing items than for the neutral items [$t(15) = 4.96$, $p < .001$; see Table 3].

The effects of negative arousal on memory did not stem from differences in processing time at encoding: An ANOVA conducted on the reaction times during the encoding phase indicated no effect of item type and no interactions with item type ($p > .3$). The effect also was not due to a general bias in memory: An ANOVA conducted on the false alarm rates indicated only a marginal effect of condition type [$F(1,15) = 3.24$, $p < .10$; partial $\eta^2 = .18$],

Table 2
Experiment 2: Effect of Emotional Content on Reality-Monitoring Ability

	Correct Attribution		Misattribution		Baseline False Alarm (Categorically Related)		Baseline False Alarm (Categorically Unrelated)	
Emotion	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Negative arousing	.64	.04	.37	.06	.21	.04	.04	.01
Neutral	.58	.04	.42	.05	.20	.04	.04	.01

Note—Correct attribution rates signify assignment of a *viewed* response to a visually presented object. Misattribution rates reflect assignment of a *viewed* response to a mentally imagined object. Baseline false alarm rates indicate assignment of a *viewed* response to a nonstudied item.

Table 3
Experiment 3A: Memory Scores as a Function of Encoding Condition and Emotional Content

	Negative Arousing				Neutral			
	Presented		Imagined		Presented		Imagined	
Memory Score	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Correct attribution	.63	.05	.66	.06	.48	.05	.45	.07
Misattribution	.14	.03	.20	.05	.17	.04	.28	.06
Conditionalized source	.72	.04	.75	.06	.57	.04	.62	.08
	Novel				Novel			
	M	*SE*			*M*	*SE*		
False alarm, presented	.14	.06			.14	.04		
False alarm, imagined	.06	.03			.09	.03		

reflecting the fact that the individuals were more likely to believe that a nonstudied item had been visually presented than that it had been imagined (see Table 3). There was no effect of item type and no interaction between emotion type and condition type.

EXPERIMENT 3B

Method

Participants

The participants for this study consisted of 16 native English speaking Harvard undergraduate, graduate, or summer school students (age range = 18–28 years; mean age = 21.3).

Materials and Design

The materials were identical to those in Experiment 2. The design was identical to that in Experiment 2, with the following exceptions: The participants were given three choices at retrieval (the corresponding object was presented, the corresponding object was only imagined, or the corresponding object was never studied), and the delay between study and test was reduced to 1 day (vs. 2 days in Experiment 2).

Results

To examine whether the results of Experiment 3B would replicate those of Experiment 2, an ANOVA was conducted with item type (negative or neutral), response type (correct attribution or misattribution), and condition (presented or imagined) as within-subjects factors. The analyses revealed an effect of item type [$F(1,15) = 9.9$, $p < .01$; partial $\eta^2 = .40$], response type [$F(1,15) = 114.6$, $p < .001$; partial $\eta^2 = .88$], and condition [$F(1,15) = 18.2$, $p < .001$; partial $\eta^2 = .55$], as well as the critical interaction between item type and response type [$F(1,15) = 100.4$, $p < .001$; partial $\eta^2 = .87$]. The interaction emerged because, as in Experiment 2, the participants showed more correct attributions for the negative arousing items than for the neutral ones [$t(15) = 5.8$, $p < .001$, for presented items; $t(15) = 4.0$, $p < .001$, for imagined items] but fewer misattributions for the negative arousing items than for the neutral items [$t(15) = 4.5$, $p < .001$, for presented items; $t(15) = 3.1$, $p < .01$, for imagined items; see Table 4]. No other interactions were significant, although there was a marginal interaction between response type and condition [$F(1,15) = 3.4$, $p < .09$; partial $\eta^2 = .19$] and between item type, response type, and condition [$F(1,15) = 3.8$, $p < .07$; partial $\eta^2 = .20$].

As in Experiment 3A, item recognition was higher for the negative items than for the neutral items [$t(15) = 2.5$, $p < .05$]. To examine whether this difference in item memory accounted for the effects of emotion on the correct attribution and misattribution rates, an ANOVA was conducted on the source memory scores conditional upon item recognition. This analysis revealed a significant effect of item type [$F(1,15) = 59.7$, $p < .001$; partial $\eta^2 = .80$], an effect of condition [$F(1,15) = 7.9$, $p < .05$; partial $\eta^2 = .34$], and no interaction. The effect of item type reflected the fact that source memory was greater for the

Table 4
Experiment 3B: Memory Scores as a Function of Emotional Content

	Negative Arousing				Neutral			
	Presented		Imagined		Presented		Imagined	
Memory Score	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Correct attribution	.71	.02	.70	.02	.58	.04	.63	.02
Misattribution	.18	.01	.10	.01	.28	.02	.15	.08
Conditionalized source	.79	.03	.87	.05	.66	.05	.81	.02
	Novel				Novel			
	M	*SE*			*M*	*SE*		
False alarm, presented	.04	.01			.04	.01		
False alarm, imagined	.17	.01			.19	.02		

negative arousing items than for the neutral items [$t(15) = 4.6$, $p < .001$, for the presented items; $t(15) = 3.4$, $p < .01$, for the imagined items], whereas the effect of condition was due to the fact that source memory tended to be higher in the imagined condition than in the presented condition, for both negative arousing [$t(15) = 2.2$, $p < .05$] and neutral [$t(15) = 2.8$, $p < .05$] items.

The effects of negative arousal did not appear to be due to differences in response bias: An ANOVA conducted on the false alarm rates revealed an effect of condition [$F(1,15) = 27.5$, $p < .001$; partial $\eta^2 = .65$], due to the higher proportion of false alarms attributed to an imagined than to a presented source [$t(15) = 5.6$, $p < .001$, for the negative items; $t(15) = 4.5$, $p < .001$, for the neutral items], but no effect of item type (partial $\eta^2 = .03$) and no significant interaction (partial $\eta^2 = .08$).

Discussion

The results from Experiments 3A and 3B supported the conclusion from Experiments 1 and 2: The participants' memories for the negative arousing items were more accurate than their memories for the neutral items. Furthermore, the finding of fewer reality-monitoring errors for the negative arousing items held even when source memory was calculated as the proportion of correctly recognized items for which the participant made the correct source judgment. Thus, the memory benefit did not stem solely from differences in the frequency with which individuals recognized the arousing and neutral items as studied.[5] In the General Discussion section, we will elaborate on the processes that may support improved memory accuracy for emotional information.

GENERAL DISCUSSION

Across four experiments, reality-monitoring errors occurred less frequently for negative arousing items than for neutral items. Coupled with the results of prior studies, these findings suggest that negative, arousing content not only can increase the probability that presented information will be remembered vividly (see, e.g., Kensinger & Corkin, 2003; Ochsner, 2000), but also can reduce the probability that memory for presented items will be distorted. Items with negative arousal appear to be remembered with additional contextual information, facilitating participants' assignment of a memory to an imagined or presented source and reducing the frequency of reality-monitoring errors.

Memory distortion for emotional versus neutral information has been investigated previously with associate lists (Kensinger & Corkin, 2004a; Pesta et al., 2001). In the design of Pesta and colleagues, the participants studied phonological associates of neutral and emotional lure items. These lure words were never studied, yet the participants falsely recognized a significant proportion of the items. Critically, the participants were less likely to recognize the emotional lures than the neutral lures. Thus, the results of the present study are broadly consistent with those of Pesta and colleagues: Arousing items were less likely to be falsely remembered than were neutral ones.

The design of the present experiments extends the finding of Pesta et al. (2001) in an important way: In the present investigation, equal numbers of neutral and negative arousing items were studied (vs. the design of Pesta and colleagues, in which the majority of studied items were neutral). Because arousing and neutral items occurred with equal frequency in the present experiments, the reduced memory distortion for the arousing items cannot be attributed to a general conceptual distinctiveness stemming from the relative infrequency of emotional items at study. Rather, the effect appears to stem more specifically from the arousing content of the items.

It has been proposed previously that emotional items may be more likely to be bound together with at least some contextual details (e.g., Doerksen & Shimamura, 2001; Heuer & Reisberg, 1990), and the results of the present study are consistent with this proposal. Enhanced binding would lead to an increase in item-specific information that could combat reality-monitoring errors in a number of ways. It could allow participants the critical information needed to assign a memory to the proper source (internal generation vs. external presentation). As was discussed in the introduction, perceived and imagined events typically differ in the degree to which different types of information are associated with the item's presentation: Perceived items are remembered with greater sensory detail, whereas memories for imagined items typically contain more information about the cognitive operations performed (Johnson et al., 1993). Subsequent retrieval of these contextual details often will allow assignment of an item to the appropriate source. Therefore, reality-monitoring errors for emotional items may have been reduced because the individuals remembered the critical features necessary for distinguishing presented from imagined events (e.g., sensory, perceptual, or semantic details; Johnson et al., 1993).

Enhanced item-specific information also could prevent stimulus confusion. For example, having studied a picture of a tomato but only the word *apple*, a participant might at retrieval confuse the two events (e.g., remember seeing a red, circular food on the computer screen and incorrectly conclude that a picture of an apple was presented; see Henkel et al., 1998). In contrast, this confusion may result less frequently for emotional items if they tend to be remembered with more detail, allowing them to be distinguished from other items.

The fact that the behavioral effects of arousal were equally strong with incidental and intentional encoding instructions suggests that the effects of arousal on memory occur relatively automatically, without engagement of intentional encoding strategies. Individuals may orient their attention toward aspects of emotional events that will later allow correct assignment to internal or external sources, and these contextual elements also may be more likely to be bound together into a stable memory (see Hamann, 2001).

An alternate hypothesis is that the increased memory accuracy for the negative arousing information may simply reflect the general tendency for manipulations that increase the overall level of memory performance to also decrease the incidence of memory errors and distortions (i.e., the *mirror effect*; see, e.g., Glanzer & Adams, 1990). Recent neuroimaging evidence, however, has suggested that the enhancement in memory accuracy for emotional items does not stem from domain-general processes that enhance accuracy for all items. Rather, activation in emotion-processing regions was related to memory accuracy specifically for emotional, but not for neutral, items: Activity in the amygdala and orbitofrontal cortex (regions selectively engaged during the encoding of emotional information) was related to the formation of emotional memories that were later remembered accurately, rather than in a distorted fashion (Kensinger & Schacter, 2005). These findings suggest that the way in which emotional information is processed increases the likelihood of accurate memory attribution.

CONCLUSIONS

In summary, individuals were able to discriminate perceived and imagined items more accurately when those items were negative and arousing than when they were not. This finding emerged regardless of encoding instructions (incidental or intentional) and occurred with both verbal stimuli and single objects. Future studies will be required to elucidate the range of stimulus types and task designs for which this effect will hold; for example, it is plausible that for items with moderate arousal levels, such as those used here, binding is enhanced, whereas for items with higher arousal, binding is reduced (see, e.g., Christianson, 1992; Deffenbacher, 1983). Nevertheless, the results of the present study indicate that memory for negative arousing information can be less prone to distortion than is memory for neutral information. Thus, negative arousal can enhance not only the subjective vividness of a memory (Dewhurst & Parry, 2000; Kensinger & Corkin, 2003; Ochsner, 2000), but also the likelihood that contextual details will be remembered.

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NOTES

1. Analyses revealed no effects of gender in any experiment, so the results from men and women are combined.

2. The participants in this experiment also rated the valence and arousal of the words after completion of the test phase. Their classifications of the words agreed with those from the ANEW database.

3. We also examined whether, within the group of arousing words, items that received higher arousal ratings were less likely to be misattributed than items receiving lower arousal ratings. No such relation existed. This null result must be interpreted cautiously, since it could stem from methodological factors (e.g., arousal ratings after the test phase may not correspond precisely with arousal elicited upon first presentation of the word). It is also plausible, however, that the effects of arousal on memory do not vary systematically within the range of arousal levels elicited by these stimuli.

4. We calibrated the number of study items and the study–test delay to ensure that memory was above chance but that sufficient rates of reality-monitoring errors, nevertheless, occurred (we did not want low rates of memory errors to obscure effects of emotion). For Experiments 1 and 3A, an immediate recognition test was chosen because longer delays reduced correct attribution rates to near-chance levels. For Experiments 2 and 3B, pilot testing indicated that delays of less than 3 h led to relatively few memory errors, whereas delays of 1 or 2 days led to higher rates of memory misattributions (and delays of 1 and 2 days resulted in similar misattribution rates).

5. This finding does not necessitate that the strength of item memory was comparable for the arousing and the neutral items (see Ochsner, 2000), but it does suggest that the source memory benefit was not due solely to the fact that people recognized more arousing items as having been studied.

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