Psychology and Aging
2005, Vol. 20, No. 2, 241–250

0882-7974/05/$12.00 DOI: 10.1037/0882-7974.20.2.241

Memory for Contextual Details: Effects of Emotion and Aging

Elizabeth A. Kensinger
Massachusetts Institute of Technology and Athinoula A.
Martinos Center for Biomedical Imaging

Olivier Piguet and Anne C. Krendl
Massachusetts Institute of Technology

Suzanne Corkin
Massachusetts Institute of Technology and Athinoula A. Martinos Center for Biomedical Imaging

When individuals are confronted with a complex visual scene that includes some emotional element, memory for the emotional component often is enhanced, whereas memory for peripheral (nonemotional) details is reduced. The present study examined the effects of age and encoding instructions on this effect. With incidental encoding instructions, young and older adults showed this pattern of results, indicating that both groups focused attention on the emotional aspects of the scene. With intentional encoding instructions, young adults no longer showed the effect: They were just as likely to remember peripheral details of negative images as of neutral images. The older adults, in contrast, did not overcome the attentional bias: They continued to show reduced memory for the peripheral elements of the emotional compared with the neutral scenes, even with the intentional encoding instructions.

Compared with the long history of studies investigating memory for neutral information, research examining memory for emotional events is in its infancy. Laboratory studies have demonstrated that in many instances, participants are more likely to remember that they have encountered emotional stimuli than neutral stimuli (see reviews by Buchanan & Adolphs, 2002; Hamann, 2001), and the vividness of their memories is also increased for emotional items (Heuer & Reisberg, 1990; Kensinger & Corkin, 2003; Ochsner, 2000). Similarly, in everyday life, anecdotal evidence indicates that individuals remember emotional information better than neutral information (e.g., Brown & Kulik, 1977). This generally improved memory for emotional material has been termed the *emotional enhancement effect.*

Elizabeth A. Kensinger and Suzanne Corkin, Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology and Athinoula A. Martinos Center for Biomedical Imaging; Oliver Piguet and Anne C. Krendl, Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology.

Portions of the data described here were presented at the annual meeting of the Society for Neuroscience, New Orleans, Louisiana, November 2003. This research was supported by National Institutes of Health Grant AG021525. Elizabeth A. Kensinger was supported by a Howard Hughes Medical Institute Predoctoral Fellowship and a Massachusetts Biomedical Research Corporation Tosteson Postdoctoral Fellowship, and she is now supported by National Institutes of Health Grant MH070199. Olivier Piguet is supported by a National Health and Medical Research Council Neil Hamilton Fairley Postdoctoral Fellowship (ID 222909).

We thank Martine Lamy and Bess Rouse for stimulus creation and assistance with testing and data management. We thank Fredda Blanchard-Fields, Colleen Parks, and Lee Wurm for helpful comments on an earlier version of this article.

Correspondence concerning this article should be addressed to Elizabeth A. Kensinger, NE20-392, 77 Massachusetts Avenue, Cambridge, MA 02139. E-mail: ekensing@alum.mit.edu

Most investigations of emotional memory have been limited to samples of young adults. Thus, whether emotional memory changes across the life span remains an open question. Some studies have revealed intact emotional memory enhancement in aging (e.g., Denburg, Buchanan, Tranel, & Adolphs, 2003; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002; Krendl, Kensinger, & Corkin, 2003), with older adults showing enhancement effects of a magnitude similar to that of young adults on tasks using verbal and nonverbal stimuli. In contrast, other reports have suggested that older adults may show altered memory enhancement for emotional information. Most of these studies have assessed "flashbulb memories" of emotionally salient (usually negative) public events (e.g., Cohen, Conway, & Maylor, 1994; Davidson & Glisky, 2002). One laboratory study, however, also demonstrated an age-related alteration in the emotional memory enhancement effect (Charles, Mather, & Carstensen, 2003). In that study, older adults did not show enhanced memory for negative as compared with neutral information, but they did show a memory benefit for positive information. The authors suggested that older adults may focus less on the negative information encountered in daily life and more on the positive information (Carstensen, Fung, & Charles, 2003).

The reasons for the contradictory findings with regard to the effects of emotional memory in aging remain unclear. A couple of possibilities are likely. One has to do with the necessity of retrieving vivid memories: In general, older adults have particular difficulties remembering information in vivid detail or with contextual associations (e.g., Craik & McDowd, 1987; Mantyla, 1993; Rugg & Morcom, 2005; Spencer & Raz, 1995). Thus, it is possible that the instances in which age-related deficits in emotional memory are most pronounced are those that require the recollection of detailed, vivid memories (of which flashbulb memory studies would be one example).

Another possible explanation regards the aspects of emotional experiences that are better remembered across the life span. Even in young adults, not all details of emotional events are remembered equally well. In fact, emotion does not always enhance memory, and there are circumstances in which emotional salience produces memory decrements. For example, individuals sometimes do not remember details of an event that immediately precedes an emotional one (Loftus & Burns, 1982), and they are more likely to forget words that appeared just before infrequently presented emotional items (Strange, Hurleman, & Dolan, 2003).

The most commonly investigated emotional memory decrement pertains to memory for peripheral details compared with central details. Emotional arousal appears to cause a narrowing of attention and a resulting inattention to peripheral details. Thus, memory for the central, arousing details of a scene is enhanced, whereas memory for the peripheral, nonarousing information is reduced (often referred to as the *trade-off* effect; e.g., Jurica & Shimamura, 1999; Safer, Christianson, Autry, & Oesterlund, 1998). In everyday life, this effect of emotional arousal has been termed the *weapon-focus* effect (Loftus, 1979): Witnesses to a crime will often be able to remember the weapon from the crime (e.g., the gun) but not other details (e.g., the perpetrator's face, the getaway vehicle). Easterbrook (1959) articulated the processes underlying this effect. His model postulated a relation between emotional arousal and attentional resources. He predicted that a threatening stimulus would increase emotional arousal, which, in turn, would decrease the attentional resources available for information processing, restricting the focus of attention to the arousal-eliciting stimulus. As a consequence, the likelihood of remembering the information central to the source of the emotional arousal would increase, whereas the probability of remembering peripheral details would be reduced. This hypothesis has been substantiated in laboratory replications of the weapon-focus effect. Participants spend a disproportionate amount of time looking at a weapon in a scene (e.g., a gun), and this exploration time is inversely related to subsequent identification of peripheral information, such as the perpetrator (Loftus, Loftus, & Messo, 1987). More broadly, the presence of any emotional component in a scene can reduce the likelihood that other, nonemotional elements of the scene are remembered (see review by Buchanan & Adolphs, 2002): Individuals will be more likely to remember those nonemotional elements if they occur in a neutral scene than if they occur in a scene with an emotional component.

If aging affects this attentional focus on negative information (e.g., Carstensen, Pasupathi, Mayr, & Nesselroade, 2000), it could follow that older adults would not show a memory trade-off between central and peripheral details in negative scenes. That is, older adults may be less likely to focus on the negative elements of the scenes and more likely to encode the nonemotional peripheral elements. Alternatively, one could argue that older adults should show an attentional focus similar to that of the young adults. The attentional focus on emotional information is likely to be mediated, at least in part, by the amygdala. This hypothesis is supported by a few lines of evidence. First, whereas healthy individuals show an enhanced ability to detect emotional stimuli when they are presented in a complex visual display (Ohman, Flykt, & Esteves, 2001) or when they occur in the attentional blink (Anderson & Phelps, 2001; Chun & Potter, 1995; Raymond, Shapiro, & Arnell, 1992), patients with damage to the amygdala do not show these effects (e.g., Anderson & Phelps, 2001). Second, patients with bilateral amygdala damage do not show the emotional memory trade-off (Adolphs, Denburg, & Tranel, 2001). Structural changes in the amygdala associated with aging are minimal, and amygdalar function is thought to remain relatively preserved across the life span (see review by Mather, 2003). Thus, to the extent that amygdalar function underlies the emotional effects, older adults may be expected to show the same focusing of attention, and the same memory trade-off effect, as young adults.

No prior study has examined memory for central and peripheral details in young and older adults. There has, however, been a prior demonstration that aging can leave intact both enhancing and impairing effects of emotional content on memory. Denburg and colleagues (2003) had young and older adults study photographs. The participants were then given different types of memory tasks (free recall, cued recall, forced-choice recognition). The logic was that memory for gist-based information, proposed to be enhanced for emotional information (Adolphs et al., 2001), would be sufficient to allow correct recall responses, whereas memory for visual detail, proposed to be impaired for emotional information, would be required to make correct recognition decisions (because the recognition foils were similar in content to the target). Denburg and colleagues reported that young and older adults showed a similar pattern of results: Both age groups had better memory for negative information when assessed via recall but poorer memory for the negative information when assessed via recognition. These results suggest that healthy aging can preserve not only the enhancing effects of emotion (e.g., Kensinger et al., 2002; Kensinger, Anderson, Growdon, & Corkin, 2004) but also at least some of the detrimental effects.

The present investigation examined the emotional memory trade-off frequently discussed in the emotional memory literature: enhanced memory for central details and impaired memory for peripheral details of emotional scenes (Christianson, 1992; Easterbrook, 1959; Jurica & Shimamura, 1999; Loftus, Loftus, & Messo, 1987; Safer, Christianson, Autry, & Oesterlund, 1998). The goal of this study was to examine how encoding instructions (intentional or incidental) affected memory for central and peripheral details of neutral and emotional scenes and whether the pattern of results differed in young and older adults. Toward this goal, young and older adults studied pictures of scenes that differed in one key element (e.g., tumbleweed in the road vs. a dead cat in the road; see the Appendix). Participants then took a recognition test in which they viewed fragments from the scene (e.g., the tumbleweed, the dead cat, the road) and indicated whether they had studied the fragment earlier and whether they vividly "remembered" the fragment, or "knew" that they had seen the fragment, but lacked a vivid memory of its presentation.

This design allowed us to assess a number of questions. First, how would the emotional content of the item (e.g., the dead cat vs. the tumbleweed) affect memory for that central element? Second, how would the emotional content of the central element affect memory for the peripheral element (e.g., the road)? We hypothesized that in young adults, memory would be better for the central elements of emotional scenes than of neutral scenes (e.g., participants would be more likely to remember the dead cat than the tumbleweed) and poorer for peripheral details of emotional compared with neutral scenes (e.g., participants would be less likely to remember the road if it occurred in the scene with the dead cat than if it occurred in the scene with the tumbleweed). Because the negative and neutral scenes were identical except for the central element, we were able to compare memory for the central elements (negative vs. neutral) and for the peripheral elements (of a negative scene vs. a neutral scene). Differences in memory for the negative central element (dead cat) versus the neutral central element (tumbleweed) would result from differences in the emotional content of the component. Differences in memory for the peripheral element (the road) would reflect differential encoding focus (or attention) toward the central element of the scene. Thus, if participants showed better memory for the negative central elements than for the neutral central elements but poorer memory for the peripheral elements included in the negative scenes than for those same elements included in the neutral scenes (i.e., demonstrated the trade-off effect), this pattern would suggest that participants had been more likely to focus encoding processes on the central elements of the negative scenes and less likely to focus such processes on the peripheral[1] elements.

Although we expected that older adults would show overall poorer memory, particularly in the ability to vividly "remember" the fragments, the critical question was whether aging would affect this pattern of results. In other words, would older adults show the same memory trade-off as young adults?

Experiment 1A: Incidental Encoding Instructions

Method

Participants. The participants were 26 young adults (12 men, 14 women; mean age = 24.54 ± 4.2 years) and 24 older adults (13 men, 11 women; mean age = 72.17 ± 5.7 years) with normal or corrected visual acuity. Young participants were undergraduate or graduate students at the Massachusetts Institute of Technology (MIT). Older participants were drawn from an existing database of healthy individuals enrolled in cognitive and neuroimaging studies at MIT or recruited through flyer distribution and local social clubs. Older and young participants did not differ with respect to level of education. All participants were screened for the presence of depression and neurologic and cardiovascular diseases, and they did not take medication that affected cognitive functioning and alertness. All participants gave informed consent to take part in the study and were remunerated at the rate of $10/hr. This study was reviewed and approved by the MIT Committee on the Use of Humans as Experimental Subjects.

Materials. Stimuli consisted of 40 pairs of stimuli, in which one member of the pair was neutral and one member of the pair was negative (for a total of 80 pictures, 40 neutral and 40 negative). Neutral and negative pairs were created by modifying pictures from the International Affective Picture System (Lang, Bradley, & Cuthbert, 1998). This set comprises 700 pictures rated for valence and arousal by a large normative sample. The selected pictures included a mixture of landscapes, people, animals, and objects. Each of the 40 pictures contained one central element (which was either negative or neutral[2]) and one peripheral element (which was always neutral[3]). We created a second version of each original picture by modifying the central element in order to change the valence (and arousal) of the picture. If the original picture was neutral, we changed the central element to create a negative picture; if the original picture was negative, we changed the central element to make it neutral (see the Appendix for examples). Thus, we had a total of 80 pictures (40 original and 40 manipulated).

These stimuli were rated by 20 young (ages 18–30) and 20 older (ages 60–80) adults for valence and arousal. Each dimension was rated on a 7-point scale (−3 to 3). For valence, negative values indicated that the picture was negative or unpleasant, and positive values indicated that the picture was positive or pleasant. For arousal, negative values indicated that the picture was soothing, calming, or relaxing, whereas positive values indicated that the picture was exciting or agitating. Negative pictures were rated by young and older adults as being both more negative and more arousing than the neutral pictures (see Table 1), and the neutral pictures were rated near the midpoints of the valence and arousal scales (i.e., they were neither positive nor negative and neither calming nor exciting). There were no differences in the ratings obtained by the young and older adults: An analysis of variance (ANOVA) indicated a main effect of emotion type, $F(1, 72) = 26.50$, $p < .01$, rating type, $F(1, 72) = 319.60$, $p < .01$, and an interaction between the two, $F(1, 72) = 214.00$, $p < .01$, but no main effect of age nor any significant interactions (all $Fs[1, 72] < 3.0$, $ps > .10$). Because the neutral pictures consisted of a neutral central element plus a peripheral element, the ratings for the neutral pictures assured us that the peripheral elements were all neutral. Differences in the valence and arousal ratings of the scenes therefore reflected the change in the central element (because the peripheral element was always identical for the two pictures in a pair).

The 80 pictures were divided into two sets of 40 pictures each (20 negative and 20 neutral). Each set constituted only one version of each picture. Both sets of pictures were used for the study and recognition tasks. Stimulus set allocation at the time of the study was randomly determined across participants; the other set was used as foils for the recognition task.

Procedure. At the time of the study, participants saw the pictures on a computer screen. Each picture was presented for 2 s with a 3-s intertrial stimulus interval. The order of presentation was randomized. For each stimulus, participants were instructed to indicate whether they wanted to approach or move away from the picture. Following an interval of approximately 15 min filled with unrelated tasks, participants were given a surprise recognition test. At recognition, participants saw 160 picture fragments: 40 previously seen central elements (20

[1] The terms *central* and *peripheral* do not refer to the spatial location of the picture element but rather to the element's relation to the source of the emotional arousal (see Adolphs et al., 2001, for further discussion).

[2] Although memory for positive scenes is also of great interest, we focused on negative scenes for a few reasons. First, most research on young adults' memories for details of emotional events has focused on negative public events (e.g., "flashbulb memories") or real-life experiences (e.g., "weapon-focus" effect) or have used negatively valenced stimuli in the laboratory. Second, the studies that have compared memory for negative and positive stimuli have found that the two valences may differentially affect the processes related to memory formation (Dolcos & Cabeza, 2002; Ochsner, 2000). Third, if positive and negative scenes were to be compared, it is important that they be similarly arousing, and it is difficult to create a large number of negative and positive scenes that are equally arousing.

[3] We thank a reviewer for pointing out that some of these peripheral elements were "object-like," and others were more of a "background." Because it was plausible that the emotional content of the central item differentially affected memory for peripheral objects vs. peripheral backgrounds, we analyzed the data separately based on the two types of peripheral items. The pattern of results was similar for both peripheral types; thus, the present study reports results combining all of the peripheral items together.

Table 1
Mean Valence and Arousal (SE) of the Negative and Neutral Pictures

Participant	*n*	Valence		Arousal	
		Neutral	Negative	Neutral	Negative
Young adults	20	−0.23 (.03)	−2.43 (.04)	0.86 (.03)	2.45 (.03)
Older adults	20	0.10 (.01)	−2.80 (.01)	0.60 (.03)	2.20 (.02)

Note. Valence and arousal scales each ranged from −3 to 3. Negative values indicated negative valence, or low arousal, and positive values reflected positive valence, or high arousal.

negative, 20 neutral), 40 central elements of the alternate (unstudied) versions of the pictures (20 negative, 20 neutral), 40 peripheral elements of the pictures (20 from negative scenes, 20 from neutral scenes), and 40 new (never seen before) picture elements. For each stimulus, participants had to indicate whether the picture fragment was *new* (never seen before) or *old* (seen previously). In addition, for *old* responses, participants indicated whether they had a clear recollection of the picture (*remember*) or rather a feeling of familiarity (*know*; see Yonelinas, 2002, for a review of this distinction). Participants were given detailed instructions, modeled after those given in Rajaram's (1993) study, of the remember–know distinction. In short, participants were instructed to respond "remember" when they had a vivid memory of the actual presentation of the scene in which the fragment had been included. "Know" responses were to be given when participants were sure that they had seen the fragment before but did not vividly remember its actual presentation at the time of the study. The remember–know procedure was used because it has been shown previously that individuals are often more likely to vividly remember emotional information (Kensinger & Corkin, 2003; Ochsner, 2000), even in instances in which overall recognition rates (saying that the item was presented) are similar for emotional and neutral items. The recognition phase was self-paced and took 10–15 min.

Data analysis. Recognition scores were corrected for the presence of false alarms (i.e., calling a picture fragment old when it was new). The correction for false-alarm rate takes into account a person's response bias—for example, some participants more than others may adopt more stringent criteria for giving a remember or a know response. Thus, corrected recognition scores (i.e., hits minus false alarms) were calculated for negative central elements, neutral central elements, negative peripheral elements, and neutral peripheral elements. We used ANOVA to examine differences between groups (young and older adults) and independent-sample *t* tests where appropriate. The critical comparison was between negative and neutral within a picture element condition. Significance level was set at $p = .05$ for all statistical tests.

Results

Overall performance. An ANOVA conducted on the total recognition scores with age as a between-subjects factor and emotion (negative, neutral) and element (central, peripheral) as within-subject factors indicated a main effect of age (young = .53, older = .38), $F(1, 48) = 19.95$, $p < .01$, but not of emotion or element, and an interaction between element and emotion (central element: negative = .53, neutral = .41; peripheral element: negative = .36, neutral = .52), $F(1, 48) = 99.04$, $p < .01$. In other words, young adults showed better overall corrected recognition scores regardless of the emotion (negative or neutral) or the element (central or peripheral) of the pictures (see Figure 1). Both young and older adults showed better recognition for negative than for neutral central elements but better recognition for the peripheral elements when they were included in neutral rather than in negative pictures. Thus, for the overall recognition scores, young and older adults showed the memory trade-off: better memory for the central element of emotional scenes than of neutral scenes and poorer memory for the peripheral details of emotional scenes than of neutral scenes.

Remember versus know scores. We conducted separate ANOVAs on the remember and know scores, with age as a between-subjects factor and emotion (negative, neutral) and element (central, peripheral) as within-subject factors. For the remember scores, the analyses revealed a main effect of age (young = .43, older = .26), $F(1, 48) = 26.10$, $p < .01$; of element

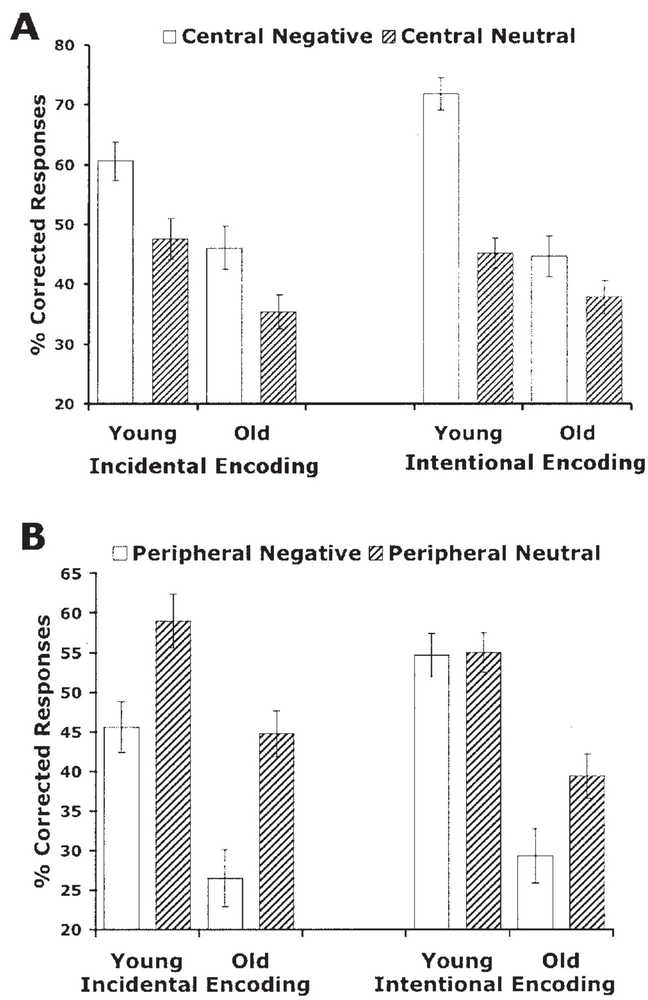

Figure 1. Young and older adults' overall corrected recognition for central and peripheral stimuli under two encoding conditions. With incidental encoding, young and older adults showed better memory for the negative central elements than for the neutral central elements (left panel of A) but poorer memory for the peripheral elements if they occurred in negative scenes than in neutral scenes (left panel of B). With intentional encoding, young adults no longer showed poorer memory for the peripheral elements when they were in negative scenes, whereas the older adults continued to show this pattern (right panel of B).

(central = .43, peripheral = .26), $F(1, 48) = 73.60$, $p < .01$; and an interaction between emotion and element (negative: central = .49, peripheral = .22; neutral: central = .36, peripheral = .31), $F(1, 48) = 70.26$, $p < .01$. In other words, older adults obtained significantly lower scores for the remember responses (i.e., responses reflecting a clear recollection of the stimuli previously presented) than did young adults (see Table 2). For both young and older adults, remember responses were significantly higher for central elements from negative pictures than from neutral pictures; in contrast, the two groups gave more remember responses to peripheral elements that had been included in neutral pictures than in negative pictures.

For the know responses, main effects of emotion (negative = .09, neutral = .14), $F(1, 48) = 11.48$, $p < .01$, and element (central = .05, peripheral = .18), $F(1, 48) = 32.70$, $p < .01$, were present, but there was no significant effect of age and no interaction. These results indicated that young and older adults did not differ in their know responses (i.e., responses indicating a sense of familiarity). Both groups showed higher know scores for neutral than for negative elements (regardless of the element type) and for peripheral than for central elements (regardless of emotion) (see Table 2).

Discussion

In this experiment, we demonstrated that young and older adults show similar patterns of memory for elements of neutral and emotional scenes when they are unaware that their memory is going to be tested subsequently (i.e., with incidental encoding). Although younger adults showed better memory generally, both age groups showed better overall recognition and higher remember scores for the central components of negative pictures compared with neutral pictures. Thus, although aging affects the ability to recognize (and to vividly remember) information in general (consistent with the findings of Mantyla, 1993; Rugg & Morcom, 2005), it does not appear to disproportionately affect the ability to vividly remember negative information.

Both age groups also showed the reverse pattern for the peripheral elements: better memory for the elements when they were in neutral than in negative scenes, supporting the narrowing-of-attention hypothesis (Easterbrook, 1959). Thus, aging leaves intact the trade-off in memory for central versus peripheral details of emotional scenes (cf. Denburg et al., 2003). This result suggests that aging does not eliminate, or significantly reduce, the focusing of attention on negative elements of scenes. Physiological changes with aging (Levenson, Carstensen, & Gottman, 1994; Tsai, Levenson, & Carstensen, 2000) and shifts in motivational behavior with aging (Carstensen et al., 2000) do not appear sufficient to disrupt this attentional effect.

The occurrence of the attentional focus phenomenon with an incidental encoding paradigm suggests that it is a relatively automatic effect of emotion (i.e., not intentionally engaged to boost memory for the emotional element of a scene). It is plausible to propose on the basis of prior research (e.g., LeDoux, 1995; Tabert et al., 2001) that this attentional focus occurs via interactions between the amygdala and lower level visual areas. Thus, the amygdala may influence the likelihood that particular elements of a scene are visually processed. The preservation of this effect in older adults would therefore be consistent with studies indicating a relative preservation of amygdala structure and function across the life span (see review by Mather, 2003).

Although these results suggest that the attentional focus on emotional elements occurs relatively automatically for young and older adults, we wondered whether this automatic attentional focusing could be overcome by engagement of controlled

Table 2
Experiments 1A and 1B: Young and Older Adults' Corrected Recognition Scores (%) as a Function of Valence and Type of Stimuli With Incidental and Intentional Encoding Instructions

	Incidental				Intentional			
	Young adults ($n = 26$)		Older adults ($n = 24$)		Young adults ($n = 27$)		Older adults ($n = 25$)	
Variable	*M*	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*
Negative central								
Total responses	60.6	3.2	46.1	3.6	71.8	2.7	44.7	3.4
Remember responses	57.1	3.8	41.8	3.4	67.7	3.4	40.2	3.1
Know responses	3.5	2.5	4.4	2.4	4.1	2.8	4.6	3.3
Neutral central								
Total responses	47.5	3.4	35.4	2.9	45.2	2.5	37.8	2.8
Remember responses	41.2	2.9	29.8	3.0	36.7	3.3	28.3	2.9
Know responses	6.3	3.0	5.6	2.7	8.5	3.2	9.4	3.7
Negative peripheral								
Total responses	45.6	3.6	26.5	2.9	54.7	3.6	29.3	3.4
Remember responses	31.4	3.2	12.4	1.7	30.7	3.7	12.1	2.2
Know responses	14.3	3.0	14.1	2.4	23.9	3.5	17.2	2.2
Neutral peripheral								
Total responses	59.0	3.3	44.8	3.7	55.0	2.9	39.4	2.5
Remember responses	41.0	2.7	20.5	2.8	34.5	2.7	19.8	3.4
Know responses	18.0	3.0	24.3	2.9	20.5	2.7	19.6	2.0

processes. To address this question, we used an intentional encoding condition to test another group of young and older adults. The encoding task was identical to that used in the previous experiment except that the present participants were explicitly informed that their memory for elements of the scenes would later be tested. We reasoned that under these circumstances, participants would likely attempt to encode all elements of the scene rather than focus only on the emotional element. In other words, the instructions promoted active encoding processes in the participants by emphasizing that they were going to perform a memory task.

The goal of this encoding manipulation was therefore twofold. First, to our knowledge, prior studies have not specifically addressed the effect of incidental versus intentional encoding instructions on memory for peripheral versus central details. Although researchers have discussed the relevance of encoding instructions for the memory trade-off (e.g., Heuer & Reisberg, 1990), the effect of manipulating encoding conditions (i.e., intentional or incidental) has not been directly tested within the same study. Thus, the first goal was to clarify the effect on young adults of switching from incidental to intentional encoding instructions. We hypothesized that young adults would be able to use encoding strategies to reduce the attentional focus on the central element of the scenes, thereby reducing the memory trade-off for central versus peripheral elements.

The second goal of this manipulation was to examine whether the effect would be similar in young and older adults. A vast literature speaks to the relative preservation of automatic encoding processes across the life span and the relative impairment in self-initiated, encoding strategies with aging (see reviews by Johnson & Raye, 2000; Light, 2000). Given this literature, we hypothesized that older adults would be less likely than young adults to effectively overcome the tendency to focus on the emotional elements of the scenes.

Experiment 1B: Intentional Encoding Instructions

Method

Participants, materials, and design. To examine the effect of instructions on task performance, we enrolled 27 young adults (13 men, 14 women; mean age = 22.6 ± 4.9 years) and 25 older adults (9 men, 16 women; mean age = 69.8 ± 8.6 years) not previously tested on this task. The content and procedure of the intentional memory task were identical to those of the previous experiment except that participants were specifically informed that their memories for components of the pictures would be assessed and that they should try to remember the pictures as best as they could. Participant groups did not significantly differ with respect to age and education with their respective counterparts from Experiment 1A.

Results

Overall performance. An ANOVA conducted on the total recognition scores with age as the between-subjects factor and emotion (negative, neutral) and element (central, peripheral) as within-subject factors indicated a main effect of age (young = .57, older = .38), $F(1, 50) = 46.70$, $p < .01$; emotion (negative = .50, neutral = .44), $F(1, 50) = 14.02$, $p < .01$; and element (central = .50, peripheral = .45), $F(1, 50) = 5.70$, $p < .02$. Interactions were present between age and emotion (young: negative = .63, neutral = .50; older: negative = .37, neutral = .38), $F(1, 50) = 22.65$, $p < .01$, and between element and emotion (central: negative = .58, neutral = .42; peripheral: negative = .42, neutral = .47), $F(1, 50) = 37.24$, $p < .01$. In other words, older adults exhibited significantly lower total corrected recognition scores overall compared with young adults, and the pattern of results between the groups was also different. In spite of the absence of a three-way interaction, post hoc t tests were conducted to further specify the results. Older adults had similar scores for negative and neutral central elements, $t(24) < 1$ (*ns*), but a significantly higher recognition score for neutral compared with negative peripheral picture components, $t(24) = 2.93$, $p = .01$. Young adults showed better total recognition for negative compared with neutral central elements, $t(26) = 12.96$, $p < .01$, and no difference in memory for peripheral elements from negative and neutral scenes, $t(26) < 1$ (*ns*). Thus, in contrast to the young adults in Experiment 1A, those in the present experiment did not demonstrate poorer memory for the peripheral elements when they were included in negative scenes (see Figure 1).

Remember versus know scores. An ANOVA conducted on the remember scores with age as a between-subjects factor and emotion (negative, neutral) and element (central, peripheral) as within-subject factors indicated main effects of age (young = .42, older = .25), $F(1, 50) = 25.75$, $p < .01$; emotion (negative = .38, neutral = .30), $F(1, 50) = 20.46$, $p < .01$; and element (central = .43, peripheral = .24), $F(1, 50) = 131.42$, $p < .01$. Interactions were also present between age and emotion (young: negative = .49, neutral = .36; older: negative = .26, neutral = .24), $F(1, 50) = 11.07$, $p < .01$; element and emotion (central: negative = .54, neutral = .33; peripheral: negative = .21, neutral = .27), $F(1, 50) = 70.45$, $p < .01$; and age, element, and emotion (young, central: negative = .68, neutral = .37; young, peripheral: negative = .31, neutral = .35; older, central: negative = .40, neutral = .28; older, peripheral: negative = .12, neutral = .20), $F(1, 50) = 5.55$, $p < .02$. In other words, in addition to a global age group difference, young and older adults showed different patterns of performance. Young adults showed higher remember scores for the negative compared with the neutral central elements, but the remember scores for peripheral picture elements were unaffected by the emotion of the picture. The older adults also showed a higher remember score for the central elements of negative compared with neutral pictures. In contrast to the young adult group, however, they exhibited higher remember responses for neutral than for negative, peripheral elements. Thus, the older adults did not show the diminution of the attentional-narrowing effect, shown by the young adults. Unlike in Experiment 1A, the two groups' remember scores did not significantly differ for the central elements of neutral pictures.

The ANOVA on the know responses revealed only a main effect of element (central = .06, peripheral = .20), $F(1, 50) = 42.42$, $p < .01$, but not of age, and no interactions. In other words, know responses were affected by the type of elements (central or peripheral) but not by emotion in either age group. This pattern did not change when we calculated independent know responses.

Discussion

Two conclusions emerge from Experiment 1B. First, for young adults, intentional encoding instructions eliminate the standard memory trade-off (i.e., better memory for the central details and poorer memory for the peripheral details of emotional vs. neutral scenes). Although young adults showed this trade-off with incidental encoding instructions (Experiment 1A), when they realized that their memory for components of a scene would be assessed, their memory was equivalent for peripheral details of negative and neutral scenes. The second conclusion is that aging eliminates this impact of intentional encoding instructions. The older adults' performance was comparable when given the incidental or intentional encoding instructions: In both cases, the older adults showed the memory trade-off between central and peripheral details of negative scenes. This contrast between the age groups is most reliable in the remember scores, which is to be expected, given that intentional encoding instructions tend to primarily alter remember responses (Gardiner & Richardson-Klavehn, 2000). We elaborate on the implications of these results in the General Discussion.

General Discussion

Two experiments examined the effects of encoding instructions (incidental vs. intentional) and aging on the ability to remember components of negative and neutral scenes. The critical findings were that with incidental encoding instructions, young and older adults performed similarly. Both age groups showed a trade-off in memory for the negative scenes: Their memory for central details of emotional scenes compared with neutral scenes was enhanced, whereas their memory for peripheral details of emotional scenes was reduced. With intentional encoding instructions, however, age differences emerged. The young adults no longer showed a memory trade-off. Although their memory remained superior for the central elements of emotional compared with neutral scenes, their memory for peripheral details was unaffected by the emotional content of the scenes. The older adults, in contrast, continued to show the memory trade-off.

Conclusions From Incidental Encoding

The critical finding from the incidental encoding task was that there are instances in which aging preserves the effects of emotional content on memory. Young and older adults showed the same enhancement in memory for the central details of the negative scenes compared with the neutral scenes. This enhancement was apparent in the overall recognition rates and also in the remember responses. Thus, just like the young adults, older adults show a memory boost for emotional information: They are more likely to recognize that they have seen an emotional item than a neutral item, and they also are more likely to have a vivid memory for an emotional item than for a neutral item. The results also indicated that not only can aging spare the emotional memory enhancement effect (Kensinger et al., 2002, 2004), but young and older adults can also show similar detrimental effects of emotion on memory (cf. Denburg et al., 2003). The finding that young and older adults were less likely to remember peripheral details of emotional scenes than of neutral scenes suggests that individuals across the adult life span have a tendency to focus on emotional elements in a scene. Future studies will be needed to examine whether this finding extends to the variety of emotional events relevant in daily life (e.g., when an individual is an eyewitness to a crime).

We wish to emphasize, however, that the results of the present incidental encoding task may not generalize to all incidental encoding tasks. The task we used was relatively unconstrained, in the sense that participants could use a variety of features to decide whether to approach or withdraw from the scene. In addition, nothing about the task instructions required processing of the peripheral elements. A possibility, worth future investigation, is that if young and older adults were given an incidental encoding task that required processing of the peripheral elements, both groups might be able to prevent the attentional narrowing. That is, there may be ways in which both age groups could process the scenes such that their attention would not be focused principally on the emotional element. Perhaps if participants were required to make a decision about the peripheral details (e.g., how plausible it would be to encounter the central element in that context) or to integrate the contextual elements (e.g., by imagining themselves in the scene), attentional narrowing would not occur. Prior studies indicated that when older adults are given constrained, incidental encoding tasks (i.e., when "encoding support" is given), their performance often improves and sometimes matches the performance of young adults (Logan, Sanders, Snyder, Morris, & Buckner, 2002). On the basis of these studies, we hypothesize that older adults could benefit from encoding support to boost their memory for peripheral elements.

Nevertheless, the main goal of the incidental encoding task of the present study was to address whether young and older adults remembered the same aspects of emotional scenes when they encoded them in a relatively unconstrained fashion. Our results support the conclusion that young and older adults typically encode, and remember, emotional scenes in much the same way. Both age groups seem to focus on the emotional aspects of the scenes, allowing them to recognize (and vividly remember) more central elements from the negative scenes than from the neutral scenes and fewer peripheral elements from the negative scenes than from the neutral scenes.

It may be instructive to note that the results of the present study contrast with those of a previous study that used verbal stimuli to examine memory for content as opposed to context in young and older adults (Kensinger et al., 2002). In that prior study, participants read sentences that were either emotional (e.g., *There was a fire in the forest*) or neutral (e.g., *There was a road in the forest*). The results were analyzed in a way that paralleled the comparisons made here (i.e., comparing memory for the "central" item, e.g., *fire* vs. *road*, and memory for the "contextual" item, e.g., *forest*, based on whether it had been included in the negative sentence or the neutral sentence). The critical findings were that both young and older adults showed enhanced memory for emotional words (e.g., *fire*) compared with neutral words (e.g., *road*). Only the young adults showed a memory benefit for the context in which a neutral word occurred; they were more likely to remember neutral words (e.g., *forest*) if the words had been embedded in an emotional as compared with a neutral sentence. Further, the magnitude of enhancement seen in the older adults correlated with measures of source memory performance.

This prior investigation would suggest that in some cases (a) the emotional content of information can enhance the likelihood that contextual elements are encoded and (b) aging disrupts this benefit. In contrast, the results of the present experiment suggest that young and older adults typically are less likely to remember contextual details of an emotional event. It is unclear what aspects of these two studies may explain the contrary findings. The stimuli in the present study were likely more arousing, and it is plausible that the narrowing of attention occurs only with stimuli above a certain level of arousal (see Christianson, 1992; Deffenbacher, 1983; Easterbrook, 1959). It is also possible that the different modalities of information (verbal vs. nonverbal) or differences in encoding instructions may have affected the results. In the prior study, participants were asked to read sentences aloud; therefore, the sentences would have needed to be processed in their entirety. In contrast, there was nothing about the encoding task in the present study that would require participants to process all aspects of the scenes. Thus, attentional focusing may have been more apparent with the stimuli and encoding task used in the present study. Future investigations will be needed to clarify which of these methodological aspects are important.

As critical as encoding effects seem to be, it is also important to consider retrieval effects (i.e., differences in retrieval access to the information encoded during study). An open question regards the effect of delay interval on the memory trade-off in young and older adults. The original proposal with regard to the trade-off for central and peripheral details (Heuer & Reisberg, 1990) was that arousal may impair memory for peripheral details with short delays, whereas memory may not be skewed in this way with longer delays. To our knowledge, no study has directly compared the performance of young and older adults tested at short delays (e.g., under a few hours) and longer delays. Thus, this proposal has not been addressed directly.[4]

Conclusions From Intentional Encoding

Although the results from the incidental encoding task indicate that there are situations in which young and older adults encode emotional scenes similarly, the results from the intentional encoding task emphasize that age differences can also occur. Specifically, older adults may have a harder time overcoming the attentional bias for emotional elements of scenes. They continued to show the memory trade-off, even with encoding instructions that allowed the young adults to overcome this effect.

Although this experiment cannot confirm the reasons why older adults may have this difficulty, one plausible hypothesis relates to age-related differences in controlled encoding strategies. A vast literature speaks to the difficulty that older adults have engaging controlled, self-initiated encoding strategies to help them integrate information (e.g., Craik, 1977; Glisky, Rubin, & Davidson, 2001; Naveh-Benjamin, Hussain, Guez, & Bar-On, 2003; Spencer & Raz, 1995). Specifically, a number of investigations have found that older adults do not use elaborative encoding strategies spontaneously. Thus, it is likely that older adults did not engage the types of encoding strategies (e.g., elaborative encoding to link the elements of the scene together) that would help them to remember the peripheral elements. It is important to note, however, that although older adults do not tend to engage encoding strategies spontaneously, their performance tends to improve markedly when they are instructed about what strategies they should engage during encoding (e.g., Logan et al., 2002; Poon, 1985). The present study did not provide participants with specific encoding instructions. If participants had been given specific information as to how to encode the scenes, it is plausible that the two age groups would have shown a similar pattern of results.

Conclusions

In summary, young and older adults typically appear to remember similar aspects from emotional scenes: With incidental encoding, both age groups show better memory for central elements of emotional scenes than of neutral scenes and poorer memory for peripheral elements in an emotional as opposed to a neutral context. When intentional encoding instructions were given, young but not older adults were able to overcome this memory trade-off. Thus, although aging appears to leave intact the attentional biasing elicited by emotional information, this bias may be more difficult for older adults to overcome, perhaps because of difficulties engaging elaborative encoding strategies.

[4] Comparing our results with those of Denburg et al. (2003), however, suggests that at least some of the enhancing and impairing effects of emotion on memory may be consistent across a range of delays. Denburg and colleagues found that the detrimental, as well as the enhancing, effects of emotion were apparent in young and older adults when they were tested at 24-hr and 8-month delay intervals. This pattern of results may suggest that encoding processes play a critical role in modulating the enhancing and detrimental effects of emotion, so that retrieval delays do not substantially alter the effect.

References

Adolphs, R., Denburg, N. L., & Tranel, D. (2001). The amygdala's role in long-term declarative memory for gist and detail. *Behavioral Neuroscience, 115,* 983–992.

Anderson, A. K., & Phelps, E. A. (2001). Lesions of the human amygdala impair enhanced perception of emotionally salient events. *Nature, 17,* 305–309.

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

Buchanan, T., & Adolphs, R. (2002). The role of the human amygdala in emotional modulation of long-term declarative memory. In S. Moore & M. Oaksford (Eds.), *Emotional cognition: From brain to behavior* (pp. 9–34). London: John Benjamins.

Carstensen, L. L., Fung, H., & Charles, S. (2003). Socioemotional selectivity theory and the regulation of emotion in the second half of life. *Motivation and Emotion, 27,* 103–123.

Carstensen, L. L., Pasupathi, M., Mayr, U., & Nesselroade, J. R. (2000). Emotional experience in everyday life across the adult life span. *Journal of Personality and Social Psychology, 79,* 644–655.

Charles, S. T., Mather, M., & Carstensen, L. L. (2003). Aging and emotional memory: The forgettable nature of negative images for older adults. *Journal of Experimental Psychology: General, 132,* 310–324.

Christianson, S.-A. 1992. Emotional stress and eyewitness memory: A critical review. *Psychological Bulletin, 112,* 284–309.

Chun, M. M., & Potter, M. C. (1995). A two-stage model for multiple target detection in rapid serial visual presentation. *Journal of Experimental Psychology: Human Perception and Performance, 21,* 109–127.

Cohen, G., Conway, M. A., & Maylor, E. A. (1994). Flashbulb memories in older adults. *Psychology and Aging, 9,* 454–463.

Craik, F. I. M. (1977). Age differences in human memory. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 384–420). New York: Van Nostrand Reinhold.

Craik, F. I. M., & McDowd, J. M. (1987). Age differences in recall and recognition. *Journal of Experimental Psychology, 13,* 474–479.

Davidson, P. S., & Glisky, E. L. (2002). Is flashbulb memory a special instance of source memory? Evidence from older adults. *Memory, 10,* 99–111.

Deffenbacher, K. A. (1983). The influence of arousal on reliability of testimony. In S. M. A. Lloyd-Bostock & B. R. Clifford (Eds.), *Evaluating witness evidence* (pp. 235–251). Chichester, England: Wiley.

Denburg, N. L., Buchanan, T. W., Tranel, D., & Adolphs, R. (2003). Evidence for preserved emotional memory in normal older persons. *Emotion, 3,* 239–253.

Easterbrook, J. A. (1959). The effect of emotion on cue utilization and the organization of behavior. *Psychological Review, 66,* 183–201.

Gardiner, J. M., & Richardson-Klavehn, A. (2000). Remembering and knowing. In E. Tulving & F. I. M. Craik (Eds.), *The Oxford handbook of memory* (pp. 229–244). New York: Oxford University Press.

Glisky, E. L., Rubin, S. R., & Davidson, P. S. (2001). Source memory in older adults: An encoding or retrieval problem? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 27,* 1131–1146.

Hamann, S. (2001). Cognitive and neural mechanisms of emotional memory. *Trends in Cognitive Science, 5,* 394–400.

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

Johnson, M. K., & Raye, C. L. (2000). Cognitive and brain mechanisms of false memories and beliefs. In D. L. Schacter & E. Scarry (Eds.), *Memory and belief* (pp. 36–86). Cambridge, MA: Harvard University Press.

Jurica, P. J., & Shimamura, A. P. (1999). Monitoring item and source information: Evidence for a negative generation effect in source memory. *Memory & Cognition, 27,* 648–656.

Kensinger, E. A., Anderson, A., Growdon, J. H., & Corkin, S. (2004). Effects of Alzheimer disease on memory for verbal emotional information. *Neuropsychologia, 42,* 791–800.

Kensinger, E. A., Brierley, B., Medford, N., Growdon, J. H., & Corkin, S. (2002). Effects of normal aging and Alzheimer's disease on emotional memory. *Emotion, 2,* 118–134.

Kensinger, E. A., & Corkin, S. (2003). Memory enhancement for emotional words: Are emotional words more vividly remembered than neutral words? *Memory & Cognition, 31,* 1169–1180.

Krendl, A. C., Kensinger, E. A., & Corkin, S. (2003). Emotional memory in aging: Dissociable effects of valence and arousal (Program No. 84.11). In *2003 Abstract Viewer/Itinerary Planner.* Washington, DC: Society for Neuroscience.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1998). Emotion, motivation, and anxiety: Brain mechanisms and psychophysiology. *Biological Psychiatry, 44,* 1248–1263.

LeDoux, J. E. (1995). Emotion: Clues from the brain. *Annual Review of Psychology,* 46, 209–235.

Levenson, R. W., Carstensen, L. L., & Gottman, J. M. (1994). The influence of age and gender on affect, physiology, and their interrelations: A study of long-term marriages. *Journal of Personality and Social Psychology, 67,* 56–68.

Light, L. (2000). Memory changes in adulthood. In S. H. Qualls & N. Abeles (Eds.), *Psychology and the aging revolution: How we adapt to longer life* (pp. 73–97). Washington, DC: American Psychological Association.

Loftus, E. F. (1979). The malleability of human memory. *American Scientist, 67,* 312–320.

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

Loftus, E. F., Loftus, G., & Messo, J. (1987). Some facts about "weapon focus." *Law and Human Behavior, 11,* 55–62.

Logan, J. M., Sanders, A. L., Snyder, A. Z., Morris, J. C., & Buckner, R. L. (2002). Under-recruitment and nonselective recruitment: Dissociable neural mechanisms associated with aging. *Neuron, 33,* 827–840.

Mantyla, T. (1993). Knowing but not remembering: Adult age differences in recollective experience. *Memory & Cognition, 21,* 379–388.

Mather, M. (2003). Aging and emotional memory. In D. Reisberg & P. Hertel (Eds.), *Memory and emotion* (pp. 272–307). New York: Oxford University Press.

Naveh-Benjamin, M., Hussain, Z., Guez, J., & Bar-On, M. (2003). Adult age differences in episodic memory: Further support for an associative-deficit hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29,* 826–837.

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

Ohman, A., Flykt, A., & Esteves, F. (2001). Emotion drives attention: Detecting the snake in the grass. *Journal of Experimental Psychology: General, 130,* 466–478.

Poon, L. W. (1985). Differences in human memory with aging: Nature, causes, and clinical implications. In J. E. Birren & K. W. Schaie (Eds.), *Handbook of the psychology of aging* (pp. 427–462). New York: Van Nostrand Reinhold.

Rajaram. (1993). Remembering and knowing: Two means of access to the personal past. *Memory & Cognition, 21,* 89–102.

Raymond, J. E., Shapiro, K. L., & Arnell, K. M. (1992). Temporary suppression of visual processing in an RSVP task: An attentional blink? *Journal of Experimental Psychology: Human Perception and Performance, 18,* 849–860.

Rugg, M. D., & Morcom, A. M. (2005). The relationship between brain activity, cognitive performance, and aging: The case of memory. In R. Cabeza, L. Nyberg, & D. Park (Eds.), *Cognitive neuroscience of aging* (pp. 132–156). Oxford, England: Oxford University Press.

Safer, M. A., Christianson, S., Autry, M. W., & Oesterlund, K. (1998). Tunnel memory for traumatic events. *Applied Cognitive Psychology, 12,* 99–117.

Spencer, W. D., & Raz, N. (1995). Differential effects of aging on memory for content and context: A meta-analysis. *Psychology and Aging, 10,* 527–539.

Strange, B. A., Hurleman, R., & Dolan, R. J. (2003). An emotion-induced retrograde amnesia in humans is amygdala- and beta-adrenergic-dependent. *Proceedings of the National Academy of Sciences, USA,* 13626–13631.

Tabert, M. H., Borod, J. C., Tang, C. Y., Lange, G., Wei, T. C., Johnson, R., et al. (2001). Differential amygdala activation during emotional decision and recognition memory tasks using unpleasant words: An fMRI study. *Neuropsychologia, 30,* 556–573.

Tsai, J. L., Levenson, R. W., & Carstensen, L. L. (2000). Autonomic, subjective, and expressive responses to emotional films in older and younger Chinese Americans and European Americans. *Psychology and Aging, 15,* 684–693.

Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language, 46,* 441–517.

(*Appendix follows*)

Appendix

Examples of Stimuli Used in the Study and Test Phases

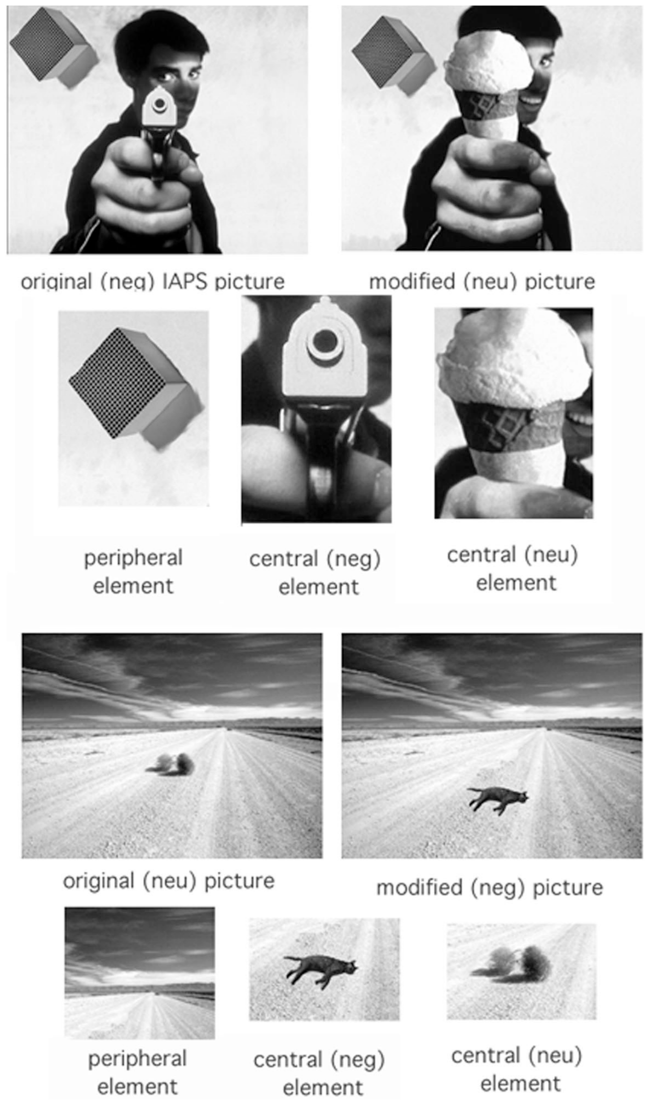

Figure A1. Stimuli pairs were created by modifying pictures from the International Affective Picture System (IAPS) set (Lang et al., 1998) to create one negative (neg) and one neutral (neu) image. Each image included one central element (which was either negative or neutral) and one peripheral element (which was always neutral). Participants studied either the neutral or the negative version of the image, and we then tested their memory for the central and peripheral elements.

Received April 30, 2004
Revision received November 19, 2004
Accepted November 30, 2004 ■