Psychology and Aging
2007, Vol. 22, No. 4, 781–795

0882-7974/07/$12.00 DOI: 10.1037/0882-7974.22.4.781

Effects of Aging and Encoding Instructions on Emotion-Induced Memory Trade-Offs

Elizabeth A. Kensinger
Boston College

Angela H. Gutchess and Daniel L. Schacter
Harvard University

The effects of emotion on memory are often described in terms of trade-offs: People often remember central, emotional information at the expense of background details. The present experiment examined the effects of aging and encoding instructions on participants' ability to remember the details of central emotional objects and the backgrounds on which those objects were placed. When young and older adults passively viewed scenes, both age groups showed strong emotion-induced trade-offs. They were able to remember the visual details as well as the general theme of the emotional object, but they had difficulties remembering the visual specifics of the scene background. Age differences emerged, however, when participants were given encoding instructions that emphasized elaborative encoding of the entire scene. With these instructions, young adults overcame the trade-offs (i.e., they no longer showed impairing effects of emotion), whereas older adults continued to show good memory for the emotional object but poor memory for its background. These results suggest that aging impairs the ability to flexibly disengage attention from the negative arousing elements of scenes, preventing the successful encoding of nonemotional aspects of the environment.

Keywords: aging, central, emotion, scenes, trade-off, peripheral

A tremendous amount of research has suggested that emotion confers memory benefits for both young and older adults (reviewed by Kensinger, 2006; Mather, 2003). In the typical study, participants are shown a series of emotional scenes, and memory for those pictures is compared with memory for nonemotional scenes. Although the valence of the emotional pictures (whether they are positive or negative) can influence the magnitude of the memory benefit, the key finding has been that both young and older adults are more likely to remember the emotional images than they are to remember the nonemotional ones (e.g., Charles, Mather, & Carstensen, 2003; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002; Leigland, Schulz, & Janowsky, 2004).

Most of these studies, however, have not allowed assessment of which aspects of the scene are better remembered because of its emotional content. This question is an important one to address because a lot of research has suggested that emotion does not boost memory for all aspects of an item. Rather, the effects of emotion on memory seem to be best characterized by trade-offs: Some aspects of an emotional event are better remembered because of the event's emotional relevance, whereas other aspects may be more likely to be forgotten (reviewed by Buchanan & Adolphs, 2002; Reisberg & Heuer, 2004). In general, it seems that those aspects tied to the affective meaning of the event tend to be remembered best, whereas other details are more likely to be forgotten.

Using passive viewing instructions, two prior studies demonstrated similar emotion-related memory trade-offs in young and older adults. Kensinger, Piguet, Krendl, and Corkin (2005, Experiment 1a) presented young and older adults with a series of scenes composed of negative or neutral objects placed upon neutral backgrounds. At test, participants were presented either with fragments of the objects or with fragments of the backgrounds. Both age groups were more likely to remember fragments of negative objects than of neutral ones, but they were less likely to remember fragments of backgrounds that had been presented with negative objects compared with neutral ones. Thus, both age groups demonstrated a trade-off whereby memory for the negative objects was enhanced, seemingly at the expense of memory for the background elements. Denburg, Buchanan, Tranel, and Adolphs (2003) also examined the effects of aging on emotion-related memory trade-offs by assessing memory for scenes. They showed young, middle-aged, and older adults a series of positive, negative, and neutral scenes. They then asked participants to perform two memory tasks: a free recall task and a recognition memory task in which participants had to distinguish the studied scene from modified foils (e.g., a picture of three smiling babies would have to be selected from alternatives including four smiling babies). The authors reasoned that free recall of a scene could be supported by *gist* memory (i.e., memory for general or nonspecific information) because reporting the general theme of the picture (e.g., a snake on a branch) was sufficient for a response to be considered accurate; by contrast, because of the similarity between the target and the foils,

Elizabeth A. Kensinger, Department of Psychology, Boston College; Angela H. Gutchess and Daniel L. Schacter, Department of Psychology, Harvard University.

This research was supported by National Institutes of Health Grants AG08411 (to Daniel L. Schacter) and AG026920 (to Angela H. Gutchess) and by National Science Foundation Grant BCS0542694 (to Elizabeth A. Kensinger). We thank Elizabeth Reese and Joan Tom for assistance with stimulus design and Alana Wong for assistance with participant recruitment.

Correspondence concerning this article should be addressed to Elizabeth A. Kensinger, Department of Psychology, Boston College, McGuinn Hall, Room 510, 140 Commonwealth Avenue, Chestnut Hill, MA 02467. E-mail: elizabeth.kensinger@bc.edu

recognizing the correct picture would require memory for the scene's visual details. Denburg et al. found that for all age groups, performance on the forced-choice recognition task was poorer for emotional pictures than for nonemotional ones, whereas performance on the free recall task was enhanced for the emotional pictures. Thus, individuals remembered the gist of emotional scenes well, but seemingly at the cost of memory for the scenes' visual details, revealing a type of emotion-related memory trade-off (see also Adolphs, Denburg, & Tranel, 2001; Adolphs, Tranel, & Buchanan, 2005).

One limitation of these prior studies is that neither of them assessed memory for the gist and the visual details separately for the emotional element of the scene and for the nonemotional scene elements. Kensinger et al. (2005) assessed memory separately for the emotional and nonemotional scene elements but did not distinguish memory for the gist of those elements (e.g., remembering that a snake had been studied) from memory for visual details (e.g., remembering exactly what the snake looked like). Conversely, Denburg et al. (2003) distinguished memory for gist versus visual detail but did not assess those levels of memory separately for the emotional and nonemotional scene elements. At least in young adults, the effects of emotion on memory for detail are critically impacted by whether memory is assessed for the emotional element itself or for other, nonemotional contextual elements. For example, if young adults are presented with a snake in isolation and a chipmunk in isolation, their memory for the negative snake will be more likely to include visual specifics than will their memory for the neutral chipmunk (Kensinger, Garoff-Eaton, & Schacter, 2006). It is important to note, however, that these benefits do not extend to scene elements extraneous to the emotional object (Kensinger, Garoff-Eaton, & Schacter, 2007). Thus, young adults remember the details of the central emotional elements well but do not retain the details of the peripheral nonemotional elements (often referred to as the *central/peripheral trade-off*; e.g., Reisberg & Heuer, 2004).

The first goal of the present study was to examine the effect of emotion on young and older adults' memories for the details of the negative arousing items in scenes, as well as for the details of the scene context in which those items are presented. This issue is of particular interest because of recent evidence that scene encoding may be less affected by aging than object encoding. Using functional magnetic resonance imaging, Chee et al. (2006) found similar neural responses to scenes for young and older adults, whereas the neural response to objects was reduced for older adults. In a follow-up study addressing age differences in scene processing during recognition, interfering background scene contexts impaired older adults' recognition more than young adults' (Gutchess et al., 2007): Older adults were less able to ignore irrelevant background information when deciding whether objects had been presented previously. These findings were reminiscent of earlier suggestions that context can provide environmental support that benefits the memory of older adults as much as, if not more than, that of young adults (Earles, Smith, & Park, 1994; Park, Smith, Morrell, Puglisi, & Dudley, 1990; Smith, Park, Cherry, & Berkovsky, 1990; Smith, Park, Earles, Shaw, & Whiting, 1998). To the extent that young and older adults both focus their attention on negative visually arousing objects in the environment, then we would expect similar effects of emotion on memory in both age groups (i.e., enhanced memory for the visual detail of negative objects and reduced memory for visual detail of backgrounds presented with negative objects). If, however, aging alters the focus on negative visually arousing information, or if it changes attentional focus from being item based to being context based, then the two age groups may show divergent effects of emotion on memory for the items and on memory for the contexts in which those items are presented. This study was designed to adjudicate between these alternatives.

The second goal of the present study was to examine the extent to which changes in encoding instructions can alter the degree of age effects demonstrated. As just described, when incidental (passive viewing) encoding instructions were used by Denburg et al. (2003) and by Kensinger et al. (2005, Experiment 1a), no age effects were demonstrated with regard to emotion-induced memory trade-offs. However, Kensinger et al. (2005, Experiment 1b) demonstrated that age effects can emerge under some encoding conditions. In particular, when given open-ended intentional encoding instructions that emphasized to participants that their memory would later be tested for elements of the scenes but did not provide participants with particular strategies to encode those elements, young adults were able to overcome the emotion-related memory trade-off, whereas older adults were not.

This prior study was important in demonstrating that young and older adults may not always show comparable effects of emotion on memory. At a broad level, the findings of that prior study were consistent with other research suggesting that older adults often remember the affective relevance of information but not the details that are tangential to the affective meaning of the presented information. For example, older adults are just as good as younger adults at remembering details such as whether food is safe to eat or is spoiled, but they do poorly at remembering whether the food should be served at a hot or cold temperature (May, Rahhal, Berry, & Leighton, 2005). Similarly, older adults can remember whether a name is associated with a "good" or a "bad" person, but they have difficulties remembering whether the name was read by a male or female voice (Rahhal, May, & Hasher, 2002).

These findings may arise because older adults are more likely than young adults to focus on emotional information. Data to support this theory have come from studies of the emotional Stroop task and from tasks in which older adults are asked to process emotional stimuli with divided attention. On emotional Stroop tasks, older adults often show more interference from negative arousing words than do young adults (Fox & Knight, 2005; Leclerc & Hess, 2004; Wurm, Labouvie-Vief, Aycock, Rebucal, & Koch, 2004). Similarly, when older adults are asked to process emotional information while concurrently performing a secondary task, they tend to focus more on negative information than do young adults (reviewed by Mather, 2006). These findings suggest that older adults may be more likely than young adults to focus automatically on negative information in the world around them. This enhanced focus on the affectively relevant information could explain the pattern of results revealed by Kensinger et al. (2005). If older adults focus more on the negative information in a scene, or on the affectively relevant scene aspects, it may be harder for them to divert their attention to other elements, even if they are given instructions to do so. This pattern of results could be particularly plausible given age-related difficulties in inhibiting processing of salient aspects of the environment (discussed by Braver & Barch, 2002; Zacks & Hasher, 1997).

An alternative possibility, however, and the one proposed by Kensinger et al. (2005), is that older adults may not benefit as much as young adults from open-ended intentional encoding instructions. In Kensinger et al. (2005, Experiment 1b), participants were asked to encode the scenes so that they would be able to recognize fragments of those scenes on a later recognition memory task. They were not given particular strategies to use in order to encode the scene elements. Some research has suggested that aging may affect the ability to use self-generated encoding strategies effectively (reviewed by Johnson & Raye, 2000; Light, 2000). Thus, Kensinger et al. (2005) concluded that the age effects resulted because young adults were able to engage effective, self-generated encoding strategies whereas the older adults were not.

If the older adults' difficulties in overcoming the trade-off did stem primarily from their inability to generate their own effective encoding strategies, then it is possible that older adults might be able to process nonaffective scene elements as effectively as young adults if they are given strategies to help them to do so. Although older adults do not always benefit from the use of elaborative encoding strategies to the same extent as young adults (see reviews by Kausler, 1994; Light, 1991), strategies that are self-relevant (Derwinger, Neely, MacDonald, & Bäckman, 2005) or that are semantically or perceptually rich (e.g., integrating sentences or elaborating upon pictorial depictions; Cherry, Park, Frieske, & Smith, 1996; Craik & Rabinowitz, 1985; Smith et al., 1998) sometimes bring older adults' performance levels closer to those of young adults. Of particular relevance to the emotional memory task described here, older adults who are asked to focus on perceptual rather than affective aspects of information sometimes do a better job of remembering the nonaffective aspects than older adults who are given no guidance as to how to process the incoming information (see Hashtroudi, Johnson, & Chrosniak, 1990; Hashtroudi, Johnson, Vnek, & Ferguson, 1994, for further discussion). In other words, although older adults may default to an affect-oriented mode of processing, there is some evidence to suggest that they can switch to a different type of processing mode if provided with the proper orienting task. Given this prior literature, it is plausible that when given encoding instructions that would focus their attention on the nonemotional scene context, young and older adults might be able to more flexibly attend to all scene elements (rather than to only the emotional element), thereby abolishing their emotion-related memory trade-off. The present study addressed this issue by assessing young and older adults' memories for scene elements not only after receiving passive viewing encoding instructions, but also after performing encoding tasks that emphasized active and elaborative encoding of all scene elements.

Experiment 1

Method

Participants. A total of 16 young adults (ages 18–35; mean age = 22.8, *SD* = 3.44 years; 8 women) and 16 older adults (ages 69–76; mean age = 72.4, *SD* = 4.95 years; 9 women) participated in the experiment for pay or course credit. Young adult data were the same as reported in Kensinger et al. (2007, Experiment 2). All participants were native English speakers with normal or corrected-to-normal vision. No participant was depressed (no participant scored more than 3 on the Geriatric Depression Scale; Sheikh & Yesavage, 1986), and no participant listed that they were taking any medications that would affect the central nervous system.

Older adults were recruited through the Harvard Cooperative on Aging or through a database of participants who had participated in other behavioral or neuroimaging investigations and had indicated that they wished to be contacted about future studies. Older adults were carefully screened to exclude those with a history of head trauma, neuropsychological or psychiatric disorder, cardiac disease, or other serious chronic illness. All older adults had Mini-Mental State Examinations scores of 27 or more (Folstein, Folstein, & McHugh, 1975), and all performed at or above age-adjusted norms on an extensive series of tasks. The older adults were more highly educated than the young adults (*M* years of education = 16.7 vs. 14.2, respectively; $p < .05$). Informed consent was acquired in a manner approved by the Harvard University institutional review board.

Materials. Materials comprised pairs of neutral objects (e.g., chipmunks), negative arousing objects (e.g., snakes), and neutral backgrounds (e.g., rivers). Members of a pair always shared the same verbal label (e.g., were both chipmunks) but differed in other perceptual features (e.g., color, shape, size, orientation). Objects were taken from those used in a prior investigation (Kensinger et al., 2006) and were supplemented with additional images from photo clip art packages. Neutral backgrounds were taken from the International Affective Picture System set (Lang, Bradley, & Cuthbert, 1997) and from online image databases.

The objects and backgrounds were selected from a group of stimuli rated by a separate group of eight young adults (ages 18–35) and eight older adults (ages 60–77). Negative objects all had been judged to have a mean arousal level greater than 4 on a scale of 1 to 7 (with low numbers signifying a calming or soothing image and higher numbers signifying an exciting or agitating image) and a mean valence level less than 3 (with lower numbers signifying a negative image and high values indicating a positive image). Neutral objects and background scenes all had been rated as nonarousing (mean arousal values less than 4), with valence ratings ranging from 3 to 5. Objects were selected only when the valence and arousal ratings did not differ for young and older adults (all *p*s $> .2$).

These objects and backgrounds were used to create scenes by placing an object (which was either neutral or negative in valence) on a plausible background. For example, a neutral scene might show a chipmunk (neutral object) near a river (background), whereas a negative scene might show a snake (negative arousing object) near a river (background). Using both items from an object pair (e.g., both chipmunks or both snakes) and both landscapes from a background pair (e.g., both rivers), we created 8 versions of 96 scenes (4 versions with a negative arousing object and 4 versions with a neutral object, e.g., Snake A with River 1, Snake A with River 2, Snake B with River 1, Snake B with River 2, Chipmunk A with River 1, Chipmunk A with River 2, Chipmunk B with River 1, and Chipmunk B with River 2; see Figure 1A). All scenes were resized so that their longest edge was 700 pixels. The stimuli were the same as those used by Kensinger et al. (2007).

Care also was taken to match the overall similarity of each pair of objects. Similarity ratings were gathered by eight young adults

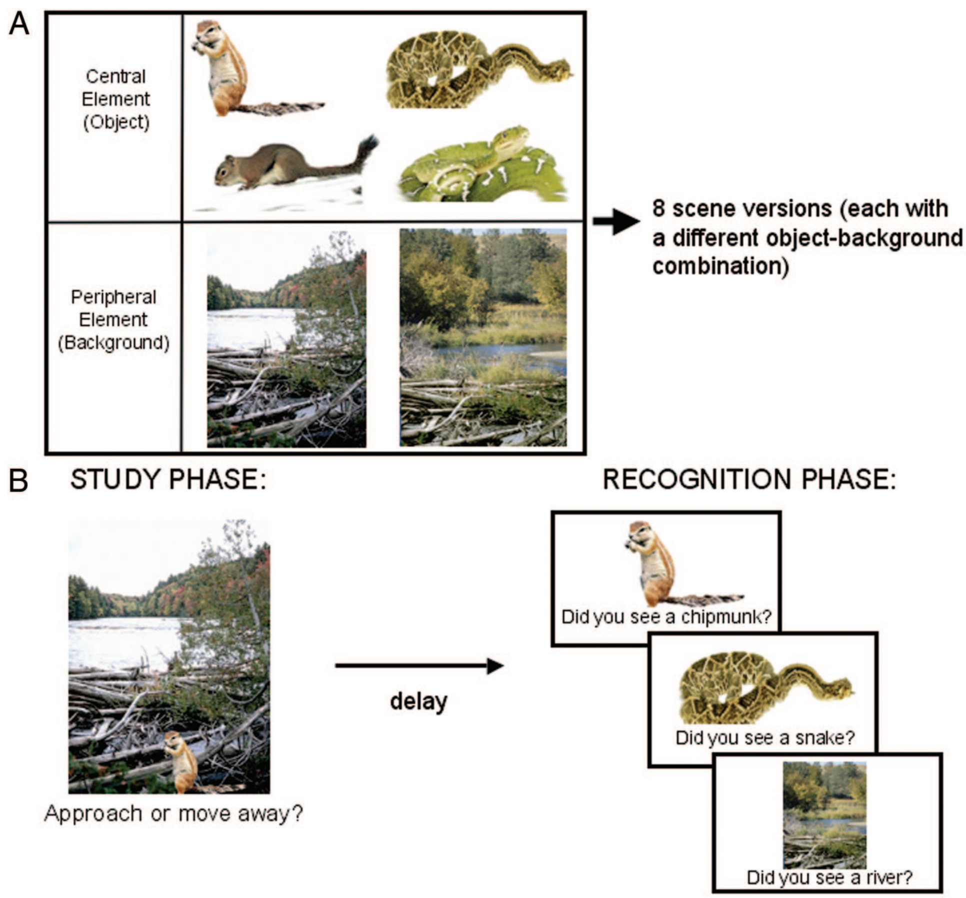

Figure 1. We created eight versions of each scene by including two versions of a neutral object (e.g., two chipmunks), two versions of a negative object (e.g., two snakes), and two versions of a neutral background on which those objects could plausibly be found (e.g., two river backgrounds). (A) Participants studied one of the eight scene versions. After a 30-min delay, participants were presented with objects and backgrounds and indicated whether each was the same as a studied item, similar to a studied item (defined as an item that shared the same verbal label as something shown at study but that was not the exact duplicate), or was a new (nonstudied) item. (B) The items on the recognition task were kept constant for all participants; the condition in which the items were tested (e.g., as a same, similar, or new object) was counterbalanced by changing the scene versions that each participant studied. (Note that objects and backgrounds from the same scene were interspersed randomly throughout the recognition task; they are shown together in this figure for illustrative purposes only.)

and eight older adults using a scale of 1 (*members of a pair are incredibly similar to one another*) to 10 (*incredibly different*). For the final pairs of objects and backgrounds selected, there was no difference between the similarity ratings for the negative arousing object pairs and for the neutral object pairs ($p > .2$). There also was no difference in ratings for degree of change in color, size, shape, and orientation between the negative arousing object pairs and the neutral object pairs (all ps $> .2$), and objects were selected such that their verbal labels were of comparable frequency and familiarity (as reported in the MRC database, Coltheart, 1981; $p > .2$).

We chose to focus on negative arousing (rather than positive arousing) objects for a few reasons. First, emotion-related memory trade-offs typically have been demonstrated for information that contains a negative arousing element (reviewed by Reisberg & Heuer, 2004), and our prior research examining trade-offs in young (Kensinger et al., 2007) and older (Kensinger et al., 2005) adults focused exclusively on negative arousing elements. Although trade-offs do sometimes occur for information that contains a positive arousing element (Denburg et al., 2003), they may not occur as consistently as with information that contains a negative arousing element (Reese, Kensinger, & Schacter, unpublished data). Second, the logistics of creating scenes with a positive, negative, and neutral element are not trivial (e.g., 12 scene versions are required, rather than only 8; backgrounds must be found that could plausibly contain a positive, a negative, or a neutral object; those three object types must be of a similar size and familiarity; positive and negative objects also must be of similar arousal levels and of similar absolute valence levels). For these reasons, we chose to focus exclusively on scenes with negative arousing versus neutral objects.

Procedure. Participants studied a set of 64 scenes (32 with a neutral object on a neutral background and 32 with a negative arousing object on a neutral background). Participants saw each scene for 5 s. Once the scene was removed from the screen, participants were prompted to indicate, by button press, whether they would want to approach or move away from the scene, using a scale of 1 to 7 (1 indicating that they would move closer, 7 indicating that they would move away). The scene version studied was counterbalanced across participants (see Figure 1A).

After a 30-min delay, participants performed a surprise,[1] self-paced recognition task in which they viewed objects and backgrounds presented separately and one at a time. Some of these objects and backgrounds were identical to the scene components that had been studied (*same*), others shared the same verbal label as a studied component but differed in the specific visual details (i.e., were the alternative version of the object or background; *similar*), and others were objects or backgrounds that had not been studied (*new*). Participants saw either the same or the similar version of an item at test (never both versions). Each object or background was presented with a question (e.g., "Did you see a chipmunk?"; see Figure 1B). Participants were instructed to respond "same" if the answer to the question was "yes" and if the object or background was an exact match to a studied component (e.g., if they had seen a chipmunk at study and if the chipmunk shown at recognition was exactly the same as the one in the studied scene). They were asked to respond "similar" if the answer to the question was "yes" but the object or background was not an exact match to the one presented at study. They were asked to respond "new" if the answer to the question was "no." The questions were included on the recognition task to provide participants with guidelines for classifying scenes as similar or new. Pilot data had indicated that, without the questions, some participants were very liberal in assigning similar rather than new responses. For example, having studied a picture of a football field, some would endorse a picture of a soccer field as similar, whereas others would classify the soccer field as new. Pilot data indicated that the provision of the verbal labels in the questions removed these individual differences in classification.

The recognition task included 32 same objects (16 negative arousing, 16 neutral), 32 similar objects (16 negative arousing, 16 neutral), 32 new objects (16 negative arousing, 16 neutral), 32 same backgrounds (16 shown with a negative arousing object, 16 shown with a neutral object), 32 similar backgrounds (16 shown with a negative arousing object, 16 shown with a neutral object), and 32 new backgrounds. The items shown at recognition were kept constant for all participants; therefore, whether an item was same, similar, or new, and whether a background had been shown with a negative arousing or neutral object, was determined by the set of scenes that participants had studied (studied scenes were counterbalanced across participants).

Data analysis. Consistent with previous studies asking participants to make a distinction of same or similar at retrieval (Garoff, Slotnick, & Schacter, 2005; Kensinger et al., 2006, 2007), we considered "same" responses to same items to reflect *specific recognition*: memory for the exact visual details of the studied object or background. Same items given either a "same" or a "similar" (and not a "new") response were considered to reflect *general recognition*: memory for at least the general theme of the studied object or background.[2] That is, for same items given either a "same" or a "similar" response, participants had to remember at least that a particular type of object or background had been studied (e.g., that they had seen a snake) because otherwise they would have instead indicated that the item was new. Thus, these general recognition scores reflected a participant's tendency to remember at least the gist of the items (with or without visual detail). This paradigm, therefore, allowed assessment of the effects of negative arousing content on memory for specific visual details (specific recognition) and on memory for at least the gist (general recognition) of the presented information. These recognition memory scores were computed separately for the central object (negative arousing or neutral) and for the peripheral background. By comparing young and older adults' specific recognition and general recognition for the objects and the backgrounds, we could examine whether aging influenced the effects of emotion on the gist/detail and the central/peripheral trade-offs.

Results

The raw data from Experiment 1 are presented in Table 1. The proportion of items given a "same," "similar," or "new" response are reported separately for young and older adults as a function of item type (same, similar, or new), scene component (object or background), and emotional content of the scene (negative or neutral). The emotion category of each background was defined by the type of object placed in the scene (i.e., a negative background signifies a background presented with a negative arousing object). Because no backgrounds were themselves emotional, there could be no new negative backgrounds.

An analysis of variance (ANOVA) with memory type (general recognition, specific recognition),[3] scene component (object, background), and emotion type (negative, neutral) as within-subject factors, and age (young, older adult) as a between-subject factor,

[1] On debriefing forms, all participants indicated that they had been surprised when they were given the instructions for the memory task, and that they had not expected that their memory would be tested. Across all experiments, no participants indicated that they had expected their memory to be tested.

[2] We restricted our analyses to participants' responses to same items, because these responses were straightforward to interpret: A "same" response to a same item reflects memory for the specific visual details of a studied item, a "similar" response indicates memory for the general type of item but not for its exact visual details, and a "new" response reflects complete forgetting of the item's presentation. Responses to items tested as similar exemplars were more difficult to interpret. For example, when a person gives a "similar" response to a similar item, either the participant can recall the visual details of the studied item and thus realizes that the similar item is not the same, or the participant can remember the general theme of the item but have no memory for its visual details and therefore indicate that the item is similar. However, even when general recognition was computed as "same" or "similar" responses to same or similar items (using the logic that, in each of these instances, participants must remember the general theme of the studied items), the qualitative nature of the results remained unchanged from when general recognition was computed as "same" or "similar" responses to same items.

[3] Across all experiments, emotional content of the scene had no effect on the distribution of responses to the new items (i.e., on the false alarm and correct rejection rates) and did not interact with effects of age on responses to the new items. Therefore, for ease of presentation, all reported scores are uncorrected for false alarm rates. The qualitative pattern of the data did not differ when scores were corrected for false alarm rates.

Table 1
Experiment 1: Mean Responses (With Standard Errors) for Objects and Backgrounds as a Function of Item Type (Same, Similar, New) and Emotion Type (Neutral, Negative)

Response	Same neutral	Same negative	Similar neutral	Similar negative	New neutral	New negative
Young adults						
Objects						
"Same"	.64 (.03)	.77 (.04)	.22 (.03)	.22 (.03)	.05 (.01)	.04 (.01)
"Similar"	.20 (.03)	.13 (.02)	.55 (.04)	.59 (.04)	.22 (.02)	.21 (.03)
"New"	.17 (.02)	.11 (.03)	.23 (.04)	.19 (.03)	.73 (.03)	.76 (.03)
Backgrounds						
"Same"	.63 (.03)	.46 (.04)	.23 (.04)	.19 (.04)	.03 (.01)	
"Similar"	.17 (.02)	.27 (.02)	.39 (.04)	.39 (.05)	.18 (.03)	
"New"	.20 (.03)	.27 (.04)	.38 (.04)	.42 (.06)	.79 (.03)	
Older adults						
Objects						
"Same"	.39 (.04)	.58 (.03)	.17 (.03)	.25 (.04)	.03 (.01)	.03 (.01)
"Similar"	.27 (.04)	.22 (.02)	.41 (.04)	.46 (.05)	.09 (.01)	.12 (.02)
"New"	.34 (.04)	.21 (.01)	.42 (.03)	.29 (.03)	.88 (.01)	.85 (.02)
Backgrounds						
"Same"	.42 (.03)	.21 (.02)	.17 (.03)	.13 (.02)	.02 (.01)	
"Similar"	.22 (.03)	.31 (.04)	.33 (.04)	.25 (.02)	.05 (.01)	
"New"	.36 (.04)	.48 (.03)	.50 (.03)	.61 (.03)	.92 (.01)	

Note. "Same" responses to same items reflect specific recognition, whereas the sum of "same" and "similar" responses to same items reflects general recognition.

revealed significant main effects of scene component, $F(1, 30) = 29.76$, $p < .001$, partial $\eta^2 = .50$; memory type, $F(1, 30) = 23.49$, $p < .001$, partial $\eta^2 = .44$; and age, $F(1, 30) = 46.99$, $p < .001$, partial $\eta^2 = .61$. These main effects were qualified by interactions between scene component and emotion type, $F(1, 30) = 32.59$, $p < .001$, partial $\eta^2 = .52$; between emotion type and memory type, $F(1, 30) = 6.27$, $p < .05$, partial $\eta^2 = .17$; and a three-way interaction among memory type, scene component, and emotion type, $F(1, 30) = 11.05$, $p < .01$, partial $\eta^2 = .27$. This three-way interaction reflected the fact that, in both age groups, there was a central/peripheral trade-off that was stronger for specific recognition scores than for general recognition scores (see Figure 2). Both memory scores did reveal the central/peripheral trade-off: Thus, both age groups had higher general recognition for the negative arousing objects than for neutral objects, $t(15) = 2.45$, $p < .05$, for young adults; $t(15) = 4.63$, $p < .001$, for older adults, and lower general recognition for backgrounds presented with negative arousing objects than with neutral objects, $t(15) = 3.67$, $p < .01$, for young adults; $t(15) = 3.92$, $p < .01$, for older adults. However, the magnitude of the trade-off was even greater for specific recognition scores, with better specific recognition of negative arousing objects compared with neutral objects, $t(15) = 2.81$, $p < .05$, for young adults; $t(15) = 6.72$, $p < .001$, for older adults, and with poorer specific recognition of backgrounds presented with negative arousing objects than with neutral objects, $t(15) = 5.84$, $p < .001$, for young adults; $t(15) = 8.25$, $p < .001$, for older adults. Critically, there were no significant interactions with age (all *p*s > .2). Thus, both age groups showed a strong central/peripheral trade-off, and in both age groups the trade-off was elicited more strongly when assessing memory for visual detail than when assessing memory for the general theme of presented information.

Discussion

Experiment 1 was designed to address the first goal of this study: to examine the effect of negative arousal on young and older adults' memories for the gist and detail of the items in scenes, as well as for the gist and detail of the scene context in which those items are presented. The results of this experiment reveal that both young and older adults show enhanced memory for the gist and detail of negative arousing objects compared with neutral ones, whereas they show reduced memory for the gist and detail of the backgrounds on which negative arousing objects are presented. These findings corroborate those of Kensinger et al. (2005) and Denburg et al. (2003), indicating that similar emotion-related memory trade-offs can be elicited in young and older adults. This lack of age effect suggests that young and older adults both focus their attention on negative visually arousing objects, thereby enhancing their memory for those elements while reducing their memory for the backgrounds on which those objects are presented.

As in Denburg et al. (2003) and Kensinger et al. (2005, Experiment 1a), young and older adults in this experiment were not given specific instructions as to how to focus their attention. As outlined in the introduction, there is reason to believe that age differences may become apparent when participants are given encoding instructions that encourage the encoding of multiple scene aspects. In particular, prior research has revealed that the trade-off effects demonstrated by young adults can be diminished when participants' attention is directed toward other aspects of the scenes. Thus, when they are asked to focus on thematic elements of the scene (e.g., by telling a story), young adults no longer show a central/peripheral trade-off in remembering the general theme of presented information (although they continue to show a central/

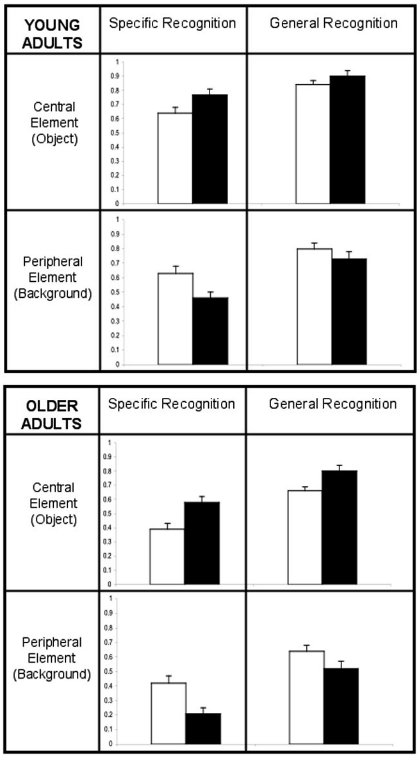

Figure 2. Proportion of central objects (white bar = neutral; black bar = negative) and peripheral backgrounds (white = presented with neutral object; black = presented with negative object) recognized with visual detail (specific recognition) and with at least gist-based information (general recognition) in Experiment 1. With passive viewing instructions, young and older adults showed a central/peripheral trade-off, with memory better for negative objects than for neutral objects and poorer for backgrounds presented with negative objects than for backgrounds presented with neutral objects. In both age groups, this central/peripheral trade-off was more pronounced for the specific recognition scores than for the general recognition scores.

peripheral trade-off in specific recognition; Kensinger et al., 2007, Experiment 3). When they are asked to focus on the visual attributes of the scene (e.g., by describing the scene's visual details), they no longer show any central/peripheral trade-off (Kensinger et al., 2007, Experiment 4). Experiments 2 through 4 of the present study were designed to examine whether older adults, like young adults, can overcome the emotion-related memory trade-offs when provided with encoding instructions that emphasize active processing of the entire scene.

Experiment 2

Experiment 2 was designed to examine whether young and older adults would overcome the emotion-induced memory trade-offs when the encoding instructions emphasized processing all elements of the scene. Given evidence that the types of encoding strategies that may be particularly helpful to older adults are those that require them to semantically or perceptually elaborate on presented information (e.g., Cherry, Park, Frieske, & Rowley, 1993; Cherry et al., 1996; Puglisi & Park, 1987; Smith et al., 1998), we chose to encourage scene processing by instructing participants to tell a story about the scene that incorporated all of the scene elements. In a prior study (Kensinger et al., 2007, Experiment 3), this manipulation was found to be successful in eliminating the central/peripheral trade-off for gist-based information in young adults. The critical question was whether older adults, like young adults, would also be able to eliminate this trade-off effect.

Method

Participants. In all, 16 young adults (ages 18–35; mean age = 24.3, *SD* = 3.67 years; 9 women) and 16 older adults (ages 65–77; mean age = 71.8, *SD* = 4.81 years; 10 women) participated in the experiment for pay or course credit. Participants met the same criteria as outlined for Experiment 1. Young adult data were the same as reported in Kensinger et al. (2007, Experiment 3).

Materials and procedure. The materials and procedure were identical to those of Experiment 1, except that rather than passively viewing the scenes, participants were asked to "tell a brief story about each scene, incorporating all of the elements in the scene into the story." Participants were instructed that they should begin telling their story while the scene was on the screen, but that they could continue with their story after the scene had been removed from the screen.

Results

The raw data from Experiment 2 are presented in Table 2. The proportion of items given a "same," "similar," or "new" response are reported for young and older adults as a function of item type (same, similar, or new), scene component (object or background), and emotional content of the scene (negative or neutral). No backgrounds were themselves emotional; the emotion of each background was defined by the type of object placed in the scene (i.e., a negative background signifies a background presented with a negative arousing object). For this reason, there could be no new negative backgrounds.

An ANOVA with memory type (general recognition, specific recognition), scene component (object, background), and emotion type (negative, neutral) as within-subject factors, and age (young, older adult) as a between-subject factor, revealed significant main effects of memory type, $F(1, 30) = 10.97$, $p < .01$, partial $\eta^2 = .27$; scene component, $F(1, 30) = 25.48$, $p < .001$, partial $\eta^2 = .46$; emotion type, $F(1, 30) = 4.43$, $p < .05$, partial $\eta^2 = .13$; and age, $F(1, 30) = 17.06$, $p < .001$, partial $\eta^2 = .36$. These main effects were qualified by a number of interactions. ANOVA revealed a two-way interaction between scene component and emotion type, $F(1, 30) = 19.15$, $p < .001$, partial $\eta^2 = .39$; and three-way interactions among scene component, emotion type, and age, $F(1, 30) = 4.15$, $p = .05$, partial $\eta^2 = .12$; among emotion type, memory type, and age, $F(1, 30) = 6.83$, $p < .05$, partial $\eta^2 = .19$; and among memory type, scene component, and emotion type, $F(1, 30) = 4.84$, $p < .05$, partial $\eta^2 = .14$. In addition, the ANOVA revealed a four-way interaction among memory type, scene component, emotion type, and age, $F(1, 30) = 4.21$, $p < .05$, partial $\eta^2 = .15$.

To further examine the basis for this four-way interaction, we conducted ANOVAs separately for the young adults and for the

Table 2
Experiment 2: Mean Responses (With Standard Errors) for Objects and Backgrounds as a Function of Item Type (Same, Similar, New) and Emotion Type (Neutral, Negative)

Response	Same neutral	Same negative	Similar neutral	Similar negative	New neutral	New negative
Young adults						
Objects						
"Same"	.58 (.04)	.72 (.05)	.25 (.05)	.21 (.03)	.05 (.01)	.05 (.02)
"Similar"	.20 (.21)	.17 (.03)	.51 (.04)	.52 (.06)	.22 (.04)	.18 (.02)
"New"	.22 (.04)	.12 (.04)	.25 (.05)	.28 (.05)	.73 (.05)	.77 (.03)
Backgrounds						
"Same"	.57 (.05)	.47 (.05)	.20 (.03)	.22 (.05)	.01 (.01)	
"Similar"	.18 (.02)	.31 (.03)	.43 (.05)	.39 (.05)	.14 (.03)	
"New"	.25 (.04)	.22 (.05)	.37 (.05)	.39 (.05)	.84 (.03)	
Older adults						
Objects						
"Same"	.38 (.04)	.54 (.05)	.13 (.03)	.19 (.02)	.04 (.01)	.05 (.01)
"Similar"	.24 (.04)	.22 (.06)	.39 (.04)	.44 (.05)	.15 (.04)	.16 (.03)
"New"	.38 (.04)	.25 (.04)	.48 (.05)	.37 (.05)	.82 (.04)	.79 (.04)
Backgrounds						
"Same"	.37 (.05)	.27 (.04)	.12 (.02)	.09 (.02)	.01 (.01)	
"Similar"	.29 (.06)	.28 (.06)	.34 (.05)	.32 (.03)	.09 (.02)	
"New"	.34 (.05)	.45 (.04)	.54 (.05)	.59 (.03)	.89 (.02)	

Note. "Same" responses to same items reflect specific recognition, whereas the sum of "same" and "similar" responses to same items reflects general recognition.

older adults, with memory type (general recognition, specific recognition), scene component (object, background), and emotion type (negative, neutral) as within-subject factors. For the young adults, this ANOVA revealed a significant three-way interaction between the factors, $F(1, 15) = 8.41$, $p = .01$, partial $\eta^2 = .36$, reflecting the fact that young adults showed a central/peripheral trade-off for specific recognition scores but not for general recognition scores (see the top panel of Figure 3). Their specific recognition was better for negative items than for neutral items, $t(15) = 3.69$, $p < .01$, but it was poorer for backgrounds presented with negative items than for backgrounds presented with neutral items, $t(15) = 3.63$, $p < .01$. In contrast, their general recognition scores were better for negative items than for neutral items, $t(15) = 3.08$, $p < .01$, but did not differ for backgrounds presented with negative items compared with backgrounds presented with neutral items ($p > .20$).

For the older adults, this ANOVA revealed no three-way interaction ($p > .20$). Post hoc *t* tests confirmed that older adults showed a central/peripheral trade-off both for specific recognition and for general recognition scores: They showed better memory for negative items than for neutral items, $t(15) = 4.39$, $p < .001$, for specific recognition; $t(15) = 4.05$, $p < .001$, for general recognition, but poorer memory for backgrounds presented with negative items than for backgrounds presented with neutral items, $t(15) = 2.94$, $p < .01$, for specific recognition; $t(15) = 2.89$, $p < .05$, for general recognition (see the top panel of Figure 3). Thus, although telling a story helped the young adults to overcome at least part of their memory trade-off (i.e., they no longer showed a central/peripheral trade-off in general recognition scores), storytelling instructions did not help the older adults to overcome any aspect of their emotion-induced central/peripheral trade-off.

Discussion

The storytelling instructions employed in Experiment 2 were sufficient to allow the young adults to overcome the central/peripheral trade-off for gist-based information. However, they continued to show the central/peripheral trade-off for specific visual details, perhaps because the storytelling instructions emphasized elaboration of the general theme of the information in the scene but not its visual details.

In contrast to the young adults, older adults continued to show a robust central/peripheral trade-off both for the visual specifics and also for the general theme of the presented information. These results indicate that there are conditions in which young adults can engage more flexible encoding of scenes than can older adults. This finding is broadly consistent with those of Kensinger et al. (2005, Experiment 1b), who also found that young adults could overcome the central/peripheral trade-off when given intentional encoding instructions, whereas older adults could not. The present results, however, suggest a somewhat different conclusion from that reached by Kensinger et al. (2005). In particular, in that prior article, the authors suggested that age differences emerged because young adults were able to spontaneously engage encoding strategies that were effective in encoding the scene elements, whereas older adults were not able to effectively engage such strategies. This hypothesis is a reasonable one, because older adults are known to spontaneously engage encoding strategies less effectively than young adults (e.g., Craik, 1977; Glisky, Rubin, & Davidson, 2001; Naveh-Benjamin, Craik, Guez, & Kreuger, 2005; Naveh-Benjamin, Hussain, Guez, & Bar-On, 2003; Spencer & Raz, 1995). However, the present results suggest that age differences in the pervasiveness of the central/peripheral trade-off can

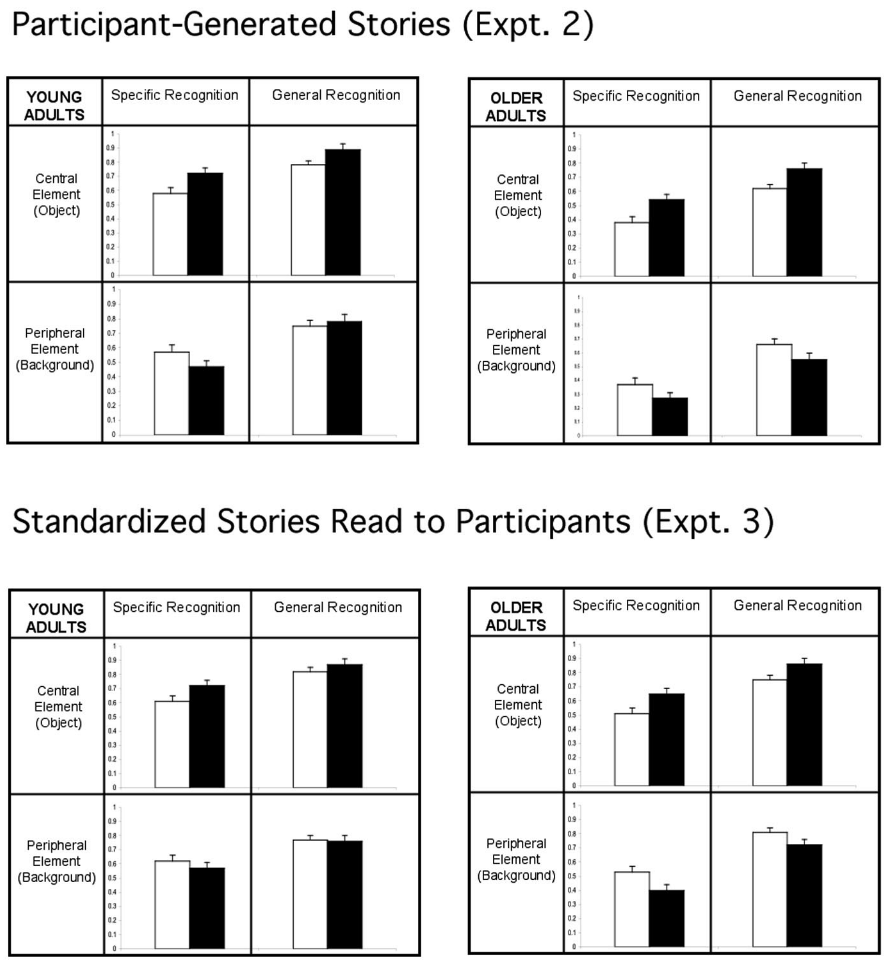

Figure 3. Proportion of central objects (white bar = neutral; black bar = negative) and peripheral backgrounds (white = presented with neutral object; black = presented with negative object) recognized with visual detail (specific recognition) and with at least gist-based information (general recognition) in Experiments 2 (Expt. 2; top) and 3 (Expt. 3; bottom). When participants generated stories (Expt. 2) or listened to stories (Expt. 3) about the scenes, young adults no longer showed a central/peripheral trade-off in general recognition scores (i.e., general recognition was no longer poorer for backgrounds presented with negative objects than for backgrounds presented with neutral objects), although they did still show some evidence of a central/peripheral trade-off for specific recognition scores. Older adults, in contrast, continued to show a robust central/peripheral trade-off in both general recognition and specific recognition scores.

be apparent even when young and older adults are given encoding strategies that should help them to direct their attention toward scene elements extraneous to the negative arousing objects. Thus, age differences may reflect changes in how automatically focused individuals are on the negative arousing element in the scene, or in the efficiency with which they can divert their attention away from the negative arousing element and toward the nonarousing components of the scene.

A potential concern, however, is that the encoding instructions may not have been equally supportive of elaborative encoding for the young and older adults. For example, perhaps older adults were not as effective as young adults at generating stories that incorporated all of the scene elements. In other words, perhaps the age differences arose not because of differences in the attentional focus of older adults, but rather because of age differences in the types of stories generated or, more broadly, in the effectiveness of the encoding instructions in guiding older adults' elaborative processing of the scenes (see Kausler, 1994; Light, 1991, for further discussion). Experiments 3 and 4 used modified encoding instructions in attempts to create encoding conditions that would be highly likely to be effective for older adults as well as young adults.

Experiment 3

To rule out the possibility that age differences in Experiment 2 reflected differences in the types of stories that young and older adults told, we devised Experiment 3 to present young and older adults with standardized stories for each scene. Therefore, if age differences still emerged, this would suggest that such differences were not attributable to differences in the types of stories told by the two age groups.

Method

Participants. In all, 16 young adults (ages 18–34; mean age = 22, SD = 5.03 years; 12 women) and 16 older adults (ages 65–77; mean age = 70.3, SD = 4.99 years; 10 women) participated in the experiment for pay or course credit. Participants met the same criteria as outlined for Experiment 1.

Materials and procedure. The materials and procedure were identical to those of Experiment 2, except that rather than generating their own stories about each scene, participants were asked to "listen as the experimenter reads aloud a short story describing the scenes presented on the computer monitor." Stories were read aloud to participants while the scenes were on the screen.

Results

Data from Experiment 3 are presented in Table 3. The proportion of items given a "same," "similar," or "new" response are reported for young and older adults as a function of item type (same, similar, or new), scene component (object or background), and emotional content of the scene (negative or neutral). All backgrounds were themselves nonemotional; the emotion of each background was defined by the type of object placed in the scene. For this reason, there could be no new negative backgrounds.

An ANOVA with memory type (general recognition, specific recognition), scene component (object, background), and emotion type (negative, neutral) as within-subject factors, and age (young, older adult) as a between-subject factor, revealed significant main effects of memory type (general > specific recognition), $F(1, 30) = 14.74$, $p < .001$, partial $\eta^2 = .33$; and scene component, $F(1, 30) = 10.89$, $p < .01$, partial $\eta^2 = .27$. These main effects were qualified by a significant three-way interaction among scene component, emotion type, and age, $F(1, 30) = 7.67$, $p < .01$, partial $\eta^2 = .20$.

To clarify the basis for this three-way interaction, we conducted ANOVAs separately for the young and older adults, with memory type (general recognition, specific recognition), scene component (object, background), and emotion type (negative, neutral) as within-subject factors. For the young adults, this ANOVA revealed a significant main effect of emotion type (negative > neutral), $F(1, 15) = 6.48$, $p < .05$, partial $\eta^2 = .30$; and of memory type (general > specific recognition), $F(1, 15) = 27.87$, $p < .001$, partial $\eta^2 = .65$. Post hoc t tests revealed that young adults showed enhanced specific and general recognition for negative items compared with neutral ones, $t(15) = 2.08$, $p = .05$, for specific recognition; $t(15) = 2.09$, $p = .05$, for general recognition, and showed marginally poorer specific recognition for backgrounds presented with negative objects compared with neutral ones, $t(15) = 1.95$, $p < .08$, and no difference in general recognition for backgrounds presented with negative objects compared with neutral ones ($p > .25$). Thus, although there was some weak evidence for a central/peripheral trade-off in the young adults' specific recognition scores, their general recognition for the backgrounds was unaffected by the type of object placed in the scene (see the bottom panel of Figure 3).

The same ANOVA conducted on the older adults' scores revealed a significant effect of component type, $F(1, 15) = 7.98$, $p < .05$, partial $\eta^2 = .35$, along with a significant interaction between component type and emotion, $F(1, 15) = 20.89$, $p < .001$, partial $\eta^2 = .58$. This interaction reflected the fact that older adults

Table 3
Experiment 3: Mean Responses (With Standard Errors) for Objects and Backgrounds as a Function of Item Type (Same, Similar, New) and Emotion Type (Neutral, Negative)

Response	Same neutral	Same negative	Similar neutral	Similar negative	New neutral	New negative
			Young adults			
Objects						
"Same"	.61 (.06)	.72 (.03)	.17 (.04)	.20 (.03)	.03 (.01)	.01 (.01)
"Similar"	.21 (.05)	.15 (.03)	.60 (.05)	.59 (.05)	.15 (.02)	.10 (.02)
"New"	.19 (.03)	.12 (.02)	.22 (.02)	.21 (.03)	.83 (.02)	.89 (.03)
Backgrounds						
"Same"	.62 (.05)	.57 (.04)	.23 (.03)	.19 (.03)	.01 (.01)	
"Similar"	.15 (.03)	.19 (.03)	.51 (.05)	.45 (.04)	.09 (.02)	
"New"	.23 (.03)	.23 (.03)	.27 (.03)	.36 (.05)	.90 (.02)	
			Older adults			
Objects						
"Same"	.51 (.06)	.65 (.05)	.29 (.06)	.34 (.06)	.06 (.01)	.03 (.01)
"Similar"	.24 (.06)	.21 (.05)	.42 (.06)	.44 (.07)	.09 (.01)	.10 (.02)
"New"	.24 (.04)	.14 (.02)	.29 (.04)	.22 (.02)	.86 (.02)	.86 (.02)
Backgrounds						
"Same"	.53 (.06)	.40 (.06)	.28 (.05)	.24 (.05)	.05 (.02)	
"Similar"	.28 (.05)	.32 (.05)	.38 (.05)	.35 (.05)	.05 (.01)	
"New"	.20 (.03)	.28 (.04)	.34 (.03)	.41 (.03)	.90 (.02)	

Note. "Same" responses to same items reflect specific recognition, whereas the sum of "same" and "similar" responses to same items reflects general recognition.

showed a central/peripheral memory trade-off both in specific recognition and in general recognition (see the bottom panel of Figure 3). Both recognition scores were higher for negative objects than for neutral ones, $t(15) = 3.55$, $p < .01$, for specific recognition; $t(15) = 3.04$, $p < .01$, for general recognition, and were lower for backgrounds presented with negative objects compared with those presented with neutral objects, $t(15) = 3.18$, $p < .01$, for specific recognition; $t(15) = 2.07$, $p = .05$, for general recognition.

Discussion

The results of Experiment 3 closely paralleled those of Experiment 2. When given a story about each scene, young adults did not show any central/peripheral trade-off when remembering the general theme of presented information, and they showed only weak evidence of a central/peripheral trade-off when remembering the specific visual details of information in the scene. Thus, young adults appeared to be able to use the story given to them to help them process most of the scene elements. In contrast, older adults showed a strong central/peripheral trade-off that was apparent both in specific recognition and in general recognition scores.

One possible explanation for older adults' difficulty in overcoming the trade-offs may relate to what they were doing while the story was being read to them. For example, perhaps young adults actively scanned the scenes, processing most of the scene elements. Older adults, in contrast, may have kept their gaze on a limited portion of the scene (e.g., on the negative arousing element) as they listened to the story. Experiment 4 was designed to create an encoding task that required both age groups to scan the background as well as the objects. We reasoned that if any instruction would help older adults to reduce their central/peripheral trade-off, it would be this type of instruction that requires active processing of the scene elements.

Experiment 4

The goal of Experiment 4 was to examine whether older adults could show a mitigated central/peripheral trade-off effect when performing an encoding task that required guided attention both to the objects and to background elements. Thus, participants were given encoding instructions that required them to answer a question about the object of each scene and about the background of each scene (e.g., "Which direction is the frog facing?" and "What color of pebbles are on the ground?").

This manipulation also served a secondary goal of examining whether, with these instructions that emphasized focusing on details of the objects and backgrounds, young adults' specific recognition would be equated for the scenes with the negative arousing objects compared with the neutral ones. In Experiment 2 there was clear evidence of a central/peripheral trade-off in the specific recognition for the young adults. In Experiment 3, although the effect was much weaker, numerically the data suggested a central/peripheral trade-off for the specific recognition scores (and evidence of a trade-off also was revealed by *t* tests). Thus, the secondary goal of this experiment was to see whether we could equate the young adults' specific recognition for backgrounds when given a task that focused them equally on visual details of the object and of the background.

Method

Participants. A total of 16 young adults (ages 18–29; mean age = 20, *SD* = 3.12 years; 8 women) and 16 older adults (ages 67–79; mean age = 74.1, *SD* = 4.66 years; 9 women) participated in the experiment for pay or course credit. Participants met the same criteria as outlined for Experiment 1.

Materials and procedure. The materials and procedure were identical to those used in Experiment 1, except that preceding each scene's presentation during encoding, participants were presented with one question about the object in the scene (e.g., "What direction is the frog facing?") and one question about the background in the scene (e.g., "What color of pebbles are on the ground?"). The order in which the object and background questions appeared on the screen was counterbalanced across participants. Participants were told that when the scene was presented, they should pay careful attention to the details so as to be able to answer those questions. After the scene had been on the screen for 5 s, it was replaced by the same questions as had preceded its presentation, and participants were instructed to give their answers verbally to the experimenter.

Results

Data from Experiment 4 are presented in Table 4. The proportion of items given a "same," "similar," or "new" response is reported for young and older adults as a function of item type (same, similar, or new), scene component (object or background), and emotional content of the scene (negative or neutral). The emotion of each background was defined by the type of object placed in the scene. All backgrounds were themselves nonemotional; for this reason, there could be no new negative backgrounds.

An ANOVA with memory type (general recognition, specific recognition), scene component (object, background), and emotion type (negative, neutral) as within-subject factors, and age (young, older adult) as a between-subject factor, revealed significant main effects of memory type, $F(1, 30) = 18.43$, $p < .001$, partial $\eta^2 = .39$; and scene component, $F(1, 30) = 22.06$, $p < .001$, partial $\eta^2 = .43$. These main effects were qualified by interactions between memory type and age (with age affecting specific recognition more than general recognition), $F(1, 30) = 5.84$, $p < .05$, partial $\eta^2 = .17$; between scene component and emotion type, $F(1, 30) = 10.40$, $p < .01$, partial $\eta^2 = .26$; and among scene component, emotion type, and age, $F(1, 30) = 9.99$, $p < .01$, partial $\eta^2 = .26$.

This three-way interaction suggested that the central/peripheral trade-off (i.e., the interaction between scene component and emotion type) differed as a function of age. To further explore the basis of this three-way interaction, we conducted ANOVAs separately for the young and older adults, with memory type (general recognition, specific recognition), scene component (object, background), and emotion type (negative, neutral) as within-subject factors. For the young adults, this ANOVA revealed a significant main effect of memory (general > specific recognition), $F(1, 15) = 27.94$, $p < .001$, partial $\eta^2 = .67$; and of scene component (memory for backgrounds better than memory for objects), $F(1, 15) = 7.50$, $p < .05$, partial $\eta^2 = .35$. Post hoc *t* tests indicated that young adults' memory for negative objects was better than their

Table 4
Experiment 4: Mean Responses (With Standard Errors) for Objects and Backgrounds as a Function of Item Type (Same, Similar, New) and Emotion Type (Neutral, Negative)

Response	Same neutral	Same negative	Similar neutral	Similar negative	New neutral	New negative
Young adults						
Objects						
"Same"	.52 (.03)	.61 (.04)	.19 (.03)	.18 (.03)	.03 (.01)	.03 (.01)
"Similar"	.19 (.03)	.15 (.03)	.31 (.04)	.42 (.05)	.13 (.03)	.09 (.01)
"New"	.30 (.03)	.24 (.03)	.50 (.04)	.40 (.04)	.84 (.03)	.88 (.02)
Backgrounds						
"Same"	.63 (.05)	.67 (.04)	.20 (.03)	.18 (.05)	.01 (.01)	
"Similar"	.20 (.04)	.18 (.03)	.39 (.05)	.41 (.03)	.12 (.02)	
"New"	.17 (.03)	.15 (.02)	.41 (.05)	.42 (.05)	.87 (.02)	
Older adults						
Objects						
"Same"	.32 (.07)	.53 (.04)	.23 (.05)	.22 (.04)	.09 (.04)	.08 (.04)
"Similar"	.33 (.05)	.23 (.05)	.34 (.05)	.46 (.07)	.14 (.03)	.17 (.03)
"New"	.34 (.06)	.24 (.04)	.42 (.06)	.32 (.06)	.77 (.06)	.75 (.06)
Backgrounds						
"Same"	.56 (.05)	.47 (.04)	.22 (.05)	.20 (.04)	.08 (.05)	
"Similar"	.26 (.05)	.29 (.05)	.34 (.05)	.41 (.06)	.13 (.02)	
"New"	.18 (.04)	.24 (.04)	.45 (.05)	.39 (.05)	.79 (.06)	

Note. "Same" responses to same items reflect specific recognition, whereas the sum of "same" and "similar" responses to same items reflects general recognition.

memory for neutral objects, $t(15) = 3.57$, $p < .01$, for specific recognition; $t(15) = 2.03$, $p = .5$, for general recognition, but that there was no difference in recognition rates for backgrounds presented with negative and neutral objects ($p > .25$). Thus, this experiment achieved its secondary goal of equating young adults' memories for the background elements of the scenes with negative arousing objects and with neutral objects (see Figure 4).

The comparable ANOVA for the older adults revealed a significant main effect of component type, $F(1, 15) = 16.06$, $p < .001$, partial $\eta^2 = .52$; and a significant interaction between component type and emotion, $F(1, 15) = 17.08$, $p < .001$, partial $\eta^2 = .53$. This interaction reflected the fact that older adults showed an emotion-related central/peripheral trade-off both in their specific recognition and in their general recognition scores. Older adults had better specific and general recognition of negative objects than of neutral ones, $t(15) = 3.09$, $p < .01$, for specific recognition; $t(15) = 1.91$, $p = .05$, for general recognition, but they had poorer specific and general recognition of backgrounds studied with negative objects compared with those studied with neutral ones, $t(15) = 1.83$, $p < .09$, for specific recognition; $t(15) = 2.45$, $p < .05$, for general recognition (see Figure 4). Thus, these encoding instructions did not serve to eliminate older adults' central/peripheral trade-off.

Discussion

The encoding task used in Experiment 4 was successful in equating young adults' memories for all scene backgrounds. Although the young adults continued to show a mnemonic advantage for negative arousing objects compared with neutral ones, they no longer showed any evidence of poorer memory for the backgrounds presented with negative arousing objects. These data emphasize that there are encoding conditions under which young adults can show no emotion-related memory trade-off (see also Kensinger et al., 2005, 2007). By contrast, older adults demonstrated a robust central/peripheral memory trade-off, both for the specific visual details of the scenes and also for the general theme of the presented information. Thus, even with an encoding task that required processing of the scene backgrounds as well as the objects in the scenes, older adults still showed a pervasive central/peripheral trade-off. The implications of these findings are expanded upon in the General Discussion.

General Discussion

There were two primary goals of the present study. The first goal was to examine the nature of the memory trade-offs elicited by negative arousal in young and older adults when they were not given specific instructions as to how to process the scenes. The second goal was to examine whether, when given encoding instructions that encouraged semantic and perceptual elaboration of the scenes, young and older adults would be able to overcome emotion-related memory trade-offs. With regard to the first goal, the results revealed that with passive viewing, both young and older adults showed an interaction between the central/peripheral and the gist/detail trade-offs. Both age groups appeared to focus on the negative objects in scenes, boosting their memory for those objects but hindering their memory for other scene elements. However, this central/peripheral trade-off was more apparent for memory for the visual details of the objects and backgrounds than for memory for the general theme of the objects and backgrounds. The fact that these effects of negative arousal on memory occurred

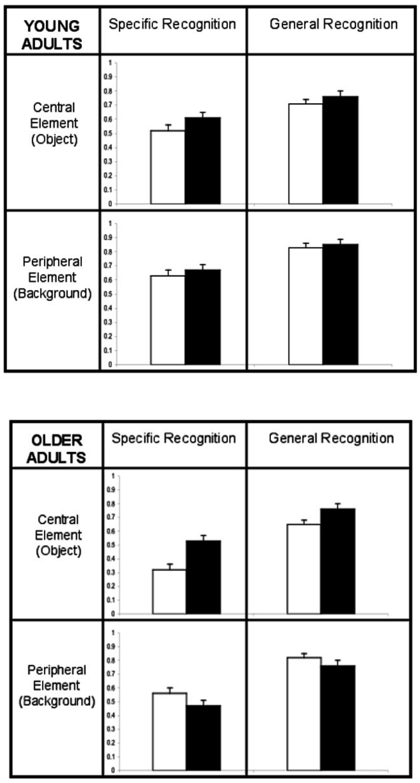

Figure 4. Proportion of central objects (white bar = neutral; black bar = negative) and peripheral backgrounds (white = presented with neutral object; black = presented with negative object) recognized with visual detail (specific recognition) and with at least gist-based information (general recognition) in Experiment 4. When participants' encoding task required that they answer a question about the object in each scene and about the background of each scene, young adults no longer showed any evidence of a central/peripheral trade-off. Older adults, in contrast, continued to show a robust central/peripheral trade-off in both general recognition and specific recognition scores.

for young and older adults is consistent with prior studies suggesting that emotion-related memory trade-offs remain relatively stable with aging (Denburg et al., 2003; Kensinger et al., 2005). Although a limitation of the present study is that we assessed adults with extreme age differences (i.e., comparing college-aged to older adults) rather than including a broader age range, the fact that the two groups of individuals showed such similar patterns of performance with the passive viewing instructions suggests that emotion-related memory trade-offs are preserved across the adult lifespan.

This preservation of the memory trade-off with aging is particularly interesting given some evidence that older adults may try to focus less on negative information in the environment than young adults (e.g., Mather & Carstensen, 2005). However, age differences in the types of information attended to and remembered tend to arise when older adults are able to use controlled emotion regulation strategies to change the way in which they process emotional information. In contrast, when relatively automatic processing of emotional information is assessed, older adults are at least as likely as young adults to focus on negative information (see Mather, 2006; Mather & Knight, 2005). The results of the present study are consistent with the idea that older adults are, if anything, more likely than young adults to focus on the negative arousing objects in scenes.

The present results also are interesting in light of evidence that when presented with relatively nonemotional scenes, older adults are more likely to focus on the context elements whereas young adults are more likely to attend to the object elements (e.g., Chee et al., 2006). The results of Experiment 1 within the present study, however, emphasize that despite some changes in how older adults process relatively nonemotional information, with passive viewing, the two age groups tend to remember similar information about scenes with negative information: Both young and older adults extract the details of the negative arousing objects and forget the surrounding scene elements. In other words, although there is evidence of an age-related shift toward focusing on contextual, background elements of scenes (Chee et al., 2006), that shift is not sufficient to reduce older adults' focus on negative arousing elements within scenes.

In regard to the second goal, Experiments 2 through 4 demonstrated that there is a much wider range of encoding conditions across which older adults show emotion-related memory trade-offs compared with young adults. Across three experiments, young adults showed an ability to reduce the trade-offs; in particular, when given encoding tasks that emphasized elaborative encoding of the scene elements, the young adults showed comparable general recognition (and sometimes comparable specific recognition as well) for the backgrounds presented with negative arousing objects and those presented with neutral objects. By contrast, older adults demonstrated robust central/peripheral trade-offs across all encoding conditions. Even when given encoding instructions that should have helped them to process all elements of the scene, older adults appeared unable to divert their encoding resources away from the negative arousing objects and toward nonemotional scene elements.

These findings are consistent with those of Kensinger et al. (2005, Experiment 1b), and yet they suggest that the age-related difficulties in overcoming the central/peripheral trade-off are not related to older adults' inabilities to spontaneously engage effective encoding strategies. Rather, even when given strategies that should help them to encode all scene elements, older adults seem to remain focused on the negative arousing elements. One possible explanation for older adults' failure to overcome the trade-off is that they may be unable to use the encoding strategies given to them. Although older adults often benefit from encoding strategies that emphasize semantic and perceptual elaboration, they do not always show benefits on par with those of young adults (reviewed by Kausler, 1994; Light, 1991). Perhaps the encoding strategies given to participants in Experiments 2 through 4 simply were not as effective for older adults as they were for young adults. There are a couple of reasons why we are not satisfied with this explanation. First, older adults' overall memory performance was better with the active encoding instructions than with the passive viewing instructions used in Experiment 1. In Experiment 1, older adults forgot (i.e., called "new") 36% of backgrounds presented with neutral objects and 48% of backgrounds presented with negative objects. The percentage of items forgotten was substantially smaller in the later experiments (e.g., 20%–28% forgotten in Experiment 3, 18%–24% forgotten in Experiment 4). These results suggest that older adults' memories did benefit from the encoding strategies; nevertheless, the strategies could not help them to overcome the emotion-related trade-offs. Second, across all three of these experiments, older adults showed robust emotion-related trade-offs. There was no evidence that their trade-offs were reduced by the use of encoding strategies. In fact, the proportional discrepancy between older adults' memories for the backgrounds presented with the negative objects and with the neutral objects remained nearly identical across the four experiments (e.g., 36% vs. 48% forgotten in Experiment 1; 18% vs. 24% forgotten in Experiment 4). Given the range of active encoding tasks used, and the evidence that older adults did show mnemonic benefits from the use of those encoding tasks, it seems unlikely that their failure to overcome the emotion-related memory trade-off is related simply to their inability to use the encoding strategies.

Instead, we suggest that older adults' failures to overcome the emotion-related memory trade-off stem from age-related changes in the attentional focus on affective information. As discussed in the introduction, there is evidence that older adults' attention can be drawn to negative information in the environment even more so than young adults' (e.g., Mather, 2006; Wurm et al., 2004). Two related mechanisms could account for this age effect. First, older adults may have a stronger attention focus on the negative arousing items than young adults. This attention focus may make it harder for older adults to shift their attention away from the negative objects and to other aspects of the scene for prolonged durations. Such a finding would be consistent with evidence for a greater focus on emotion and emotion regulation with age (Gross et al., 1997; Labouvie-Vief & DeVoe, 1991; Labouvie-Vief & Medler, 2002). Second, older adults may have more difficulties deploying attentional control; thus, even if they have the same degree of attention focusing on the negative arousing objects as young adults, they may nevertheless find it harder to shift their attention away from the negative object and toward other scene elements (see Wurm et al., 2004, for further discussion). This pattern of findings would be consistent with evidence for broad failures of cognitive control with age (e.g., Braver & Barch, 2002; Gutchess et al., 2007). Of course it is possible that both mechanisms are at play. It also is plausible that age-related differences arise not only from encoding influences but also from older adults' failure to use encoded details to guide their retrieval (Naveh-Benjamin, Brav, & Levy, 2007). Future research will be needed to examine to what extent it is increased attention focus on the emotional items themselves, or difficulty engaging strategic attentional shifts, that creates the persistent central/peripheral trade-off in older adults. One interesting avenue for future research will be to examine whether differences in older adults' cognitive control ability correspond with older adults' ability to overcome the trade-off. It is plausible that older adults with particularly good cognitive control ability will be more likely to overcome the trade-offs than those with poorer cognitive control. Future investigations also will do well to include a broader age range of participants to examine at which point in the adult lifespan individuals begin to have difficulties overcoming the emotion-related memory trade-off.

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.

Adolphs, R., Tranel, D., & Buchanan, T. W. (2005). Amygdala damage impairs emotional memory for gist but not details of complex stimuli. *Nature Neuroscience, 8,* 512–518.

Braver, T. S., & Barch, D. M. (2002). A theory of cognitive control, aging, cognition, and neuromodulation. *Neuroscience and Biobehavioral Reviews, 26,* 809–817.

Buchanan, T. W., & 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). Amsterdam: John Benjamins.

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.

Chee, M. W. L., Goh, J. O. S., Venkatraman, V., Tan, J. C., Gutchess, A., Sutton, B., et al. (2006). Age-related changes in object processing and contextual binding revealed using fMR-adaptation. *Journal of Cognitive Neuroscience, 18,* 495–507.

Cherry, K. E., Park, D. C., Frieske, D. A., & Rowley, R. (1993). The effect of verbal elaborations on memory in young and older adults. *Memory & Cognition, 21,* 725–738.

Cherry, K. E., Park, D. C., Frieske, D. A., & Smith, A. D. (1996). Verbal and pictorial elaborations enhance memory in younger and older adults. *Aging, Neuropsychology, and Cognition, 3,* 15–29.

Coltheart, M. (1981). The MRC psycholinguistic database. *Quarterly Journal of Experimental Psychology, 33A,* 497–505.

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. 679–698). New York: Van Nostrand Reinhold.

Craik, F. I., & Rabinowitz, J. C. (1985). The effects of presentation rate and encoding task on age-related memory deficits. *Journal of Gerontology, 40,* 309–315.

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

Derwinger, A., Neely, A. S., MacDonald, S., & Bäckman, L. (2005). Forgetting numbers in old age: Strategy and learning speed matter. *Gerontology, 51,* 277–284.

Earles, J. L., Smith, A. D., & Park, D. C. (1994). Age differences in the effects of facilitating and distracting context on recall. *Aging and Cognition, 1,* 141–151.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-Mental State": A practical method for grading the state of patients for the clinician. *Journal of Psychiatric Research, 12,* 189–198.

Fox, L. S., & Knight, B. G. (2005). The effects of anxiety on attentional processes in older adults. *Aging & Mental Health, 9,* 585–593.

Garoff, R. J., Slotnick, S. D., & Schacter, D. L. (2005). The neural origins of specific and general memory: The role of the fusiform cortex. *Neuropsychologia, 43,* 847–859.

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.

Gross, J. J., Carstensen, L. L., Pasupathi, M., Tsai, J., Skorpen, C. G., & Hsu, A. Y. C. (1997). Emotion and aging: Experience, expression, and control. *Psychology and Aging, 12,* 590–599.

Gutchess, A. H., Hebrank, A., Sutton, B., Leshikar, E., Chee, M. W. L., Tan, J. C., et al. (2007). Contextual interference in recognition memory with age. *Neuroimage, 35,* 1338–1347.

Hashtroudi, S., Johnson, M. K., & Chrosniak, L. D. (1990). Aging and qualitative characteristics of memories for perceived and imagined complex events. *Psychology and Aging, 5,* 119–126.

Hashtroudi, S., Johnson, M. K., Vnek, N., & Ferguson, S. A. (1994). Aging and the effects of affective and factual focus on source monitoring and recall. *Psychology and Aging, 9,* 160–170.

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.

Kausler, D. H. (1994). *Learning and memory in normal aging.* San Diego, CA: Academic Press.

Kensinger, E. A. (2006). Remembering emotional information: Effects of aging and Alzheimer's disease. In E. M. Welsh (Ed.), *Progress in Alzheimer's disease research* (pp. 213–226). Hauppauge, NY: Nova Science.

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

Kensinger, E. A., Garoff-Eaton, R. J., & Schacter, D. L. (2007). Effects of emotion on memory specificity: Memory trade-offs elicited by negative visually arousing stimuli. *Journal of Memory and Language, 56,* 575–591.

Kensinger, E. A., Piguet, O., Krendl, A. C., & Corkin, S. (2005). Memory for contextual details: Effects of emotion and aging. *Psychology and Aging, 20,* 241–250.

Labouvie-Vief, G., & DeVoe, M. (1991). Emotional regulation in adulthood and later life: A developmental view. In K. W. Schaie & M. P. Lawton (Eds.), *Annual review of gerontology and geriatrics: Behavioral science and aging* (Vol. 11, pp. 172–194). New York: Springer.

Labouvie-Vief, G., & Medler, M. (2002). Affect optimization and affect complexity: Modes and styles of regulation in adulthood. *Psychology and Aging, 17,* 571–587.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1997). *International Affective Picture System (IAPS): Technical manual and affective ratings.* Gainesville: University of Florida.

Leclerc, C. M., & Hess, T. M. (2004, November). *Age differences in attentional interference effects with emotional versus neutral information.* Poster presented at the 57th Annual Scientific Meeting of The Gerontological Society of America, Washington, DC.

Leigland, L. A., Schulz, L. E., & Janowsky, J. S. (2004). Age related changes in emotional memory. *Neurobiology of Aging, 25,* 1117–1124.

Light, L. L. (1991). Memory and aging: Four hypotheses in search of data. *Annual Review of Psychology, 42,* 333–376.

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.

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

Mather, M. (2006). Why memories may become more positive as people age. In B. Uttl, N. Ohta, & A. L. Siegenthaler (Eds.), *Memory and emotion: Interdisciplinary perspectives* (pp. 135–158). Malden, MA: Blackwell.

Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Science, 9,* 496–502.

Mather, M., & Knight, M. (2005). Goal-directed memory: The role of cognitive control in older adults' emotional memory. *Psychology and Aging, 20,* 554–570.

May, C. P., Rahhal, T., Berry, E. M., & Leighton, E. A. (2005). Aging, source memory, and emotion. *Psychology and Aging, 20,* 571–578.

Naveh-Benjamin, M., Brav, T. K., & Levy, O. (2007). The associative memory deficit of older adults: The role of strategy utilization. *Psychology and Aging, 22,* 202–208.

Naveh-Benjamin, M., Craik, F. I., Guez, J., & Kreuger, S. (2005). Divided attention in younger and older adults: Effects of strategy and relatedness on memory performance and secondary task costs. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31,* 520–537.

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.

Park, D. C., Smith, A. D., Morrell, R. W., Puglisi, J. T., & Dudley, W. N. (1990). Effects of contextual integration on recall of pictures by older adults. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 45,* P52–P57.

Puglisi, J. T., & Park, D. C. (1987). Perceptual elaboration and memory in older adults. *Journal of Gerontology, 42,* 160–162.

Rahhal, T. A., May, C. P., & Hasher, L. (2002). Truth and character: Sources that older adults can remember. *Psychological Science, 13,* 101–105.

Reese, E., Kensinger, E. A., & Schacter, D. L. (2007). [Effects of positive and negative emotion on memory trade-offs]. Unpublished raw data.

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

Sheikh, J. I., & Yesavage, J. A. (1986). Geriatric Depression Scale (GDS): Recent evidence and development of a shorter version. In T. L. Brink (Ed.), *Clinical gerontology: A guide to assessment and intervention* (pp. 165–173). New York: Haworth Press.

Smith, A. D., Park, D. C., Cherry, K., & Berkovsky, K. (1990). Age differences in memory for concrete and abstract pictures. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 45,* P205–P209.

Smith, A. D., Park, D. C., Earles, J. L. K., Shaw, R. J., & Whiting, W. L. (1998). Age differences in context integration in memory. *Psychology and Aging, 13,* 21–28.

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.

Wurm, L. H., Labouvie-Vief, G., Aycock, J., Rebucal, K. A., & Koch, H. E. (2004). Performance in auditory and visual emotional Stroop tasks: A comparison of older and younger adults. *Psychology and Aging, 19,* 523–535.

Zacks, R., & Hasher, L. (1997). Cognitive gerontology and attentional inhibition: A reply to Burke and McDowd. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences, 52,* 274–283.

Received October 3, 2006
Revision received April 25, 2007
Accepted April 26, 2007 ■