

The effects of emotional content and aging on false memories

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After studying a list of words related to a nonpresented *lure* word, people often falsely recall or recognize the nonpresented lure. Older adults are particularly susceptible to these forms of false memories. The age-related false memory enhancement likely occurs because older adults do not encode, or later retrieve, items in enough detail to allow them to discriminate between presented words and other associated but nonpresented items. Pesta, Murphy, and Sanders (2001) suggested that the emotional salience of the lures may provide distinctiveness, so that individuals would be less likely to endorse an emotional lure as a studied item than to endorse a neutral lure. In the present investigation, young and older adults were less likely to falsely recall or recognize emotional, as compared with neutral, lures. Both age groups appeared capable of using the distinctiveness of the emotional lures to reduce, although not to eliminate, false recall and recognition.

Memory is reconstructive, and the reconstruction process is often flawed (see Loftus, Feldman, & Dashiell, 1995; Schacter & Curran, 2000, and Schacter & Dodson, 2001, for reviews). Thus, we can falsely believe that we have previously encountered items that, in fact, are novel. A large literature has used the Deese–Roediger–McDermott word lists to evoke false memories, finding that young (Hintzman, 1988; Roediger, & McDermott, 1995; Shiffrin, Huber, & Marinelli, 1995) and older (Koutstaal & Schacter, 1997; Norman & Schacter, 1997; Tun, Wingfield, Rosen, & Blanchard, 1998) adults are susceptible to memory distortions. In this task, participants study a list of semantically associated words (e.g., *table, sit, legs, seat*) related to a nonpresented lure (e.g., *chair*). A false memory occurs when the lure word is incorrectly judged to have been a presented word. False memories can also arise after lists of orthographic (Schacter, Verfaellie, & Anes, 1997; Watson, Balota, & Roediger, 2003) or phonemic (Sommers & Lewis, 1999) associates of lure words have been studied.

Recent evidence has suggested that individuals' likelihood of falsely remembering an item may be related to how distinctively they encode, and thus expect to retrieve, the stimuli (Dodson & Schacter, 2001; Schacter, Cendan, Dodson, & Clifford, 2001; Schacter, Koutstaal, & Norman, 1997). Although distinctiveness is a somewhat ill-defined concept (Hunt & McDaniel, 1993), we use it to refer to the uniqueness of an item: Distinctive items share few features with other information stored in memory or with items presented in a particular study list. Thus, encoding manipulations that increase the distinctiveness of

items, such as inclusion of pictorial associations (Dodson & Schacter, 2002a, 2002b; Israel & Schacter, 1997; Weiss, Dodson, Goff, Schacter, & Heckers, 2002), tend to reduce the likelihood of false memories.

Emotion may provide another dimension along which an item's distinctiveness can be increased. Emotionally arousing items tend to be remembered more vividly than nonemotional ones (Doerksen & Shimamura, 2001; Kensinger & Corkin, 2003; Ochsner, 2000). This qualitative memory benefit for emotional information may stem from the additional distinctiveness provided by emotional content. Emotional salience results in a number of additional dimensions (e.g., personal relevance or physiological response) that are not present with neutral stimuli (see, e.g., Christianson & Engelberg, 1999; LeDoux, 2000). It is plausible to propose that these additional dimensions would increase the distinctiveness of emotional, as compared with neutral, items, thereby reducing the likelihood that emotional information will be falsely remembered.

A recent study has provided evidence that, in some instances, emotional information may be less likely to be falsely remembered than neutral information. Pesta, Murphy, and Sanders (2001) conducted a study to examine whether emotional lures could be falsely remembered. They presented young adults with orthographic associates of either emotional (e.g., *bitch*) or nonemotional (e.g., *shave*) words. Consistent with the hypothesis that the emotional salience of the lures would serve to increase their distinctiveness, the participants recognized significantly fewer emotional than nonemotional lures. The likelihood of falsely recognizing the emotional lures was also related to manipulations in their distinctiveness: Including other emotional items at encoding (thereby decreasing the distinctiveness of the emotional lure words) increased the likelihood of false memories of emotional words. Thus, it

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appears that young adults benefit from the distinctiveness provided by emotion; they can use that distinctiveness to reduce their false responses to nonpresented emotional lures.

This distinctiveness effect demonstrated by Pesta et al. (2001) differs from the typical distinctiveness manipulations of Schacter and colleagues (e.g., Dodson & Schacter, 2002b). The standard distinctiveness manipulation occurs at encoding: For example, individuals study some items as pictures and others as words. In Pesta et al.'s design, there was no encoding manipulation. Thus, the individuals could not use information about how vividly they had encoded particular study items to reject the emotional lures. Rather, the emotional lures were likely to be rejected on the basis of general expectations about how vividly emotional items tend to be remembered. Young adults likely expect more vivid memories for emotional than for neutral items. Thus, they may set a higher criterion for the vividness that they expect to be associated with emotional words versus neutral ones, thereby leading to lower false alarm rates to emotional than to neutral words.

The goal of the present investigation was to examine whether older adults also can take advantage of the distinctiveness provided by emotional lures to reduce their false alarm rates. Older adults are particularly susceptible to false memories. Numerous investigations, using a range of stimuli, have demonstrated elevated false recall and false recognition rates in older adults relative to young adults (e.g., Koutstaal & Schacter, 1997; Norman & Schacter, 1997; Rankin & Kausler, 1979; Smith, 1975; Tun et al., 1998). It has been proposed that part of the older adults' false memory enhancement stems from their inability to encode, or to retrieve, specific, distinctive details of studied items (e.g., Schacter, Koutstaal, & Norman, 1997).

Consistent with a deficit in detailed encoding or retrieval of information, older adults have greater difficulty on recall tasks than on recognition tasks (e.g., Craik, Anderson, Kerr, & Li, 1995; Glisky, Polster, & Routhieaux, 1995; Light, 1991). They also show difficulties vividly recollecting, or reexperiencing, information they have previously encountered, while showing a relatively preserved ability to indicate that an item is familiar to them from a study list (see Yonelinas, 2002, for a review). Similarly, when manipulations increase the distinctiveness of items encoded (e.g., by presenting items pictorially as well as verbally; Dodson & Schacter, 2002a; Schacter, Israel, & Racine, 1999), older adults, just like young adults, are capable of reducing their rate of false memories.

Although methods of increasing distinctiveness have been investigated in older adults (e.g., Dodson & Schacter, 2002a; Schacter et al., 1999), no prior study has examined whether older adults can use the distinctiveness provided by emotion to reduce their false memories. With increasing age, adults often place a greater emphasis on emotionally salient information and on emotion-relevant goals (see Carstensen, Isaacowitz, & Charles, 1999; Mather, 2003). Older adults also often demonstrate enhanced mem-

ory for emotional, as compared with neutral, stimuli (Denburg, Buchanan, Tranel, & Adolphs, 2003; Kensinger, Anderson, Growdon, & Corkin, 2004; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002; cf. Charles, Mather, & Carstensen, 2003), including enhanced memory for sexual versus neutral words (Krendl, Kensinger, & Corkin, 2003). In addition, they appear more likely to claim that they vividly remember having encountered emotional items than to claim remembering neutral items (Krendl et al., 2003), as is also the case with young adults (Kensinger & Corkin, 2003; Ochsner, 2000).

These results suggest that older adults can use the enhanced distinctiveness of emotional items, at least to increase their ability to correctly identify a previously presented item as having been studied. In the present investigation, we asked whether older adults can also use the distinctiveness provided by the emotional lures to reduce their rates of false recall (Experiment 1) and false recognition (Experiment 2) to these items, as compared with neutral lures.

A number of possible findings could result. Older adults may show a disproportionate benefit from the emotional salience of the lures, relative to young adults. If emotional information does gain relevance with aging (e.g., Carstensen et al., 1999), older adults may be even more likely to appreciate emotion as a form of distinctiveness than are young adults. Thus, manipulations that allow older adults to capitalize on this dimension may actually result in a diminution of age-related enhancements in false memory. Another possibility is that older adults may benefit from emotional distinctiveness to the same extent as young adults. This result would be consistent with findings that older adults show similar (not exaggerated) emotional memory enhancement effects, relative to young adults (Kensinger et al., 2002), perhaps suggesting that the distinctiveness of emotion benefits young and older adults equally. Another possibility is that emotional salience may have a lesser impact on older adults' false memories than it does on the false memory rates of young adults. This pattern could result for a number of reasons—because of age-related differences in the processing of the emotional stimuli or because of age-related differences in metacognitive processes, making older adults less able to use the distinctiveness provided by emotion. The present investigation addressed which of these patterns would best describe the effect that the distinctiveness of the emotional items would have on the false memories of older adults.

EXPERIMENT 1

Effects of Emotional Content and Aging on False Recall

Method

Participants. The participants were 30 older adults (14 women; ages, 65–82 years; mean age = 70.0; 14–22 years of education; mean education = 16.8 years), recruited through the Harvard Cooperative on Aging, the MIT Alumni Association, and fliers posted throughout the greater Boston area, and 30 young adults (15 women; ages, 18–35 years; mean age = 25.1; 13–20 years of education;

mean education = 14.1 years) who were MIT or Harvard undergraduate or graduate students. All were native English speakers.

All the participants were screened to exclude those with a history of alcoholism, drug abuse, or depression, those who were currently taking psychotropic medication, or those currently depressed. In addition, older adults were screened to exclude those with a history of heart disease, cancer, neurological or psychiatric diagnosis, untreated hypertension, or diabetes. No participants were taking centrally acting medications, and none was depressed: All scores on the Geriatric Depression Scale (Sheikh & Yesavage, 1986) were less than 5. The young and older adult groups had similar scores on the WAIS-III vocabulary subtest.

The participants were remunerated at \$10/h, and completion of the task required about 30 min. Testing materials and procedures were approved by the MIT Committee on the Use of Humans as Experimental Subjects. To meet with committee approval, all the participants were told in advance that "vulgar" or "taboo" words would be presented as part of the study.

Procedure. The participants viewed one of two lists of 71 words. The words were presented on a Macintosh computer screen, with each word appearing for 1.5 sec. The participants were instructed to watch as the words were presented, and they were informed that they would be given a recall task following the words' presentation.

The list studied was counterbalanced across participants. Each list included three sets of 10 words that were associated with a neutral lure and three sets of 10 words that were associated with an emotional lure (lure lists were taken from Pesta et al., 2001, Appendix A). The lure words were not included on the study list. List A included three sets associated with neutral lures (*hook*, *rink*, and *shave*) and three with emotional lures (*bitch*, *rape*, and *slut*). List B included three sets associated with neutral lures (*digit*, *park*, and *peach*) and three with emotional lures (*hell*, *penis*, and *whore*). List construction was identical to that in Pesta et al. Five of the 10 items from each associate list were presented together at study, so that the study lists rotated through words from the six associate lists (e.g., the first 5 items from the *hook* list were presented, followed by the first 5 items from the *rape* list, etc.). Four neutral buffer words were included at the beginning and end of each of the lists, to avoid primacy or recency effects, and three emotional *filler* words were interspersed throughout the list (as in Pesta et al., 2001, their Experiment 3, although in our experiment, the words were presented in the same font as the other words). These *filler* words were inserted in between these blocks of five words (e.g., *asshole* was inserted after the five associates of *hook* and before the five associates of *rape*) and were included to boost overall false retrieval rates for the emotional lures (by making the emotional lures less distinctive; see Pesta et al., 2001, for further discussion).

After a brief delay (1–2 min) following presentation of the study list, the participants were given a recall test, in which they were asked to write all of the words they remembered from the list.

After completion of the experiment, the young and the older adults rated all the studied words and nonstudied lure words for

arousal (from -3 , indicating *highly calming*, to 3 , indicating *highly exciting or agitating*). The results confirmed that the 6 emotional lures were rated as high in arousal by both age groups and that there were no differences in the arousal ratings given by the young and the older adults (young adult $M = 2.3$, $SD = 0.71$; older adult $M = 2.1$, $SD = 0.85$).

Scoring and data analysis. The participants' recall responses were scored to determine, for each category of lure list (emotional or neutral), the number of (1) correctly recalled studied words and (2) falsely recalled lure words. We also tallied the number of correctly recalled emotional filler words and the number of intrusions. We discovered that the participants occasionally made intrusions of words that were phonologically associated with studied items. In contrast, there were nearly no intrusions that were phonologically unrelated to studied words. We therefore scored the data two ways. In the *lenient* scoring method, we included phonological intrusions as false recall responses. Intrusions were scored as emotional or neutral false recall responses on the basis of the emotional salience of the intrusion (to parallel the scoring of the critical lures, where emotional lures contained emotional salience, whereas neutral lures did not). Thus, the word *well* would be counted as a neutral false alarm even though it was an associate of words presented on an emotional lure list (*hell*). In the *strict* scoring method, only the lure words were counted in the false recall tally.

In the strict scoring method, all the scores were converted to proportions (e.g., total number of false alarms to emotional lures divided by the total number of emotional lures in a list). In the lenient scoring method, it was not possible to convert the false recall responses to proportions in the traditional way, because there was no set upper bound on the number of phonological intrusions a participant could make. To translate the raw values to proportions, allowing comparison of false recall and veridical recall rates, we set the upper bound for phonological intrusions as the highest number of such responses made by any individual (four phonological intrusions). Thus, in the lenient scoring system, recall of the lures was combined with phonological intrusions to create one false recall score for emotional items and one for neutral items. The proportions in this lenient scoring system were computed out of a total of seven (three critical lures plus four phonological intrusions).

Repeated measures analyses of variance (ANOVAs) and post hoc t tests determined the effect of emotion on false recall. Neither the strict nor the lenient scoring method revealed sex differences, so the data from the men and the women were combined. Furthermore, because the strict and the lenient scoring systems led to qualitatively similar results, we will describe only the results with the strict scoring method.

Results

An ANOVA conducted for the young adults with lure type (emotional or neutral) and item type (list word or lure word) as within-subjects factors revealed an effect of lure type

Table 1
Experiment 1: Mean Proportions of Words Recalled (With Standard Errors) as a Function of Lure Type (Emotional or Neutral) and Item Type (List Item, Lure Item, or Phonological Intrusion)

	Emotional Lure List						Neutral Lure List							
	List Item*		Lure Item		Phonological Intrusion**		List Item*		Lure Item		Phonological Intrusion**		Emotional Fillers	
	(30 Maximum)		(3 Maximum)		(4 Maximum)		(30 Maximum)		(3 Maximum)		(4 Maximum)		(3 Maximum)	
Participants	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>
Young adults	.20	.02	.07	.03	.01	.01	.20	.02	.19	.04	.11	.04	.64	.06
Older adults	.11	.04	.11	.04	.02	.02	.11	.02	.28	.06	.11	.02	.46	.06

*All list items were neutral. **The valence of the phonological intrusion was determined by the emotional salience of the word generated, not of the lure word to which the intrusion was a phonological associate.

[$F(1,29) = 4.97, p < .05$], an effect of item type [$F(1,29) = 7.14, p < .05$], and an interaction between lure type and item type [$F(1,29) = 4.33, p < .05$]. Subsequent t tests indicated that the effect of item type resulted from the young adults' higher correct recall rates, as compared with false recall rates, for the words from the emotional lure lists [$t(29) = 3.88, p < .001$]; their correct and false recall rates for the words from the neutral lure lists were similar.

The interaction between emotion and item type stemmed from the fact that the young adults correctly recalled a similar number of associates of emotional and neutral lures but falsely recalled more neutral than emotional lures [$t(29) = 2.36, p < .05$]. Nevertheless, false recall of emotional lures was significantly above zero [$t(29) = 2.27, p < .05$]. Thus, the emotional salience of the lures reduced but did not eliminate false recall in the young adults (Table 1).

An ANOVA conducted for the older adults uncovered a significant effect of lure type [$F(1,29) = 7.17, p < .05$], a marginal effect of item type [$F(1,29) = 3.34, p < .08$], and a significant interaction between lure type and item type [$F(1,29) = 8.97, p < .01$]. Subsequent t tests indicated that the older adults had similar correct recall and false recall rates for the emotional lists and had higher false recall than correct recall rates for the neutral lists [$t(29) = 3.05, p < .01$]. These results, therefore, differed from those obtained from the young adults (for whom correct recall rates were not lower than false recall rates). This finding is consistent with those of prior studies, indicating that older adults are more susceptible to false memory formation than are young adults (Johnson, Hashtroudi, & Lindsay, 1993; Koutstaal & Schacter, 1997; Rankin & Kausler, 1979; Tun et al., 1998). Even with this overall elevation in false recall rates, however, the older adults falsely recalled significantly more neutral lures than emotional lures [$t(29) = 3.00, p < .01$], while correctly recalling a similar number of list items from the neutral lure and emotional lure lists. Furthermore, although emotional lures were less likely to be falsely remembered than neutral lures, they were, nevertheless, falsely recalled a significant proportion of the time: A one-sample t test indicated that the older adults' false recall of emotional lures was significantly greater than zero [$t(29) = 3.34, p < .01$].

To examine whether the older adults showed the same magnitude of benefit from the distinctiveness of the emotional lures as the young adults, we conducted an ANOVA with lure type (emotional or neutral) and item type (lure or list item) as within-subjects factors and group as a between-subjects factor. This analysis revealed an effect of lure type [$F(1,58) = 12.14, p < .001$], an interaction between group and item type [$F(1,58) = 9.82, p < .01$], and an interaction between lure type and item type [$F(1,58) = 12.94, p < .001$]. The interaction between group and item type emerged because older adults showed higher false recall than correct recall scores, whereas young adults showed lower false recall than correct recall scores. Crit-

ically, the analysis revealed no interaction between group and lure type or between group, lure type and item type. Thus, the magnitude of the benefit from emotional salience was similar in the young and the older adults: Both groups were able to use the emotional salience of the lures to reduce their false recall responses (Table 1).

Discussion

The results of Experiment 1 indicated that young and older adults falsely recalled emotional lures but that they recalled them less frequently than they did neutral lures. This effect was not due to differences in the probability of recalling associates of emotional, as compared with neutral, lures. The interaction between emotion and item type is important because it indicates that the young adults did not simply recall more associates of the neutral lures (perhaps making it more likely that they also would recall the neutral lure). Rather, there was a specific difference in the likelihood of generating the emotional, as compared with the neutral, lures, despite similar recall of the associated words. These results extend the findings of Pesta et al. (2001), demonstrating that emotional lures are capable not only of being falsely recognized, but also of being falsely recalled. Nevertheless, the distinctiveness of the emotional lures does appear to reduce the likelihood of false recall, just as Pesta et al. demonstrated that this distinctiveness can reduce the probability of false recognition.

The critical finding with regard to aging was that the interaction between emotion and item type was of similar magnitude for the young and the older adults. Thus, the older adults showed a reduction in false recall to the emotional, as compared with the neutral, words similar to that for the young adults.

Although it is clear that the distinctiveness of the emotional lures reduced the probability that these items were falsely recalled by the young and the older adults, the mechanism by which this effect occurred remains underspecified. One possibility is that the individuals may have generated the emotional lures at retrieval less frequently than they generated the neutral lures. An item that is relatively distinct can also be thought of as being less globally related to other study items. Perhaps this relative difference between the emotional lures and the studied items (as compared with the neutral lures and the studied items) made it less likely that the participants generated the emotional lures as they performed the recall task.

Another possibility is that the emotional lures were generated with the same frequency as the neutral lures but that the participants were then able to reject having studied the emotional lures. Rejection could have occurred due to at least two types of processes: by a recall-to-reject strategy (e.g., Clark & Gronlund, 1996; Gallo, 2004; Rotello & Heit, 2000) or by use of the distinctiveness of the emotional lures. The logic of the recall-to-reject strategy is that if the participants were able to recall the few emotional words that appeared at study, they might then be able to reject the possibility that the emotional lure word that had

come to mind had been presented at study. In other words, by recalling what words had been presented at study, they could deduce that the emotional lure word had not been presented. If this process were the primary contributor to the reduced false recall rates to the emotional lures, we would expect that those participants who recalled more of the emotional filler words would also show low false recall rates for the emotional lures. In fact, no such correlation existed ($r = -.12$ for the young adults, $r = .14$ for the older adults). We also found no difference in false recall rates for the emotional lures for those individuals who recalled all of the emotional filler words presented at study, as compared with those individuals who did not recall any of the emotional filler words ($p > .3$).¹ Although these data cannot rule out the contribution of a recall-to-reject process, they do lessen the probability that it was the dominant strategy allowing reduction in the false recall responses to the emotional lures.

Another means by which the participants could have rejected having studied an emotional lure is based on the distinctiveness of the lure. They may have recognized that the emotional lure word was inconsistent with the items presented at study. The majority of the items presented at study were not emotional, and therefore, the emotional lure items may have been identified as distinct from those seen at study. Debriefing of the participants suggested that a number of the young and older adults had used this process: When an emotional associate came to mind, they did not write it down, because it seemed “inconsistent with the other words,” “more emotional than anything that was on the list,” and so forth.

Although this evidence would suggest that the main contributor to the reduction in false recall rates for the emotional lures was distinctiveness, we wanted to attempt to reduce the potential contributions of the other factors. One way to eliminate differences in self-generation at retrieval is to use a recognition task rather than a recall task: By using a recognition task, the items presented at retrieval are controlled.² Thus, differences in rates of endorsement of emotional lures must reflect differential abilities to reject the presented items as studied, rather than differences in the generation of the item as a candidate from the study list. A recognition task is also beneficial in overcoming a number of difficulties with recall tasks. For example, false recall rates are typically relatively low. Thus, it may be more difficult to find interactions with age, given that the overall levels of false recall in both age groups are low. Another potential shortcoming of recall tasks when used to assess aging memory is that older adults are known to show disproportionate deficits on recall tasks, relative to recognition (see Light, 1991). It is, therefore, possible that the pattern of results obtained on a recall task would be qualitatively different from the pattern obtained on a recognition task. To address these issues and to explore the generality of the finding in Experiment 1, we next assessed the effect of emotional content and aging on false recognition.

EXPERIMENT 2

Effects of Emotional Content and Aging on False Recognition

Method

Participants. The participants were 40 young adults (18 women) who were MIT or Harvard undergraduate or graduate students and 40 older adults (22 women) who were MIT alumni or individuals recruited through the Harvard Cooperative on Aging or via fliers posted throughout the greater Boston area. All the participants met the criteria outlined for Experiment 1.

Procedure. The participants viewed lists of 91 words, with each word presented for 1.5 sec. The lists included 8 of the 12 associate lists from Pesta et al. (2001). Four lists were associated with an emotional lure, and four with a neutral lure. The associate lists presented together at study were pseudorandomized across participants.

As in Experiment 1, words were blocked so that five words from an associate list were presented together. To avoid primacy or recency effects on the recognition task, four buffer items were included at the beginning and end of the study list. Three emotional filler words were interspersed throughout the study list.

Immediately following presentation of the study list, the participants performed a recognition test that included eight lures that were associates of study list words, four lures that were not associates of study list words, 12 unstudied words (3 from each nonpresented list), and 24 studied words (3 from each presented list). We included a relatively small number of words from each associate list on the recognition test, to decrease the likelihood that the participants' false recognition rates would be spurred by seeing phonological associates on the recognition test (vs. on the study list).

Scoring and data analysis. The participants' recognition responses were scored to determine the proportion recognized for each lure type (emotional or neutral), item type (studied list item or nonstudied lure item), and list type (related or unrelated). The related list items were those that had been studied (or lures phonologically related to those studied), whereas the unrelated list items were foils included at recognition.

In addition to these scores, we also calculated corrected recognition scores. In this scoring method, recognition rates to unrelated item types were subtracted from the recognition rates to related item types. For example, the proportion of falsely recognized unrelated emotional lures was subtracted from the proportion of falsely recognized related emotional lures to create a *corrected recognition* score for emotional lures. Because the results from the uncorrected and the corrected analyses were qualitatively similar, we will report only the results with the uncorrected data. We found no sex differences, so the data from the men and the women were combined.

Results

An ANOVA conducted for the young adults, with lure type (emotional or neutral) and item type (lure item or list item) as within-subjects factors, indicated a marginal effect of lure type [$F(1,39) = 3.56, p < .07$], a significant effect of item type [$F(1,39) = 1.54, p < .05$], and a significant interaction between emotion and item type [$F(1,39) = 6.87, p < .05$]. Subsequent *t* tests confirmed that the interaction resulted because the young adults showed a higher false alarm rate to neutral lures than to emotional lures [$t(39) = 2.56, p < .05$], while showing equivalent correct recognition rates to presented associates of neutral and emotional lures (Table 2). The young adults had similar veridical and false recognition scores for the emotional word lists but showed higher false recog-

Table 2
Experiment 2: Mean Recognition Scores (With Standard Errors) as a Function
of Age Group, Item Type, and Emotional Content

Participants	Emotional Lure Lists										Neutral Lure Lists									
	List Item					Lure Item					List Item					Lure Item				
	Rel		Unrel		Diff	Rel		Unrel		Diff	Rel		Unrel		Diff	Rel		Unrel		Diff
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	
Young adults	.58	.04	.18	.05	.40	.55	.06	.12	.05	.43	.53	.04	.13	.03	.40	.73	.06	.07	.05	.66
Older adults	.47	.03	.08	.02	.39	.43	.07	.10	.03	.33	.48	.03	.08	.02	.40	.68	.07	.08	.02	.60

Note—Rel, related to items on study list; Unrel, unrelated to items on study list; Diff, difference between recognition scores for related and unrelated items. Only the values in the “List Item, Related” cells correspond to recognition rates for items that the participants actually saw in the study phase.

dition than correct recognition scores for the neutral word lists [$t(39) = 1.24, p < .05$].

The same ANOVA for the older adults revealed a significant main effect of lure type [$F(1,39) = 9.13, p < .01$], no effect of item type, and a significant interaction between lure type and item type [$F(1,39) = 9.63, p < .01$]. The critical interaction between lure type and item type emerged because the older adults showed similar correct recognition rates for the list items associated with emotional and neutral lures but lower false recognition rates for the emotional lures than for the neutral lures [$t(39) = 3.49, p < .001$].

Although the young and the older adults showed a reduction in false recognition rates to the emotional lures, false recognition for these emotional items did still occur. The participants were more likely to endorse a phonologically related emotional word as presented than they were to endorse an unrelated emotional word [$t(39) = 4.5, p < .001$, for the young adults; $t(39) = 3.8, p < .001$, for the older adults], just as they were more likely to endorse a phonologically related neutral word as presented than an unrelated neutral word [$t(39) = 6.4, p < .001$, for the young adults; $t(39) = 6.3, p < .001$, for the older adults].

To examine whether the magnitude of the effects were comparable in the young and the older adults, an ANOVA was conducted with group as a between-subjects factor. This analysis indicated significant effects of lure type [$F(1,78) = 12.52, p < .001$] and group [$F(1,78) = 4.51, p < .05$], as well as a significant interaction between lure type and item type [$F(1,78) = 16.17, p < .0001$]. Importantly, the ANOVA indicated no interaction between group and emotion or between group, emotion, and item type, indicating that the magnitude of the emotion effect was similar in the young adults and the older adults.

Discussion

The results in Experiment 2 replicated the main findings in Experiment 1: The young adults and the older adults showed lower false recognition rates for the emotional lures than for the neutral lures. Furthermore, the results suggest that the magnitude of the benefit from the distinctiveness of the emotional lures was similar in the young adults and the older adults. These results add additional support to the claim that young and older adults can cap-

italize on the distinctiveness of emotional lures to reduce their false endorsements. Thus, although the false recognition rates for the emotional lures remained above the baseline false recognition rates for nonpresented emotional items, they were well below the rates of false recognition for neutral lures.

Again, there is the question of what processes underlie this reduction in false responses. The fact that the findings were similar with recognition and recall tasks suggests that the critical process is not restricted to differences in the likelihood of generating the lure at retrieval (although differences in item generation at encoding cannot be ruled out). Even when the test presentation of the lures was held constant (i.e., all emotional and neutral lures were presented in the recognition task), the rates of false memories remained significantly lower for the emotional lures than for the neutral lures. Thus, the participants must have been better able to reject that an emotional lure had been presented than that a neutral lure had been studied. A recall-to-reject strategy could be effective in supporting this rejection; however, as on the recall task, we found no significant correlation between the accuracy in recognizing the emotional filler items and the likelihood of falsely recognizing emotional lures ($r = .05$ for young adults, $r = .16$ for older adults). Similarly, we found no significant differences in the false recognition rates to emotional lures for the adults who correctly recognized all emotional filler items, as compared with the adults who recognized one or none of the filler items ($p > .4$). On the basis of these results and of the debriefing forms of the participants, the process that seems most likely to have supported the reduction in false memory rates to the emotional lures concerns the participants' use of the distinctiveness of the emotional lures to reject having studied the item.

GENERAL DISCUSSION

In the present investigation, we used a paradigm developed by Pesta et al. (2001) to ask whether older adults, like young adults, are less likely to falsely remember emotional lures than to falsely remember neutral lures. To summarize the critical findings, Experiment 1 demonstrated that both groups did falsely recall emotional lures, as well as neutral lures, but that their rates of false recall were sig-

nificantly lower for the emotional than for the neutral lures. This reduction in false recall responses was similar in magnitude in the two age groups. Thus, young and older adults were less likely to falsely recall emotional lures than to falsely recall neutral lures. The conclusions from Experiment 2, in which a recognition task was used, were similar. Both age groups showed false recognition rates for emotional lures and neutral lures that exceeded their false response rates to items that were unassociated with words presented at study. But as in Experiment 1, their rates of false retrieval were substantially higher for the neutral lures than for the emotional lures, further indicating that both age groups show an ability to reduce their false memories for emotional lures.

On the basis of these results, we suggest that young and older adults can capitalize on the distinctiveness provided by the emotional lures to reduce their false memories. The data suggest that not only can young and older adults use the distinctiveness provided by emotion to enhance their ability to richly encode items, thereby increasing their rates of free recall (Kensinger et al., 2002) or of recollection (Kensinger & Corkin, 2003; Krendl et al., 2003), but also they can use the emotional salience of lures to reduce their rates of false retrieval.

The distinctiveness of the emotional lures could serve to reduce false recall or false recognition responses in two ways. First, distinctiveness could function as a way to segregate the lure from the studied items. Individuals may have viewed the emotional lure as inconsistent with the items that they had studied and rejected the emotional lure on the basis of its incongruence. This investigation leaves open the question of whether it is really the distinctiveness provided by emotion that results in reduced false alarm rates or whether it is, more broadly, the conceptual distinctiveness of the items that causes the effect. Some of the reduction in false memories may stem from conceptual incongruence. For example, numerous studies have demonstrated that after studying exemplars from particular semantic categories, young and older adults are less likely to indicate that they have studied an exemplar from an unrelated category (e.g., Kensinger & Schacter, 1999; Koutstaal & Schacter, 1997). As a thought experiment to further this line of reasoning, one could imagine that, after studying a list of emotional words, an individual might later be more likely to reject a neutral lure as having been previously studied than to reject an emotional lure. Thus, it may be the conceptual distinctiveness, rather than the emotional nature of the lures per se, that underlies the decreased false response rates. Future studies will be needed to examine whether young and older adults benefit from the distinctiveness provided by the emotional salience of items when conceptual distinctiveness is held relatively constant.

Another way in which the distinctiveness of the emotional lures could have impacted false recall and false recognition rates is through adoption of a *distinctiveness heuristic*, whereby individuals set their criteria for re-

sponding *old* at different levels, depending on the distinctiveness with which they believe they should have encoded items (Schacter et al., 1999). Thus, for example, individuals will be more conservative after studying pictures, as compared with words, because pictures are encoded more distinctively than words (e.g., Dodson & Schacter, 2002b; Israel & Schacter, 1997). Older adults seem as capable of engaging this distinctiveness heuristic as do young adults (Dodson & Schacter, 2002a; Schacter et al., 1999).

The results of the present experiment can be interpreted within this framework. It is plausible that young and older adults sense that when they encounter emotional items, they are likely to remember them vividly (and indeed, laboratory investigations have supported this conclusion; Doerksen & Shimamura, 2001; Kensinger & Corkin, 2003; Krendl et al., 2003; Ochsner, 2000). Thus, they may expect different levels of distinctiveness for their memories of emotional words, as compared with neutral words. Using this logic, both young and older adults may set a higher criterion for the vividness that they expect to be associated with emotional lures, as compared with neutral lures, causing them to have lower false recall or recognition rates for emotional lures than for neutral lures.

It is important to note that this hypothesized function of distinctiveness would operate in a slightly different way in the present study than in prior studies. Typically, when item distinctiveness is altered, the manipulation occurs at encoding. Thus, the critical comparison is between sets of items studied in a different manner (e.g., as pictures vs. as words). In the present study, no manipulation occurred at encoding. Rather, any adopted distinctiveness heuristic would likely stem from individuals' expectations of how vividly they would remember emotional, as compared with neutral, words (i.e., "If I had studied the word *bitch*, I'd remember" may be intuitive to many people, whereas "If I had studied the word *shave*, I'd remember" may seem a less obvious assertion). Thus, the manipulation would be related not to how the words were encoded in this particular test session but, rather, to individuals' assumptions about the distinctiveness with which emotional versus neutral words are encoded in general.

Adoption of a distinctiveness heuristic is consistent with data reported by Pesta et al. (2001): They found that a greater proportion of young adults' false responses to emotional lures were *remember* responses than was the case for their false responses to neutral lures. In their study, the young adults may have accepted emotional lures as studied only when they felt that they were associated with relatively high levels of vividness. This interpretation would converge with the hypothesis that young adults set different criteria for the vividness required to accept an emotional word as *old*, as compared with a neutral word.

Another possibility is that the young and the older adults were able to use the arousal response elicited by the emotional words (by which we refer to both the cognitive and the physiological changes that occurred) as a basis for

a distinctiveness heuristic. This arousal response could, in essence, act as a retrieval cue: The participants could think back to the encoding episode to determine whether they had experienced a similar arousal response as they were processing the study words. Using the logic, "if I'd felt this way at study, I'd remember . . .," the participants could thus reject the emotional lure. In contrast, this arousal dimension would not have been present during processing of the neutral lures, prohibiting the exclusion of the neutral lures on this basis.

Although the present study cannot weigh the relative importance of these different contributions of distinctiveness, the results do suggest that whatever processes are engaged benefit young and older adults to a similar extent. Future studies will be needed to examine the specific processes that allow young and older adults to reduce their false responses to emotional lures and to confirm that the same types of processes underlie false memory reduction in the two age groups.

In conclusion, the results of the present study indicate that older adults, like young adults, are less likely to falsely recall or recognize emotional lures, as compared with neutral lures. The magnitude of this effect was similar in the two age groups, suggesting that older adults are as capable of using the distinctiveness provided by the emotional lures as are young adults. Although additional experiments will be needed to clarify whether this effect extends to other paradigms (e.g., ones in which similar numbers of emotional and neutral items are studied), we propose that the relative preservation of emotional processing with aging (see Mather, 2003, for a review) allows older adults to benefit from the distinctiveness of emotional salience in a manner similar to that for young adults.

REFERENCES

- CARSTENSEN, L. L., ISAACOWITZ, D., & CHARLES, S. T. (1999). Taking time seriously: A theory of socioemotional selectivity. *American Psychologist*, *54*, 165-181.
- 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., & ENGELBERG, E. (1999). Organization of emotional memories. In T. Dalgleish & M. Power (Eds.), *The handbook of cognition and emotion* (pp. 211-227). Chichester, U.K.: Wiley.
- CLARK, S. E., & GRONLUND, S. D. (1996). Global matching models of recognition memory: How the models match the data. *Psychonomic Bulletin & Review*, *3*, 37-60.
- CRAIK, F. I. M., ANDERSON, N. D., KERR, S. A., & LI, K. Z. H. (1995). Memory changes in normal aging. In A. D. Baddeley, B. A. Wilson, & F. N. Watts (Eds.), *Handbook of memory disorders* (pp. 211-241). New York: 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.
- DODSON, C. S., & SCHACTER, D. L. (2001). "If I had said it I would have remembered it": Reducing false memories with a distinctiveness heuristic. *Psychonomic Bulletin & Review*, *8*, 155-161.
- DODSON, C. S., & SCHACTER, D. L. (2002a). Aging and strategic retrieval processes: Reducing false memories with a distinctiveness heuristic. *Psychology & Aging*, *17*, 405-415.
- DODSON, C. S., & SCHACTER, D. L. (2002b). When false recognition meets metacognition: The distinctiveness heuristic. *Journal of Memory & Language*, *46*, 782-803.
- DOERKSEN, S., & SHIMAMURA, A. P. (2001). Source memory enhancement for emotional words. *Emotion*, *1*, 5-11.
- GALLO, D. A. (2004). Using recall to reduce false recognition: Diagnostic and disqualifying monitoring. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, *30*, 120-128.
- GALLO, D. A., ROBERTS, M. J., & SEAMON, J. G. (1997). Remembering words not presented in lists: Can we avoid creating false memories? *Psychonomic Bulletin & Review*, *4*, 271-276.
- GLISKY, E. L., POLSTER, M. R., & ROUTHIEAUX, B. C. (1995). Double dissociation between item and source memory. *Neuropsychology*, *9*, 229-235.
- HINTZMAN, D. L. (1988). Judgments of frequency and recognition memory in a multiple-trace memory model. *Psychological Review*, *95*, 528-551.
- HUNT, R. R., & MCDANIEL, M. A. (1993). The enigma of organization and distinctiveness. *Journal of Memory & Language*, *32*, 421-445.
- ISRAEL, L., & SCHACTER, D. L. (1997). Pictorial encoding reduces false recognition of semantic associates. *Psychonomic Bulletin & Review*, *4*, 577-581.
- JOHNSON, M. K., HASHTRUDI, S., & LINDSAY, D. S. (1993). Source monitoring. *Psychological Bulletin*, *114*, 3-28.
- 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.
- KENSINGER, E. A., & SCHACTER, D. L. (1999). When true memories suppress false memories: Effects of aging. *Cognitive Neuropsychology*, *16*, 399-415.
- KOUTSTAAL, W., & SCHACTER, D. L. (1997). Gist-based false recognition of pictures in older and younger adults. *Journal of Memory & Language*, *37*, 555-583.
- KOUTSTAAL, W., SCHACTER, D. L., VERFAELLIE, M., BRENNER, C., & JACKSON, E. M. (1999). Perceptually based false recognition of novel objects in amnesia: Effects of category size and similarity to category prototypes. *Cognitive Neuropsychology*, *16*, 317-341.
- KRENDL, A. C., KENSINGER, E. A., & CORKIN, S. (2003). Emotional memory in aging: Dissociable effects of valence and arousal (Program No. 84.11). *2003 Abstract Viewer/Itinerary Planner* (On line). Washington, DC: Society for Neuroscience.
- LEDOUX, J. E. (2000). Cognitive-emotional interactions: Listen to the brain. In R. D. Lane & L. Nadel (Eds.), *Cognitive neuroscience of emotion* (pp. 129-155). New York: Oxford University Press.
- LIGHT, L. L. (1991). Memory and aging: Four hypotheses in search of data. *Annual Review of Psychology*, *42*, 333-376.
- LOFTUS, E. F., FELDMAN, J., & DASHIELL, R. (1995). The reality of memory illusions. In D. L. Schacter (Ed.), *Memory distortions: How minds, brains, and societies reconstruct the past* (pp. 47-68). Cambridge, MA: Harvard University Press.
- MATHER, M. (2003). Aging and emotional memory. In D. Reisberg & P. Hertel (Eds.), *The interplay between emotion and memory* (pp. 272-307). New York: Oxford University Press.
- NORMAN, K. A., & SCHACTER, D. L. (1997). False recognition in younger and older adults: Exploring the characteristics of illusory memories. *Memory & Cognition*, *25*, 838-848.
- OCHSNER, K. N. (2000). Are affective events richly recollected or simply familiar? The experience and process of recognizing feelings past. *Journal of Experimental Psychology: General*, *129*, 242-261.
- PESTA, B. J., MURPHY, M. D., & SANDERS, R. E. (2001). Are emotionally charged lures immune to false memory? *Journal of Experimental Psychology: Learning, Memory, & Cognition*, *27*, 328-338.
- RANKIN, J. S., & KAUSLER, D. H. (1979). Adult age differences in false recognition. *Journal of Gerontology*, *34*, 58-65.
- ROEDIGER, H. L., III, & MCDERMOTT, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, *21*, 803-814.
- ROTELLO, C. M., & HEIT, E. (2000). Associative recognition: A case of recall-to-reject processing. *Memory & Cognition*, *28*, 907-922.

- SCHACTER, D. L., CENDAN, D. L., DODSON, C. S., & CLIFFORD, E. R. (2001). Retrieval conditions and false recognition: Testing the distinctiveness heuristic. *Psychonomic Bulletin & Review*, **8**, 827-833.
- SCHACTER, D. L., & CURRAN, T. (2000). Memory without remembering and remembering without memory: Implicit and false memories. In M. S. Gazzaniga (Ed.), *The new cognitive neurosciences* (pp. 829-840). Cambridge, MA: MIT Press.
- SCHACTER, D. L., & DODSON, C. S. (2001). Misattribution, false recognition, and the sins of memory. *Philosophical Transactions of the Royal Society: Series B*, **356**, 1385-1393.
- SCHACTER, D. L., ISRAEL, L., & RACINE, C. (1999). Suppressing false recognition in younger and older adults: The distinctiveness heuristic. *Journal of Memory & Language*, **40**, 1-24.
- SCHACTER, D. L., KOUTSTAAL, W., & NORMAN, K. A. (1997). False memories and aging. *Trends in Cognitive Sciences*, **1**, 229-236.
- SCHACTER, D. L., VERFAELLIE, M., & ANES, M. D. (1997). Illusory memories in amnesic patients: Conceptual and perceptual false recognition. *Neuropsychology*, **11**, 331-342.
- SHEIKH, J. I., & YESAVAGE, J. A. (1986). Geriatric Depression Scale: Recent evidence and development of a shorter version. *Clinical Gerontology*, **5**, 165-172.
- SHIFFRIN, R. M., HUBER, D. E., & MARINELLI, K. (1995). Effects of category length and strength on familiarity in recognition. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **21**, 267-287.
- SMITH, A. D. (1975). Partial learning and recognition memory in the aged. *International Journal of Aging & Human Development*, **6**, 359-365.
- SOMMERS, M. S., & LEWIS, B. P. (1999). Who really lives next door: Creating false memories with phonological neighbors. *Journal of Memory & Language*, **40**, 83-108.
- TUN, P. A., WINGFIELD, A., ROSEN, M. J., & BLANCHARD, L. (1998). Older adults show greater susceptibility to false memory than young adults: Temporal characteristics of false recognition. *Psychology & Aging*, **13**, 230-241.
- UNDERWOOD, B. J. (1965). False recognition produced by implicit verbal responses. *Journal of Experimental Psychology*, **70**, 122-129.
- WATSON, J. M., BALOTA, D. A., & ROEDIGER, H. L., III (2003). Creating false memories with hybrid lists of semantic and phonological associates: Over-additive false memories produced by converging associative networks. *Journal of Memory & Language*, **49**, 95-118.
- WEISS, A. P., DODSON, C. S., GOFF, D. C., SCHACTER, D. L., & HECKERS, S. (2002). Intact suppression of increased false recognition in schizophrenia. *American Journal of Psychiatry*, **159**, 1506-1513.
- YONELINAS, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory & Language*, **46**, 441-517.

NOTES

1. This comparison also alleviates the concern that some individuals may have declined to write down emotional words that they believed that they had studied because they deemed them improper, embarrassing and so on.

2. Recognition tasks, however, still leave unaffected any differences in the likelihood that an individual self-generates an associate during encoding. Indeed, there have been many discussions as to whether the false memory phenomenon is spurred by the fact that individuals often generate the lure items while they are studying the associated lists (e.g., Gallo, Roberts, & Seamon, 1997; Koutstaal, Schacter, Verfaellie, Brenner, & Jackson, 1999; Roediger & McDermott, 1995; Underwood, 1965).

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