

Effects of Emotion on Memory Specificity in Young and Older Adults

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To examine how emotional content affects the amount of visual detail remembered, young and older adults studied neutral, negative, and positive objects. At retrieval, they distinguished "same" (identical) from "similar" (same verbal label, different visual details) and "new" (nonstudied) objects. A "same" response to a *same* item indicated memory for visual details (specific recognition) while a "same" or "similar" response to a *same* or *similar* item signified memory for the general sort of object (general recognition). Both age groups showed enhanced specific recognition for negative (not positive) objects. Young adults' general recognition advantage also was restricted to negative objects, whereas older adults showed enhanced general recognition for positive and negative objects. Negative (not positive) content enhanced the visual specificity of memory in both ages, but positive content conferred a general memory advantage only for older adults.

Not all memories are equally detailed. We can remember seeing a coffee cup on our desk but fail to recall its color, size, or shape. Or, we can remember seeing a large, blue mug with a logo. Although at some level both of these memories are accurate, the latter memory contains more visual detail than the former. The present study investigated whether the amount of visual detail that young and older adults remember about an object is influenced by the item's emotional valence (whether it is positive or negative).

Although we have shown previously that young adults remember visual details for negative objects more often than for neutral objects (Kensinger, Garoff-Eaton, & Schacter, 2006), we had reason to believe that they might not show a similar enhancement in memory for the visual details of positive objects. The memory boost for negative items often results from enhancements in the memory's vividness or level of detail (Dewhurst & Parry, 2000; Kensinger & Corkin, 2003; Kensinger & Schacter, 2006; Ochsner, 2000). By contrast, when there are memory enhancements for positive information, they are more likely to result from an increased feeling of familiarity, or from memory for general (nonspecific) information (Bless & Schwartz, 1999; Clore et al., 2001; Fiedler,

2001; Gasper & Clore, 2002; Ochsner, 2000). Thus, individuals often claim they "know" a positive item was presented but do not "remember" the details of its presentation (Dewhurst & Parry, 2000; Ochsner, 2000). Participants also can be more likely to falsely or inconsistently remember positive information compared to negative information (Kensinger & Schacter, in press; Levine & Bluck, 2004), likely because of their increased reliance on schematic information when processing positive information (Storbeck & Clore, 2005). Given this prior research, we hypothesized that, in young adults, negative (but not positive) emotional content would lead to enhancement in memory for visual details.

It was less clear whether these divergent effects of positive and negative emotion would occur in older adults. In general, older adults have less access to information about the specific details of an item's presentation than do young adults (Kensinger & Schacter, 1999; Koutstaal, 2003; Schacter, Koutstaal, & Norman, 1997). Thus, we expected that there would be an overall effect of age on the specificity of a memory. The critical question, however, was whether valence would differentially affect memory for visual detail in young and older adults. Recent evidence

has suggested that older adults are more likely than young adults to focus attention on emotional information (Fung et al., 1999; Hashtroudi et al., 1990; Isaacowitz et al., 2006; May et al., 2005), and perhaps specifically on positive information (see Mather & Carstensen, 2005; Mikels et al., 2005). While it is likely that enhanced attention toward emotional information would result in a memory benefit for that information (see D'Argembeau & van der Linden, 2004), it is less clear whether it would lead to enhancements primarily in memory for the general theme of an item, or also would boost older adults' memory for visual detail. On the one hand, if positive and negative stimuli are processed in fundamentally different ways from one another by both young and older adults (i.e., with positive stimuli processed in a heuristic way and negative stimuli processed in a detail-oriented fashion), then both ages may show enhancements in memory for detail only for negative items and not for positive items. On the other hand, if negative content enhances the specificity of young adults' memories because their attention is drawn toward negative stimuli (Dolan & Vuilleumier, 2003; Mather & Carstensen, 2003; LeDoux, 2000), then the effect could be reversed in older adults, who tend to focus more attention, and more elaborative encoding processes, on positive than on negative information (Isaacowitz et al., 2006; Mather & Knight, 2005).

Despite increased interest in understanding the effects of advancing age on memory for emotional information (reviewed by Kensinger, 2006; Mather & Carstensen, 2005), only one prior study has used retrieval tasks that can tease apart visually specific from more general memories. In this prior study, Denburg et al. (2003) assessed participants' memories for the general theme and specific visual details of complex visual scenes (e.g., a dead body in a forest). Their results suggested that throughout the adult lifespan, positive and negative emotional content can be associated with enhancements in memory for "gist" but with impairments in memory

for visual details. They did not, however, distinguish memory for details of the emotional item in the scene (e.g., the dead body) from memory for details of the nonemotional context (e.g., the forest). An extensive literature has demonstrated that the emotional elements of an event often are remembered well, whereas nonemotional elements often are forgotten (reviewed by Reisburg & Heuer, 2004). Thus, it is plausible that the results of this prior study would have been different had the authors assessed memory for the visual details of the emotional elements only, rather than also requiring memory for details peripheral to the emotional content of the scenes. In fact, a few studies have demonstrated that, at least in young adults, memory for both the specific visual details as well as the general theme of information can be enhanced for emotional items (Burke et al., 1992; Kensinger, Garoff-Eaton, & Schacter, 2006; Kensinger et al., in press). For example, when presented with a scene depicting a snake in a forest, young adults remember the visual details of the snake, as well as the fact that there was a snake. By contrast, they fail to remember the visual details of the forest – details not linked to the emotional element (Kensinger et al., in press).

In the present study, we examined young and older adults' abilities to remember the visual details of positive, negative, or neutral objects that were presented in isolation against a blank background. We have shown previously that young adults are more likely to remember the visual details of negative objects than of neutral ones (Kensinger, Garoff-Eaton, & Schacter, 2006). The goals of the present study were to investigate whether young adults also would show enhanced memory specificity for positive items and to examine whether the effects of emotion on memory for visual detail would change between young adulthood and old age.

Experiment 1

In Experiment 1, we addressed our goals within an experiment in which young and older adults were tested after different

delays (30-minutes for the older adults and 2 days for the young adults) in order to roughly numerically equate the memory performance of the two groups. We reasoned that if the two groups did not have similar memory performance for the neutral items, then it could be difficult to interpret age differences in emotional memory enhancements. For example, if older adults' performance was worse than younger adults', and if older adults also showed a greater emotional memory enhancement than young adults, that additional enhancement could simply reflect the fact that there was more room for improvement in the older adults than in the young adults.

At study, participants viewed positive, negative, and neutral objects. At test, they distinguished "same" objects (identical to those studied) from "similar" (same verbal label, different visual details) or "new" ones. Consistent with previous studies using variants of this paradigm (Garoff et al., 2005; Kensinger, Garoff-Eaton, & Schacter, 2006), we considered a "same" response to a *same* item to reflect memory for specific visual details ("specific recognition"). Collectively, *same* or *similar* items given either a "same" or a "similar" response were considered to reflect memory for at least the general sort of objectⁱ ("general recognition"). Thus, we assessed the effects of negative and positive content on young and older adults' memories for (a) specific visual details ("specific recognition") and (b) general object information ("general recognition").

It is worth noting that although our measurement of general recognition shares many similarities with the conceptualization of "gist" memory, the two also differ in a couple of important ways. First, gist memory often has been used to refer to memory for the general theme of previously presented information in the absence of memory for specific details (e.g., Brainerd & Reyna, 2005). In the present study, we conceptualized general recognition as memory for *at least* the gist information, regardless of whether individuals also remembered the specific visual details.

Second, gist memory often refers to the extraction of commonalities among a series of items or to inferences regarding presented information (e.g., Adams et al., 1990, 1997; Gould et al., 1991). In the present study, general recognition reflected memory for the general theme of a single item, not for a common theme shared among multiple items.

Method

Participants

Participants were 32 young and 32 older adults (see Table 1 for demographic information). Young adults were Harvard or Boston College students. Older adults were recruited from a database maintained at Harvard University or through the Harvard Cooperative Program on Aging. All participants were native English speakers with normal or corrected-to-normal vision and with no history of a neuropsychological or psychiatric disorder. No participant listed taking medications that affected the central nervous system. Informed consent was obtained in a method approved by the Harvard University and Boston College Institutional Review Boards.

Materials and Procedure

Materials. Materials comprised 180 pairs of photo objects (from Kensinger, Garoff-Eaton, & Schacter, 2006 and supplemented with additional positive objects). Pairs shared the same verbal label (e.g., were both umbrellas) but differed in other perceptual features (e.g., color, shape, size, orientation). The final images were selected from a larger set that had been rated by a separate group of 6 young and 6 older adults for their valence and arousal, using 9-point likert-type scales (with low numbers indicating low valence and low arousal, respectively). One-third of the selected objects were negative and arousing (i.e., valence < 3.5, arousal ratings \geq 5), one-third were positive and arousing (i.e., valence > 5.5, arousal \geq 5), and one-third were neutral (i.e., valence between 3 and 6, arousal < 5). The positive and negative objects did not differ from one another in arousal nor in absolute valence, $p > .15$, and positive and negative objects were more arousing than neutral ones,

$p < .001$. Valence and arousal ratings for each group of objects did not differ for the young and older adults, $p > .15$.

Negative, positive, and neutral pairs were matched for the overall similarity of the two items, the dimensions (color, size, shape, orientation) that differed between the two items, and the familiarity of the items (see Kensinger, Garoff-Eaton, & Schacter, 2006 for details of matching procedures). Study Procedure. Participants viewed 144 objects (one-third of each emotion type) for 1 sec. Following the object's presentation, participants indicated, by key press, whether the object would fit inside of a filing cabinet drawer.

Test Procedure. After approximately a 30-min delay for the older adults, and a 2-day delay for the young adults, participants performed a surprise object recognition task. On subsequent debriefing forms, all participants indicated that they were surprised that their memory was assessed. These delays were chosen because pilot data indicated that neither ceiling nor floor effects existed for participants when tested after these delays, and because these delays resulted in approximate, numerical matching of performance for the young and older adultsⁱⁱ. Participants were presented with 180 objects: 72 (24 negative, 24 positive, 24 neutral) were identical to those that had been studied (*same* objects), 72 shared the same verbal label as a studied item but differed in visual features (*similar* objects), and 36 were *new* (**Figure 1**). Participants indicated, by key press, whether the item was "same," "similar," or "new." The same object within the object pair was tested across all participants; the studied items were counterbalanced between subjects to manipulate the condition of each object shown at recognition. For *same* items, the identical image was studied; for *similar* items, the alternate member of the pair was studied; for *new* items, neither member of the pair was studied. Only one member of a particular pair was shown on the recognition test.

Results

The data are presented in **Table 2**: The proportion of items given a "same," "similar," or "new" response are reported as a function of item type (*same*, *similar*, or *new*), emotion type (negative, positive, neutral) and age (young, older adults). We examined the effects of emotional content and age on the three different types of items presented at recognition (*new* items, items that were *similar* to studied items, and items that were the *same* as studied items; **Figure 1**).

New items. For the *new* items, we conducted an ANOVA with response ("same," "similar"), and emotion (negative, positive, neutral) as within-subject factors and age as a between-subject factor. This analysis revealed a main effect of response, $F(1,62)=60.72$, $p < .001$, partial eta-squared = .50, and a marginal interaction between response and age, $F(1,62)=3.44$, $p < .07$, partial eta-squared = .05. This interaction reflected the fact that older adults gave more "new" responses, but fewer "similar" responses, to *new* items than young adults. Importantly, this ANOVA revealed no effects of emotion, nor any interactions with emotion.

Similar items. For the *similar* items, an ANOVA revealed only a significant effect of response, $F(1,62)=31.49$, $p < .001$, partial eta-squared = .34, with more "similar" than "same" responses given to the *similar* items. As with the *new* items, there was no effect of emotion, nor any interactions with emotion.

Same items. For the *same* items, an ANOVA revealed significant main effects of response, $F(1,62)=54.87$, $p < .001$, partial eta-squared = .47, and of emotion, $F(2,61)=11.05$, $p < .001$, partial eta-squared = .26. These main effects were qualified by interactions between emotion and response, $F(2,61)=11.31$, $p < .001$, partial eta-squared = .27, and between emotion and age, $F(2,61)=4.37$, $p < .05$, partial eta-squared = .13. Post-hoc t tests indicated that the interaction between emotion and response reflected the greater proportion of "same" responses to *same* negative objects as

compared to positive or to neutral ones, $t(63)=4.94$, $p<.001$. The interaction between emotion and age arose because young adults showed a similar response distribution for positive and neutral items, $p>.25$, whereas older adults gave more “same” or “similar” responses to positive than to neutral objects, $t(31)=2.69$, $p<.05$).

Comparison of Specific and General Recognition. To further examine the effects of emotion on young and older adults’ responses to the *same* items, we calculated participants’ ability to remember the specific visual details of an item (i.e., the proportion of “same” responses to *same* items, referred to as *specific recognition*) and to remember at least the general features of an item, regardless of whether the specific visual details were remembered (i.e., the proportion of “same” and “similar” [not “new”] responses given to *same* and *similar* items).

An ANOVA with recognition (specific, general) and emotion (positive, negative, neutral) as within-subject factors and age as a between-subject factor revealed main effects of recognition, $F(1,62)=83.36$, $p<.001$, partial eta-squared = .53, and emotion, $F(2,61)=12.45$, $p<.001$, partial eta-squared = .29, qualified by a three-way interaction among recognition, emotion, and age, $F(2,62)=3.01$, $p<.05$, partial eta-squared = .09. Separate ANOVAs conducted on the specific recognition and general recognition scores clarified that emotion affected both memory scores, $F(2,61)=9.26$, $p<.001$, partial eta-squared = .24 for specific recognition; $F(2,61)=7.24$, $p<.01$, partial eta-squared = .19 for general recognition. However, there was an interaction between emotion and age for the general recognition scores, $F(2,61)=3.13$, $p<.05$, partial eta-squared = .09, but not for the specific recognition scores, partial eta-squared = .02. These results reflected the fact that young adults showed enhanced general recognition for negative items (73%) as compared to neutral (68%), $t(31)=2.32$, $p<.05$, or positive ones (67%), $t(31)=2.86$, $p<.01$, and no difference between the general recognition rates for the positive and

neutral items, $p>.15$ (i.e., negative > positive = neutral). By contrast, older adults showed a boost in general recognition for both positive (77%), $t(31)=2.74$, $p<.01$, and negative (77%), $t(31)=3.03$, $p<.01$, objects as compared to neutral ones (69%), and no difference in general recognition rates for the negative and positive items, $p>.15$ (i.e., negative = positive > neutral). In contrast, both young and older adults showed enhanced specific recognition only for negative items compared to positive, $t(63)=5.19$, $p<.001$, or neutral ones, $t(63)=4.94$, $p<.001$, and no difference in specific recognition scores for positive and neutral items, $p>.15$ (i.e., negative > positive = neutral). Older adults’ general recognition scores for the positive items also were significantly better than those of the young adults, $t(62)=2.77$, $p<.01$, whereas despite the shorter retention interval for the older adults, their general recognition scores for the negative and neutral items were no different than those of the young adults, $p>.15$.

Discussion

Emotion had a similar effect on memory specificity in the two age groups. For young and older adults, negative items were associated with enhanced specific recognition, whereas positive items were not. These results suggest that negative emotion in particular facilitates memory for visual detail, and that this benefit of negative emotion persists across the adult lifespan.

In contrast to the similar effect of emotion on young and older adults’ specific recognition, emotion had divergent effects on general recognition in the two ages. Young adults showed a general recognition benefit only for negative (and not for positive) objects as compared to neutral ones, whereas older adults showed equivalently elevated general recognition for negative and positive objects. These results are broadly consistent with evidence that positive emotion benefits older adults’ memories more than young adults’ memories (Charles et al., 2003; Hill et al., 2005; Leigland et al., 2004; Mather & Knight, 2005). However, the present results

suggest that in some instances, older adults' mnemonic benefit for positive information is limited to extraction of general features of an item and does not extend to memory for the specific visual details of the previously-encountered information.

Older adults also showed significantly better general recognition for the positive items than young adults; yet, despite the shorter retention interval for older adults, their general recognition of negative and neutral information was no better than that of young adults. Although this finding is somewhat difficult to interpret due to the different study-test delay intervals for the young and older adults, it suggests a relative age-related sparing of general recognition for positive information as compared to negative or neutral information. Experiment 2 more directly examined this issue by testing young and older adults after the same delay.

Experiment 2

A potential concern in Experiment 1 was that young and older adults were tested after different delays in order to roughly equate the performance of the two ages. On the one hand, this matching reduces the concern that age differences in emotional memory enhancement arise because of different levels of performance for the neutral items (e.g., more room for improvement in the older adults than in the young adults). On the other hand, this matching technique has the potential to create interactions between age and emotion if the effects of emotion on memory change over a delay (and see Labar & Phelps, 1998), and it also prevents a straightforward comparison of young and older adults' memory performance. To circumvent these limitations, Experiment 2 examined whether the different effects of emotion on young and older adults' general recognition ability would hold when the two ages were tested with the same retention interval.

Method

Participants

Participants were 32 young and 32 older adults (see Table 1 for demographic

information) meeting the criteria outlined for Experiment 1.

Materials and Procedure

The materials and procedure were identical to those of Experiment 1 except that, in order to avoid ceiling effects in the young adults, a larger number of stimuli were studied: Participants were presented with 180 stimuli and were tested with 270 objects. All participants performed the recognition memory task after a 30-min delay. During the delay, all participants performed the same cognitive tasks.

Results

The data are presented in **Table 3**. We examined the effects of emotion and age on the *new*, *similar*, and *same* items; **Figure 1**). As in Experiment 1, there were no main effects of emotion, nor any interactions with emotion, for the *new* and *similar* items. Thus, we focus here on responses to the *same* items and on the comparison of specific and general recognition scores.

An ANOVA with response to *same* items ("same," "similar"), and emotion (negative, positive, neutral) as within-subject factors and age as a between-subject factor revealed significant main effects of response, $F(1,62)=95.47$, $p<.001$, partial eta-squared = .61, and of emotion, $F(2,61)=36.39$, $p<.001$, partial eta-squared = .54. These main effects were qualified by interactions between emotion and response, $F(2,61)=22.84$, $p<.001$, partial eta-squared = .43, between response and age, $F(2,61)=6.06$, $p<.05$, partial eta-squared = .09, and between emotion and age $F(2,61)=7.77$, $p<.01$, partial eta-squared = .20. Post-hoc t tests indicated that the interaction between emotion and response reflected the greater proportion of "same" responses given to *same* negative objects compared to positive, $t(63)=5.63$, $p<.001$, or neutral ones, $t(63)=7.44$, $p<.001$. The interaction between response and age emerged because young adults gave more "same" responses, $t(31)=2.5$, $p<.05$, and fewer "new" responses, $t(31)=2.6$, $p<.05$, to *same* items than did older adults (see **Table 3**). The interaction between emotion and age reflected the fact that young adults

showed a similar distribution of responses for positive and neutral items, $p > .15$, whereas older adults gave more “same” or “similar” responses to positive objects than to neutral ones, $t(31)=6.79$, $p < .001$.

We also calculated participants’ *specific recognition* and *general recognition* scores as described in Experiment 1. An ANOVA conducted on these recognition scores with recognition (specific, general) and emotion (positive, negative, neutral) as within-subject factors and age as a between-subject factor revealed main effects of recognition, $F(1,62)=77.91$, $p < .001$, partial eta-squared = .59, emotion, $F(2,61)=20.99$, $p < .001$, partial eta-squared = .41, and age, $F(1,62)=8.09$, $p < .01$, partial eta-squared = .12. These main effects were qualified by an interaction between emotion and recognition, $F(2,61)=5.07$, $p < .01$, partial eta-squared = .14, and by a three-way interaction among the factors, $F(2,61)=3.64$, $p < .05$, partial eta-squared = .07.

To elucidate the basis for this three-way interaction, separate ANOVAs were conducted on the specific recognition and general recognition scores with emotion as a within-subject factor and age as a between-subject factor. For the specific recognition scores, ANOVA revealed a main effect of emotion, $F(2,61)=19.97$, $p < .001$, partial eta-squared = .40, reflecting enhanced specific recognition for the negative items compared to the neutral, $t(63)=4.94$, $p < .001$, or positive ones, $t(63)=5.38$, $p < .001$. ANOVA also showed a main effect of age, $F(1,62)=5.01$, $p < .05$, partial eta-squared = .08, with older adults exhibiting poorer specific recognition than the young adults, $t(62)=2.01$, $p < .05$. Critically, there was no interaction between emotion and age.

The general recognition ANOVA revealed an effect of emotion, $F(2,61)=17.64$, $p < .001$, partial eta-squared = .37, and a marginal effect of age, $F(1,62)=2.99$, $p < .09$, partial eta-squared = .05, qualified by an interaction between emotion and age, $F(2,61)=3.58$, $p < .05$, partial eta-squared = .09. This interaction emerged because young adults showed enhanced general recognition for negative

items (73%) as compared to neutral (68%), $t(31)=3.42$, $p < .01$, or positive ones (69%), $t(31)=2.57$, $p < .05$. By contrast, older adults showed a boost in general recognition both for positive (70%), $t(31)=4.98$, $p < .001$, and for negative (67%), $t(31)=3.2$, $p < .01$, objects as compared to neutral ones (62%). Older adults’ general recognition scores for the positive items also were comparable to those of the young adults, $p > .15$, whereas their general recognition scores were lower than those of the young adults for the negative and neutral items, $t(62)=2.14$, $p < .05$.

Discussion

The results of Experiment 2 generally replicated those of Experiment 1. Both ages showed an emotion-related enhancement in memory for detail that was restricted to negative items and did not extend to positive items. Young adults’ emotional enhancement of general recognition also was limited to negative items, whereas older adults showed better general recognition for positive and for negative items as compared to neutral ones.

The results of Experiment 2 also corroborated the suggestive evidence from Experiment 1 that aging may leave relatively preserved the ability to recognize the general theme of positive information. Although older adults had lower general recognition scores for the neutral and negative items than did young adults, the two age groups did not differ in their general recognition of the positive items. Older adults often rely more on heuristic processing than do young adults (e.g., Adams et al., 1990; Gould et al., 1991), and as discussed in the introduction, positive items appear to be a class of stimuli that are particularly prone to this type of schematic processing. It is plausible that older adults’ relative preservation of general recognition for the positive items reflects the synergy between the types of information that older adults process well and the types of information that tend to be recorded for positive items.

In contrast to the preservation of general recognition for positive items, older adults had lower specific recognition scores

than did young adults for all items. This result is consistent with prior investigations suggesting that older adults do not use memory for visual detail as effectively at retrieval as do young adults (see Koutstaal, 2003) and suggests that the mnemonic boost provided by emotion is not sufficient to bring older adults' specific recognition scores to the same level demonstrated by the young adults. The implications of these results will be expanded upon in the general discussion.

General Discussion

The fact that young and older adults were able to remember the details of negative items better than those of neutral items is broadly consistent with a few prior studies indicating that both ages are more likely to form vivid memories of negative experiences than of neutral ones (Comblain et al., 2004; Davidson & Glisky, 2002; Kensinger, Krendl, & Corkin, 2006; Wolters & Goudsmit, 2005). These results suggest that negative emotion can facilitate memory for detailed information throughout the adult lifespan.

At first blush the enhanced specificity of memory for the negative items seems to conflict with the findings of Denburg et al., (2003), who demonstrated that positive and negative emotion impaired memory for detail while enhancing memory for the "gist" or general theme of presented information. However, it is important to note that in the present study, emotion enhanced memory for the visual details of the objects themselves. In contrast, in the study by Denburg et al (2003), memory for details tangential to the emotional content of the scenes often was required for successful performance. Prior studies have indicated that, in young adults, negative emotion can enhance memory for details directly tied to the emotional stimuli (Burke et al., 1992; Kensinger, Garoff-Eaton, & Schacter, 2006; Kensinger et al., in press). The present results indicate that this beneficial effect of negative emotion on memory specificity is consistent across the adult lifespan. Recent neuroimaging evidence has suggested that, in young adults, the enhanced specific

recognition for negative items may stem from increased engagement of the amygdala and the fusiform gyrus during encoding of negative items (Kensinger et al., submitted). The amygdala seems to show relatively little age-related decline (reviewed by Chow & Cummings, 2000), leaving open the possibility that amygdala-fusiform modulation of encoding processes occurs in older adults as well.

Negative items also were remembered with visual detail more frequently than positive items, consistent with prior research demonstrating that, in young adults, positive emotion leads to more gist-based or heuristic processing, whereas negative emotion leads to more detailed processing (Bless et al., 1996; Kensinger & Schacter, in press; Levine & Bluck, 2004; Storbeck & Clore, 2005). Critically, the present findings suggest that these divergent effects of positive and negative emotion remain consistent across the lifespan. Despite age-related increases in the prioritization of processing for positive emotion-eliciting information (reviewed by Mather, 2006), older adults do not show enhanced memory specificity for positive information.

Although emotional content had similar influences on memory specificity in young and older adults, it had divergent effects on general recognition in the two ages. Whereas young adults showed a general recognition benefit only for negative objects as compared to neutral ones, older adults showed elevated general recognition for positive and negative objects. These results are broadly consistent with data indicating that positive emotion has more of an enhancing effect on older adults' memories than on young adults' memories (Charles et al., 2003; Hill et al., 2005; Leigland et al., 2004; Mather & Knight, 2005). However, these results suggest that there are limitations on the types of information better remembered for positive than neutral information (see also Gruhn et al., 2005). Older adults' "positivity effect" is limited to extraction of general information, and does not extend to memory

for the specific visual details of previously-encountered positive information.

Not only did older adults show a “positivity effect” when comparing their general recognition of positive items to neutral items, they also showed selectively preserved general recognition (compared to young adults) for the positive items. Although older adults are not always as likely as young adults to remember items with positive emotional content (Denburg et al., 2003; Gruhn et al., 2005; Kensinger et al., 2005), Charles et al (2003) also demonstrated that age-related deficits in memory can be eliminated for positive information. It is plausible that when the memory task is constructed such that memory for the general theme of the information is sufficient for successful task performance, age differences in memory for positive items may be reduced or eliminated. This proposal fits well with previous research suggesting that older adults sometimes rely more on general than specific information when making recognition decisions (e.g., Koutstaal & Schacter, 1997; Kensinger & Schacter, 1999) or when recalling previously presented information (e.g., Adams et al., 1990; Gould et al., 1991). It may be that older adults can capitalize on the overlap between the types of information that they process well and the types of information most likely to be processed for positive items (i.e., thematic or heuristic information). Age-related increases in reliance on general information thus appear to have significant consequences for the performance of older adults in multiple aspects of memory.

In contrast to the equivalent general recognition for positive items, the presence of emotion never equated young and older adults' specific recognition performance, consistent with evidence that older adults rely less on detailed information when deciding whether particular items have been studied (Koutstaal, 2003; Koutstaal & Schacter, 1997; Schacter, Koutstaal, & Norman, 1997). Thus, although the presence of emotion can equate some

aspects of young and older adults' memories, it does not serve to equalize all aspects of young and older adults' mnemonic performance.

It is important to note that the present study compared individuals at extremes of the adult lifespan (i.e., college-aged and older adults). Despite this extensive age gap, emotion had similar effects on specific recognition in both groups. Although the results of the present study do not speak to the mechanisms that lead to the divergent effects of positive and negative valence on specific recognition, the results suggest that these valence-specific processes operate throughout the adult lifespan. In contrast, the effects of emotion on general recognition ability appear to change with age, with older adults showing a unique recognition advantage for positive information. It will be interesting for further research, including a broader age range of participants, to examine whether this enhancement in general recognition for positive information corresponds with adults' increased reliance on heuristic processing with advancing age.

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Footnotes

ⁱ All results remained qualitatively the same when general recognition was computed as “same” or “similar” responses to *same* items [i.e., when responses to *similar* items were not included in the general recognition score].

ⁱⁱ Note that our use of this matching procedure was only to provide numerical equation of memory performance; we do not claim that changing the delay interval equated the processes associated with memory performance in the two age groups.

Table 1. Demographic information and mean (SE) test scores for participants in Experiments 1 and 2.

Age group	Gender	Age (yrs)	Education (yrs)	MMSE	Digit Span		WAIS-III Digit/Symbol		WAIS-III Vocabulary	
					Forward	Backward	number completed*	Age-adjusted scaled score	percentage correct *	Adjusted score
Experiment 1										
Young adults	10 men 22 women	20.1 (.63) Range = 18-30	15.1 (.38) Range = 13-20;	N/A	7.09 (.18)	4.69 (.27)	73.1 (2.6)	9.7 (.51)	87.1 (1.0)	16.3 (.37)
Older adults	10 men 22 women	73.4 (1.2) Range = 65-80	16.5 (.32) Range = 14-22	29.3 (.13)	6.88 (.19)	4.19 (.28)	48.3 (2.3)	10.0 (.49)	90.6 (1.3)	16.7 (.42)
Experiment 2										
Young adults	11 men 21 women	20.8 (.57) Range = 19-28	14.7 (.34) Range = 13-19;	N/A	7.06 (.27)	5.56 (.30)	66.5 (2.6)	9.8 (.42)	84.6 (2.7)	15.8 (.53)
Older adults	8 men 24 women	70.3 (1.1) Range = 67-79	16.8 Range = 14-23	29.0 (.20)	6.56 (.29)	4.88 (.29)	48.4 (2.9)	10.5 (.63)	90.4 (2.2)	16.1 (.44)

Notes. MMSE = Mini Mental Status Exam (Folstein et al., 1975). WAIS-III = Wechsler Adult Intelligence Scale, 3rd Edition (Wechsler, 1997). * = measure on which there was a significant age difference ($p < .01$). Older adults completed significantly fewer entries on the digit/symbol copy than young adults, and older adults correctly defined more words on the Vocabulary assessment than young adults; however, the age groups did not differ from one another in their age-adjusted scaled scores on either of these tasks.

Table 2. Proportion of “same,” “similar,” and “new” responses (mean, SE) as a function of item type (*same*, *similar*, or *new*), emotion type (negative, positive, neutral) and age (young, older adults) in Experiment 1.

Response Type	Same	Similar	New
YOUNG ADULTS			
Negative objects			
“same”	.54 (.05)	.23 (.03)	.11 (.02)
“similar”	.25 (.03)	.45 (.03)	.24 (.03)
“new”	.21 (.04)	.33 (.03)	.65 (.03)
Positive objects			
“same”	.41 (.04)	.22 (.03)	.09 (.02)
“similar”	.28 (.03)	.43 (.03)	.23 (.03)
“new”	.31 (.05)	.35 (.03)	.68 (.04)
Neutral objects			
“same”	.41 (.04)	.23 (.03)	.09 (.02)
“similar”	.31 (.02)	.42 (.03)	.23 (.02)
“new”	.29 (.04)	.35 (.04)	.68 (.03)
OLDER ADULTS			
Negative objects			
“same”	.67 (.03)	.26 (.03)	.09 (.01)
“similar”	.18 (.02)	.43 (.03)	.19 (.02)
“new”	.14 (.02)	.31 (.04)	.71 (.03)
Positive objects			
“same”	.52 (.04)	.28 (.02)	.09 (.02)
“similar”	.33 (.04)	.40 (.03)	.19 (.02)
“new”	.15 (.02)	.32 (.03)	.72 (.03)
Neutral objects			
“same”	.51 (.05)	.26 (.03)	.11 (.02)
“similar”	.22 (.03)	.40 (.04)	.18 (.02)
“new”	.27 (.04)	.34 (.03)	.71 (.03)

Note: Specific recognition reflects the proportion of “same” responses to *same* items, whereas general recognition reflects the proportion of “same” or “similar” responses to *same* or *similar* items.

Table 3. Proportion of “same,” “similar,” and “new” responses (mean, SE) as a function of item type (*same*, *similar*, or *new*), emotion type (negative, positive, neutral) and age (young, older adults) in Experiment 2.

Response Type	Same	Similar	New
YOUNG ADULTS			
Negative objects			
“same”	.58 (.03)	.23 (.02)	.10 (.02)
“similar”	.23 (.02)	.42 (.03)	.26 (.02)
“new”	.19 (.02)	.35 (.03)	.64 (.03)
Positive objects			
“same”	.49 (.02)	.21 (.03)	.10 (.03)
“similar”	.27 (.02)	.42 (.03)	.25 (.02)
“new”	.24 (.02)	.38 (.03)	.65 (.03)
Neutral objects			
“same”	.48 (.02)	.20 (.01)	.10 (.02)
“similar”	.25 (.02)	.43 (.03)	.25 (.03)
“new”	.26 (.02)	.37 (.03)	.65 (.03)
OLDER ADULTS			
Negative objects			
“same”	.51 (.02)	.24 (.02)	.07 (.01)
“similar”	.25 (.02)	.35 (.02)	.18 (.02)
“new”	.24 (.02)	.41 (.03)	.75 (.03)
Positive objects			
“same”	.44 (.02)	.26 (.02)	.06 (.01)
“similar”	.35 (.02)	.35 (.02)	.18 (.02)
“new”	.21 (.01)	.39 (.02)	.75 (.03)
Neutral objects			
“same”	.40 (.02)	.23 (.02)	.07 (.01)
“similar”	.28 (.02)	.35 (.02)	.19 (.02)
“new”	.32 (.01)	.42 (.02)	.74 (.02)

Note: Specific recognition reflects the proportion of “same” responses to *same* items, whereas general recognition reflects the proportion of “same” or “similar” responses to *same* or *similar* items.

Figure 1. Task design: At study, young and older adults viewed objects for 1000ms. One-third of the objects were negative and arousing (e.g., tarantula), one-third were positive and arousing (e.g., diamond ring), and the other third were neutral (e.g., barometer). At test, participants were presented with objects that were the *same* as a studied item (identical), *similar* to a studied item (sharing the same verbal label but not an identical picture), or *new* (not studied). Participants indicated whether the item was “same,” “similar,” or “new.”

