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Age Differences in Memory for Arousing and Nonarousing Emotional Words

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Older adults sometimes demonstrate a mnemonic ``positivity effect," remembering more positive than negative information. The present study examined whether this effect would occur for arousing words (*elation* vs *slaughter*) or for nonarousing ones (*serenity* vs *sorrow*). The results revealed no positivity effect for arousing words: Young and older adults remembered negative and positive arousing words equally well and more often than neutral words. However, a positivity effect emerged for nonarousing words. Young adults remembered negative nonarousing words better than positive nonarousing items. Older adults remembered positive nonarousing words better than negative nonarousing words and showed no mnemonic benefit for negative nonarousing words as compared with neutral words. These findings suggest that aging preserves responses to arousing information while altering the processing of nonarousing information.

MEMORY complaints are frequent among older adults (reviewed by Grady & Craik, 2000; Light, 1992), but recent research has highlighted that older adults may perform more similarly to young adults when tasks assess memory for emotionally relevant information. In particular, a number of studies have suggested that older adults may perform better when remembering positive information (reviewed by Mather & Carstensen, 2005) and that, in some instances, age-related memory impairments may be reduced or eliminated when memory for positive information is assessed (Charles, Mather, & Carstensen, 2003; Kensinger, Garoff-Eaton, & Schacter, 2007). However, this age-related ''positivity effect'' does not always occur. For example, it appears to be most pronounced when young and older adults process information without being asked to focus on its emotional content (reviewed by Mather, 2006) and when memory is assessed by means of memory measures that do not require participants to retrieve the precise details of an item's presentation (Kensinger, Garoff-Eaton, & Schacter, 2007; Kensinger, O'Brien, Swanberg, Garoff-Eaton, & Schacter, in press).

Despite the extensive discussions about the reliability and generality of the ''positivity effect,'' the role of a potentially important factor—the arousal level of the stimuli—has not been systematically examined. Influential models of emotion have proposed a two-dimensional space in which all emotions lie: One dimension is valence (how positive or negative) and the other is arousal (how exciting or agitating or calming or subduing; Russell, 1980). Extensive research has revealed that although young adults remember arousing information and also information that is positive or negative but that does not elicit arousal (e.g., words such as *sorrow* or images of a cemetery), the processes contributing to the mnemonic enhancement for arousing and nonarousing information are likely to be distinct. Patients with damage to the amygdala show normal enhancement in memory for nonarousing information, but they do not show the time-dependent boost in memory for arousing information (LaBar & Phelps, 1998). Healthy young adults show a correspondence between amygdala activation and memory for arousing information but no link between amygdala activation and memory for nonarousing information (Kensinger & Corkin, 2004).

Young adults also show a mnemonic benefit for arousing information even when their attention is divided during encoding, whereas their mnemonic benefit for nonarousing information vanishes as soon as they cannot devote their full attention toward processing the information (Bush & Geer, 2001; Kensinger & Corkin, 2004). On the basis of this evidence, it has been argued that the memory enhancement for arousing information may occur relatively automatically, as a result of the engagement of emotion-specific processes, whereas the memory enhancement for nonarousing information may result from the engagement of more controlled processing strategies (see also Talmi, Schimmack, Paterson, & Moscovitch, 2007). For example, memory enhancement for nonarousing information may arise because individuals are more likely to process those items in reference to themselves or to semantically elaborate upon that information (see Kensinger, 2004; LaBar & Phelps, 1998; Rogers, Kuiper, & Kirker, 1977).

My goal in the present study was to examine how well young and older adults remember emotional information with a range of valence and arousal characteristics. In particular, I examined whether the positivity effect would occur equally strongly for arousing and nonarousing stimuli, or whether arousal would influence the strength of the effect. Because the positivity effect has been purported to arise from controlled processing (i.e., in the service of older adults' emotion regulation goals; reviewed by Mather & Carstensen, 2005), and because memory for nonarousing items is thought to rely more on controlled processing than is memory for arousing items (reviewed by Kensinger, 2004), I hypothesized that the positivity effect would be manifest more strongly in memory for nonarousing items than in memory for arousing items. To examine the validity of this hypothesis, colleagues and I conducted two experiments in which the recall (Experiment 1) and recognition (Experiment 2) performance of younger adults (ages 18–35 years) and older adults (ages 64–80 years) was compared for neutral items and for items from four emotion categories: negative

Table 1. Valence and Arousal Ratings for Stimuli Used in the Present Study

	Arousing		Nonarousing		
Group	Negative *M* (*SE*)	Positive *M* (*SE*)	Negative *M* (*SE*)	Positive *M* (*SE*)	Neutral
Valence					
ANEW	2.6 (.41)	7.3 (.63)	2.5 (.44)	7.0 (.53)	N/A
Young adults	2.3 (.75)	7.1 (.82)	2.3 (.67)	7.2 (.65)	5.3 (.66)
Older adults	2.1 (.67)	7.4 (.55)	2.4 (.82)	7.3 (.71)	5.6 (.57)
Arousal					
ANEW	6.1 (.68)	6.1 (.61)	4.4 (.61)	4.3 (.51)	N/A
Young adults	6.9 (.73)	6.6 (.59)	3.7 (.81)	3.5 (.69)	3.4 (.67)
Older adults	6.9 (.91)	6.3 (.71)	3.5 (.65)	3.6 (.84)	3.2 (.81)

Notes: ANEW = Affective Norms for English Words (database). Ratings are for all stimuli used in Experiment 2; stimuli in Experiment 1 were a subset of those used in Experiment 2. ANEW values are from the published normative data (Bradley & Lang, 1999). Young and older adult values reflect the ratings given by 20 young and 20 older adults who did not participate in the current experiments but who rated a subset of the ANEW words, as well as the neutral words used in these experiments, for valence and arousal.

arousing, negative nonarousing, positive arousing, and positive nonarousing.

Experiment 1

The positivity effect has been demonstrated most consistently on tasks using free recall (e.g., Charles et al., 2003). For this reason, the first experiment assessed young and older adults' free recall of information from the different emotional categories.

Methods

Participants

The participants comprised 30 young adults (age range = 18–35 years; $M = 26.1$, $SD = 3.7$) with between 12 and 22 years of education ($M = 16.3$, $SD = 2.7$) and 30 older adults (age range = 64–80 years; $M = 73.5$, $SD = 3.9$) with between 14 and 22 years of education ($M = 16.7$, $SD = 1.8$). Colleagues and I recruited the young adults by posting fliers throughout the greater Boston area. We recruited the older adults through the Harvard Cooperative Program on Aging and by posting advertisements in senior center newsletters. We screened all participants to eliminate those who were taking medications that could affect the central nervous system and to exclude those with a history of alcoholism, drug abuse, cancer, depression, or other psychiatric or neurological disorders.

All older adults had Mini-Mental Status Examination (Folstein, Folstein, & McHugh, 1975) scores of greater than 28 ($M = 29.5$). Young and older adults did not significantly differ on forward and backward digit span measures (for older adults, $M = 6.71$ on forward, 5.13 on backward; for young adults, $M = 7.22$ on forward, 5.44 on backward). Older adults were slower than young adults on the third edition of the Wechsler Adult Intelligence Scale (WAIS-III; Wechsler, 1997) Digit Symbol Copy task (completed number for older adults, $M = 51.1$; for young adults, $M = 68.2$; $p < .001$) but performed better than young adults on the WAIS-III Vocabulary assessment (92.1% correct for older adults; 83.8% for young adults; $p < .001$). Young and older adults did not differ in their age-adjusted scores on any of these measures. Both age groups performed at average levels on the Digit Symbol task (age-adjusted scaled score, $M = 10.0$ for young adults and $M = 10.7$ for older adults), and both groups performed above average on the Vocabulary assessment (age-adjusted scaled score, $M = 15.3$ for young adults and $M = 16.4$ for older adults).

Materials and Design

The stimuli were 75 words. We included five categories of 15 words each: neutral (e.g., *figment*), negative nonarousing (e.g., *lonely*), negative arousing (e.g., *slaughter*), positive nonarousing (e.g., *lake*), and positive arousing (e.g., *casino*). Colleagues and I selected words from the Affective Norms for English Words, known as ANEW, database of words (Bradley & Lang, 1999) such that negative words had valence ratings of 1 to 3 (on a scale of 1–9, with 1 being highly negative and 9 being highly positive), neutral words had valence ratings of 3.1 to 5.9, and positive words had valence ratings of 6 to 9. Arousing words had arousal ratings of 5 to 9 (on a scale of 1–9, with 1 being calming or soothing and 9 being agitating or exciting) and nonarousing and neutral words had arousal ratings of 1 to 4.9. We selected words so that arousing and nonarousing words did not differ in valence (i.e., negative arousing words were just as negative as negative nonarousing words). We also matched positive and negative words on arousal level (e.g., the negative arousing words were just as arousing as the positive arousing words) and on absolute valence level (i.e., distance from neutral valence). Because of concerns that the semantic relatedness of emotional words may lead to some of the mnemonic advantages (Talmi et al., 2007),[1] we selected the neutral words to be related to the concepts "think" and "mind." We selected words from the five categories so that they did not differ significantly in word length, in the number of abstract and concrete words, in imageability, or in word frequency (Coltheart, 1981; Kuchera & Francis, 1967).

As a way to determine whether there were age differences in valence and arousal ratings, a separate group of 20 young adults (ages 18–30 years) and 20 older adults (ages 65-80 years) who did not participate in this study, but who met the eligibility requirements outlined herein, rated the words for valence and arousal. Analyses revealed no effects of age on the valence or arousal ratings given to any word category (all $ps > .15$; see Table 1). Therefore, any effects of age on memory should not arise from differences in the perceived valence or arousal of the words.

Colleagues and I divided the 75 words across three lists of 25 items; each list included 5 words from each emotion category. Participants saw each word in the list for 5 seconds, and words from each emotion category were randomly interspersed with the constraint that no more than four items from a single emotion category could be shown consecutively. Participants were instructed to pay careful attention to the words, because their memory for the words would be assessed by means of a free recall test. To ensure that participants were attending to the words, we had the participants rate each as an "abstract" or "concrete" word by making an appropriate button press. Older adults were slower than young adults to make the word rating (reaction time, $M = 1{,}835$ ms, young adults; $M = 2{,}258$ ms, older adults), but there were no effects of emotion on the reaction times.[2] Young and older adults were highly accurate at making the decision (fewer than 5% of all responses were

errors) and there were no effects of age or emotion on judgment accuracy.

We included three neutral buffer words at the beginning and end of each word list. Immediately after presentation of the word lists, participants were asked to write down all of the words that they remembered from the list. They then cycled through the same study and free recall components for the other two lists. The order of the lists (i.e., which was first, second, or third) was counterbalanced across the participants.

Results

We computed recall scores for each of the five emotion categories (see Figure 1). We then conducted an analysis of variance (ANOVA) on those scores, with emotion type as a within-subject factor and age as a between-subject factor. This ANOVA revealed main effects of emotion, $F(4, 55) = 11.82$, $p < .001$, $\eta_p^2 = .46$, and age, $F(1, 58) = 30.34$, $p < .001$, $\eta_p^2 = .34$, qualified by an interaction between emotion and age, $F(4, 55) = 3.79$, $p < .01$, $\eta_p^2 = .22$. Post hoc t tests examined the influence of valence on memory for arousing and nonarousing words. These t tests revealed that there was no effect of valence on memory for the arousing words for either age group; negative arousing and positive arousing words were remembered equally well ($p > .25$). However, both age groups showed an effect of valence on memory for nonarousing words. Young adults remembered positive nonarousing words more poorly than they did negative nonarousing words ($p < .05$), although they did remember the positive nonarousing words better than they did the neutral words ($p < .05$). Older adults showed the opposite effect of valence on memory for the nonarousing words: They remembered negative nonarousing words more poorly than they did positive nonarousing words ($p < .01$) and, in fact, showed no memory benefit for the negative nonarousing words as compared with the neutral words ($p > .5$; see Figure 1).

Discussion

The results revealed no evidence of a positivity effect for the arousing words: Both age groups remembered negative arousing words just as well as they remembered positive arousing words. However, there was evidence of an age-related positivity effect for the nonarousing words: Whereas young adults remembered positive nonarousing words less well than they remembered negative nonarousing words, the older adults showed the opposite pattern of results.

These results place an important constraint upon the positivity effect, suggesting that the effect may be most robust for items low in arousal, whereas age differences may be minimal for items high in arousal. These results align well with recent proposals that the positivity effect arises as a result of age-related differences in the controlled processing of emotional information, and that memory for nonarousing information is more dependent upon controlled processing than is memory for arousing information. It makes sense that if older adults' positivity effect arises from age-related changes in the controlled processing of emotional information, then such an effect would be strong for the nonarousing words, whose memorization appears to rely on controlled, elaborative processes, but would not be apparent for arousing words whose retention results from relatively automatic processes (reviewed by Dolan & Vuilleumier, 2003; Kensinger, 2004).

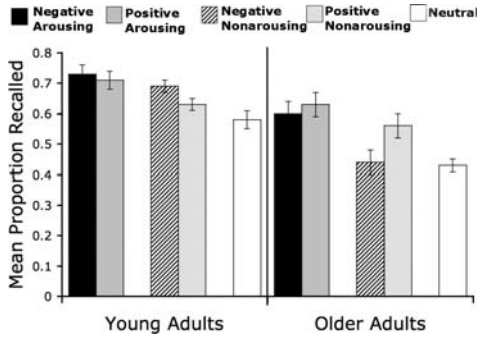

Figure 1. Mean recall rates in Experiment 1 as a function of emotion type and age. Valence had no effect on memory for the arousing words but did influence memory for the nonarousing words. Young adults remembered positive nonarousing words less well than they remembered negative nonarousing words, whereas older adults showed the opposite pattern. Bars indicate standard error of the mean.

An open question from Experiment 1, however, was whether the positivity effect demonstrated for the nonarousing words was tied to the intentional encoding instructions. It is plausible that the effect emerged because participants were attempting to memorize the words—perhaps the strategies invoked by young adults were least beneficial to remembering the positive nonarousing words, whereas the strategies enlisted by the older adults were least effective for learning the negative nonarousing words. If the positivity effect were tied to strategies used to memorize the words, then it would be expected that such an effect would not emerge if participants did not know that they should learn the words for a later memory test. Alternately, it is plausible that young and older adults naturally engage different levels of elaborative processes whenever they encounter negative and positive nonarousing information, with young adults elaborating more on negative nonarousing information (and see Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001) and older adults elaborating more upon positive nonarousing information. If this alternative were true, then it would be expected that the positivity effect would emerge even if participants processed emotional information with no expectation that their memories would later be assessed. Experiment 2 distinguished between these alternatives by assessing memory for words encoded in an incidental fashion.

Experiment 2

As just discussed, the positivity effect may have emerged in Experiment 1 because participants knew that their memory would be assessed and therefore evoked particular encoding strategies to help them remember the words. It was not possible to perform the recall task with incidental encoding instructions because of the need to present participants with multiple study lists (i.e., to perform the three study-recall cycles, making it impossible to keep the mnemonic demands of the task a surprise to participants). Performing a single study-recall cycle was not an option because recall rates would be too low if words were presented in one long list (i.e., a 75-item list), and a shorter list would prevent having enough items of each emotion category to detect reliable differences in recall.

Table 2. Experiment 2: Mean Hit, FA, and CR Rates as a Function of Emotion Type and Age

	Negative Arousing			Positive Arousing			Negative Nonarousing			Positive Nonarousing			Neutral		
Group	Hit	FA	CR	Hit	FA	CR	Hit	FA	CR	Hit	FA	CR	Hit	FA	CR
Young adults	.79 (.03)	.21 (.02)	.59 (.04)	.74 (.03)	.19 (.02)	.56 (.03)	.77 (.03)	.21 (.02)	.57 (.04)	.70 (.02)	.20 (.02)	.50 (.03)	.65 (.03)	.22 (.02)	.43 (.03)
Older adults	.65 (.03)	.31 (.02)	.34 (.04)	.65 (.03)	.29 (.03)	.36 (.04)	.44 (.05)	.33 (.02)	.11 (.05)	.60 (.03)	.30 (.03)	.31 (.05)	.48 (.04)	.32 (.02)	.16 (.04)

Notes: FA = false alarm; CR = corrected recognition. Standard errors are shown in parentheses.

Experiment 2 circumvented these difficulties by using a recognition paradigm. Thus, Experiment 2 allowed an examination of whether the age-related positivity effect for nonarousing items would occur when participants did not know that their memory for the items would be assessed.

Methods

Participants

The participants comprised 30 young adults (age range = 18–35 years; $M = 24.6$, $SD = 3.3$) with between 12 and 20 years of education ($M = 15.9$, $SD = 2.5$) and 30 older adults (age range = 64–78 years; $M = 72.3$, $SD = 3.1$) with between 14 and 22 years of education ($M = 16.4$, $SD = 2.3$) meeting the criteria outlined for Experiment 1. No participant included in Experiment 2 had also completed Experiment 1. All older adults had Mini-Mental Status Examination (Folstein et al., 1975) scores of 28 or greater ($M = 29.0$). Young and older adults did not differ significantly from one another on forward and backward digit span measures (for older adults, $M = 6.5$ on forward, $M = 4.8$ on backward; for young adults, $M = 7.1$ on forward, $M = 5.3$ on backward). Older adults were slower than young adults were on the WAIS-III Digit Symbol Copy task (completed number for older adults, $M = 43.5$; for young adults, $M = 78.1$; $p < .001$), but they performed better than young adults on the WAIS-III Vocabulary assessment (90.5% correct for older adults; 82.5% for young adults; $p < .001$). Young and older adults did not differ in their age-adjusted scores on any of these measures. The performance of both age groups was average on the Digit Symbol task (age-adjusted scaled score, $M = 10.9$ for young adults and $M = 10.4$ for older adults), and it was above average on the Vocabulary assessment (age-adjusted scaled score, $M = 14.9$ for young adults and $M = 16.1$ for older adults).

Materials and Design

The stimuli were 350 words, 70 from each of the five emotion categories, selected in the same manner as described in Experiment 1, except that some neutral words did not come from the ANEW database but rather were selected from words used in a prior experiment (Kensinger & Corkin, 2003). Once again, neutral words were related to the concepts of "think" and "mind." Colleagues and I divided the words into two lists of 175 words (with 35 words from each emotion category). One of these lists served as the study list, and the other list of words supplied the foils on the recognition task. The list that was used at study, versus as foils at recognition, was counterbalanced across participants.

At study, participants saw each word in the list for 3 seconds. Words from each emotion category were randomly interspersed with the constraint that no more than four items from a single emotion category could be shown consecutively. Participants were asked to decide whether each word was "abstract" or "concrete" by making an appropriate button press. No mention was made of a subsequent memory task, and debriefing forms completed at the end of the session indicated that no participant anticipated that his or her memory would be assessed. As in Experiment 1, older adults were slower than young adults to make the word rating (reaction time, $M = 1{,}911$ ms for young adults and $M = 2{,}339$ ms for older adults), but there were no effects of emotion on the reaction times. Both age groups made the judgments accurately (fewer than 5% of all responses were errors) and there were no effects of age or emotion on judgment accuracy.

Approximately 10 minutes after completion of the study phase, participants performed the recognition memory task. On this task, participants were presented with a series of words, one at a time. Words from each emotion category were randomly intermixed with one another, as were studied words and lure words. For each word, participants indicated whether it was an "old," studied word or a "new," nonstudied word. As soon as participants made their response to one word, the next one appeared.

Results

We computed corrected recognition scores for each of the five emotion categories (see Table 2) by subtracting the false-alarm rate (saying "old" to a new item) for a particular category from the hit rate (saying "old" to an old item). For example, we subtracted the proportion of false alarms to negative arousing items from the proportion of hits to negative arousing items to give a corrected recognition score for those items. We then conducted an ANOVA on the corrected recognition scores, with emotion type as a within-subject factor and age as a between-subject factor. This ANOVA revealed main effects of emotion, $F(4, 55) = 5.81$, $p < .001$, $\eta_p^2 = .30$, and age, $F(1, 58) = 117.08$, $p < .001$, $\eta_p^2 = .67$, qualified by an interaction between emotion and age, $F(4, 55) = 2.6$, $p < .05$, $\eta_p^2 = .16$. Post hoc t tests examined the influence of valence on young and older adults' memory for arousing and nonarousing words. For the arousing words, there was no influence of valence; both age groups remembered negative arousing words as well as they remembered positive arousing words ($p > .25$). By contrast, valence influenced memory for the nonarousing words (see Table 2). Young adults remembered positive nonarousing words more poorly than they did negative nonarousing words ($p < .05$), although they still remembered the positive nonarousing words better than they remembered the neutral words ($p < .05$). Older adults showed the opposite effect of valence: They remembered negative nonarousing words more poorly than they did positive nonarousing words ($p < .01$), and they showed no memory benefit for the negative nonarousing words as compared with the neutral ones ($p > .3$). These results remained qualitatively the same when we

analyzed the hit rates, uncorrected for false-alarm rates; there were no significant effects of emotion on the false-alarm rates.

Discussion

The results of Experiment 2 replicated those of Experiment 1. There was no evidence of an age-related positivity effect for the arousing words, with negative arousing and positive arousing words being remembered equally well. However, there was a positivity effect for the nonarousing items, with young adults remembering more negative nonarousing than positive nonarousing words but older adults remembering more positive nonarousing than negative nonarousing words, and showing no mnemonic enhancement for the negative nonarousing words. Thus, the positivity effect demonstrated for the nonarousing items extends not only to recall tasks but also to recognition memory tasks, and it exists both when participants are intentionally encoding the words and when they are processing them with no knowledge of a subsequent memory test.

Of course, because both the intentionality of encoding and the type of memory task (recognition vs recall) were changed between Experiment 1 and Experiment 2, it is impossible to know whether these two variables interacted in some way. It cannot be ruled out that intentionality may play a role on recall tasks, or that the effects of intentionality could be reversed on recognition tasks as compared with recall tasks. Nevertheless, the findings from Experiment 2 suggest that the positivity effect cannot be explained solely by differences in the strategies evoked as young and older adults attempt to memorize words. The fact that similar results were revealed in the two experiments also indicates that the positivity effect for nonarousing items generalizes across at least a couple of different paradigms. The implications of these findings will be expanded upon in the general discussion.

General Discussion

It has been debated whether young and older adults show similar memory enhancements for emotional information (reviewed by Mather, 2006; also see Kensinger, 2006). The present results emphasize that young and older adults can show similar memory boosts for emotional information, at least when that information is arousing. However, the two age groups do not show the same memory benefit for all emotional information. Young adults remember negative nonarousing and positive nonarousing information better than neutral information, but they show better memory for the negative than the positive nonarousing information. By contrast, older adults retain positive nonarousing information better than negative nonarousing information, and they show no memory enhancement for negative nonarousing information as compared with neutral information. Thus, there is a critical impact of valence upon the types of nonarousing information remembered by young and older adults, whereas there is no effect of valence upon the types of arousing items remembered by the two age groups.

These results suggest that the enhancement for arousing items is supported by processes relatively preserved with aging. Although further research will be required to elucidate these processes fully, the present results are consistent with evidence suggesting that the memory boost for arousing information is supported by relatively automatic processes (reviewed by Kensinger, 2004). For example, a number of experiments have demonstrated that arousing information benefits from prioritized processing (e.g., Anderson & Phelps, 2001; Pessoa, 2005) and can be detected even when attentional resources are taxed (Dolan & Vuilleumier, 2003). Within this framework, it makes sense that older adults would show enhancement for arousing words regardless of their valence: A number of studies have suggested that automatic processing of emotional information is relatively preserved in aging (reviewed by Mather, 2006). Young and older adults are quick to detect emotionally arousing information (Hahn, Carlson, Singer, & Gronlund, 2006; Knight, Seymour, Gaunt, Baker, Nesmith & Mather, in press; Leclerc & Kensinger, in press; Mather & Knight, 2006) and they tend to focus on arousing information within a complex scene (Kensinger, Gutchess, & Schacter, in press). It follows that if the two age groups have a similar automatic focusing upon arousing information, and if this automatic focusing confers many of the mnemonic benefits to arousing words, then the two age groups should show the same mnemonic benefit for that information.

In contrast to age-related preservation in automatic processing of arousing information, aging seems to have a large impact upon the more controlled and regulated processing of emotional information, and it has been proposed that these changes are what lead to the positivity effect (reviewed by Mather, 2006). The strongest evidence for this proposal has come from studies demonstrating that the positivity effect tends to be most robust when older adults can direct their full attention toward encoding the information and that older adults with good cognitive control are those who show the greatest positivity effect (Mather & Knight, 2005). However, the results of the present study can be interpreted within this framework. The age-related positivity effect demonstrated here for nonarousing information may result from age differences in elaborative processing (Kensinger, 2004; Talmi et al., 2007). Young adults may be likely to associate the negative nonarousing words together conceptually or to link those words with autobiographical experiences, whereas they may do this less often for the positive nonarousing words (see Baumeister et al., 2001). For a young adult, the negative nonarousing word *sorrow* may be more likely to bring to mind a personal experience than the neutral word *phase* or the positive nonarousing word *dawn*.

By contrast, older adults may be unlikely to elaborate upon negative nonarousing information but may elaborate on positive nonarousing information. A recent neuroimaging study provides support for this hypothesis. In that study (Gutchess, Kensinger, & Schacter, 2007), brain activity was measured as young and older adults processed nonarousing positive or negative adjectives. Young adults showed more activity in the medial prefrontal cortex, a region associated with self-referential processing, during the viewing of negative adjectives as compared with positive ones. By contrast, older adults recruited the medial prefrontal cortex disproportionately during the processing of positive adjectives (Gutchess, Kensinger, & Schacter, 2007). These results are consistent with the suggestion that young adults process negative nonarousing information in reference to themselves, whereas older adults process positive nonarousing information in a self-referent manner. Self-referential processing provides robust mnemonic benefits for both young and older adults (Gutchess, Kensinger, Yoon, & Schacter, 2007; Rogers

et al., 1977; Symons & Johnson, 1997); therefore, it makes sense that if there are age-related changes in the types of information that are processed in a self-relevant fashion, this could lead to differences in the types of information that the two age groups remember best.

In conclusion, the results of the present study highlight an important constraint for the age-related positivity effect. The effect is robust for nonarousing words, but it does not occur for arousing words. Because nonarousing information is thought to be remembered well as a result of the engagement of controlled, elaborative encoding strategies whereas arousing information is believed to be remembered well because of automatic processes, these findings are consistent with the proposal (Mather, 2006) that the age-related positivity effect may be most pronounced when older adults rely on controlled processing of emotional information.

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End Notes

[1]This concern has arisen because emotional words can be grouped by their valence (e.g., someone can remember that they studied "a bunch of unpleasant words") and because words with negative or positive valence tend to be at least weakly associated with one another (e.g., negative words such as *snake* and *slaughter* are more likely to be associated than neutral words such as *cabbage* and *garage*). If neutral words are not categorically constrained, memory for emotional words can be better than memory for neutral words simply because the emotional words are more closely associated with one another.

[2]Note that the word stayed on the screen for the entire 5 seconds, regardless of when the participants made their word rating.