

Are the Memories of Older Adults Positively Biased?

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There is disagreement in the literature about whether a “positivity effect” in memory performance exists in older adults. To assess the generalizability of the effect, the authors examined memory for autobiographical, picture, and word information in a group of younger (17–29 years old) and older (60–84 years old) adults. For the autobiographical memory task, the authors asked participants to produce 4 positive, 4 negative, and 4 neutral recent autobiographical memories and to recall these a week later. For the picture and word tasks, participants studied photos or words of different valences (positive, negative, neutral) and later remembered them on a free-recall test. The authors found significant correlations in memory performance, across task material, for recall of both positive and neutral valence autobiographical events, pictures, and words. When the authors examined accurate memories, they failed to find consistent evidence, across the different types of material, of a positivity effect in either age group. However, the false memory findings offer more consistent support for a positivity effect in older adults. During recall of all 3 types of material, older participants recalled more false positive than false negative memories.

Keywords: memory, aging, emotion, autobiographical, picture

Normal aging seems to be associated with superior emotional self-regulation. As people age, they focus increasingly on maintaining positive emotions and decreasing negative emotions (Carstensen, 1995). Seniors’ efforts to accentuate the positive appear to be successful: Relative to their younger counterparts, older adults report experiencing fewer and less persistent negative emotions (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Charles, Reynolds, & Gatz, 2001). A growing number of studies have also demonstrated enhanced emotional self-regulation in older adults. They experience fewer negative emotions (Gross et al., 1997; Mather & Carstensen, 2005), and when they do experience a negative mood, it is less likely to persist, suggesting an age advantage in reducing negative affect (Carstensen et al., 2000). In a large-scale study, negative affect was shown to decrease with advancing age (Charles et al., 2001). Research has also indicated that efforts to regulate emotions influence people’s performance on cognitive tasks (Kennedy, Mather, & Carstensen, 2004). For example, older adults are slower to localize a dot probe when preceded by a face with a negative (e.g., angry) expression and

faster when preceded by a face with a positive (e.g., happy) expression (Mather & Carstensen, 2003); also, older adults do not sustain attention to negative stimuli (Rösler et al., 2005). These findings are consistent with socioemotional selectivity theory (Carstensen, 1995), which postulates that as people age, their goals shift from novelty seeking to emotion regulation, defined as the maintenance of a positive affective state. In the current experiment, we study how the emotional tone of information influences memory and whether its influence changes with age.

It is important to study episodic memory in this context because it can be a source of emotional self-regulation in both older and younger adults (Meichenbaum, 2006; Pasupathi, 2001; Wilson & Ross, 2003). Reminiscing is a powerful way for older adults to generate positive emotional experiences (Pasupathi & Carstensen, 2003). If older adults are highly motivated to maintain positive emotions, they should exhibit an especially strong positivity effect in their episodic memory, showing better memory for positively than for negatively valenced information. There is some research evidence in support of this, and the phenomenon has come to be referred to in the literature as a *positivity effect*. Older adults show enhanced memory for positive-valence autobiographical events (Kennedy et al., 2004) and working memory for positive images (Mikels, Larkin, Reuter-Lorenz, & Carstensen, 2005). In contrast, younger adults in these studies showed better memory for negative material relative to positive material. In a study of picture recall, older adults recalled more positive than negative and neutral images, whereas younger adults showed better memory for both positive and negative, relative to neutral images (Charles, Mather, & Carstensen, 2003). Research has also shown that there is a source memory advantage in older adults for emotionally laden sources compared to neutral sources (May, Rahhal, Berry, &

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Leighton, 2005), suggesting that emotional characteristics of material can improve memory in older adults (though it remains to be shown whether positive sources are remembered better than negative ones).

Other researchers, however, have failed to find a positivity effect in the memories of older adults. When older adults actively rated the emotional characteristics of positive, negative, and neutral pictures or words during encoding, they showed no positivity effect in later memory (Comblain, D'Argembeau, Van der Linden, & Aldenhoff, 2004; Denburg, Buchanan, Tranel, & Adolphs, 2003; Kensinger, Brierley, Medford, Growdon, & Corkin, 2002). In another study, Grühn, Smith, and Baltes (2005) presented younger and older adults with emotionally toned words and found no evidence of a positivity effect in recall, leading these researchers to suggest that the effect may not generalize to memory of verbal material. Finally, Alea, Bluck, and Semegon (2004) failed to find age differences in the frequency and intensity of positive emotions as participants recalled their reactions to the O. J. Simpson verdict and found greater negative affect in older adults on some measures.

The inconsistency of past memory findings indicates the importance of identifying variables or conditions influencing the age-related positivity effect in memory. We studied two potentially relevant variables. First we examined biases in both accurate and false recall. If older adults are predisposed to remembering positive information, a positivity effect might be evident in their memory errors as well as in accurate recall. Normal aging is associated with an increased tendency to make false recall and recognition responses, even when the number of hits does not change (Koutstaal, 2003; Norman & Schacter, 1997; Rankin & Kausler, 1979; Ross, Spencer, Linardatos, Lam, & Perunovic, 2004; Smith, 1975). We hypothesized that an age-related increase in false recall would reflect, in part, an escalating tendency to produce false memories that are positively rather than negatively valenced.

There is some support for this hypothesis in past research (Mather & Johnson, 2000; Mather, Knight, & McCaffrey, 2005). For example, Mather and Johnson (2000) asked younger and older adults to choose between two options, both of which had positive and negative features. Older adults later attributed (and misattributed) more positive features to their chosen option than did younger adults. Thus as people age, there is a tendency to distort memory in favor of chosen options. This tendency to accentuate the positive can also be seen in autobiographical recall. Kennedy et al. (2004) reported an age-related positivity effect in long-term autobiographical recall. They asked nuns to recall their responses to a questionnaire about their personal information (health, physical symptoms, level of depression and hostility, etc.) that they had originally answered 14 years earlier. The nuns ranged in age from 47 to 102 years of age. Older nuns tended to remember their responses more positively than they had originally reported. Younger nuns tended to remember the past more negatively than originally recorded. Other researchers have also reported that older adults are more likely than younger adults to produce later memories that are more positive than their original accounts (Field, 1981, 1997). Kennedy et al. and Mather and Carstensen (2005) have suggested that such positivity effects in memory likely contribute to the age-related increase in positive affect. We propose, in addition, that older people's propensity for false recall should

reflect emotional self-regulation. In particular, older adults' false memories should be positively biased.

Second, we manipulated the type of material to be remembered as a within-participant variable, including autobiographical, picture, and word memory tasks. We examined whether an age-related positivity effect in hits and false recall generalized across the different materials that have been used with varying success in past research. It may be that emotional biases in accurate memories are more likely with complex or detailed material (autobiographical and picture material), which can elicit greater emotional reactivity in older adults than in younger adults (Kunzmann & Grühn, 2005), than they are with verbal material (Grühn et al., 2005). The evidence to date suggests this to be the case. In contrast, there is less reason to suppose that the frequency of positivity effects in memory errors would vary systematically with the type of material presented. Biases in false recall reflect, in part, reconstructive memory processes that can depend more on cues and motivation at the time of retrieval (Mather & Johnson, 2000) than on encoding processes (Schacter & Addis, 2007; Schacter & Dodson, 2001; Schacter, Norman, & Koutstaal, 1998). We test these hypotheses in the current study.

We also examined individual differences in the tendency to differentially recall positive information. We investigated, for example, whether participants who showed positivity effects in recall of pictures also showed positivity effects in recall of words or autobiographical memories. To assess whether individual differences in memory were consistent, we conducted correlational analyses on memory of each valence across materials.

Finally, we assessed the plausibility of an alternative account of the positivity effect in memory. Although Carstensen and her colleagues (2000; Charles et al., 2003) related the positivity effect to mood regulation, a positivity effect in recall could reflect mood-dependent memory. In demonstrations of mood-dependent recall, Eich, Macaulay, and Ryan (1994) showed that participants retrieved memories that were affectively consistent with induced moods. The mood-dependent memory hypothesis would predict that, in studies showing the age-related positivity effect, older participants were in a better mood than their younger counterparts. This mood difference might occur when the older participants engage in mood self-regulation. Such an hypothesis is suggested by work that has shown that depressed and demented older adults report more negative autobiographical memories than age-matched controls, and recovery from depression is associated with increased recall of neutral life events (Fromholt & Larsen, 1991; Fromholt, Larsen, & Larsen, 1995). We test the mood-congruent memory hypothesis in the current study by assessing participants' current mood and relating it to age of participant as well as valence of recall for each type of material.

Method

Participants

Ninety-seven participants took part in the study: 49 were younger adults and 48 were older adults. Younger participants (31 women) were undergraduate students enrolled in an introductory psychology class; they ranged in age from 17 to 29 years ($M = 19.00$ years) and received partial course credit for participating. Older participants (28 women) were recruited from the Waterloo

Research in Aging Participant (WRAP) pool; they ranged in age from 60 to 84 years ($M = 72.25$ years) and received a \$20 remuneration for participating. The WRAP pool consists of a database of senior citizens from the Kitchener-Waterloo community recruited through newspaper advertisements and flyers in senior centers. Seniors recruited from the WRAP pool reported that they were in good physical and mental health and had normal or corrected-to-normal vision and hearing.

The National Adult Reading Test—Revised (NART-R; Blair & Spreen, 1989; Nelson, 1982), which is based on number of errors in pronunciation during vocabulary reading, was administered and used to calculate an estimate of Full Scale IQ (FSIQ). There was a significant difference in FSIQ, $F(1, 94) = 46.81$, $MSE = 49.72$, $p < .001$, with older adults having higher estimates than younger adults (see Table 1). Each participant also completed the Trail Making Test (Partington & Leiter, 1949), which provides a neuropsychological assessment of cognitive flexibility and inhibitory capacity. The test requires attention, speeded sequencing, and visual search (Strauss, Sherman, & Spreen, 2006). As expected, performance differed across age groups for both Trail A, $F(1, 95) = 55.88$, $MSE = 76.80$, and Trail B, $F(1, 95) = 21.10$, $MSE = 1781.61$, $ps < .001$; older adults took longer than younger adults did on both Trails A and B (see Table 1). The Digit Span Forward and Digit Span Backward tests (Wechsler, 1997) were also administered to assess working-memory capacity across age groups. The Digit Span Forward test requires participants to repeat sequences of three to nine digits recited by the experimenter in the same order and in reverse order for the Digit Span Backward test. Performance on the Digit Span Forward test differed across age groups, $t(95) = 2.32$, $p < .05$, with older adults showing a poorer span than younger adults (see Table 1); although older adults had a shorter Digit Span Backward score than younger adults did, the difference was not significant, $t(95) = 0.48$, $p > .05$. Mean performance on the Trail Making Test and Digit Span tests was in the normal range for each age group (Strauss et al., 2006) and was in line with the expected deficit in executive functioning in older adults. Thus, we consider our sample of older adults to be representative of the general aging population, despite the fact that they showed higher FSIQ estimates than our younger adult sample did.

Table 1
Background Measures for Each Age Group

Measure	Younger		Older	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age (in years)	19.00	2.14	72.25	7.83
FSIQ	104.45	6.84	114.30	7.25
Trails A (in seconds)	21.13	6.11	34.44	10.82
Trails B (in seconds)	40.98	15.56	80.36	57.91
Digit Span (Forward)	9.24	2.27	8.19	2.23
Digit Span (Backward)	7.29	2.47	7.06	2.11
PANAS-X (Positive) Session 1	2.81	0.72	3.39	0.69
PANAS-X (Negative) Session 1	1.34	0.59	0.68	0.52
PANAS-X (Positive) Session 2	2.69	0.82	3.32	0.83
PANAS-X (Negative) Session 2	1.56	0.87	0.76	0.57

Note. The full scale IQ (FSIQ) was derived from the National Adult Reading Test-Revised. PANAS-X = Positive and Negative Affective Schedule-Expanded.

Materials

Mood. To assess mood at time of test, we asked participants to complete the Positive and Negative Affective Schedule—Expanded (PANAS-X; Watson & Clark, 1994) before the experimental tasks in each session. For the PANAS-X, participants were asked to rate the extent to which they were currently experiencing the emotion conveyed by each emotion word (e.g., sad, contented) on a 5-point scale ranging from 1 = *very slightly or not at all* to 5 = *extremely*.

Pictures. We used the same 64 color pictures as Charles et al. (2003) had used in their study. Thirty-two were included in a study list consisting of 8 positive, 8 negative, and 16 neutral pictures. Half of the pictures in each valence group included people and half did not. Twenty-seven of these images were chosen from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2005), but because the IAPS lacks a substantial number of neutral images with people, Charles et al. had chosen an additional 5 photos that were included in the neutral/person category, and the same pictures were used here. Mean valence scores of the IAPS pictures, based on the 9-point rating scale (such that a 9 represents a high rating of pleasure and 1 a low rating) from Lang et al. (2005), were 7.76, 4.70, and 2.32 for the positive, neutral, and negative valence categories, respectively. All pictures were 1010×752 pixels and covered almost the whole computer screen during presentation; a black border filled the remainder.

Words. Stimuli were selected from the Affective Norms for English Words (ANEW; Bradley & Lang, 1999). Thirty-two words were used for this part of the study, 8 of which were positive, 8 negative, and 16 neutral. Positive words had a valence mean of 7.70, neutral words 5.26, and negative words 2.45, according to ANEW's 9-point rating scale (in which a 9 represents a high rating of pleasure and 1 a low rating). All words were selected to have a word frequency count between 15 and 24 occurrences per million, according to Kucera and Francis (1967).

Procedure

Participants completed the study in two sessions separated by 1 week. Participants were randomly assigned to a task order and were tested individually. In the consent form, participants were informed that the main objective of the study was to examine whether there were differences between senior citizens and young adults in terms of their memory for words, pictures, and personal events with positive, negative, or neutral emotional valence.

Session 1. Participants completed the PANAS-X followed by Part 1 of the autobiographical memory task, followed by either the word or picture memory task. For the autobiographical memory task, participants were instructed to think about their experiences during the previous 2 weeks and were given a calendar as a visual aid. They were asked to record four positive, four negative, and four neutral events from this time period. If participants needed further clarification, the researcher provided examples, such as "a neutral event for me would be going grocery shopping," or "a negative event for me would be going to the dentist." There was no time limit for this task. Participants were allowed to stop when they could not think of any more events, regardless of whether they had recorded the required four events for each valence type.

Participants were then asked to rate how positive, negative, and neutral they believed each event to be, using a scale ranging from -3 (for *extremely negative*) to $+3$ (for *extremely positive*).

Following the autobiographical task, participants completed either the word or picture memory task, counterbalanced across participants. Performance on the remaining task was assessed in Session 2. Stimulus presentation and response recording for each of these was controlled by an IBM PC, with E-prime v.1.1 software (Psychology Software Tools Inc., Pittsburgh, PA).

For the picture task, participants viewed the list of 32 pictures (16 neutral and 16 emotional), presented one at a time in random order, at a rate of 2 s per picture. Each picture presentation began with a black fixation cross on a white background in the center of the screen for 500 ms, immediately followed by a picture. During this incidental study phase, participants were told to view the images as they would a television screen. For the word task, participants viewed a series of 32 words (16 neutral and 16 emotional), presented one at a time in random order, at a rate of 2 s per word. Each word presentation began with a black fixation cross on a white background in the center of the screen for 500 ms, immediately followed by a word. During this incidental study phase, participants were told to simply view the words. No mention was made of a later memory test, though in Session 2, participants may have guessed that their memory would be assessed as it had been on the (picture or word) computer task in Session 1.

Following the study phase for either the picture or word task, a 5 min filler task was administered consisting of either the Digit Span tests or the Trail Making Test. The remaining filler task was administered as the filler task in Session 2. This was done to introduce a delay between viewing the items and the subsequent memory test. Participants were then given 3 min to write down brief descriptions of pictures (or 2 min to write down words) they could recall from the previously presented list.

Session 2. Participants completed Session 2 a week later. They completed the PANAS-X followed by Part 2 of the autobiographical memory task, followed by either the word or picture memory task. For the autobiographical memory task, participants were instructed to write a description of each of the four positive, four negative, and four neutral events they could remember reporting in Session 1. No time limit was given, and participants informed the researcher when they had written all they could remember. As in the first session, participants were then asked to rate how positive, negative, and neutral they believed each event to be using a scale ranging from -3 (for *extremely negative*) to $+3$ (for *extremely positive*).

Subsequently, participants were shown all of their original recorded events from Session 1 and asked to indicate whether their written descriptions of an event listed in Session 2 referred to the same event they had listed in Session 1. Following the autobiographical task, participants completed either the word or picture memory task, whichever task they had not completed in Session 1. The filler task between study and recall phase was either the Digit Span tests or Trail Making Test, whichever task they had not completed in Session 1. At the end of the word or picture task during Session 2, participants completed the NART-R.

Results

As preliminary analyses revealed no effects for gender, it is not included as a factor in the analyses reported below. The data were analyzed in a 2 (age group: younger, older) $\times$ 3 (valence: positive, negative, neutral) analysis of variance (ANOVA). Age was a between-subjects factor and valence a within-subjects factor. For all of the analyses in this article, we used a .05 alpha level and used η_p^2 to measure effect sizes.

Autobiographical Memories Produced in Session 1

Autobiographical data from 1 older and 1 younger participant were excluded because they failed to follow instructions. The analyses were conducted on the proportion of requested events (four of each valence) provided by participants (see Table 2). Main effects of age group, $F(1, 93) = 6.70, p < .05, \eta_p^2 = .07$, and valence, $F(2, 186) = 6.89, p < .05, \eta_p^2 = .07$, were qualified by a significant Age $\times$ Valence interaction, $F(2, 186) = 3.71, p < .05, \eta_p^2 = .04$. To understand the interaction, we examined the effect of valence separately in each age group. In recalling the last 2 weeks, younger adults showed an effect of valence, $F(2, 94) = 3.53, p = .05, \eta_p^2 = .07$. Simple-effects contrasts showed that younger adults recalled more positive than neutral events, $F(1, 47) = 4.27, p < .05, \eta_p^2 = .08$, but similar proportions of positive and negative events, $F(1, 47) = 0.33, p = .57$, and negative and neutral events, $F(1, 47) = 3.43, p = .07$. Recall also varied with valence in older participants, $F(2, 92) = 5.68, p < .01, \eta_p^2 = .11$. Simple-effects contrasts showed that older participants recalled more positive than negative, $F(1, 46) = 10.44, p < .01, \eta_p^2 = .19$, and neutral events, $F(1, 46) = 8.78, p < .01, \eta_p^2 = .16$; their recall of negative and neutral events did not differ significantly, $F(1, 46) = 0.32, p = .58$. FSIQ, based on performance on the NART-R, was not correlated with production of events of any valence in either age group.

Perhaps the most intriguing result is that older participants were less able than their younger counterparts to recall negative life events, $t(93) = 3.05, p < .01$. It is unclear whether this finding reflects differences in life experiences or genuine age discrepancies in retrieval of negative events.

Autobiographical Memories Recalled in Session 2

The mean proportions of autobiographical events reported in Session 1 that were recalled in Session 2 are presented in Table 2.

Table 2
Proportion of Autobiographical Events Produced in Session 1 and Recalled in Session 2

Session and valence of event	Younger adults		Older adults	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Session 1				
Positive	.99	.04	.98	.08
Negative	.99	.05	.88	.25
Neutral	.95	.13	.90	.23
Session 2				
Positive	.82	.17	.60	.28
Negative	.68	.25	.56	.31
Neutral	.61	.28	.31	.28

There was a main effect of age, $F(1, 93) = 34.41, p < .001, \eta_p^2 = .27$, with older adults recalling fewer events overall than younger adults did. There was a main effect of valence, $F(2, 186) = 26.67, p < .001, \eta_p^2 = .22$, and the Age $\times$ Valence interaction approached significance, $F(2, 186) = 2.81, p = .06, \eta_p^2 = .03$. Given our a priori hypotheses and the direction of the interaction, we examined the effect of valence separately in each age group. The main effect of valence was significant, $F(2, 94) = 12.39, p < .001, \eta_p^2 = .21$. Simple-effects contrasts showed that younger adults recalled more positive than negative or neutral events, $F(1, 47) = 12.57, \eta_p^2 = .21$, and $F(1, 47) = 26.40, \eta_p^2 = .36, ps < .01$, respectively; the latter two did not differ significantly, $F(1, 47) = 2.41, p = .13$. In older adults, the main effect of valence was also significant, $F(2, 92) = 16.26, p < .001, \eta_p^2 = .26$. Simple-effects contrasts showed that older adults recalled more positive and negative than neutral events, $F(1, 46) = 26.29, \eta_p^2 = .36$, and $F(1, 46) = 17.17, \eta_p^2 = .27, ps < .001$, respectively. The difference between positive and negative events recalled was not significant, $F(1, 46) = 0.77, p = .39$. Participants' recall of autobiographical events that they listed during the first session thus differed from their initial recall of events from their lives. In Session 2, younger adults recalled more positive events, whereas older adults recalled more of the emotionally toned events, negative or positive.

Rated Emotionality of Events in Sessions 1 and 2

Participants were asked to rate how positive, negative, and neutral they believed each event produced in Sessions 1 and 2 to be using a scale ranging from -3 (for *extremely negative*) to $+3$ (for *extremely positive*). Scores were converted to a scale ranging from 1 to 7 and analyzed in a 2 (age group: younger, older) $\times$ 3 (valence: positive, negative, neutral) repeated-measures ANOVA. A main effect of valence validated the classification of events into the three valence categories in both Session 1 and Session 2 data, $F(2, 186) = 530.15, \eta_p^2 = .85$, and $F(2, 144) = 146.96, \eta_p^2 = .67, ps < .001$, respectively (see Table 3). No other effects attained significance. Thus older and younger adults did not differ in their perceived emotionality of negative, neutral, and positive autobiographical events.

False Autobiographical Recall

During recall of autobiographical events in Session 2, some participants recalled events that they had not reported in Session 1.

Table 3
Ratings of Degree of Emotionality of Autobiographical Events Produced in Session 1 and Recalled in Session 2

Event type	Younger adults		Older adults	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Session 1				
Positive	5.08	0.94	5.41	0.94
Negative	1.13	0.60	1.43	1.21
Neutral	3.07	0.75	3.19	1.16
Session 2				
Positive	4.95	0.86	5.38	0.89
Negative	1.41	1.11	1.76	1.44
Neutral	3.33	1.26	3.01	1.71

These errors were determined by the participant's own classification of whether their written descriptions of an event listed in Session 2 referred to an event they had listed in Session 1. An independent coder also classified events as "reported" or "not reported" (error). The percentage agreement in classification was 94% for both the younger and older age groups. We used each participant's own classifications in our analyses, tabulating false recall by valence (see Table 4). These data were analyzed in a 2 (age group: younger, older) $\times$ 3 (valence: positive, negative, neutral) repeated-measures ANOVA.

A main effect of age, $F(1, 93) = 5.33, p < .05, \eta_p^2 = .05$, was qualified by an Age $\times$ Valence interaction, $F(2, 186) = 5.57, p < .01, \eta_p^2 = .06$. To understand the interaction, we examined the effect of valence separately in each age group. Younger adults showed no significant differences in memory errors across valence type, $F(2, 94) = 1.75, p = .18$. The effect of valence was significant in older adults, $F(2, 92) = 4.36, p < .05, \eta_p^2 = .09$, and simple-effects contrasts showed that they reported more erroneous positive than negative or neutral memories, $F(1, 46) = 6.26, \eta_p^2 = .12$, and $F(1, 46) = 4.95, \eta_p^2 = .10, ps < .05$, respectively. With respect to autobiographical memory, then, older participants exhibited a positivity effect in false recall but not in hits, whereas younger adults showed a positivity effect in hits but not in false recall.

Memory for Pictures

Hits. Data from 1 older and 2 younger participants were excluded from the picture analyses due to faulty computer storage and researcher errors. Descriptions of pictures were coded for accuracy with the study list by a rater blind to the age of each participant. Descriptions that did not match any of those in the study list were considered false recalls (analyzed separately below). An independent rater (blind to the age of the participants) also coded 50% of the picture descriptions for accuracy. The interrater agreement was high (96%). The accuracy coding done by the first rater on the full set of pictures was used in the analysis. An analysis of hits (see Table 5) revealed a main effect of age group, $F(1, 92) = 27.55, p < .001, \eta_p^2 = .23$, with older adults recalling a lower proportion of the pictures than younger adults did. The main effect of valence was significant, $F(2, 184) = 48.71, p < .001, \eta_p^2 = .35$, and simple-effects contrasts showed that a higher proportion of positive than negative and neutral pictures were recalled, $F(1, 92) = 5.39, \eta_p^2 = .06$, and $F(1, 92) = 109.51, \eta_p^2 = .54, ps < .05$, respectively. Participants also recalled a higher proportion of negative than neutral pictures, $F(1, 92) = 64.08, p < .001, \eta_p^2 = .41$.

Although the Age $\times$ Valence interaction was nonsignificant, $F(2, 184) = 1.19, p = .31$, we examined the effect of valence separately for younger and older adults because we had hypothesized that the magnitude of the positivity effect would be larger in older adults. For younger adults, the effect of valence was significant, $F(2, 92) = 29.39, p < .001, \eta_p^2 = .39$. Simple-effects contrasts showed that positive and negative pictures were better recalled than neutral ones, $F(1, 46) = 55.35, \eta_p^2 = .55$, and $F(1, 46) = 48.72, \eta_p^2 = .51, ps < .001$, respectively. Of particular relevance, the younger adults recalled similar proportions of positive and negative pictures, $F(1, 46) = 1.20, p = .28$. The same analysis in older adults revealed a main effect of valence, $F(2,$

Table 4
False Autobiographical Events Recalled in Session 2 and False Pictures and False Words Recalled

Task and valence	Younger adults		Older adults	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Autobiographical events				
Positive	0.35	0.56	1.09	1.25
Negative	0.58	0.87	0.62	0.95
Neutral	0.44	0.62	0.62	1.03
Pictures				
Positive	0.08	0.35	0.15	0.36
Negative	0.02	0.14	0.06	0.24
Neutral	0.25	0.48	0.40	0.64
Words				
Positive	0.54	0.74	0.96	1.25
Negative	0.60	0.76	0.52	0.77
Neutral	0.71	0.97	0.50	0.65

Note. A false autobiographical event is one that was not produced in Session 1.

92) = 20.57, $p < .001$, $\eta_p^2 = .31$. Simple-effects contrasts showed that positive and negative pictures were better recalled than neutral ones, $F(1, 46) = 54.40$, $\eta_p^2 = .54$, and $F(1, 46) = 19.04$, $\eta_p^2 = .29$, $ps < .001$, respectively. Unlike younger adults, however, older adults recalled a significantly greater proportion of positive than negative pictures, $F(1, 46) = 4.63$, $p < .05$, $\eta_p^2 = .09$.

False recall. We tabulated the total number of false pictures recalled of each valence type (see Table 4). Because the valence classification could not be verified by IAPS, two independent raters (blind to the age of the participants) classified each picture description as positive, negative, or neutral. The percentage agreement in valence classification was 84%. Disagreements were resolved by having a third rater independently classify the set of picture descriptions with conflicting classifications (8 of the 51). Final valence classification was determined by majority vote. We found a main effect of valence, $F(2, 188) = 13.21$, $p < .001$, $\eta_p^2 = .12$. Simple-effects contrasts showed that participants erroneously recalled more positive than negative pictures, $F(1, 94) = 3.85$, $p = .05$, $\eta_p^2 = .04$, and more neutral than positive, $F(1, 94) = 10.40$, $p < .01$, $\eta_p^2 = .10$, or negative pictures, $F(1, 94) = 19.22$, $p < .001$, $\eta_p^2 = .17$. No other effects or interactions were significant.

Because we had hypothesized that the effects of valence would differ with age, we examined the effect of valence separately for younger and older adults. Both age groups showed an effect of valence, $F(2, 94) = 5.94$, $\eta_p^2 = .11$ for younger adults, and $F(2, 94) = 7.36$, $\eta_p^2 = .14$, $ps < .05$, for older adults, duplicating the pattern of effects described above.

Memory for Words

Hits. The repeated-measures ANOVA revealed a main effect of age group, $F(1, 95) = 40.77$, $p < .001$, $\eta_p^2 = .30$, with younger adults recalling more words than their older counterparts, and a main effect of valence, $F(2, 190) = 3.32$, $p < .05$, $\eta_p^2 = .03$. Contrasts showed that the mean proportion of negative words recalled was significantly higher than neutral words recalled, $F(1, 95) = 6.79$, $p < .05$, $\eta_p^2 = .07$. No other effects were significant.

False recall. We tabulated the total number of words falsely recalled and classified these according to valence (see Table 4). The valence of 106 of the 188 falsely recalled words could be determined by classifications according to ANEW. For the remaining words, two independent raters (blind to the age of each participant) independently classified each word into valence category. The percentage agreement was 80%. Disagreements in valence classification were resolved by having a third rater independently classify the set of words with differing classifications. Final valence classification was determined by majority vote.

The repeated-measures ANOVA revealed a significant Age $\times$ Valence interaction, $F(2, 188) = 4.74$, $p < .05$, $\eta_p^2 = .05$. To understand the interaction, we examined the effect of valence separately in each age group. There was no effect of valence in younger adults, $F(2, 94) = 0.72$, $p = .49$. In contrast, the effect was significant in older adults, $F(2, 94) = 5.07$, $p < .05$, $\eta_p^2 = .10$. Contrasts showed that they recalled significantly more positive than neutral, $F(1, 47) = 6.98$, $p < .05$, $\eta_p^2 = .13$, or negative false words, $F(1, 47) = 5.28$, $p < .05$, $\eta_p^2 = .10$. The difference between recall of false negative and neutral words was not significant, $F(1, 47) = 0.03$, $p = .86$.

Mood

Older adults reported experiencing more positive emotion in both sessions, $t(95) = -4.00$, $p < .001$, and $t(95) = -3.78$, $p < .001$, respectively, and less negative emotion, $t(95) = 5.82$, $p < .001$, and $t(95) = 5.39$, $p < .001$, respectively, than did younger adults (see Table 1). To examine whether current mood predicted recall, we investigated the relations between scores on the PANAS-X and recollections of positive and negative information. The few significant results did not reliably support mood-dependent recall. For autobiographical memories, no significant relationships were obtained within the younger and older groups in Session 1. In Session 2, younger adults' PANAS-X negative scores correlated inversely with their recall of positive autobiographical memories ($r = -.30$, $p < .05$), a finding that is consistent with mood-dependent memory. For picture and word recall, current mood was uncorrelated with memory for positively or negatively valenced information in either group. In sum, differences in participants' current moods were largely unrelated to variations in the positivity of their recall.

Table 5
Proportion of Pictures and Words Recalled of Each Valence

Task and valence	Younger adults		Older adults	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Pictures				
Positive	.53	.18	.43	.16
Negative	.49	.20	.34	.18
Neutral	.29	.12	.22	.13
Words				
Positive	.24	.14	.10	.11
Negative	.23	.16	.15	.13
Neutral	.20	.10	.11	.09

Correlations Among Responses to the Memory Tasks

There was some evidence of consistent individual differences in recall of positive and neutral information. Collapsed across age groups, the recall of positively valenced words was correlated significantly with the recall of positively valenced pictures ($r = .24, p < .05$) and autobiographical memories in Session 2 ($r = .34, p < .001$). Similarly, the recall of neutral words was related to the recall of neutrally valenced pictures ($r = .22, p < .05$) and neutral autobiographical memories in Session 2 ($r = .37, p < .001$). However, correlations among recollections of negative words, pictures, and autobiographical memories were uniformly nonsignificant.

Discussion

Although studies of attention support the possibility of a positivity effect in cognitive processing in older adults, evidence for a corresponding bias in memory has been mixed. Some studies have found better memory of positive compared to negative or neutral valence information in older but not younger adults. Others, however, have found either no difference in memory between positive and negative information across age groups or even a negativity bias in memory performance of older adults.

In the present study, we examined whether the inconsistent support for a positivity effect could be due to the material used to assess memory in different studies. It has been suggested that the positivity effect in older adults may be limited to nonverbal material (Grühn et al., 2005), as the most consistent evidence in favor of the effect examined memory for faces or scenes (Charles et al., 2003; Mather & Carstensen, 2003; Mikels et al., 2005) rather than memory for verbal material (Grühn et al., 2005). We measured memory in each participant for word, picture, and autobiographical material with positive, negative, or neutral valences and examined biases in both accurate memories and memory errors.

When we examined accurate memories, we failed to find consistent evidence across the different types of material of a positivity effect in either age group. We hypothesized that an age-related positivity effect would occur primarily in autobiographical and picture recall, but even here the evidence was variable. With autobiographical memories, the positivity effect in older participants was present in the first session, when they were asked to produce four positive, four negative, and four neutral events from recent weeks. Older adults recalled more positive than negative or neutral events and recalled fewer negative events than did their younger counterparts. Because the target events were uncontrolled, we don't know whether performance reflects differences in life experiences or genuine memory biases; we are also unable to assess memory accuracy. Experience-sampling data on emotional experience in everyday life (Carstensen et al., 2000), however, suggests that age is unrelated to frequency of positive emotional experiences. Although we have no verification of the veridicality of the reported events in our study, our results are consistent with Kennedy et al.'s (2004) finding that nuns recalled their personal past, recorded 14 years earlier, more positively with advancing age. That study and ours thus offer support for Carstensen's (1995) theory: When participants reminisce about their own lives, older participants preferentially recall positive events.

To evaluate the veridicality of reported autobiographical events, future researchers could include more online reporting of events,

for example, daily diaries or experience-sampling procedures. Researchers could then examine whether older people report experiencing a higher proportion of positive events on a daily basis than do their younger counterparts and whether any age difference in the positivity of daily events is magnified in subsequent long-term recall of those daily experiences.

When participants were asked to recall the same autobiographical events a week later, however, the pattern of findings was quite different. Older people recalled more emotional events, positive or negative, than neutral events. Since older people appeared to have difficulty reporting negative events (in Session 1), it is possible that those they did recall in Session 2 were highly intense relative to those of younger adults. Our analysis of ratings of degree of emotionality of positive, negative, and neutral autobiographical events produced in Session 1 and recalled in Session 2, however, do not support this interpretation as there was no interaction of valence of rating with age. It is also possible that older adults' autobiographical memories were distinct in other ways from those of younger adults. The classification of events as positive, negative, or neutral does not capture differences in how events are interpreted over time. It may be that older adults are more likely to derive a positive lesson, or outcome, from an initially negative event and that this accounts for their higher than expected memory for negative events in Session 2. The current experimental design did not allow a systematic examination of this speculation. As well, other factors, such as self-relevance or distinctiveness of events reported in Session 1, were not recorded, and these may also differentiate the memories of older and younger adults and contribute to differences in retention in Session 2.

These suggestions are in line with those of Tomaszczyk, Fernandes, & MacLeod (in press). They found that older adults recalled an equal number of positive and negative pictures when the pictures were rated as high in personal relevance. We did not assess personal relevance in the autobiographical task, but it is highly likely that memories of life events are personally relevant. It may be that older adults are motivated to recall information that is negative in valence when it is personally relevant and appropriate or particularly relevant to the task. This suggestion is supported by other work in which there was no age difference in memory for highly relevant emotional information. For example, flashbulb memories for the September 11th attack were preserved in both older and younger United States citizens (Davidson, Cook, & Glisky, 2006), and older adults showed greater negative affect than did younger adults in recalling their reactions to the O. J. Simpson verdict (Alea et al., 2004).

Younger participants, who readily recalled four positive and four negative episodes from their lives in Session 1, showed a positivity effect when recalling these same episodes 1 week later in Session 2. This measure of autobiographical recall is the only assessment on which younger adults showed a positivity effect in accurate recall. Though speculative, one reason for this positivity effect may be that younger adults were motivated to focus on the emotionality of their personal memories. Task instructions were to produce the four positive, negative, and neutral events from Session 1. In other research, when younger adults were told to focus on emotional states rather than accuracy during recall, they tended to remember the past more positively (Kennedy et al., 2004; Mather & Johnson, 2000).

The findings for accurate recall of pictures support Carstensen's (1995) theory. Older participants but not younger participants recalled more positive than negative pictures, though negative pictures were still better recalled than neutral ones. These results are in line with other work in which an age-related positivity effect has been documented using scenes or faces as materials (Charles et al., 2003; Mather & Carstensen, 2003; Mikels et al., 2005). Our results differ, however, from those of Comblain et al. (2004), Denburg and colleagues (2003), and Kensinger and colleagues (2002), who did not find such an effect of better memory for positive than negative items. In the former two studies, memory was assessed following a minimum 24-hr delay rather than within the same session, as in our study and other studies in which a positivity effect has been found. It may be that introducing such a delay benefits memory for negative pictures (particularly in older adults). In line with this suggestion, other work has shown that at long delays, compared to short delays, memory for highly arousing negative words improves significantly (Kleinsmith & Kaplan, 1963). In the Kensinger et al. study, they also allowed older adults to view study items twice before testing, whereas younger adults saw items only once; this age-related variation in procedures may have prevented the positivity effect from emerging in older adults. Our design for the picture (and word) memory tasks, but not the autobiographical tasks, included twice as many neutral items (16 of them) as positive or negative ones (8 items each). Such a weighting was done to replicate the design in Charles et al.'s (2003) study, who examined memory for pictures in younger and older adults. Because we found a positivity effect in picture and autobiographical memory (Session 1), we do not believe the relative weighting of positive and negative, to neutral items, is a factor in producing the positivity effect in older adults; there was no difference in the weighting of positive over negative items, yet positive ones were better remembered in older adults.

Accurate recall of positive and negative words, however, did not differ across age groups. This finding is in line with Grühn et al. (2005) and Kensinger et al. (2002), who failed to find evidence for an Age $\times$ Valence interaction for this material. It may be that the emotion conveyed by a word is more ambiguous than that conveyed by a scene or a personal autobiographical memory in which the valence of the material is clear. For example, the word "kick" may be interpreted as positive (kick a soccer ball) or negative (kicked during an assault), depending on the context in which it is used. In addition, words in a list are likely to possess less emotional power than are pictures or personal memories. The word "smile," for example, is likely to be rated positively but would undoubtedly have less emotional strength compared to a picture of a child smiling. Such ambiguity in both valence of words and their relative lack of emotional strength may contribute to the lack of an Age $\times$ Valence interaction.

Had we assessed only accurate recall, we would have concluded that the evidence for an age-dependent positivity effect in memory was equivocal at best. However, the false memory findings offer more consistent support. On all three recall tasks, older participants recalled more false positive than false negative memories. It is perhaps especially intriguing that older adults showed a positivity effect on false recall of words. Neither we nor any previous investigator has demonstrated an age-related positivity effect in accurate word recall, leading some researchers to conclude that memory for words is impervious to such biases (Grühn et al.,

2005). Our findings suggest that the positivity effect hypothesized to characterize senior citizens is a pervasive feature of false memory. On the basis of our results, we suggest that researchers might generally obtain stronger support for Carstensen's (1995) theory by examining false rather than accurate recall.

As with accurate recall, younger adults showed a positivity effect on only one measure of false memory, though this time it was in picture rather than autobiographical recall. Previous researchers have reported positivity effects in younger adults' false recollections or reconstructions of other kinds of material, for example, academic grades (Bahrack, 1998). The results from our research reveal which measures consistently show positivity effects in older adults (false memories) but are less clear about when younger adults are likely to show such effects. There is little doubt, however, that younger adults do sometimes exhibit positivity effects, though it is not a pervasive feature of how they reconstruct their past, as it is in older adults. Further research is necessary to specify the conditions leading to such effects in young adults. On the basis of the findings of the current study, we argue that false-memory data show more consistent evidence in favor of a positivity effect in older adults than do accuracy data. We interpret this finding as suggesting that older adults reconstruct the past in such a way as to accentuate the positive, and, as others have suggested, this may reflect efforts at emotional regulation in older adults. Because younger adults can also show a positivity bias, particularly when told to focus on emotional states (Kennedy et al., 2004; Mather & Johnson, 2000), it suggests that this tendency to accentuate the positive is a by-product of a heightened awareness of one's emotional state. Older adults, unlike younger ones, seem to focus on their emotions spontaneously, whereas younger adults appear to do so with less consistency.

In testing the mood-dependent memory hypothesis, we found that older participants reported more positive moods than did their younger counterparts. Differences in mood, however, do not appear to account for age differences in memory, as the relations between mood and recall were inconsistent and small. Correlations within an individual's data in their recall of both positive and neutral valence autobiographical events, pictures, and words were significant, however. Thus there is some consistency across materials in how emotional valence affects an individual's memory, but this effect is distinct from factors influencing the positivity effect in older adults.

The major new finding in this study is that false memories exhibit biases toward positive information, particularly in older adults. To our knowledge, no other study has documented a consistent age-related positivity effect in false memories across different material types. We suggest that older people's propensity for false recall reflects efforts at emotional self-regulation. Their false memories are not haphazard. They preferentially recall positive information.

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