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Choice-Supportive Source Monitoring: Do Our Decisions Seem Better to Us as We Age?

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Participants were given several 2-option choices and then asked to review how they felt about their decisions, to review the details of their decisions, or to do an unrelated task. When later asked to attribute features to the previous options, in each condition older adults (64–83 years) attributed significantly more positive and fewer negative features to their chosen options than to foregone options. Younger adults' (18–22 years) attributions were as choice-supportive as those of older adults in the affective review condition but were less so in the other conditions. The age difference was present even when older and younger adults were equated for source identification and recognition accuracy. This study suggests that as people age, their tendency to distort memory in favor of the options they chose increases. In addition, it suggests that affectively reviewing choices increases younger adults' tendency toward choice-supportive memory.

People make choices throughout their lives. The way they remember these choices has implications for their well-being and their beliefs about themselves. For instance, remembering that the option one selected had many good features and that foregone options had many negative features should make one feel satisfied. Many studies motivated by Festinger's cognitive dissonance theory (Festinger, 1957) have demonstrated that after making a choice, people shift their attitudes to be more consistent with the decision they made (e.g., Brehm, 1956). People also seem to remember their choices in a regret-minimizing fashion (Mather, Shafir, & Johnson, 2000). That is, when asked first to choose one of two options and then later to indicate which option particular features had been associated with (or whether they were new features), younger adults tended to attribute (and misattribute) more positive features to the option they chose than to the foregone option, and they sometimes also tended to attribute (and misattribute) more negative features to the foregone option than to the option they chose. Choice-supportive asymmetries appeared not only for features that were actually associated with the options, but also sometimes appeared for new features (those that were misattributed to one of the options).

These choice-supportive asymmetries presumably reflect the constructive–reconstructive processes that are a key aspect of remembering (Bransford & Johnson, 1973; Ross, 1989). In particular, people may have the implicit theory that because one of the options was selected over the other, it probably had more positive features and fewer negative features than the other option. In any event, we expect the degree to which people show such choice-supportive asymmetries will be affected by a number of factors, including both goals and agendas and one's ability or tendency to engage in the types of reflective cognitive activities that are critical for reality monitoring and source monitoring more generally (Johnson, Hashtroudi, & Lindsay, 1993; Johnson & Raye, 1981, 1998).

There are reasons to suspect that as we age, choice-supportive source monitoring might increase. Older adults rely more than younger adults on categorical or general knowledge about an event to recognize particular elements from the event (e.g., Hess & Slaughter, 1990; Koutstaal & Schacter, 1997; Koutstaal, Schacter, Galluccio, & Stofer, 1999; Reder, Wible, & Martin, 1986). Of particular relevance is the finding that older adults rely more than younger adults on categorical or schematic knowledge when making source attributions (Mather, Johnson, & De Leonardis, 1999). Thus, older adults were more likely than younger adults to mistakenly attribute the statement, "I work out almost every day," to someone previously described as an athlete (when it actually had been said by a different speaker). In contrast, they were just as accurate as younger adults at attributing speaker-consistent statements.

A number of studies suggest that using stereotypes or general knowledge to help remember an event is less cognitively demanding than relying on other types of memorial information and thus might require less reflective activity. For example, Sherman and Bessenoff (1999) found that participants who were asked to do a second task while completing a recognition memory test were more likely to misattribute unfriendly behaviors to a skinhead than participants who were not asked to do the second task. Other studies have shown that increasing cognitive load can also lead people to recall more stereotype-consistent information relative to stereotype-inconsistent information (Macrae, Hewstone, & Griffiths, 1993) and to rely more on activated stereotypes when rating someone else's personality traits (Gilbert & Hixon, 1991). Inducing a cognitive load at encoding has similar effects—for example, participants presented with information about members of a social

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group later recalled more stereotype-consistent than stereotype-inconsistent information if the information was presented quickly (Dijksterhuis & Van Knippenberg, 1995). The pattern was reversed when the information was presented slowly. Thus, in general, remembering stereotype-inconsistent information seems to require more reflective activity, both at encoding and at retrieval.

Normal aging may be accompanied by neuropathology in frontal brain regions (e.g., Haug & Eggers, 1991; Raz, Gunning-Dixon, Head, Dupuis, & Acker, 1998; West, 1996). In the Mather et al. (1999) study, older adults who performed poorly on a battery of tests often used clinically to assess frontal function had particular difficulty correctly remembering who said speaker-inconsistent statements, in contrast with their unimpaired memory performance for speaker-consistent statements. According to the source-monitoring framework (Johnson et al., 1993; Johnson & Raye, 1998), the reflective or executive functions usually associated with frontal regions help people encode or use specific memorial attributes to make source judgments. The Mather et al. study suggests that when these frontally based functions decline, schematic information about the sources is weighted more heavily. This age-related increase in reliance on general knowledge has implications for remembering information about past decisions. If knowledge about which option was chosen is weighted more heavily in the attributions of older adults than in those of younger adults, then the older adults should show larger choice-supportive asymmetries.

Remembering a choice has many potential emotional side effects. Negative emotions such as sorrow, regret, bitterness, and disappointment, or positive emotions such as joy, satisfaction, contentment, and relief may be experienced. In general, older adults focus more on affective information and are more likely to remember emotional aspects of situations than are younger adults. For example, on a memory characteristic questionnaire, older adults rated remembered events as having more associated thoughts and feelings than did younger adults, in contrast to their lower ratings of clarity and contextual detail (Hashtroudi, Johnson, & Chrosniak, 1990). Similarly, comparing four age groups' (20–29 years, 35–45 years, 53–67 years, 70–83 years) recall of a narrative revealed that the proportion of emotional material recalled increased linearly with age (Carstensen & Turk-Charles, 1994). Older adults also seem to give greater weight to thoughts and feelings when making source attributions (Johnson & Multhaup, 1992). That is, when trying to decide whether they had imagined or actually experienced an event, older adults had a higher correlation between their confidence and their ratings of associated thoughts and feelings for that event than did younger adults.

In addition, as we age, regulating personal emotion becomes a higher priority, whereas knowledge acquisition becomes less of a powerful motive (for reviews see Blanchard-Fields, 1997; Carstensen, Isaacowitz, & Charles, 1999; Labouvie-Vief, 1997). Carstensen (1992, 1995, 1998) posits that these goals shift when time is perceived as limited, such as when facing a terminal illness, the natural end of a lifetime, graduation, or a move to a new location. For example, older adults' problem-solving style is more defensive and emotionally regulating than that of younger adults (Blanchard-Fields, Camp, & Casper Jahnke, 1995) and their style of coping with daily hassles is also more emotion focused (Folkman, Lazarus, Pimley, & Novacek, 1987). In addition, older adults' self-reports also indicate they have greater emotional control than do younger adults (Gross et al., 1997). Emotion regulation strategies may help older adults remain satisfied with their lives even as their resources (e.g., health, income, social networks) decrease. Indeed, a number of studies have found that subjective well-being does not decline with age and may even increase slightly (e.g., Argyle, 1987; Cohn, 1999; Diener & Suh, 1997; Witt, Lowe, Peek, & Curry, 1980). Older adults also report fewer experiences of negative emotions (Gross et al., 1997; Lawton, Kleban, & Dean, 1993; Lawton, Kleban, Rajagopal, & Dean, 1992). In addition, a study in which participants were paged at random times for a week to indicate what emotions they were experiencing found that the frequency and duration of positive emotions is similar across adulthood, but negative emotions decline in frequency and duration (Carstensen, Pasupathi, Mayr, & Nesselroade, in press).

These changing social–emotional goals are another reason to suspect choice-supportive source monitoring will increase with age. Remembering more positive features and fewer negative features about one's chosen option than about foregone options should help increase positive affect and decrease negative affect. Thus, if older adults are guided more by emotional goals than are younger adults, then they may remember in a more choice-supportive fashion. In turn, inducing younger adults to focus more on emotional goals should increase their choice-supportive biases in memory. (See Hashtroudi, Johnson, Vnek, & Ferguson, 1994, for an example of emotional focus increasing the similarity between younger and older participants in a memory task.)

In summary, there are several reasons to expect that choice-supportive source monitoring will be greater in older than younger adults. In addition, there is also reason to believe that younger adults' memory will be more choice supportive if they have focused on how they felt about the choice rather than on the factual details of the options. To test these hypotheses, we had older (aged 64 to 83 years) and younger (aged 18 to 26 years) adults make four different two-option choices, each composed of a list of positive and negative features. After they completed all four choices, participants' task varied by condition. In the affective review condition, they were asked to think about how they felt about each choice. In the factual review condition, they were asked to think about the details of each choice. Finally, in a control condition, they did an unrelated task. After a delay and a repetition of the directed review or control task, participants were given a source identification test that included old features from the choice scenarios and some new features.

We expected that, given the same retention interval as younger adults, older adults would have lower overall memory accuracy. In particular, because aging is associated with disproportionate difficulty with source memory (e.g., Brown, Jones, & Davis, 1995; Ferguson, Hashtroudi, & Johnson, 1992; Johnson, De Leonardis, Hashtroudi, & Ferguson, 1995; McIntyre & Craik, 1987; Schacter, Kazniak, Kihlstrom, & Valdiserri, 1991; Spencer & Raz, 1995), we expected that older adults would be less likely to accurately attribute the features to the correct option. Nevertheless, we wanted to test whether older adults' memory attributions would be more choice supportive than those of younger adults, even when their source attributions were just as accurate. In previous studies, younger adults' source accuracy after 2 days was similar to that of older adults tested within one session (e.g., Henkel, Johnson, & De

Leonardis, 1998). Thus, in addition to having a group of older adults who were equated with the younger adults for the length of the delay (they were tested after 2 days), we also had a group of older adults who were tested after a shorter delay (20 min), to equate their memory accuracy with that of the younger adults.

Method

Participants

Fifty-four younger adults who were students at Princeton (16 males and 38 females) and 108 community-dwelling older adults (54 in each of two delay conditions; 27 males and 27 females in the 30-min delay condition and 19 males and 35 females in the 2-day delay condition) participated. Younger adults' ages ranged from 18–26 years (M = 19.7 years, SD = 1.4). Older participants' ages ranged from 64–83 years in the 30-min group (M = 74.4, SD = 4.5) and from 67–83 years in the 2-day group (M = 74.6, SD = 3.9). The mean rating older participants gave for their general health on a 10-point scale (1 = *poor*, 10 = *excellent*) was 8.0 in both delay groups. Older participants had completed more years of formal education (M = 15.3, SD = 2.3) than had the younger adults (M = 14.5, SD = 1.2), $t(154) = 2.18$, $p < .05$, but among older participants, educational attainment did not significantly differ between the 30-min (M = 15.0, SD = 2.3) and the 2-day (M = 15.5, SD = 2.2) groups.

Participants completed a vocabulary subscale (maximum score = 30) of the Wechsler Adult Intelligence Scale—Revised (Wechsler, 1981). Mean scores were 20.7 (SD = 4.7), 20.9 (SD = 5.0), and 20.6 (SD = 4.4) for the younger 2-day, older 30-min, and older 2-day participants, respectively, and did not significantly differ across the groups ($F < 1$).

Within each of these three groups, 18 participants were randomly assigned to each review condition (affective, factual or no review control). All of the older adults and some of the younger adults received financial compensation for their participation. The rest of the younger adults received credit toward a course requirement.

Materials

Four 2-option choice scenarios were used. The choices were amongst (a) two houses, (b) two job candidates, (c) two airline flights, and (d) two potential blind dates (see Appendix for an example). In the house scenario, one option had 11 features and the other had 12; in the job candidate scenario one option had 7 features and the other had 9; in the airline flight scenario each option had 6 features; in the blind date scenario one option had 10 features and the other had 11. About half of the features in each option were positive (e.g., "Has been responsible for a number of successful projects" for one of the job candidates) and about half were negative (e.g., "Sometimes snaps at the people she works with" for a job candidate). Across the four scenarios, there were also a few features for which the valence was more ambiguous and thus more likely to depend on the participant's personal preferences (e.g., "Many neighbors have children" for one of the houses).

Each scenario had a separate source identification test (see Appendix for the test items from one of the scenarios). Of the 72 old features from the decision scenarios, 36 were tested on the memory test. The tests also included 56 new items. Each old or new test item was preselected to be clearly positive or negative in the context of its associated decision. In addition, as discussed later, we conducted a manipulation check that confirmed that participants agreed with our judgments about the valence of the features. Number of positive old items, negative old items, positive new items, and negative new items on the tests, respectively, for each scenario, was 8, 4, 5, and 8 for the house scenario; 8, 4, 9, and 8 for the job candidates scenario; 2, 0, 4, and 5 for the airline flight scenario; 4, 6, 6, and 11 for the blind date scenario.

Among the 56 new items, there were 22 that were not directly related to old items and 34 that could be a potential inference based on the set of old items (e.g., the test item "roof leaks" was an inference that could be made based on the old item "water stains on the ceiling on the top floor"). These two classes of new items did not differ in any interesting way, as will be apparent in the results.

Procedure

Participants first completed the vocabulary test. Subsequently, all experimental instructions and information were presented on a computer screen (using Hypercard on a Macintosh computer). Participants were asked if they felt comfortable using a computer mouse. If not, they were given a short tutorial on how to use it. Participants were told that the next task consisted of making several decisions and that for each decision they would see descriptions of two options. Four 2-option decisions were then presented, one at a time (the house decision was always first, followed by the job candidate, flight, and blind date decisions). Each decision scenario had a brief description of the decision context. For example, the following paragraph introduced the dating decision:

> Imagine that you are single and do not have the opportunity to meet many other single people. A friend of yours would like to set you up on a blind date. She has two people in mind that she would like to set you up with. However, those two people are friends with each other and your friend doesn't want to cause problems between them. Thus, she says you should pick just one that you would be interested in dating. She gives you a description of each of them. Who would you choose for a blind date?[1]

The two options were presented in adjacent boxes (whether a particular option appeared in the right-hand or left-hand box was counterbalanced across participants). Participants clicked in one of the two boxes to indicate their choice. After making all four choices, participants in the affective review condition saw instructions to think about how they felt about the two options in the house purchase decision. These instructions remained on the screen for a minute, followed by a beep, and were then repeated for each of the other decisions, in the sequence in which they had been seen. Participants in the factual review condition engaged in the same 4-min review sequence, except that they were asked to review the details of each option. In the control condition, participants engaged in a filler task for 4 min. They were given a minute to write as many words as they could by using the letters from a random letter string; after each minute ended, they heard a beep and were presented with a new letter string.

Next, all participants had 20 min to complete an unrelated drawing task (they were timed by the computer). Subsequently, they repeated their 4-min review sequence (control participants received new random letter strings for their filler task). The 2-day delay participants were then told that they were done for that session and would be doing similar tasks when they returned. When they returned 2 days later, they received the source identification test. The 30-min delay participants instead began the test phase immediately after the second review or control task in the first session. Instructions were presented separately for each decision scenario. During the test, participants were presented with one feature at a time at the top of the screen. They were asked whether the feature referred to the first option (e.g., "red brick house"), the second option (e.g., "white house built of wood"), or neither option. They indicated their source decision and rated confidence on a scale of 1 (*not at all confident*) to 5 (*extremely confident*).

As a manipulation check, after completing the tests for all four scenarios, participants were shown each feature from the memory test again and asked to rate (on a scale of -2 to 2, with 0 indicating a neutral rating) how negative or positive the feature would be in the context of making the

[1] None of the option features indicated the gender of the dating options.

decision it was associated with. For each feature, we tested whether its mean valence rating across participants differed from zero. All ratings were significantly negative for our predetermined negative items and significantly positive for our predetermined positive items (all *p*s < .001). Older 2-day and younger 2-day participants did not differ in their average ratings.[2] On average, for the negative items participants rated 75% of them as being negative (a rating of −1 or −2), 19% of them as being neutral (a rating of 0), and 5% of them as being positive (a rating of +1 or +2). For the positive items, participants rated 87% of them as being positive, 11% of them as being neutral, and 2% of them as being negative.

Finally, participants were asked to indicate which option they had previously chosen for each decision.

Approximately half of the older participants (21 affective review, 17 factual review, and 18 control participants, out of the 36 in each of the review conditions) returned for a separate session to complete a battery of neuropsychological tests (see Glisky, Polster, & Routhieaux, 1995, for details). Five tests required the type of executive or reflective processing usually associated with frontal lobe regions of the brain: the modified Wisconsin Card Sorting Test (Hart, Kwentus, Wade, & Taylor, 1988), the Controlled Oral Word Association Test (Benton & Hamsher, 1976), the Mental Arithmetic Test from the Wechsler Adult Intelligence Scale—Revised (Wechsler, 1981), and the Mental Control Test and Backward Digit Span Test from the Wechsler Memory Scale—Revised (Wechsler, 1987), and four tests required memory functions usually associated with medial-temporal or diencephalic regions of the brain: (a) Logical Memory I, (b) Verbal Paired Associates I, and (c) Visual Paired Associates II (all from the Wechsler Memory Scale—Revised; Wechsler, 1987), and (d) the Long-Delay Cued Recall measure from the California Verbal Learning Test (Delis, Kramer, Kaplan, & Ober, 1987). For older adults, these two sets of tests have been found to load onto two different factors (Glisky et al., 1995; Henkel et al., 1998), indicating that the two sets of tests measure different types of processes and that individuals with high functioning on one set of tests may not necessarily have high functioning on the other.

Table 1
Correct Source Attributions, Correct Hits to Old Items, False Alarms to New Items, and Corrected Recognition (Hits-False Alarms) for Each Condition

Memory measure and condition	Group: Younger 2-day *M*	*SE*	Older 30-min *M*	*SE*	Older 2-day *M*	*SE*
Source attributions						
Affective	.73	.03	.73	.04	.67	.03
Factual	.75	.05	.75	.03	.63	.03
Control	.71	.04	.80	.02	.64	.03
Hits to old items						
Affective	.85	.02	.87	.02	.77	.03
Factual	.83	.02	.86	.02	.81	.03
Control	.86	.02	.85	.03	.65	.04
False alarms to unrelated new items						
Affective	.13	.03	.18	.05	.35	.05
Factual	.14	.04	.20	.04	.33	.06
Control	.18	.04	.23	.04	.33	.05
False alarms to inference new items						
Affective	.50	.04	.54	.05	.56	.04
Factual	.53	.03	.52	.03	.59	.05
Control	.52	.03	.54	.04	.53	.04
Corrected recognition						
Affective	.50	.02	.47	.04	.30	.03
Factual	.45	.02	.47	.03	.32	.04
Control	.47	.03	.44	.04	.20	.04

Results

General Memory Accuracy

As can been seen in Table 1, the older 30-min group and the younger 2-day group had similar levels of memory accuracy. These scores were compared using 2 (group: younger 2-day, older 30-min) × 3 (review condition: affective, factual, control) analyses of variance (ANOVAs) separately for hits to old items (correctly calling an item old, regardless of whether the source attribution was correct), correct source attributions (the proportion of hits correctly attributed), false alarms to unrelated new items, false alarms to inference new items, and corrected recognition (hits minus proportion of false alarms to all new items). Across each of these measures, there were no significant main effects of group, all $Fs(1, 102) < 1$, main effects of review condition, all $Fs(2, 102) < 1$, or Group × Review Condition interactions, all $Fs(2, 102) < 1.16$. Thus, these two groups were equated for overall memory accuracy.[3]

Adding the older 2-day group to the previous ANOVAs revealed significant effects of group for hits, $F(2, 153) = 16.60$, $MSE = .01$, $p < .001$, source attributions, $F(2, 153) = 8.27$, $MSE = .02$, $p < .001$, false alarms to unrelated new items, $F(2, 153) = 13.88$, $MSE = .03$, $p < .001$, and corrected recognition, $F(2, 153) = 30.94$, $MSE = .02$, $p < .001$. As can be seen from the means in Table 1, the older 2-day group had poorer memory than both of the other groups for each of these measures. In addition, for hits there was a significant interaction of Group × Review condition, $F(1, 153) = 3.60$, $MSE = .01$, $p < .01$. Follow-up one-way ANOVAs run separately for each group revealed that the review condition significantly affected the number of correct hits for older 2-day participants, $F(2, 51) = 6.11$, $MSE = .02$, $p < .005$. Examining the means and their 95% confidence intervals (CIs) revealed that participants who reviewed their decisions had more correct hits ($M = .81 \pm .07$ for the factual condition and $M = .77 \pm .07$ for the affective condition) than those who did not review them ($M = .65 \pm .07$). In contrast, the review condition did not significantly affect performance for the other two groups, $F(2, 51) < 1$ for both groups (cf. Koutstaal, Schacter, Johnson, Angell, & Gross, 1998). There were no other significant effects.

Choice-Supportive Source Monitoring

Overview of analysis. To obtain a summary measure of choice-supportive memory, we calculated asymmetry scores on the basis of the method used in Mather et al. (2000). First, for each

[2] Interestingly, the older 30-min group rated negative items less negatively ($M = -.81 \pm .12$) than either the young 2-day group ($M = -1.12 \pm .12$) or the older 2-day group ($M = -1.00 \pm .12$), although the three groups rated positive features equally positively (*M*s = 1.32, 1.29, 1.31; CI = .08, for young 2-day, older 30-min, and older 2-day, respectively). This suggests that negative features of decision alternatives may seem worse with time, at least for older adults.

[3] In addition, there were no significant differences in the overall proportion of items identified as *old*.

decision scenario, we calculated how much each participant's memory attributions favored one of the options (call this Option A) by subtracting the attributed features favoring the other option (call this Option B) from those favoring A:

$$\begin{aligned}&(\text{proportion of positive features attributed to Option A}\\&+\text{proportion of negative features attributed to Option B})\\&-(\text{proportion of negative features attributed to Option A}\\&+\text{proportion of positive features attributed to Option B}).\end{aligned}$$[4]

For each scenario, we converted the resulting sums to *z* scores such that (a) across all participants the mean value was zero, and (b) a positive value indicated that participants favored Option A in their attributions relative to the mean, whereas a negative value indicated they favored Option B. Next, for participants who chose Option B, we multiplied their *z* score by -1. The resulting value provides an asymmetry score. If participants tend to make choice-supportive memory attributions, then the average asymmetry score will be positive. In contrast, if their attributions tend to favor their foregone options more than their chosen options, then the average score will be negative. If participants' decisions do not help predict their memory attributions, then the expected value for the average asymmetry score is zero.

Next, we averaged the asymmetry scores across the four decision scenarios for each participant—unless the participant had misremembered one or more of the options they had chosen, in which case we only averaged the scores for correctly remembered decisions (see later section for analyses of the misremembered decisions). In addition, because participants were tested on more items for some scenarios than others, the average was weighted by the total number of items in each scenario.

Overall asymmetry scores. Participants' weighted asymmetry scores were, on average, significantly greater than zero, $F(1, 153) = 40.93$, $MSE = .39$, $p < .001$. In addition, there were more participants with positive asymmetry scores than with negative asymmetry scores (114 vs. 48; $\chi^2 = 26.89$, $p < .001$). Thus, in general, participants' memory attributions favored their chosen options. However, in a 3 (group: younger 2-day, older 30-min, older 2-day) × 3 (review condition: affective, factual, control) ANOVA on the weighted asymmetry scores there was a main effect of group, $F(2, 153) = 3.90$, $MSE = .39$, $p < .05$. Examining the means and their 95% CIs revealed that the younger 2-day group had lower asymmetry scores ($M = .12 \pm .17$) than either the older 30-min group ($M = .41 \pm .17$) or the older 2-day group ($M = .42 \pm .17$), indicating that older participants' source attributions were more choice-supportive than those of younger adults. There were no other significant effects.[5,6]

Although the Group × Condition interaction was not reliable, we examined each group separately (see Figure 1) because, based on prior findings and the theoretical issues described in the introductory section, we were interested in the impact of emotional focus on both younger and older adults in this situation. Overall, both the older 30-min group and the older 2-day group's average asymmetry scores were significantly greater than zero, $F(1, 51) = 37.78$, $MSE = .23$, $p < .001$; $F(1, 51) = 14.68$, $MSE = .64$, $p < .001$, respectively, indicating that older adults' attributions tended to be choice supportive. One-way ANOVAs with review condition (affective, factual, control) as a factor indicated that the way that choices were reviewed did not significantly affect how choice-supportive attributions were for either the 2-day older group, $F(2, 51) = .08$, $MSE = .64$, or for the 30-min older group, $F(2, 51) = 1.08$, $MSE = .23$. In contrast, for the younger 2-day group, there was a main effect of condition, $F(1, 51) = 3.99$, $MSE = .30$, $p < .05$. Examining the means and their 95% CIs indicated that affective review participants' attributions significantly favored their chosen options ($M = .41 \pm .26$), whereas factual review ($M = .02 \pm .26$) and control ($M = -.07 \pm .26$) participants' attributions did not significantly favor either option. The overall pattern of results is also illustrated by Table 2, which shows that there were more participants with positive asymmetry scores (indicating choice-supportive memory attributions) than

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[4] For all of the analyses reported in the Results section, particular features were classified as positive or negative according to our predetermined classification (which was corroborated by participants' average ratings of those items). However, when calculating the asymmetry score, features could instead be classified as positive or negative on an individual basis for each participant, according to their rating of the item. As might be expected (because participants generally agreed which features were positive and which were negative) these two methods of classifying positive and negative features yielded the same set of significant results for the asymmetry score analyses.

[5] We also conducted some secondary analyses to see whether various item factors affected asymmetry scores: (a) Calculating asymmetry scores separately for positive and negative items revealed that, on average, attributions were choice-supportive for both positive and negative items, although, as found in Mather et al. (2000), they were more choice-supportive for positive items ($M = .32$) than for negative items ($M = .17$), $F(1, 153) = 7.64$, $MSE = .25$, $p < .01$. Item valence did not interact with participant group or condition. (b) Calculating asymmetry scores separately by item type (correctly attributed old, misattributed old, misattributed unrelated new, and misattributed inference) and including it as a factor did not reveal any significant interactions of age or condition with item type. (c) We also calculated asymmetry scores separately for each scenario. Because we could not use scenario as a within-subject factor without losing those participants who had misremembered which option they chose for at least one decision, we used 95% CIs to compare scores. Overall, participants were significantly choice-supportive for each choice, with the highest average asymmetry score for the dating scenario ($M = .41 \pm .15$), followed by the job candidate scenario ($M = .30 \pm .16$), the house scenario ($M = .26 \pm .15$), and finally the airline flight scenario ($M = .19 \pm .16$). This study was not designed to examine the effects of different types of choices on choice supportiveness; nevertheless, the fact that a choice between two hypothetical dating partners yielded more choice-supportive memory than a choice between two hypothetical airline flights suggests the possibility that choices with more emotional content may yield more choice-supportive memory. In addition, older adults had, on average, higher choice-supportive asymmetry scores for each of the scenarios than did younger adults, suggesting that the age difference in the degree of choice-supportive memory held across different types of choices. This observation was supported by the fact that in a 3 (group: younger 2-day, older 30-min, older 2-day) × 3 (review condition: affective, factual, control) × 4 (scenario: house, job candidate, flight, blind date) ANOVA with those participants who correctly remembered which options they had chosen for all four scenarios, there were no significant interactions with scenario.

[6] Adding gender as a factor to the Group × Condition ANOVA did not yield a main effect of gender, $F(1, 144) = .00$, or any significant interactions with gender, all $Fs < 1$. Thus, men and women did not significantly differ in how choice supportive their attributions were.

with negative asymmetry scores in every group except the two nonemotional review groups of younger adults.[7]

The present finding of greater choice-supportive asymmetries with affective than with factual focus in younger adults is consistent with prior research that shows that source monitoring can be influenced by emotional self-focus instructions (Johnson, Nolde, & De Leonardis, 1996; Mather et al., 1999). We should note that in previous studies (e.g., Mather et al., 2000) younger adults have shown significant choice-supportive source attributions without specific emotional focus instructions. Our main point is not that emotional focus is necessary for choice-supportive memory but rather that it can increase the likelihood of choice-supportive memory.

Asymmetry Scores for Misremembered Choices

The previous asymmetry score analyses included only data from choice scenarios for which participants correctly remembered which option they had selected. The remaining data are of particular interest, however, because they allow us to see whether people are biased in favor of what they think they chose or in favor of what they actually chose. Of 54 participants in each group, the number who misremembered at least one selection was 19 for the young 2-day delay group (overall, 9% of the choices, or 20 choices, were misremembered), 20 for the older 30-min group (12% of all choices, or 25 choices, were misremembered), and 32 for the older 2-day delay group (22% of all choices, or 47 choices, were misremembered). The number of participants who misremembered at least one choice was similar across review conditions, with 23 in the emotional review condition (13% of all choices, or 27 choices were misremembered), 23 in the factual review condition (16% of all choices, or 34 choices were misremembered), and 25 in the control condition (14% of all choices, or 31 choices were misremembered). In the following analysis, we only included participants who had misremembered one or more choices, taking a weighted average of their asymmetry scores for those choices they had misremembered. As in the previous analyses, positive scores indicate participants favor their chosen option—however, in this case, positive scores would also indicate a bias against the option they remembered choosing.

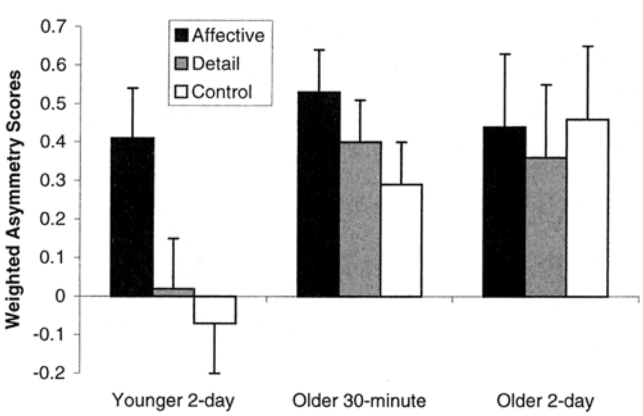

Figure 1. Asymmetry scores by review condition. Positive values indicate attributions of choice features favored chosen options instead of foregone options. Error bars show the standard error of the mean.

Table 2
Number of Participants in Each Condition With Positive Asymmetry Scores (+; Indicating Choice-Supportive Memory Attributions) Vs. Number With Negative Asymmetry Scores (−)

	Group					
	Younger 2-day		Older 30-min		Older 2-day	
Condition	+	−	+	−	+	−
Affective	16	2	15	3	16	2
Factual	9	9	13	5	12	6
Control	9	9	13	5	11	7

A 3 (group: younger 2-day, older 30-min, older 2-day) × 3 (review condition: affective, factual, control) ANOVA revealed a main effect of group, $F(2, 62) = 4.38$, $MSE = .99$, $p < .05$. The means and 95% CIs revealed that both younger ($M = -.46 \pm .46$) and older ($M = -.51 \pm .35$) 2-day groups' attributions favored their remembered choice rather than their actual choice, whereas the older 30-min group favored their actual choice (although not significantly; $M = .29 \pm .45$). This suggests that, with time, one's remembered choice becomes more likely to influence memory attributions than one's actual choice. There were no other significant effects.

Neuropsychological Correlates

To calculate a frontal battery score for each older participant who had taken the neuropsychological tests, we converted scores

[7] Across all groups, 17 participants misremembered which option they chose for two scenarios and 2 participants misremembered which option they chose for three scenarios (no one misremembered all their choices). These participants were remembering their choices at or below chance levels, and therefore might have been responding at random. To ensure that their data were not distorting the overall pattern of results, we reran the previous ANOVAs without including these 19 participants. As in the previous analysis, the 3 (group: younger 2-day, older 30-min, older 2-day) × 3 (review condition: affective, factual, control) ANOVA on the weighted asymmetry scores revealed a main effect of group, $F(2, 134) = 3.54$, $MSE = .29$, $p < .05$, with lower choice-supportive asymmetry scores for younger adults ($M = .12 \pm .15$) than for older adults in the 2-day delay group ($M = .35 \pm .16$) or 30-min delay group ($M = .38 \pm$ 16). In addition, there was a main effect of condition, $F(2, 134) = 4.49$, $MSE = .29$, $p < .05$, with affective review leading to higher choice-supportive asymmetry scores ($M = .47 \pm .15$) than either factual review ($M = .17 \pm .16$) or the no review control ($M = .20 \pm .16$). The individual ANOVAs for each group revealed a main effect of Condition for younger adults, $F(2, 50) = 3.91$, $p < .05$, with affective review leading to higher scores ($M = .41 \pm .26$) than either factual review ($M = .02 \pm .27$) or no review ($M = -.07 \pm .26$). There were no significant effects of condition for either of the older groups. Thus, these analyses revealed the same pattern of results as the analyses including all participants except for one additional significant result: Across all groups, there was a main effect of condition. As before, there was no significant interaction of Group × Condition—therefore we do not have strong evidence that older adults are affected differently by the review conditions than are younger adults. However, it is clear that the review condition affected the degree of choice supportiveness for younger adults.

on each of the five tests associated with executive processing to standardized z scores and then averaged the z scores (Glisky et al., 1995; Henkel et al., 1998; Mather et al., 1999). The same process was repeated with the four memory tests to obtain the medial-temporal score. Correlations between participants' battery scores and choice-supportive asymmetry scores were performed separately for each review condition. As can be seen in Table 3, in the control condition, older participants' frontal scores were correlated with how choice-supportive they were, with low frontal scores associated with higher choice supportiveness ($r = -.47, p < .05$). The correlations were not significant in the other two conditions. Correlations partialing out the effects of age yielded the same pattern of results, although the correlation in the control condition was only marginally significant when age was partialled out, $r = -.43, p < .09$. As also shown in Table 3, there were no significant correlations between the medial-temporal scores and choice supportiveness. This is consistent with the fact that overall memory accuracy of the experimental groups did not help predict how choice-supportive participants were (i.e., choice-supportive asymmetries did not differ for the older adult 2-day and 30-min delay groups). Thus, neither one's general ability to recall or recognize information nor one's specific recall or recognition for the target event seems to affect how choice-supportive memory attributions will be.

Confidence Ratings

One possibility is that participants were most choice supportive when they were not sure about which source a feature was associated with. To examine this possibility, we categorized each attribution as choice supportive (any positive item attributed to the chosen option or any negative feature attributed to the foregone option) or not choice supportive, and we included this variable as a factor in our analysis of confidence ratings. However, a 3 (group: younger 2-day, older 30-min, older 2-day) × 3 (review condition: affective, factual, control) × 2 (supportiveness of attribution: supporting choice, not supporting choice) × 2 (accuracy: correct attribution, incorrect attribution) ANOVA on confidence ratings did not reveal a main effect of supportiveness of attribution or any interactions with that factor. Thus, confidence did not significantly differ for attributions that supported one's choice and those that did not.

In contrast, confidence did vary with accuracy. Correctly attributed features were, on average, assigned higher confidence ratings ($M = 4.03 \pm .12$) than incorrectly attributed features ($M = 3.59 \pm .11$), $F(1, 151) = 192.69$, $MSE = .16$, $p < .001$. Reviewing choices also increased confidence: Control participants indicated less confidence in their responses ($M = 3.57 \pm .19$) than either factual review ($M = 3.99 \pm .19$) or affective review ($M = 3.87 \pm .19$) participants, as indicated by a main effect of condition, $F(2, 151) = 5.38$, $MSE = 1.87$, $p < .01$. In addition, there was a main effect of group, $F(2, 151) = 6.12$, $MSE = 1.87$, $p < .005$. Older 2-day participants were less confident in their responses ($M = 3.54 \pm .19$) than either younger 2-day participants ($M = 3.91 \pm .19$) or older 30-min participants ($M = 3.97 \pm .19$), which corresponds with their lower overall accuracy.

Table 3
Neuropsychological Battery Correlations With Choice-Supportive Asymmetry Scores (r) for Older Participants

Condition	Frontal battery	Medial-temporal battery	N
Affective	.24	.22	21
Factual	−.27	−.34	17
Control	−.47*	−.17	18

* $p < .05$.

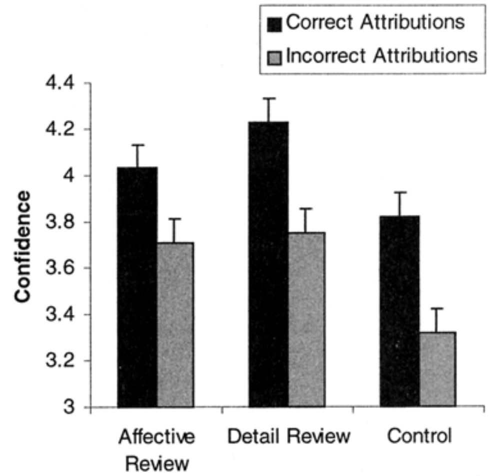

Figure 2. Confidence ratings for correct and incorrect attributions by condition. Error bars show the standard error of the mean.

As can be seen in Figure 2, participants in the affective review condition had the smallest difference in their confidence ratings for correct and incorrect attributions, which led to an interaction of accuracy and condition, $F(2, 151) = 3.13$, $MSE = .16$, $p < .05$. Thus, having thought about one's feelings about a choice can reduce how well confidence helps differentiate correct and incorrect responses. There were no other significant effects.

Decision Time

When choosing an option in the decision scenarios, participants were free to take as long as they liked. The length of time they took to make each choice was recorded. Comparing average decision times using a 3 (group: younger 2-day, older 30-min, older 2-day) × 3 (review condition: affective, factual, control) ANOVA revealed a significant main effect of group, $F(2, 153) = 27.97$, $p < .001$. Younger adults made their decisions faster ($M = 58.46$ s $\pm$ 5.30) than both older adults in the 30-min delay group ($M = 86.21$ s $\pm$ 5.30) and in the 2-day delay group ($M = 77.35$ s $\pm$ 5.30).[8]

Both older and younger adults may have taken longer to make the decisions they found difficult. One possibility (suggested by cognitive dissonance theory, e.g., Brehm, 1956; Gerard, 1967; H. J. Greenwald, 1969) is that difficult choices will lead to more

[8] The fact that older adults in the 30-min delay group were slower than those in the 2-day delay group seems to be due to an outlier in the 30-min group, who was the slowest participant in making the decisions ($M = 151.98$ s).

conflict and arousal, which will in turn produce more distortion in memory than produced by easy choices. To test this possibility, we conducted correlations between decision times and choice-supportive asymmetries separately for each decision scenario for younger adults and for older adults (we did not include participants who misremembered which option they had chosen for that decision). Difficulty in making a choice did not seem to lead to memory attributions that were more choice supportive—there was only one significant correlation and that was in the opposite direction: Older adults who took longer to decide between the two houses were less choice supportive in their source attributions than those who made the decision more quickly ($r = -.23$, $p < .05$, $N = 93$).

Discussion

Remembering that the option we chose was the better option is more emotionally gratifying than remembering that the foregone option was better. In general, memory reconstruction tends to shift memories in an emotionally gratifying and self-enhancing direction. For example, a driver explaining an accident says, "The telephone pole was approaching. I was attempting to swerve out of its way when it struck my front end." (A. G. Greenwald, 1980, p. 605). College students remembering their high school grades tend to make errors that inflate their grades (Bahrick, Hall, & Berger, 1996).

People also tend to remember their choices in a way that should minimize regret and maximize satisfaction with the chosen option (Mather et al., 2000). When presented with a positive feature and asked to make a source attribution (i.e., "Was this feature associated with Option A, Option B, or is it a new feature?"), college-aged participants were more likely to attribute (or misattribute) that feature to their chosen option than to a rejected option. In contrast, when presented with a negative feature, participants tended to be more likely to attribute (or misattribute) that feature to a rejected option than to their chosen option. Although not conducive for memory accuracy, these choice-supportive asymmetries should help people feel good about their past decisions.

The current study further suggests that whether people will reconstruct their memory of past choices in an emotionally gratifying fashion can be affected by the type of processing goals that have been activated. Often when processing information, achieving later memory accuracy is not one's most salient goal. Instead, one may be more focused on emotional dimensions, such as feelings and reactions associated with the event. In the present study, college-aged participants who had reviewed how they felt about the options were more likely to later engage in choice-supportive source monitoring than those who were asked to review the details of the options or those who were not given any review instructions. These differences in the degree of choice-supportive memory occurred even though there were no differences across the review conditions in memory accuracy for the choice features. Thus, knowing how accurately someone remembers that certain features were considered when a choice was made—or even how accurate he or she was overall at attributing features to options—is not enough to predict how choice supportive that person's memory will be. Source-monitoring distortions can be more subtle than what is revealed by an accuracy score. Two individuals could have the same overall number of correct attributions, but one person may have made their attributions in a more choice supportive way than the other person.

The impact of emotional focus on the attributions of features to choice options is generally consistent with other recently demonstrated effects of emotion on memory. Focusing on one's own reactions to what speakers are saying later leads to better memory for the content of the statements, but poorer memory for who said the statements than focusing on the speakers' feelings and reactions (Johnson et al., 1996; Mather et al., 1999). For both younger and older adults, emotional self-focus also leads to a greater reliance on general knowledge when later making source attributions (Mather et al., 1999). Memory rehearsal that focuses on how one felt about an event later leads to more recall of elaborations that were not actually part of the event (Hashtroudi et al., 1994).

With respect to choices, a recent study found that emotional processing affects how people evaluate their past choice options (Lyubomirsky & Ross, 1999). Participants' focus was manipulated after they made choices (and before they rerated them). Participants who were induced to focus on their feelings and personal characteristics subsequently rated rejected options even more negatively than before. In contrast, participants who were induced to focus on neutral information did not show any change in their ratings of the options. Thus, in addition to affecting memory (as shown in this study), emotional self-focus can also make choice-supportive attitude change more likely. Indeed, choice-supportive memory distortion may be a mechanism by which postchoice attitude change comes about (e.g., as in cognitive dissonance paradigms).

Across all conditions, older adults' choice-supportive asymmetries were about as large as those of younger adults in the affective review condition. Thus, when averaging across conditions, older adults were more choice-supportive than younger participants. This was the case even when their source identification and recognition performance were equated with that of younger adults by decreasing their retention interval. This pattern of results is consistent with findings that older adults seem to regulate their emotions better than do younger adults and express more desire to have control over their emotions (e.g., Gross et al., 1997; Lawton et al., 1992). Choice-supportive source monitoring may help avoid negative emotions such as regret or disappointment.

Research with younger adults has found that the reliance on emotional information to inform social judgments increases with the complexity and time pressures of the judgment task (see Schwarz & Clore, 1996, for a review). Knowing that you preferred your chosen option over the foregone option can be thought of as a type of affective information. Older adults whose ability to engage in complex processing is impaired may, like younger adults with limited time, rely more on their feelings as information. This possibility is supported by the fact that in the condition in which no review was specified, older adults who performed poorly on the frontal battery (tests requiring more reflective processing) were most likely to engage in choice-supportive source monitoring.

This correlation between choice-supportive memory and performance on tests that require complex reflective processing conceptually replicates Mather et al. (1999), in which older adults with low frontal battery test scores relied more on stereotypes about speakers to attribute statements to the speakers. In addition, it is consistent with a case study of a patient with frontal lobe damage (Schacter, Curran, Gallucio, Milberg, & Bates, 1996) who had high false recognition to items that were in the same category or class as actually presented items. (See Johnson, Hayes, D'Esposito, & Raye, 2000, for a review of cases of clinical confabulation resulting from brain damage and Raye, Johnson, Mitchell, Nolde, & D'Esposito, 2000.)

This study provides evidence that both emotional or motivational (e.g., the extent to which emotional goals are activated) and more strictly cognitive (e.g., the ability to engage in complex processing) factors can affect memory for choices. These factors may come into play in a number of different ways, beyond the ones explored in this study. For example, choices with a more emotionally engaging content may be more likely to be distorted in a choice-supportive fashion. People remembering choices under conditions that discourage reflective processing (e.g., while attention is divided) may engage in more choice-supportive memory distortion.

Making good decisions is important throughout our lives. There is little evidence to suggest that aging affects the quality of our judgments or decisions (Sanfrey & Hastie, in press). However, the present study suggests that perceptions of our past decisions may change as we age. Because older adults' memory for their choices was more choice supportive, they may end up more satisfied with and confident in their decisions. This increased choice-supportive bias may be part of a spectrum of strategies (both conscious and unconscious) engaged in by older adults that help regulate emotion.

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(Appendix follows)

Appendix

Home Purchase Decision

Imagine that you are planning to move to a new area of the country and have decided to buy a house. After looking at many houses and learning about the different locations you could live in, you have narrowed your choice down to two houses.

Red brick house	White house built of wood
More expensive than you would like	Asking price is within your range
Beautiful architectural details in the house	Smaller than you would like
Cathedral ceilings	Lots of sunlight
Large living room	Poor insulation
Basement leaks	Beautifully landscaped yard
Within walking distance to stores	Safe neighborhood
Driveway is shared with neighbors	Has a roach problem
Many neighbors have children	Has an old oil furnace
Newly renovated and fully equipped kitchen	Water stains on the ceiling on the top floor
Floor visibly uneven in some places	Some shingles missing from the roof
Cracks in the walls	Bedrooms are very small
	Newly refinished wood floors

Which house would you choose to buy?

1. House A (the red house)
2. House B (the white house)

Recognition test items
Positive old items
From red-brick house
Within walking distance to stores
Newly renovated and fully equipped kitchen
Beautiful architectural details in the house
Cathedral ceilings
From white house built of wood
Lots of sunlight
Beautifully landscaped yard
Safe neighborhood
Newly refinished wood floors
Negative old items
From red-brick house
Floor visibly uneven in some places
Cracks in the walls
From white house built of wood
Has a roach problem
Smaller than you would like
New items
Positive new
Plenty of electrical outlets in each room
Excellent plumbing system
Real estate in the neighborhood is expected to rise in value
Large bedrooms
Asking price seems reasonable for the house
Negative new
House has been on the market for a really long time
Only one bathroom in the house
Oil furnace needs to be replaced
Roof leaks
Costs a lot to heat the house
Yard requires a lot of maintenance
Basement has flooded before
Neighborhood tends to be noisy

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