Affective review and schema reliance in memory in older and younger adults

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Previous studies have found that, when remembering, older adults often rely more on schematic knowledge than do younger adults. We replicated this finding when participants were induced to review the facts of the event; furthermore, neuropsychological correlates suggested that this age-related increase in schema reliance is associated with declines in reflective processes. In addition, when they were induced to focus on their feelings and reactions when reviewing an event, both older and younger adults' later memory of the event was strongly affected by their schematic knowledge.

Emotional appraisals of events are an essential part of evaluating the significance of that event for well-being (Lazarus & Smith, 1988). In the process of thinking or talking about emotional reactions to a past event, however, people do more than just evaluate the impact of the event on their feelings. They also reactivate various aspects of the event in memory (Johnson, 1997). Therefore, it would not be surprising to find that an event that was emotionally reviewed is remembered better than one that was not reviewed at all. A question with perhaps more interesting implications is whether emotionally focused review of an event leads to a qualitatively different type of memory of the event than other ways of reviewing the event.

Past research indicates that schemas, goals, and objectives when reviewing an event at one point in time have an impact on how the event is remembered later, even if at the later time the focus is on being accurate (Bransford & Johnson, 1973; Higgins & Rholes, 1978; Lane, Mather, Villa, & Morita, 2001; McGregor & Holmes, 1999; Tversky & Marsh, 2000). Focusing on the emotional aspects of an event may also have specific implications for long-term memory. Focusing on feelings and reactions to an event may bring to mind salient aspects of the event but is also likely to lead to associations and related thoughts. Because an affective review may direct less attention to the event itself and may incorporate additional information, it may lead events to be remem-

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bered differently (and perhaps less accurately) than a more factually or perceptually oriented review.

Some evidence consistent with this speculation comes from a study by Hashtroudi, Johnson, Vnek, and Ferguson (1994). When older and younger adults were asked to "act" in a play by either repeating or thinking about lines of the play that the experimenter read to them, participants who subsequently reviewed how they felt about what was said (affective focus condition) later remembered less from the play than participants who reviewed the details of the play (factual focus condition) or participants who reviewed anything they chose to review about the play (control condition). In addition, participants in the affective focus condition later recalled more inferences about and elaborations of the play than participants in the other conditions. In fact, 51% of what the older adults recalled and 38% of what the younger adults recalled in the affective focus condition was nonscript elaborative information (compared with less than 30% in both other conditions). Thinking about feelings also seems to decrease the vividness of remembered perceptual aspects of the event (Hashtroudi, Johnson, & Chrosniak, 1990; Suengas & Johnson, 1988).

The combination of greater recall of inferences and elaborations and more impoverished recall of specific perceptual details after focusing on the emotional aspects of events may lead to memories that are more schema reliant—that is, more strongly influenced by the rememberer's beliefs about what happened. One study suggesting that this may be the case had older and younger participants make choices (Mather & Johnson, 2000). Each choice had two options (e.g., a choice between two job candidates), and each option had some positive and some negative features (e.g., "Seemed quite motivated," "Has little professional experience"). After making the choices, one group of participants were instructed to review how they felt about each choice, another group to review the details of the choice options, and a third to do an unrelated task. After a delay, participants were given a list of the features from the choice options mixed with some new features and asked whether the feature had been associated with the first option, the second option, or neither option.

Presumably, participants believed that the options they chose were better than the ones they did not choose. If this belief influenced memory of the choices, we would expect it to do so by increasing the number of choice-supportive attributions. That is, participants should be more likely to attribute positive features to the options they chose and negative features to the options they rejected. In fact, for younger participants, thinking about how they felt led to a greater proportion of choice-supportive memory attributions (in contrast to if they had

thought about the choice option details or not reviewed the choices at all).

Interestingly, in all the review conditions, older adults were as choice-supportive as the affectively focused younger adults. This greater impact of beliefs and schemas about the choice options on older adults' source attributions is consistent with studies that have found that older adults are more likely than younger adults to falsely recognize words semantically associated with sets of studied words (Balota et al., 1999; Kensinger & Schacter, 1999; Norman & Schacter, 1997; Tun, Wingfield, Rosen, & Blanchard, 1998; Watson, Balota, & Sergent-Marshall, 2001), to falsely recognize words highly associated with one studied word (Isingrini, Fontaine, Taconnat, & Duportal, 1995; Rankin & Kausler, 1979; Smith, 1975), to falsely recognize pictures categorically related to previously presented pictures (Koutstaal & Schacter, 1997; Koutstaal, Schacter, & Brenner, 2001; Koutstaal, Schacter, Galluccio, & Stofer, 1999; Schacter, Israel, & Racine, 1999), to be less able to discriminate old and new typical script actions than to discriminate atypical script actions (Hess, 1985; but for no age differences for typicality in script memory see Light & Anderson, 1983; Zelinski & Miura, 1988), to falsely recognize schema-consistent objects as having been in a scene (Hess & Slaughter, 1990), and to incorrectly attribute schematically related statements to a speaker associated with that schema (Mather, Johnson, & De Leonardis, 1999). Together, these studies suggest that, compared with younger adults, older adults are more influenced by their schematic knowledge when remembering.

One reason for this may be that older adults are less likely to engage in effortful, extended retrieval (Craik & McDowd, 1987; Hasher & Zacks, 1979) or evaluation processes that can help identify the origin of memories (Johnson, Hashtroudi, & Lindsay, 1993; Multhaup, 1995). The type of reflective (Johnson, 1992) or executive (Baddeley, 1995) processes needed for extended retrieval and evaluation have been associated with frontal brain regions (Craik & Grady, 2002; Johnson & Raye, 2000; Prull, Gabrieli, & Bunge, 2000; Shimamura, 1995; Stuss & Benson, 1986). Normal aging often is accompanied by neuropathology in frontal brain regions (Haug & Eggers, 1991; Raz, 2000; Raz, Gunning-Dixon, Head, Dupuis, & Acker, 1998; West, 1996). One consequence of age-related decline in reflective activity may be a greater reliance on schematic knowledge in monitoring memories (Mather et al., 1999).

Consistent with this hypothesis, Mather and Johnson (2000) found that, in their factual review and control conditions, older adults who performed poorly on a battery of neuropsychological tests associated with frontal brain region functioning were more choice-supportive (indicating they were more influenced by their schematic knowledge about

the choice options). Similarly, Mather et al. (1999) found that older adults with poorer frontal battery scores were more schema reliant when asked to attribute statements to speakers. For example, they were more likely to falsely attribute the statement "I'm pro-choice" to a speaker who had been described as a Democrat than to a speaker described as a Republican (who had actually made the statement). Also supporting this connection between frontal brain region functioning and schema reliance is 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.

The findings from Mather and Johnson (2000) suggest that, at least for younger adults, engaging in an affective focus while reviewing an event increases the influence of general knowledge and beliefs when remembering the event later. However, it is possible that the impact of affective review on memory is specific to affectively significant situations such as choices. Remembering that one's chosen option was the better option should make one feel happier with one's choice. Therefore, reviewing how one feels about a recent choice may activate emotional goals that lead to more choice-supportive biases when remembering.

In the current study, we investigated whether affective review would increase the influence of schematic knowledge on memory of an event even when there is no motivation to remember the event in a more schematic fashion. Participants read a story that included several unstated inferences. After reading the story, they were asked to review how they felt about the story, review the details of the story, or do an unrelated task. On a final memory test for the story, participants were asked whether specific statements had been part of the story. Some of the statements had been part of the story, some were the unstated inferences that had not actually been in the story, and some were new statements. False recognition of the unstated (and not necessarily true) inferences was used as a measure of the influence of schematic knowledge on memory of the story (Johnson, Bransford, & Solomon, 1973).

In short, when testing memory of past choices (Mather & Johnson, 2000) and memory of who said what (Mather et al., 1999) we found that older adults were more schema reliant than younger adults except in the emotional review condition in Mather and Johnson (2000), in which younger adults were as schema reliant as older adults. In addition, older adults' schema reliance was negatively correlated with performance on a battery of tests associated with frontal brain region functioning. We hypothesized that this pattern would be replicated in the current study, despite the fact that the type of information to be remembered (a brief story) was very different from that in our previous studies. Such

a finding would extend the generality of our conclusions about emotional review and also about the link between frontal brain region functioning and schema reliance.

EXPERIMENT

METHOD

Participants

Forty-five younger adults (17–22 years old, $M = 19$) and 56 older adults (62–85 years old, $M = 73$) participated and were randomly assigned to one of three conditions. There were no significant differences in ages between participants in the three conditions and no significant differences on the frontal or medial battery of tests (described in the *Procedure* section) for the older adults in different conditions. Older adults were screened to ensure that they did not suffer from primary degenerative brain disorders (e.g., Alzheimer's disease, Parkinson's disease) or other conditions or medications that might affect memory performance (e.g., stroke, brain trauma, chronic psychiatric illness, or psychotropic medications).[1]

Materials

We used a brief story about a grocery shopping trip containing some unstated inferences:

> I parked in the supermarket lot next to a brand new Ferrari. When I opened my car door, I discovered three $20 bills lying on the ground. I wondered if they belonged to the owner of the Ferrari. I didn't know exactly what I should do. In the meantime, I found a shopping cart.
>
> In the store, I started by going to get some milk and eggs. As usual, I opened up the egg carton to check the eggs. But somehow my hand slipped and they all fell on the floor. The manager of the store was walking by right then, so I asked her if they had a mop to clean up the mess. She said they did, that she would be right back with it. I waited for her, standing by the broken eggs on the floor. Several people passed by. The few minutes I was waiting felt like a long time. She returned and handed me the mop, saying "Here you are!"
>
> After this, I was ready to get home, so I went straight to the checkout line. As I was walking out of the store, a security guard stopped the guy in front of me and asked to check his backpack. The guy opened it up. The guard pulled out an unopened bag of chips and said, "Did you pay for these?"
>
> I walked over to my car and put the bag of groceries in the trunk. I went to open the car door to get in. Then I saw a big dent on the side of my car. I slammed the door shut and went back into the store.

On the recognition test, there were four statements from the story ("I parked in the supermarket lot next to a brand new Ferrari," "As usual, I opened up the egg carton to check the eggs," "After this, I was ready to get home, so I went straight to the checkout line," "I slammed the door shut and went back into the store") and four inference items ("I picked up three $20 bills that were lying

on the ground," "I mopped up the broken eggs as several people passed by," "The security guard said, 'You didn't pay for these!'" "I realized my car had been hit while I was in the store"). The inference items were reasonable but not necessarily true inferences based on events in the story. There were also eight new items that would make sense if they were in the story, but they were not in the story or directly implied by anything in the story. Some examples of the new items are, "It was raining hard and I didn't have an umbrella, so I ran from my car to the store," "I knew I would have nothing to eat for breakfast the next day, so I decided to take a quick trip to the grocery store," "I drove to the store in my new Honda Civic," "The man in front of me in line had a cart full of groceries."

Procedure

Before starting the first of the two experimental sessions, participants were asked whether they felt comfortable using a computer mouse. If they did not, they were given a computer-run tutorial to familiarize them with using a mouse to click on buttons on the screen. Next, they were asked to read the story on the computer screen carefully and to click on a button to indicate when they were done reading the story. After they pressed the button, instructions appeared, which varied by condition. In the affective review condition, participants were asked to think about their feelings and reactions to the story. In the factual review condition, they were asked to think about the details of the story. In the control condition, they were asked to think of as many places beginning with the letter *A* as they could and to try to remember those place names. In each condition, participants were told that the screen would remain the same for a few minutes and were asked to engage in their respective task until the current screen instructions changed.

The instructions remained on the screen for 2 min. Then participants were given the Duncker candle task (Duncker, 1945). The candle task was presented in a format modeled after Weisberg and Suls's (1973) experiment (participants were given a picture of a box of tacks, a matchbook, and a candle and were asked to draw solutions for mounting the candle on the wall). After they had completed the candle task, the participants were informed that the experiment had been about problem solving and that some participants had been primed with clues for solving the candle task in the story (all participants were told that they were in the control condition that did not receive any clues). This cover story was given so that participants in the no-review control condition would not feel it was necessary to rehearse the stories over the subsequent retention interval.

Next, all participants engaged in an unrelated experiment (in which they were exposed to and then tested on their memory of shapes and their locations) for approximately 15 min. They were then given a pen-and-paper questionnaire. If they were in the factual review condition, they were asked to describe the details of the story and then were informed that next week they would be asked about the details of the story and that they should try to think about the details over the next week. If they were in the affective review condition, they were asked to describe their feelings about and reactions to the story and then were

informed that next week they would be asked about their feelings and reactions and that they should try to think about them over the next week. If they were in the control condition, they were asked to list all the places they had thought of earlier in the session beginning with the letter *A*.

When participants returned the next week, they were given a second copy of the same questionnaire to provide another review opportunity. Then participants did an unrelated experiment for approximately 30 min. At this point, they were given a final recall test, in which everyone was asked to describe the details of the two stories. On this final recall, accurate recall of details was emphasized for all conditions. Finally, participants were given a recognition test in which they were given 12 statements (four inference items, four old, and eight new, randomly intermixed) and were asked to decide whether each statement had been in the story and to rate their confidence for their response on a five-point scale.

Forty-eight of the older participants also returned for a separate session to complete a battery of neuropsychological tests (see Glisky, Polster, & Routhieaux, 1995, for details) that included tests used clinically to evaluate frontal lobe and medial temporal lobe functioning. Frontal measures were 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 (WAIS; Wechsler, 1981), and the Mental Control Test and Backward Digit Span Test from the Wechsler Memory Scale—Revised (Wechsler, 1987). Medial temporal measures were Logical Memory I, Verbal Paired Associates I, and Visual Paired Associates II (all from the Wechsler Memory Scale—Revised) and the Long-Delay Cued Recall measure from the California Verbal Learning Test (Delis, Kramer, Kaplan, & Ober, 1987).

RESULTS

Recall

The story was divided into 103 idea units (phrases or elements such as "As I was walking out," "a security guard," "a big dent"), and each idea unit was scored as having been recalled if the participant conveyed the same general meaning. The inference items were included in the scoring protocol as idea units that could be recalled as well but were analyzed separately from the correctly recalled items. In addition, the number of elaborations each participant made and the number of items they recalled incorrectly (e.g., recalling a Porsche instead of a Ferrari) were recorded. One rater, blind to condition, scored the final recall protocol for each participant. To obtain a measure of interrater reliability, a second rater, also blind to condition, scored 53 of the final recall protocols. When checking reliability, we included only the subset of idea units for each participant that at least one scorer had scored as having been recalled (including the additional clearly nonrecalled idea units

would have led to much higher reliability estimates). Across participants, if one scorer scored an idea unit as having been recalled, there was 72.4% chance that the other scorer would also have scored it as having been recalled. In addition, correlations between the two scorers were $r = .75$ ($p < .001$) for the number of elaborations counted and $r = .75$ ($p < .001$) for the number of errors counted.

Participants in the three conditions were compared for their recall of the story on the final questionnaire, using a 2 (age: younger, older) × 3 (condition: affective review, factual review, no review) ANOVA on the number of idea units correctly recalled (see Table 1 for means). There was a main effect of age, with older adults recalling less of the story, $F(1, 95) = 17.22$, $MSE = 120.57$, $p < .001$. In addition, there was a main effect of condition, $F(1, 95) = 53.75$, $MSE = 120.57$, $p < .001$. Inspection of the means and 95% confidence intervals indicated that all three conditions were significantly different from each other. As expected, factual review led to the most idea units recalled, $M = 32.91 \pm 3.79$, and no review to the least idea units recalled, $M = 5.26 \pm 3.77$. Recall after affective review fell between the other two conditions, $M = 17.13 \pm 3.87$. The interaction between age and condition was not significant, $F < 1$. The percentage of participants in each condition who did not recall any idea units at all from the story is displayed in Table 2. Most participants remembered at least one idea unit. However, in the no-review condition, 89% (16 out of 18) of the older adults did not recall any idea units at all. Thus, in the absence of any structured rehearsal opportunities or retrieval cues, older adults tended to be unable to recall anything about the story after 2 days.

Among the participants who recalled at least one idea unit, we analyzed what proportion of the idea units recalled were not actually from the story but instead were one of the four inference items. A 2 (age: younger, older) × 3 (condition: affective review, factual review, no review) ANOVA revealed a main effect of condition, $F(2, 74) = 4.10$, $MSE = 5.66$, $p < .05$, with affective review leading to a larger proportion of inference items spontaneously recalled, $M = .08 \pm .03$, than factual review, $M = .03 \pm .04$, or no review, $M = .03 \pm .04$. There was no main effect of age or interaction of age and condition. Repeating this ANOVA with elaborations revealed that no review led to a higher proportion of elabora-

Table 1. Average number of items correctly recalled

Group	Condition		
	Affective review	Factual review	No review
Younger	21.00 (2.67)	38.87 (3.23)	9.13 (3.32)
Older	13.26 (2.51)	26.95 (2.91)	1.39 (0.96)

Note. Standard errors are in parentheses after each mean.

Table 2. Percentage of participants who did not recall anything from the story in each condition

Group	Condition		
	Affective review	Factual review	No review
Younger	0% (0/14)	0% (0/15)	25% (4/16)
Older	26% (5/19)	5% (1/19)	89% (16/18)

tions, $M = .35 \pm .11$, than affective review, $M = .09 \pm .08$, or factual review, $M = .05 \pm .07$, $F(2, 74) = 11.44$, $MSE = .04$, $p < .001$. In addition, older adults' recall consisted of a higher proportion of elaborations, $M = .22 \pm .08$, than younger adults' recall, $M = .12 \pm .06$, $F(1, 74) = 3.92$, $MSE = .04$, $p = .05$. The interaction of age and condition was not significant. Finally, in a third ANOVA we found that the proportion of recall that consisted of errors varied by condition, $F(2, 74) = 4.64$, $MSE = .03$, $p < .05$. A higher proportion of recalled idea units were errors in the no-review condition, $M = .17 \pm .08$, than in the affective review condition, $M = .03 \pm .06$, or the factual review condition, $M = .03 \pm .06$. There were no other significant effects.[2]

Recognition

The proportion of old items, new items, and inference items identified as old are presented in Table 3. From these data, we calculated corrected recognition scores (the proportion of old items identified as old minus the proportion of new items identified as old) and schema reliance scores (the proportion of inference items identified as old minus the proportion of new items identified as old) for each participant (these scores are displayed in Figure 1). The corrected recognition scores indicate overall accuracy, whereas the schema reliance scores

Table 3. Proportion of old items, new items, and inference items identified as old

Item type	Condition		
	Affective review	Factual review	No review
Younger			
Old	.71 (.08)	.72 (.07)	.77 (.05)
New	.10 (.04)	.03 (.01)	.21 (.04)
Inference	.59 (.06)	.22 (.06)	.56 (.07)
Older			
Old	.58 (.06)	.62 (.06)	.54 (.07)
New	.14 (.04)	.07 (.03)	.35 (.05)
Inference	.53 (.07)	.43 (.06)	.54 (.08)

Note. Standard errors are in parentheses after each mean.

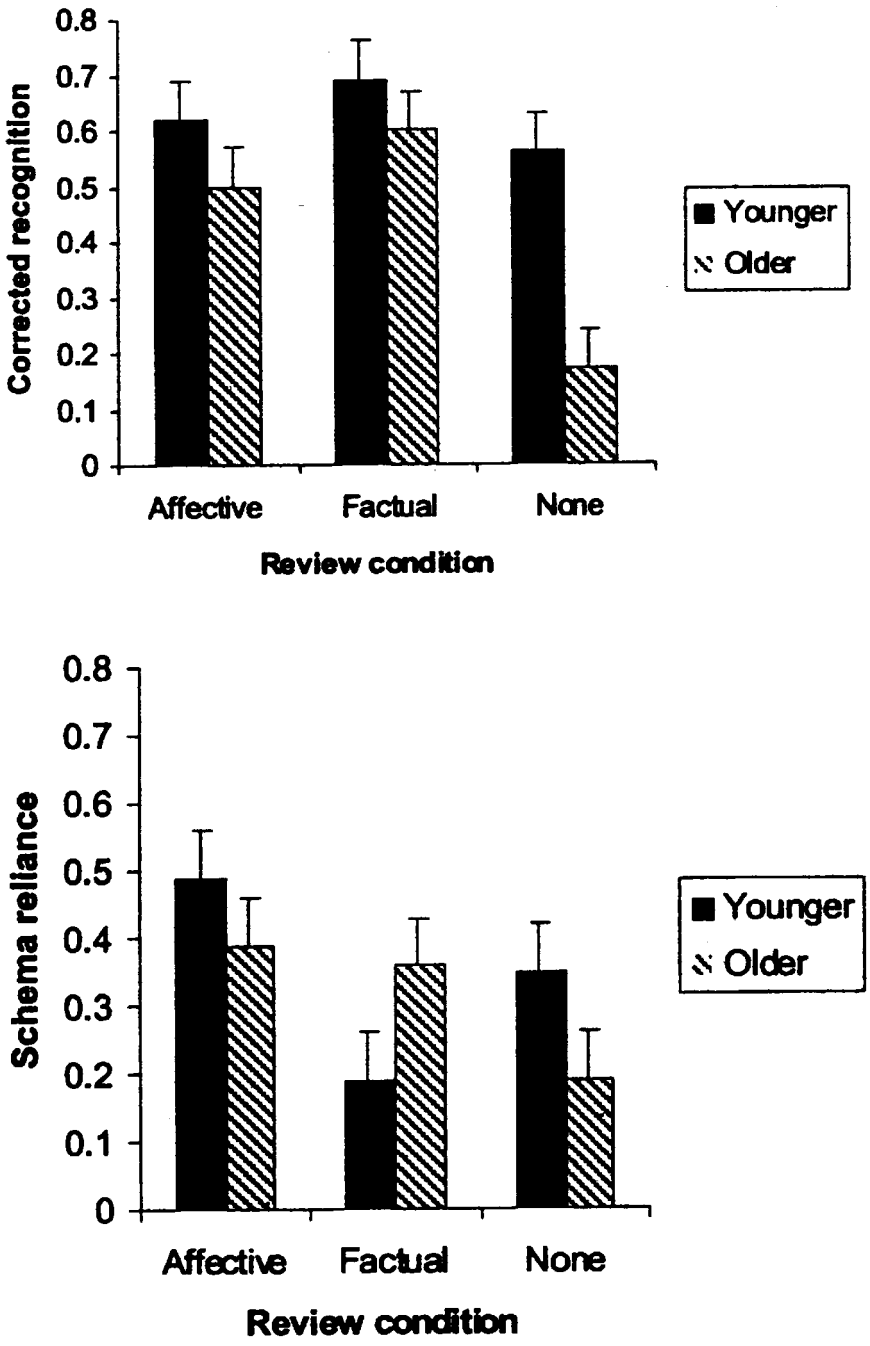

Figure 1. *Top,* Corrected recognition (hits to old items – false alarms to noninference new items) for younger and older adults in the affective, factual, and no-review conditions. *Bottom,* Schema reliance (false alarms to inference items – false alarms to noninference new items) for younger and older adults in the affective, factual, and no-review conditions.

indicate how much participants were relying on their schematic knowledge when making recognition judgments.

Consistent with the recall findings, a 2 (age: younger, older) × 3 (condition: affective review, factual review, no review) ANOVA revealed that younger adults had better corrected recognition, $M = .62 \pm .08$, than did older adults, $M = .39 \pm .08$, $F(1, 95) = 17.16$, $MSE = .08$, $p < .001$, and that the review conditions affected accuracy, $F(2, 95) = 6.63$, $MSE = .08$, $p < .01$. Factual review, $M = .62 \pm .10$, and affective review, $M = .52 \pm .10$, led to better accuracy than no review, $M = .37 \pm .10$. The interaction of age and condition was not significant, $F(2, 95) = 1.47$.

For the schema reliance measure, a 2 (age: younger, older) × 3 (condition: affective review, factual review, no review) ANOVA revealed a main effect of condition, $F(2, 95) = 3.48$, $MSE = .07$, $p < .05$. Inspection of the means and 95% confidence intervals revealed that affective review participants were more likely to rely on their schematic knowledge in making recognition judgments, $M = .43 \pm .10$, than either factual review participants, $M = .28 \pm .09$, or no-review participants, $M = .27 \pm .09$. Overall, younger and older adults' schema reliance did not significantly differ, $F(1, 95) = .57$. However, there was a significant interaction of age and condition, $F(2, 95) = 3.52$, $MSE = .07$, $p < .05$. In the affective review condition, both older and younger adults had high schema reliance, $M = .36 \pm .12$ and $M = .49 \pm .15$, respectively. In contrast, in the factual review condition, older adults had higher schema reliance than younger adults, $M = .36 \pm .13$ and $M = .19 \pm .14$, respectively. Finally, in the no-review condition, older adults had lower schema reliance than younger adults, $M = .19 \pm .13$ and $M = .35 \pm .14$, respectively.

Confidence

Average confidence ratings for correctly and incorrectly attributed items were compared separately for old, new, and inference items using a 2 (age: younger, older) × 3 (condition: no review, affective review, factual review) × 2 (response type: correct, incorrect) ANOVA for each type of item. Means and standard errors are displayed in Table 4. If participants did not answer any items of a particular type correctly or did not answer any incorrectly, they were not included in that analysis. For both old, $F(2, 70) = 5.04$, $MSE = 1.54$, $p < .01$, and new, $F(2, 49) = 8.33$, $MSE = 1.37$, $p < .01$, items, there were main effects of condition, with participants in the no-review condition reporting lower confidence on average than participants in the other two conditions. There was also a main effect of response type for new items, $F(1, 49) = 4.46$, $MSE = .51$, $p < .05$, which indicated that correctly rejected items were given higher confidence ratings than incorrectly attributed items. In contrast, for inference items, a significant main effect of response type, $F(1, 71) =$

Table 4. Confidence ratings compared for correct and incorrect responses and number of participants, with both correct and incorrect responses in each category collapsed across review condition

	Younger adults' confidence ratings			Older adults' confidence ratings		
	N	Correct responses	Incorrect responses	*N*	Correct responses	Incorrect responses
Old items	30	3.67 (.19)	3.11 (.20)	46	3.35 (.15)	3.49 (.16)
New items	23	3.75 (.23)	2.94 (.25)	32	3.21 (.17)	3.30 (.19)
Inference items	33	3.57 (.21)	3.96 (.14)	44	3.26 (.18)	3.83 (.12)

Note. Standard errors are in parentheses after each mean.

9.97, $MSE = .86$, $p < .01$, indicated that inferences incorrectly recognized as being part of the story were given higher confidence ratings than inferences correctly identified as new. This is a striking example of how convincing false memories based on schematic knowledge can be.

An intriguing finding is that for both old, $F(1, 70) = 7.00$, $MSE = .66$, $p < .05$, and new items, $F(1, 49) = 4.56$, $MSE = .51$, $p < .01$, there was an interaction of age and response type (see Table 4 for the means corresponding with this interaction and their corresponding *N*s). When younger adults correctly attributed old or new items, they gave significantly higher confidence ratings than when they incorrectly attributed old or new items. In contrast, for old and new items, older adults' confidence ratings did not differentiate correct and incorrect responses. This pattern suggests that memory confidence may be a poorer indicator of actual accuracy for older adults than for younger adults (see also Mather et al., 1999; Mitchell, Johnson, & Mather, in press). There were no other significant effects.

Neuropsychological correlates

Neuropsychological test scores were converted to standardized *z* scores for each of the older participants who had completed the frontal battery. The *z* scores for the five tests associated with a frontal factor were averaged to obtain the frontal score, and the *z* scores from the four tests associated with a medial-temporal factor were averaged to obtain the medial temporal score (Glisky et al., 1995; Henkel, Johnson, & De Leonardis, 1998; Mather & Johnson, 2000; Rubin, Van Petten, Glisky, & Newberg, 1999). Frontal and medial temporal scores did not significantly correlate with each other.

Correlations between older participants' neuropsychological scores and their memory performance were performed separately for each review condition, partialling out the effects of age. As shown in Table 5, participants in all three conditions had positive correlations between

Table 5. Correlations between neuropsychological test scores and memory performance of older adults with age partialled out

	Frontal battery	Medial temporal battery
Affective review condition (n = 14)		
Corrected recognition	.25	.65*
Schema reliance	.19	.51
Factual review condition (n = 16)		
Corrected recognition	−.09	.35
Schema reliance	−.55*	−.07
No-review condition (n = 17)		
Corrected recognition	.32	.27
Schema reliance	.25	.12

Note. Corrected recognition = proportion of correctly identified old items − proportion of false alarms to new items; schema reliance = proportion of false alarms to inference statements − proportion of false alarms to new statements.

*$p < .05$.

their medial temporal scores and their corrected recognition performance (although the correlation was significant only in the affective review condition, $r = .65$, $p < .05$). Thus, as expected, participants with higher scores on the medial temporal battery were better at recognizing which statements had been in the story. In addition, there was a negative correlation between frontal scores and schema reliance in the factual review condition ($r = -.55$, $p < .05$),[3] the condition in which older adults were more schema reliant than younger adults. That is, among older adults, those who performed well on the frontal battery had memory judgments that were less influenced by schematic knowledge.

DISCUSSION

Emotional review and schema reliance

Reviewing one's own feelings and reactions after reading a story increased how much schematic knowledge influenced later memory of the story. When averaging across older and younger adults' performance, schema reliance was greater in the affective review condition than in either the factual review condition or the no-review condition. This higher false memory rate for inference items in the affective review condition was reflected in both free recall and recognition memory. An affective review emphasizes connections between central aspects of an event and one's own reactions to the event and may encourage generation of associations and elaborations (Hashtroudi et al., 1994). We hypothesize that it is this combination of a few well-remembered cen-

tral aspects of the event, a higher incidence of elaborations that might be confused with the event itself, and poorer memory of specific details associated with the event that sets the stage for misattributions based on schematic knowledge. Inferences and elaborations may seem no less vivid than actual details of the event; this, in combination with the high coherence and plausibility of these inferences and elaborations, fosters false memories (Johnson & Raye, 1981, 2000).

We have only begun to assess the impact on memory of emotional review. Various types of emotions may have specific effects on memory rehearsal. Inducing an unhappy mood before experiencing an event decreases later memory of the event (Ellis, Moore, Varner, Ottaway, & Becker, 1997; Seibert & Ellis, 1991). Of particular interest is the fact that this decrease is associated with an increase in irrelevant thoughts during the unhappy mood. For unhappy participants, self-focused rumination after seeing a list of words is particularly detrimental to their later memory of the words (Hertel, 1998). Thus, the type of emotional self-focus associated with feeling sad can lead to an overall decrease in memory accuracy. Extrapolating from our results, we expect self-focused rumination associated with an unhappy mood to also lead to a greater reliance on schematic knowledge when remembering.

Aging and schema reliance

As noted at the beginning of this article, a number of studies have found that older adults are more likely than younger adults to falsely recognize information schematically associated with an event as having been part of the event (Balota et al., 1999; Hess, 1985; Hess & Slaughter, 1990; Kensinger & Schacter, 1999; Koutstaal & Schacter, 1997; Koutstaal et al., 1999; Norman & Schacter, 1997; Schacter et al., 1999; Tun et al., 1998). For example, after viewing a series of pictures of objects from several categories, older participants were more likely than younger participants to falsely recognize new pictures associated with a studied category (Koutstaal & Schacter, 1997).

In the current experiment, there was no main effect of age on schema reliance. Instead, there was an interaction of age and review condition. Without a structured review opportunity, older adults had lower corrected recognition and were less schema reliant, suggesting that they remembered so little about the story that they did not even have access to schematic knowledge about the story (their poor memory of the story was also reflected in their extremely low free recall scores for the story). In fact, older adults' performance in the no-review condition resembled that of amnesics tested after a much shorter delay (Schacter, Verfaellie, & Anes, 1997; Schacter, Verfaellie, & Pradere, 1996). Amnesics are less likely than controls to falsely recognize lure items related

to a set of previously presented items, presumably because of their poorer encoding and retrieval of the information that activates schematic knowledge.

Nevertheless, the extent of schema reliance cannot simply be predicted by recognition memory accuracy, as demonstrated by the affective and the factual review conditions (which have similar patterns of age differences in recognition accuracy but very different patterns for schema reliance, as displayed in Figure 1). With an affective review, the corrected recognition of the older adults was better than it was without any review, but the cost was an increase in schema reliance (as it was for younger adults also). The condition that most distinguished older and younger adults in this study was the factual review, in which, relative to no review, both younger and older adults had higher corrected recognition but only younger adults were less schema reliant than in other conditions.

In the factual review condition, the one condition in which older adults were more schema reliant than younger adults, older adults' performance on a battery of tests assessing the types of reflective processes associated with frontal brain region functioning helped to predict their schema reliance scores.[4] Low scores on the frontal battery were associated with greater schema reliance. This association between older adults' schema reliance and their performance on the frontal battery has now been found across three different types of memory tasks (the current study, Mather & Johnson, 2000, and Mather et al., 1999). A number of studies investigating the influence of stereotypes on memory have found that remembering stereotype-inconsistent information is more cognitively demanding than remembering stereotype-consistent information (Dijksterhuis & Van Knippenberg, 1995; Gilbert & Hixon, 1991; Macrae, Hewstone, & Griffiths, 1993; Macrae, Milne, & Bodenhausen, 1994; Sherman & Bessenoff, 1999). For example, in conditions in which younger adults' executive functioning is disrupted, they are less likely to remember stereotype-inconsistent information than when nonexecutive cognitive operations were disrupted (Macrae, Bodenhausen, Schloerscheidt, & Milne, 1999). The correlation between frontal battery scores and schema reliance in our study suggests that there are individual differences in how likely people are to be influenced by their general knowledge about an event when remembering it and that these individual differences are associated with age-related changes in reflective processes supported by frontal brain regions.

The fact that younger adults in the affective review condition were also highly reliant on their schematic knowledge (both in the current study and in Mather & Johnson, 2000) suggests that age-related frontal dysfunction is not the only individual difference that helps predict sche-

ma reliance in memory. One possibility is that people who spend more time thinking about their reactions to past events may tend to have more schematic memories in general. This category may include anxious people (Johnson, 1999) and, as suggested earlier, depressed people. In addition, there is reason to believe that older adults are more likely to spend time thinking about feelings and reactions than younger adults. In later years, emotional goals become more salient (Carstensen, Isaacowitz, & Charles, 1999). Thus, in settings in which the rehearsal focus is not explicitly manipulated, older adults may be more naturally inclined to engage in an emotional review of events than younger adults (Hashtroudi et al., 1994; Mather, in press).

Conclusions

Reviewing feelings and reactions associated with an event is one way to rehearse the event. Whether the affective review occurs as an internal rumination or is part of a conversation with others about the event, it is likely to have an impact on the way the event is remembered later (Pasupathi, 2001; Suengas & Johnson, 1988). In particular, the current findings suggest that, for both older and younger adults, thinking or talking about one's feelings about an event leads the event to be remembered in a more schematic fashion later, presumably because the information that is activated during emotional self-focus compared with factual focus is less likely to be specific details associated with the event. In addition, this study suggests that in other contexts in which older adults are more schema reliant than younger adults, the degree to which they are influenced by their general knowledge may be associated with their ability to engage in the type of complex reflective processes needed both for encoding events (e.g., associating or binding features together; Mitchell, Johnson, Raye, & D'Esposito, 2000; Prabhakaran, Narayanan, Zhao, & Gabrieli, 2000) and for extended retrieval and evaluation of mental experiences (Johnson & Raye, 2000; Raye, Johnson, Mitchell, Nolde, & D'Esposito, 2000).

Notes

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1. Thirty younger participants completed a vocabulary subscale (maximum score = 30) of the Wechsler Adult Intelligence Scale—Revised (WAIS; Wechsler, 1981). Because of experimenter error, we did not collect WAIS scores for the older participants or for the rest of the younger participants. However, we did have scores for seven of the older adults who had participated in an experiment previously in our lab. The scores for these younger, $M = 23.08$, $SD = 3.70$, and older adults, $M = 22.86$, $SD = 2.06$, were not significantly different, $t(35) = .16$. In addition, we know from previous experiments using participants from the same populations that the older and younger adults typically have similar WAIS scores.

2. We also had scorers count the number of emotional reactions included in participants' recall. However, the number of personal and characters' emotional reactions was quite low (1% of total recall across participants) and insufficient for comparing across groups.

3. One factual review participant was an outlier on the schema reliance measure, with a score of 1 (in contrast to the other factual review participants' scores, which ranged from 0 to .5). Recalculating the partial correlation without this outlier did not reduce the correlation between schema reliance and the frontal battery, $r = -.62$, $p < .05$.

4. In Mather and Johnson (2000) and Mather et al. (1999) as well as this study, there was a nonsignificant correlation between frontal battery scores and schema reliance in emotional self-focus conditions, despite the fact that schema reliance is quite high in emotional self-focus conditions. One possibility is that participants with high frontal scores are more likely to follow instructions and engage in the requested emotional review and thus be more likely to be schema reliant. Therefore, relative to low scorers, high scorers on the frontal battery might be led to be more schema reliant when instructed to think about their feelings and less schema reliant when instructed to think about factual aspects of the story.

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