Published in final edited form as:

Psychol Aging. 2013 June ; 28(2): 457–466. doi:10.1037/a0032732.

Impaired Retrieval Monitoring for Past and Future Autobiographical Events in Older Adults

Ian M. McDonough and

School of Behavioral and Brain Sciences, Center for Vital Longevity, University of Texas at Dallas

David A. Gallo

Department of Psychology, Center for Cognitive and Social Neuroscience, University of Chicago

Abstract

Older adults are more likely than younger adults to confuse real and imagined events in episodic memory. This deficit may be attributed to a reduction in the specific features available for recollection (i.e. retrieval success) or to a deficit in the search and decision processes operating during recollection attempts (i.e. retrieval monitoring). The present experiments used a two-phase event-generation task to manipulate retrieval success and test for age-related deficits in retrieval monitoring. In the first phase, participants generated real autobiographical events from their past and imagined plausible future events in response to cue words. We used elaboration instructions to experimentally manipulate the amount of features associated with these generated events. In the second phase administered 24 hours later, we gave recollection tests that required participants to discriminate between these previously generated past and future events in memory. As predicted, the elaboration manipulation increased the amount of features that could be recollected in association with the generated events in both age groups (including cognitive operations in Experiment 1 and perceptual details in Experiment 2). However, older adults were more likely than younger adults to confuse past and future events in memory, and critically, elaboration did not minimize these age-related confusions. These findings imply that aging impairs the ability to accurately monitor retrieval for features that are characteristic of autobiographical events, above and beyond age-related impairments in the retrieval of the recollected information itself.

Keywords

aging; autobiographical memory; reality monitoring; memory retrieval; retrieval monitoring

Accurately remembering the past requires distinguishing between events that actually happened and those that we only imagined or planned (see Johnson & Raye, 1981; Mitchell & Johnson, 2009). This ability involves the successful retrieval of features associated with prior events (i.e., retrieval success), as well as use of search and decision processes to retrieve this information from memory and evaluate its accuracy (i.e., retrieval monitoring). A deficit in either of these processes might increase memory confusions with aging, with important consequences for the daily lives of the elderly. For instance, older adults have been found to omit taking their medications, possibly because they thought they had already done so (for review, see Park & Kidder, 1996). An important goal of aging research is to

Correspondence concerning this article should be addressed to Ian M. McDonough, Center for Vital Longevity, University of Texas at Dallas, 1600 Viceroy Dr., Suite 800, Dallas, TX 75235. Contact: ian.mcdonough@gmail.com.

Aspects of these data were presented at the 83rd Annual Meeting of the Midwestern Psychological Association (2011, Chicago, Illinois). We thank Melissa Mongrella, Alex Anneken, Amy Bolin, and Eneida Revueltas for assistance in collecting data.

understand the mechanisms underlying these memory confusions and the conditions that can reduce them, both in laboratory tasks and in everyday life.

Compared with stimuli used in standard laboratory experiments (e.g., words and pictures), autobiographical memories formed in daily life often are more personally significant, contain richer features, and can have different neural signatures (Hassabis, Kumaran, & Maguire, 2007; McDermott, Szpunar, & Christ, 2009). The complexity of these features is a key factor to retrieval monitoring in real-life settings, as when people need to differentiate between events that are real (e.g., remembering the past) and those that are only imagined (e.g., daydreaming or planning for the future). Along these lines, recent studies probing the content of autobiographical memories have focused on the types of features that characterize real events occurring in the past as well as imagined events that might occur in the future. Past events contain many features having to do with one's perceptions (what one saw, heard, etc.), contextual information (spatial or temporal), and the feelings of reliving the event (Berntsen & Jacobsen, 2008; D'Argembeau & Van der Linden, 2004; McDonough & Gallo, 2010; Szpunar & McDermott, 2008). In contrast, imagined-future events contain many features regarding the thoughts and reasoning processes (cognitive operations), as well as feelings of emotion and of importance (Addis, Wong, & Schacter, 2008; D'Argembeau & Van der Linden, 2004; Hassabis et al., 2007; McDonough & Gallo, 2010). Importantly, these different kinds of recollected features occur to some extent in both past and imagined events, so that people must often engage in retrieval monitoring to successfully distinguish one kind of event from another in memory.

Research suggests that older adults retrieve fewer specific features associated with autobiographical memories than younger adults (i.e. reduced retrieval success). A popular method to measure the amount of features in autobiographical memories is the autobiographical interview (Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002). In Levine et al. (2002), younger and older adults were asked to retrieve past memories from various time periods. Those memories were then rated by the experimenters for the amount of specific episodic information (across various types of features) and more general semantic information. Levine et al. (2002) found that older adults recalled less episodic information compared with younger adults, but reported more semantic information (see also, Piolino, Desgranges, Benali, & Eustache, 2002). In another study, Addis et al. (2008) replicated this finding and extended it to imagined-future events. Older adults retrieved less episodic information and more semantic information for both real-past and imagined-future events compared with younger adults. These results from the autobiographical interview suggest that aging impairs the amount of episodic information in both real-past events and imagined-future events.

Age-related deficits in retrieval success could impact the ability of older adults to discriminate between past and future events in autobiographical memory. For example, in a study by Gallo, Korthauer, McDonough, Salom, and Johnson (2011), younger and older adults generated real past events and imagined-future events in response to cue words. Consistent with research using the autobiographical interview, analyses of these generated events indicated that older adults generated fewer specific features for both past events and imagined-future events compared with younger adults, demonstrating reduced retrieval success. Critically, after this initial generation phase participants were given a source memory test, whereby they were represented with each cue word and needed to recollect whether it had previously been associated with a past event or an imagined-future event. It was found that older adults were impaired at distinguishing between past and imagined-future events on this subsequent source memory test, often confusing the source of studied events (e.g., a source misattribution). These results are consistent with the idea that age-related impairments in retrieval success can enhance confusions between past and future

autobiographical events. However, aging also might have impaired retrieval monitoring on the source memory test, or the strategic search and decision processes operating on retrieved features (cf, Henkel, Johnson, and De Leonardis, 1998). In general, impairments on traditional source memory tests can be due to reduced retrieval success, reduced retrieval monitoring, or some combination of both.

To our knowledge, no study has attempted to investigate whether age-related deficits in retrieval monitoring processes could reduce discrimination between past and imagined-future autobiographical events in memory, above and beyond age-related deficits in retrieval success. Nevertheless, studies with other complex materials have found that age differences in source memory accuracy can be reduced by providing guidance at retrieval, potentially by facilitating retrieval monitoring processes. In a study conducted by Thomas and Bulevich (2006), younger and older adults performed and imagined performing various actions, and on a later source memory test were either given standard retrieval instructions or guided instructions to use perceptual and contextual details to inform their decisions. Thomas and Bulevich found that older adults benefitted from this guidance to a greater extent than younger adults, as evidenced by a reduction in their source memory confusions. These authors concluded that older adults were able to retrieve relevant features (e.g., perceptual and contextual details), and the additional guidance allowed them to better use those features to appropriately monitor the correct source of the event (see also Koutstaal, 2003; Multhaup, 1995; Schacter, Koutstaal, & Norman, 1997).

This age-specific benefit from retrieval guidance is consistent with the environmental support hypothesis put forth by Craik and his colleagues (e.g., Craik & Byrd, 1982; Craik & Jennings, 1992). According to this hypothesis, older adults have reduced processing resources to employ during tasks, resulting in deficiencies in self-initiating effortful or controlled strategies. Evidence supporting this hypothesis comes from cued-recall and recognition memory tests, which show reduced age impairments compared with free recall tests (e.g., Angel, Fay, Bouzzaoui, & Isingrini, 2010; Craik, 1986; Craik & McDowd, 1987). Whereas cued-recall and recognition memory tests provide rich external cues that can help to automatically trigger the recollection of relevant features from memory, free recall tests require relatively more effortful search and retrieval strategies that may be impaired by aging. To the extent that these findings also apply to autobiographical memories, they would suggest that age-related increases in memory confusions between real past and imagined-future events can be minimized by increasing the number of recollected features at retrieval, thereby providing additional support for the retrieval monitoring process.

The Current Experiments

While much research has revealed age-related deficits in the ability to successfully retrieve autobiographical information, little research has attempted to disentangle these deficits from age-related differences in the monitoring of autobiographical information during retrieval attempts. To address this gap, the current experiments tested for an age-related impairment when monitoring the retrieval of autobiographical events, above and beyond any age differences in the overall availability of autobiographical features. We manipulated the availability of autobiographical features by having younger and older adults elaborate on autobiographical details of past and imagined-future events during an initial generation phase. Elaboration should increase the availability of source-relevant features during retrieval, thereby facilitating retrieval monitoring processes and reducing memory confusions. Of critical interest was whether this manipulation of source-relevant features would have a larger benefit in older adults, analogous to the aforementioned studies of retrieval guidance and environmental support.

Experiment 1 tested for age-related differences when searching memory for imagined-future events, whereas Experiment 2 tested for differences when searching memory for actual past events. In this way, we were able to separately assess age-related impairments in the ability to monitor memory for the features that are differentially associated with each of these kinds of events (e.g., cognitive operations for future events, perceptual details for past events). We also gathered subjective ratings of recollection to confirm that our elaboration manipulation was successful in changing the availability of relevant features within each age group.

Experiment 1

In the first phase of Experiment 1, participants generated autobiographical events that occurred in their past and imagined events that might happen in their future. Participants were explicitly required to engage in extra elaboration for half of the future events (elaborative-future condition), so that the features associated with these events (e.g., cognitive operations) would be strengthened in memory relative to the features associated with future events that were not given extra elaboration (non-elaborative-future condition). This elaboration manipulation enabled us to objectively assess, within each age group, the extent that relative increases in the availability of these features would benefit subsequent source memory accuracy.

Source memory accuracy was assessed in a second phase by having participants discriminate between previously generated future events, past events, and new events. Unlike traditional source memory tests, in which participants must indicate which of two sources an item had occurred, we used tests that selectively targeted memory for one source at a time (i.e., criterial recollection tests; Gallo, in press; Gallo, Weiss & Schacter, 2004). On the elaborative-future test participants needed to identify events that had been associated with the elaborative-future condition, whereas on the non-elaborative-future test they needed to identify events that had been associated with the non-elaborative-future condition. Critically, the events potentially leading to memory confusions (lures) were kept constant on both elaborative and non-elaborative tests (i.e., the lures were items associated with the past condition or never previously seen). Thus, any differences in memory confusions (or source misattributions) could be ascribed to differences in how participants monitored retrieval for information that is characteristic of future events across the elaborative and non-elaborative conditions.

Based on earlier work with this kind of task in younger adults, we predicted that increasing the features associated with future events in the elaborative compared with the non-elaborative condition would lead to reductions in source misattributions (i.e., a kind of distinctiveness heuristic, see McDonough & Gallo, 2010). For instance, elaborative future imaginations (e.g., planning a wedding) should contain more cognitive operations compared with less-elaborative future imaginations (e.g., planning to send an email) and these additional details should help people later discriminate whether the event was imagined or not. Of critical interest was whether older adults would benefit from elaboration to a greater extent than younger adults, and whether making additional features available during retrieval monitoring would minimize age differences in source misattributions.

Method

Participants

Thirty-two younger adults ($M_{\text{age}} = 20.63$, range = 18–30, $M_{\text{education}} = 14.28$, 26 females/6 males) were recruited from the University of Chicago and received course credit for participation. Thirty-two older adults ($M_{\text{age}} = 74.90$, range = 65–89, $M_{\text{education}} = 16.94$, 17 females/15 males) were recruited from the Chicago community and received \$20 payment

for participation. The older adults were screened for no history of mental illness, showed no signs of depression as measured by the Geriatric Depression Scale ($M_{GDS} = 3.23$), and had high levels of cognitive functioning as measured by the Mini-Mental State Exam ($M_{MMSE} = 28.97$; Folstein, Folstein, & McHugh, 1975).

Procedure

In each experimental session, the experimenter and the participant sat together in front of a computer screen. Stimuli were presented using the Cogent2000 toolbox (Wellcome Department of Imaging Neuroscience) in Matlab. The experimenter read all instructions aloud to the participant and monitored performance to ensure each participant was completing the tasks appropriately. For all instructions, the experimenter gave examples and asked participants whether they understood the instructions, and if not the experimenter rephrased the instructions until the participants understood them.

A schematic of the procedure can be found in Figure 1. In the first phase, participants engaged in three generation blocks: the past-memory block, the elaborative-future block and non-elaborative-future block. Across all the blocks, the words consisted of 32 positive words (e.g., magical, puppy) that were taken from emotional word norms (Bradley & Lang, 1999) and thirty-two neutral words (e.g., package, mirror) that were taken from McDonough and Gallo (2010). Sixteen of these words served as cues to generate past events, 16 to generate imagined-future events, 16 to generate *both* past and imagined-future events, and 16 were reserved as non-studied lures at test, counterbalanced across participants.

During the past-memory block, participants were presented with a cue word and a prompt indicating the task in which they were to engage (i.e., “In the past, I remember when...”). Participants were told that they would be given one minute to retrieve a past memory associated with the cue word with the requirements that the event occurred in the participant’s personal life at a specific location and lasted for less than one day.¹ After thinking of each event to themselves, participants were given up to an additional 1.5 minutes to generate aloud three one-word descriptions: a title, who was in the event, and location of the event (for a similar task, see Addis, Pan, Vu, Laiser, & Schacter, 2008). Each of these descriptions was typed by the experimenter and checked for appropriateness (e.g., one word or compound words only). These descriptions were used to help cue participants on the subsequent memory tests (in the second phase). The past-memory block always appeared first to equate familiarity of the corresponding lures at test (i.e., the items in this block were used as lures at test, and were evenly distributed across the subsequent future tests).

During the future-imagination blocks, participants were presented with a cue word and a prompt indicating the task in which they were to engage (i.e., “In the future, there may be a time when...”). Participants were given one minute to imagine a future event to themselves that was associated with the cue word with the requirements that the event was consistent with their goals and plans for the future, would likely occur in a specific location, and would last for less than one day. After generating each event, participants were given up to an additional 1.5 minutes to provide three one-word descriptions aloud to serve as a title, who will be in the event, and the location of the event. For half of the future imaginations, participants were instructed to generate a future event associated with the cue word that corresponded to their personal plans as described above (non-elaborative condition). For the other half of the future imaginations, participants also were instructed to generate a future event, but in addition were given a 1.5 more minutes to generate three steps needed to

¹Participants were not asked to further constrain their generated events (e.g., by time period, emotionality, etc.) because we wanted to sample from a wide variety of events, thus fully capitalizing on natural age-related biases that occur for remembering real past and imagining future events.

accomplish the future plan and to provide a one-word description for each step (elaborative condition). For example, when presented with the word “hopeful,” one participant generated the following key words: *title*-car, *who*-daughter, *location*-dealership, *step 1*-locate, *step 2*-arrive, *step 3*-bargain). These steps ensured that participants generated more cognitive operations for the elaborative than non-elaborative condition. The two future-imagination blocks were counterbalanced across participants.

The second phase occurred one day later and participants took two criterial recollection tests: the elaborative-future test and the non-elaborative-future test. These tests separately assessed source memory accuracy for these different types of events or sources. Each memory test consisted of 8 past items, 8 future items, 8 *both* items, and 8 new items. All item types consisted of half positive and half neutral words. On each test, a prompt at the top of the screen indicated the appropriate test (e.g., “Was this event presented during the elaborative-future block?”) along with the originally presented word and the descriptions that each participant generated during the first phase (title, who, location). The descriptions for new items were taken from pilot data in younger adults and were used for both younger and older adults to keep the events identical across age groups. For *both* items, two sets of descriptions were generated by each participant (one for past events and one for imagined-future events), but only the descriptions that corresponded to the appropriate test were used (i.e., *both* descriptions generated during the future-imagination block were used for *both* items on the future test).

On the elaborative-future test, participants were instructed to respond “yes” only to words for which the participant remembered imagining an event and planning multiple steps to accomplish it during the first phase (elaborative-future and *both* items, referred to as criterial hits), otherwise to respond “no” (past and new items, referred to as source misattributions). Participants also were told at this time that non-elaborative-future events would not be on the elaborative-future test to encourage the retrieval of the elaborated descriptions on this test. On the non-elaborative-future test, participants were instructed to respond “yes” only to words for which the participant remembered imagining an event in the future and not planning additional steps to accomplish it (non-elaborative-future and *both* items), otherwise “no” (past and new items). Participants were told at this time that elaborative-future events would not be on the non-elaborative-future test. After responding whether each cued event was associated with a future imagination, participants were asked to provide subjective reports of the amount of perceptual details and cognitive operations recollected from 1 (low) to 4 (high). Perceptual details were defined as features regarding what was seen, heard, tasted, touched, or smelled during the future event. Cognitive operations were defined as features regarding the mental activities during planning of the future event including memories for thoughts, decisions, or the formation of mental imagery. The elaborative and non-elaborative tests were counterbalanced across participants.

Results and Discussion

Generation phase

The number of descriptions generated provided a measure of elaboration quality during the elaborative and non-elaborative conditions in each age group. Younger adults had a mean of 2.99 descriptions ($SE = .004$) for past events, 3.00 descriptions ($SE = .000$) for non-elaborative-future events, and 5.90 descriptions ($SE = .094$) for elaborative-future events. Older adults had a mean of 2.97 descriptions ($SE = .011$) for past events, 2.98 descriptions ($SE = .0077$) for non-elaborative-future events, and 5.95 descriptions ($SE = .023$) for elaborative-future events. A 2 (age: young, old) $\times$ 2 (event: elaborative future, non-elaborative future) mixed ANOVA on the number of descriptions revealed a main effect of event, indicating that more descriptions were generated for elaborative than non-elaborative-

future events as instructed, $F(1, 62) = 3715.57$, $MSE = .074$, $p < .001$, $\eta^2 = .98$. No other main effects or interactions approached significance (all p 's $> .52$). These results show that both younger and older adults appropriately followed instructions by generating more cognitive operations for the elaborative than non-elaborative-future events.

Criterial recollection tests

Mean proportion correct on each test for each age group is presented in Table 1. Although our primary analyses of interest were the proportion of source misattributions, we first analyzed memory accuracy to test our basic assumption that additional elaboration improved memory accuracy. Memory accuracy was assessed by subtracting source misattributions to studied lures from criterial hits and entered into a 2 (age: young, old) $\times$ 2 (test: elaborative future, non-elaborative future) mixed ANOVA. A main effect of age indicated that memory accuracy was better for younger than older adults ($M = .73$ and $.49$), $F(1, 62) = 11.19$, $MSE = .16$, $p = .001$, $\eta^2 = .15$. A main effect of test indicated that memory accuracy was better on the elaborative-future test ($M = .84$ and $.19$ for hits and misattributions, respectively) than the non-elaborative-future test ($M = .83$ and $.26$ for hits and misattributions, respectively), $F(1, 62) = 6.45$, $MSE = .032$, $p = .014$, $\eta^2 = .09$. As clearly apparent in the means, the effect of test was driven by the misattribution differences. The age $\times$ test interaction was not significant ($p > .15$). Thus, elaboration improved memory accuracy and accuracy was worse overall in older adults, but there was no evidence that older adults benefitted more from elaboration than did younger adults.

We next analyzed source misattributions, which may be more sensitive to detecting retrieval monitoring effects than hit rates (see Gallo et al., 2004; McDonough & Gallo, 2011). Studied lures and new lures were averaged together for simplicity, as they should both be affected by retrieval monitoring in this comparison, and entered into a 2 (age: young, old) $\times$ 2 (test: elaborative future, non-elaborative future) mixed ANOVA. A main effect of age indicated that older adults had more misattributions than younger adults ($M = .19$ and $.08$), $F(1, 62) = 12.94$, $MSE = .030$, $p = .001$, $\eta^2 = .17$. A main effect of test indicated that misattributions on the non-elaborative-future test were greater than on the elaborative-future test ($M = .15$ and $.12$), $F(1, 62) = 5.38$, $MSE = .007$, $p = .024$, $\eta^2 = .08$. Finally, a marginal test $\times$ age interaction, $F(1, 62) = 3.69$, $MSE = .007$, $p = .059$, $\eta^2 = .056$, indicated that elaboration reduced misattributions marginally more for younger ($M = .11$ and $.05$), than older adults ($M = .18$ and $.20$). As with the discrimination measure, this analysis again provided no evidence that older adults benefitted more from elaboration than younger adults. If anything, the results suggest that elaboration aided younger adults to a greater extent than older adults, although this latter conclusion must be treated with caution as the interaction was not significant. We return to this idea after presenting the results of Experiment 2.

As a final analysis, we directly compared the non-elaborative misattributions for younger adults with the elaborative misattributions for older adults. Because older adults in the elaboration condition generated more features associated with future events compared with younger adults in the non-elaboration condition, this comparison provided a strong test of the ability of older adults to benefit from the elaboration manipulation. This direct comparison again revealed greater misattributions for older compared with younger adults ($M = .19$ and $M = .11$), $t(62) = 2.05$, $SEM = .037$, $p = .045$, $d = .51$. As with the other analyses, these results are inconsistent with the prediction that elaboration would facilitate retrieval monitoring more for older adults than younger adults. Instead, older adults were impaired in all conditions relative to younger adults.

Subjective recollection ratings

Subjective judgments of recollected perceptual details and cognitive operations were gathered when participants claimed to recollect an imagined-future event. Means for these subjective recollection ratings for criterial hits and source misattributions to studied lures are presented in Table 2. We were primarily interested in providing evidence that adding steps in one's future plans (elaboration manipulation) affected the amount of cognitive operations subsequently recollected. Thus, we conducted a 2 (age: young, old) x 2 (test: elaborative future, non-elaborative future) mixed ANOVA on cognitive operation ratings for criterial hits. This ANOVA revealed a main effect of test, indicating that cognitive operation ratings were higher on the elaborative-future test ($M = 2.55$) than the non-elaborative-future test ($M = 2.41$), $F(1, 62) = 6.11$, $MSE = .11$, $p = .016$, $\eta^2 = .090$. A main effect of age indicated that older adults ($M = 2.78$) rated cognitive operations higher than younger adults ($M = 2.18$), $F(1, 62) = 14.77$, $MSE = .79$, $p < .001$, $\eta^2 = .19$.² Critically, the age x test interaction did not approach significance ($p = .65$), suggesting elaboration enhanced recollected features for cognitive operations in imagined-future events equally for young and older adults.

The same ANOVA was conducted on perceptual detail ratings to test the extent that planning additional steps also increased the amount of perceptual details subsequently recollected in imagined-future events. This ANOVA revealed a main effect of age, indicating that older adults ($M = 3.07$) provided higher ratings than younger adults ($M = 2.63$), $F(1, 62) = 10.51$, $MSE = .58$, $p = .002$, $\eta^2 = .15$. Importantly, neither the effect of test nor the age x test interaction reached significance (all p 's $> .22$). Overall the subjective reports of recollected features suggest that, as intended, planning additional steps during the first phase primarily influenced subsequent recollection for cognitive operations and not perceptual details.

The results of this experiment indicated that age-related impairments in source memory accuracy were found even when additional features associated with cognitive operations were available during retrieval. These results suggest that the age-related increase in source misattributions was due, at least in part, to failures using relevant features to monitor the accuracy of memory retrieval, and cannot be entirely attributed to a lack of generating cognitive operations at encoding or to the reduced availability of these features at retrieval.

Experiment 2

Experiment 2 was analogous to Experiment 1, except the design was modified so that the elaboration manipulation and tests focused on past events as opposed to future events. As in Experiment 1 participants generated past and future events in the first phase, but in Experiment 2 they elaborated on half of the past events. In the second phase, participants were separately tested on memory for items in the elaborative-past and non-elaborative-past conditions, using items that had been generated in the future condition as lures. For younger adults, we assumed that more-detailed past memories would contain more perceptual details and should lead to less memory confusions compared with less-detailed past memories. The critical question was the extent to which older adults' would show a similar reductions in memory confusions following elaboration compared with younger adults. To the extent that older adults have reduced availability of recollected features in past events, increasing

²This main effect of age on subjective recollection ratings needs to be interpreted with caution, as subjective ratings from autobiographical memory may be anchored differently in younger than older adults (see Gallo et al., 2011). To avoid this ambiguity, we only interpret relative subjective ratings between the elaborative and non-elaborative conditions, thus providing an appropriate anchor for each participant.

the availability of those features via elaboration might improve their monitoring ability and reduce misattributions compared with younger adults.

Method

Participants—Forty younger adults ($M_{\text{age}} = 20.16$, range = 18–23, $M_{\text{education}} = 14.13$, 26 females/14 males) were recruited from the University of Chicago and received course credit for participation. Forty older adults ($M_{\text{age}} = 77.38$, range = 64–92, $M_{\text{education}} = 15.84$, 26 females/14 males) were recruited from the Chicago community and received \$20 payment for participation. The older adults were screened for no history of mental illness, showed no signs of depression ($M_{\text{GDS}} = 3.63$) and had high levels of cognitive functioning ($M_{\text{MMSE}} = 28.13$).

Procedure—The design and procedure used in Experiment 2 paralleled those in Experiment 1. In the first phase, the instructions to generate the future imaginations (used as common lures) were the same as the non-elaborative-future condition in Experiment 1. For half of the past events, participants were instructed to retrieve a specific past memory of an event associated with the cue word that occurred in a specific location and lasted less than a day (non-elaborative condition). For the other half of the past events, participants also were asked to generate three additional perceptual details contained within each event (elaborative condition). If needed, participants were prompted to generate additional perceptual details including what else they saw, heard, touched, smelled, and tasted. For example, when presented with the cue word “cake”, one participant generated the following key words: *title*-creampuffs, *who*-father, *location*-Montreal, *detail 1*-chocolate, *detail 2*-whipped cream, *detail 3*-cold.

In the second phase, participants took two memory tests: the elaborative and non-elaborative-past tests. The tests were identical to those in Experiment 1 except participants were oriented towards past events. On the elaborative-past test, participants were instructed to respond “yes” only to words for which the participant remembered describing a past event and elaborating upon the perceptual details (elaborative-past and *both* items), otherwise respond “no” (future and new items). Participants were told that non-elaborative-past events would not be on the elaborative-past test to encourage retrieval of the elaborated descriptions. The same instructions were given in the non-elaborative test, except that participants were instructed to respond “yes” only to words for which the participant remembered minimal description of a past event and did not elaborate upon (non-elaborative-past and *both* items), otherwise “no” (future and new items). Participants were told that elaborative-past events would not be on the non-elaborative test.

Results and Discussion

Generation phase

As in Experiment 1, the number of descriptions provided a measure of elaboration quality. Younger adults had a mean of 3.00 descriptions ($SE = .0013$) for imagined-future events, 3.00 descriptions ($SE = .0015$) for non-elaborative-past events, and 5.99 descriptions ($SE = .0040$) for elaborative-past events. Older adults had a mean of 2.95 descriptions ($SE = .023$) for imagined-future events, 2.98 descriptions ($SE = .0078$) for non-elaborative-past events, and 5.75 descriptions ($SE = .082$) for elaborative-past-events. A 2 (age: young, old) x 2 (event: elaborative past, non-elaborative past) mixed ANOVA on the number of descriptions revealed a main effect of event, indicating that more descriptions were generated for elaborative than non-elaborative-past events as instructed, $F(1, 78) = 5010.57$, $MSE = .066$, $p < .001$, $\eta^2 = .99$. A main effect of age indicated that younger adults generated more descriptions than older adults, $F(1, 78) = 9.42$, $MSE = .069$, $p = .003$, $\eta^2 = .11$. An event x

age interaction indicated that the difference in generated perceptual details between elaborative and non-elaborative conditions was larger in younger than older adults, $F(1, 78) = 7.31$, $MSE = .066$, $p = .008$, $\eta^2 = .086$. The fact that older adults were not able to generate as many perceptual details as younger adults is consistent with previous findings (Addis et al., 2008; Levine et al., 2002). Nevertheless, the main effect of event still suggests that both younger and older adults followed instructions and generated more perceptual details for the elaborative than non-elaborative-past events.

Criterion recall tests

Mean proportion correct on each test for each age group is presented in Table 3. As in the previous experiment, we first analyzed memory accuracy to assess the effects of elaboration on perceptual details across the past tests. Memory accuracy (criterion hits–misattributions) was entered into a 2 (age: young, old) $\times$ 2 (test: elaborative past, non-elaborative past) ANOVA. A main effect of age indicated that memory accuracy was better for younger than older adults ($M = .49$ and $.24$), $F(1, 78) = 16.87$, $MSE = .15$, $p < .001$, $\eta^2 = .18$. A main effect of test indicated that memory accuracy was better on the elaborative-past test ($M = .93$ and $.52$ for hits and misattributions, respectively) than the non-elaborative-past test ($M = .89$ and $.56$ for hits and misattributions, respectively), $F(1, 78) = 5.99$, $MSE = .046$, $p = .017$, $\eta^2 = .071$. The age $\times$ test interaction was not significant ($p > .29$). Replicating Experiment 1, elaboration improved memory accuracy and accuracy was worse overall in older adults, but older adults did not benefit more from elaboration than younger adults.

Next, we analyzed source misattributions to the lures as in Experiment 1. Source misattributions to studied lures and new lures were averaged together and entered into a 2 (age: young, old) $\times$ 2 (test: elaborative past, non-elaborative past) mixed ANOVA. A main effect of age indicated that older adults had more misattributions than younger adults ($M = .44$ and $.22$), $F(1, 78) = 27.11$, $MSE = .076$, $p < .001$, $\eta^2 = .26$, but the main effect of test and age $\times$ test interaction did not reach significance (p 's $> .17$). This analysis provided no evidence for an effect of elaboration on retrieval monitoring, or that older adults would benefit more from elaboration than younger adults. Similar to Experiment 1, we also compared the non-elaborative misattributions for younger adults with the elaborative misattributions for older adults. Even though older adults had generated more features during the study phase than younger adults in this comparison, older adults continued to show greater misattributions than younger adults ($M = .44$ and $M = .24$), $t(78) = 4.20$, $SEM = .048$, $p < .001$, $d = .94$. These findings conceptually replicate and extend Experiment 1, and suggest that older adults have retrieval monitoring impairments relative to younger adults.

Subjective recall ratings

The amount of recollected perceptual details and cognitive operations were gathered when participants claimed to recollect a past event (see Table 2). We were primarily interested in providing evidence that adding perceptual details (elaboration manipulation) affected the amount of perceptual details subsequently recollected in past events. Thus, we conducted a 2 (age: young, old) $\times$ 2 (test: elaborative past, non-elaborative past) mixed ANOVA on perceptual detail ratings for criterion hits. This ANOVA revealed a main effect of test, indicating that perceptual detail ratings were higher on the elaborative-past ($M = 3.31$) than non-elaborative-past test ($M = 3.17$), $F(1, 78) = 8.60$, $MSE = .094$, $p = .004$, $\eta^2 = .10$. A main effect of age indicated that older adults ($M = 3.42$) rated perceptual details higher than younger adults ($M = 3.06$), $F(1, 78) = 9.65$, $MSE = .52$, $p = .003$, $\eta^2 = .11$. The age $\times$ test interaction did not approach significance ($p = .66$), suggesting elaboration enhanced recollection for perceptual details similarly in younger and older adults.

The same ANOVA was conducted on cognitive operation ratings for criterial hits to test whether elaborating on additional perceptual details also increased the amount of cognitive operations subsequently recollected in past events. This ANOVA revealed a main effect of age, indicating that older adults ($M = 3.03$) provided higher ratings than younger adults ($M = 2.28$), $F(1, 78) = 20.18$, $MSE = 1.13$, $p < .001$, $\eta^2 = .21$. Importantly, neither the effect of test nor the age $\times$ test interaction reached significance (all p 's $> .29$). Overall the subjective reports of recollected features in past events suggest that, as intended, elaborating on additional perceptual details during the first phase primarily influenced subsequent recollection for perceptual details and not cognitive operations.

The findings from Experiment 2 showed that despite older adults' reported increases in available perceptual details following the elaboration manipulation, they did not benefit from the available details more than younger adults. Rather, source misattributions persisted and did not reach levels of younger adults in the non-elaborative condition. Thus, as in Experiment 1, these findings provide evidence that older adults' source memory impairments were due, at least in part, to difficulties using relevant features in the retrieval monitoring process and cannot be entirely due to a lack of generating perceptual details at encoding or the reduced availability of these features at retrieval.

Cross-experiment Analysis

The misattribution patterns in Experiments 1 and 2 suggested that older adults did not benefit from the elaboration manipulation to a greater extent than younger adults, despite reporting increases in the availability of recollected features following elaboration. In fact, younger adults showed a numerical advantage as a function of the elaboration manipulation relative to older adults in both experiments, although the age $\times$ test interactions did not reach conventional levels of significance. This finding implies that not only did older adults not benefit from the availability of additional features to a greater extent than younger adults, but older adults may have failed to take advantage of the additional features altogether. In addition, the data suggest that misattributions were greater on the past tests in Experiment 2 than the future tests in Experiment 1. This latter pattern is consistent with the results in McDonough and Gallo (2010) in younger adults, who also found greater misattributions on the past test than future test.

To further investigate these effects, we conducted a 2 (age: young, old) $\times$ 2 (experiment: 1, 2) $\times$ 2 (test: elaborative, non-elaborative) ANOVA on source misattributions, averaging across studied status. In addition to several main effects, two key interactions were found. As seen in Figure 2, an age $\times$ test interaction, $F(1, 140) = 4.15$, $MSE = .011$, $p = .04$, $\eta^2 = .03$, indicated that misattributions were greater on the non-elaborative tests than elaborative tests in younger adults ($t(71) = 4.47$, $SEM = .012$, $p < .001$, $d = .34$), but misattributions did not differ between tests in older adults ($t(71) = .20$, $SEM = .021$, $p = .84$, $d = .02$). This interaction suggests that older adults did not use the additional availability of features to aid the retrieval monitoring process following elaboration to the same extent as younger adults. As seen in Figure 3, an age $\times$ experiment interaction, $F(1, 140) = 4.36$, $MSE = .056$, $p = .04$, $\eta^2 = .03$, indicated that the source misattribution difference between younger and older adults was larger in Experiment 2 (past test), $t(78) = 5.21$, $SEM = .044$, $p < .001$, $d = 1.16$, than in Experiment 1 (future test), $t(62) = 3.60$, $SEM = .031$, $p = .001$, $d = .90$. This interaction suggests that older adults were especially likely to confuse imagined-future events and new events as having been generated in the past condition, a misattribution asymmetry that we discuss more below.

General Discussion

Older adults are more likely to confuse real (past) and imagined (future) events in memory than younger adults. The present study investigated the extent that increasing the availability of features within past and future autobiographical events would reduce these memory confusions in younger and older adults. According to the environmental support hypothesis (e.g., Craik & Byrd, 1982; Craik & Jennings, 1992), contextual factors that aid effortful or controlled processing should help older adults to a greater extent than younger adults. Based on these arguments, we reasoned that increasing the availability of retrieved features should help older adults differentiate between autobiographical events more than younger adults. We found that both age groups generated more autobiographical features in the elaborative compared with the non-elaborative conditions, and on the subsequent source memory tests, subjective reports of recollected features indicated that participants recollected more features for elaborative than non-elaborative events. Nevertheless, regardless of whether recollected features were increased in future-autobiographical events (Experiment 1) or past-autobiographical events (Experiment 2), source memory in older adults did not benefit from elaboration to a greater extent than younger adults. Furthermore, elaboration did not reduce older adults' source misattributions to the level of younger adults in the non-elaboration condition, and cross-test analyses indicated that only younger adults were able to take advantage of the increased recollected features to reduce misattributions. Overall, these findings implicate an age-related retrieval monitoring deficit above and beyond deficits in the successful retrieval of recollected information itself.

The present findings extend previous work by revealing age-related retrieval monitoring impairments for the kinds of autobiographical information that occur in everyday events, and that are not captured by more standard laboratory materials. Prior studies using laboratory materials (i.e., words and pictures) have suggested that age-related differences in retrieval monitoring depend on the ability to successfully recollect studied events (Dodson & Schacter, 2002a; Gallo, Cotel, Moore & Schacter, 2007; Schacter, Israel, & Racine, 1999). In these studies, retrieval success was manipulated by varying the distinctiveness of the encoded stimuli. When non-distinctive materials such as words have been used, older adults show large differences in memory accuracy, but these differences are minimized when distinctive materials such as pictures have been used. These studies suggest that older adults can accurately monitor memory when rich perceptual details can be recollected. As argued by Schacter and colleagues (Dodson & Schacter, 2002b; Schacter et al., 1999), rich perceptual details aid retrieval monitoring by changing one's retrieval expectations. If one expects to recollect many features, but only few features come to mind (as is typically the case for non-studied items), then the event can be rejected as not having occurred (i.e., a distinctiveness heuristic).

In the current study, increasing recollected features reduced source memory confusions in younger adults, further supporting the idea that retrieval expectations can enhance retrieval monitoring for autobiographical events (see also, McDonough & Gallo, 2010). In contrast, we found that increasing the recollected features associated with autobiographical events did not aid retrieval monitoring in older adults. While the complexity of autobiographical events allows for a large variation in the amount of recollected features, older adults may have failed to perceive (i.e., did not expect) that additional recollected features would be useful during retrieval monitoring (cf., Bink, Marsh, & Hicks, 1999; Dodson & Schacter, 2002b). One possible explanation for the age-related deficits observed in each of the present experiments was that the two memory tests were very similar to each other (i.e., imagined-future events containing less features compared imagined-future events containing more features). As such, these tests may not have made the differences in the types of events being searched in memory sufficiently salient for older adults. These age-related monitoring

impairments may reflect a reduced flexibility in adjusting retrieval expectations during memory decisions, despite having sufficient recollected features available in memory. Thus, in addition to more available features, older adults may also need supportive cues or explicit direction to use those features to during retrieval monitoring (e.g., Thomas & Bulevich, 2006).

Reality-Monitoring Asymmetry in Older Adults

In addition to our primary goal of testing age-related differences in retrieval monitoring, the present study also revealed an asymmetrical pattern of source misattributions across the past and future tests. In McDonough and Gallo (2010), we found that source misattributions were lower on the future tests relative to the past tests, a finding that was referred to as a reality-monitoring asymmetry because it involved differential confusions between real and imagined events in memory (cf. Johnson & Raye, 1981). In the present study, we replicated this asymmetry in younger adults, and we also found that this asymmetry was even greater in older adults. This pattern indicates that older adults' memory accuracy was particularly impaired when searching memory for past events. Similar effects have been found using performed and imagined actions in older adults (see McDaniel, Lyle, Butler, & Dornburg, 2008). To the extent that these findings generalize to everyday events, they suggest that older adults not only make more reality-monitoring errors than younger adults, but older adults are particularly prone to believe that imagined events were actually experienced. Returning to our earlier example, older adults may be likely to omit taking their daily medication because they believe they already took it.

At least two possible explanations exist for this reality-monitoring asymmetry, and its exaggeration with age. One explanation is that people expect to recollect different kinds of features for imagined-future events than real-past events, and they also weigh these features differently during retrieval monitoring (McDonough & Gallo, 2010). If people expect to recollect cognitive operations (thoughts and reasoning processes) associated with future events more than they expect to recollect perceptual details (what one saw, heard, etc.) associated with past events, then these different retrieval expectations might lead to more conservative responses for future events, and thus fewer misattributions. According to this idea, a larger reality-monitoring asymmetry in older adults could be due to different relative levels of retrieval expectations for real-past and imagined-future events. Older adults may have expected to recollect fewer features than younger adults overall, but this difference may have been the most exaggerated for expectations about perceptual details associated with past events.

A second explanation possibly for this reality-monitoring asymmetry focuses on differences in the confusability of the relevant features themselves, as opposed to differences in retrieval expectations (cf. Gamboz, Brandimonte, & De Vito, 2010). Specifically, both real-past and imagined-future events may contain many perceptual details, and this overlap potentially biases people to claim that an event occurred in the past regardless of its origin (i.e., whether it was a real-past or imagined-future event). In contrast, imagined-future events may contain more cognitive operations than real-past events, creating a situation where people are not as biased to claim that past events were imagined. According to this idea, the exaggerated reality-monitoring asymmetry in older adults could have been due to more overlap in perceptual details between real-past and imagined-future events relative to younger adults. Consistent with this account, we found that older adults were particularly impaired in their ability to generate descriptions of perceptual details associated with past events. However, impairments in retrieving perceptual details recollected for past events could, in turn, lead to subsequent changes in retrieval expectations for past events, so that our results do not definitively test between these two explanations of the reality-monitoring asymmetry. While

the nature of the reality-monitoring asymmetry remains uncertain, the present study provides evidence that retrieval monitoring impairments for autobiographical features may play a critical role in older adults' memory confusions.

Acknowledgments

This research described in this paper was supported in part by APF/COGDOP Graduate Research Scholarship in Psychology, the APA Dissertation Research Award granted to I.M.M., and National Institute of Aging grant AG30345.

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Figure 1.

Procedural schematic for Experiment 1. In the first phase, participants generated past, non-elaborative-future, and elaborative-future events. In the past generation block, participants generated a past autobiographical memory associated with the cue word and three descriptions (title of the event, who was in the event, and the location of the event). In the non-elaborative-future generation block, participants imagined a future event associated with the word and provided the three event descriptions. In the elaborative-future generation block, participants imagined a future event associated with the cue word, provided the three event descriptions, and generated three steps needed to accomplish the future event. The order of the future blocks was counterbalanced across participants. The second phase occurred one day later and two source memory tests were given: the non-elaborative-future test and the elaborative future test. On each test, participants were given the cue word and the three event descriptions they provided during the first phase and had to decide whether the event was a future event or not. The tests differed in the types of targets (non-elaborative vs. elaborative events), but both tests included the same types of lures (past and new events).

Figure 2. Mean misattributions in elaborative and non-elaborative tests collapsing across Experiments 1 and 2 for younger and older adults. Younger adults reduced misattributions on the elaborative tests relative to the non-elaborative tests, but older adults did not.

Figure 3. Mean misattributions on the future tests (Experiment 1) and past tests (Experiment 2) collapsing across elaboration conditions for younger and older adults. Both younger and older adults reduced misattributions on the future tests relative to the past tests, but this effect was greater in older compared with younger adults.

Table 1

Mean Proportion Recognized as a Function of Age and Test Type in Experiment 1

Test Type	Younger Adults		Older Adults	
	<i>M</i>	<i>SEM</i>	<i>M</i>	<i>SEM</i>
Elaborative-future Test				
Elaborative-both Hit	.89	(.02)	.85	(.03)
Elaborative-future Hit	.89	(.03)	.79	(.04)
Past Misattributions	.10	(.02)	.28	(.05)
New Misattributions	.00	(.00)	.10	(.03)
Non-elaborative-future Test				
Non-elaborative-both Hit	.83	(.03)	.81	(.03)
Non-elaborative- future Hit	.88	(.02)	.79	(.04)
Past Misattributions	.21	(.04)	.31	(.05)
New Misattributions	.02	(.01)	.08	(.02)

Notes. Standard error of the mean in parenthesis.

Table 2

Mean Subjective Ratings of Perceptual Details and Cognitive Operations for Criterial Hits and Source Misattributions on each Test as a Function of Age in Experiments 1 and 2

	Perceptual Details		Cognitive Operations	
	YA	OA	YA	OA
	<i>M (SEM)</i>	<i>M (SEM)</i>	<i>M (SEM)</i>	<i>M (SEM)</i>
Experiment 1 (Future)				
Elaborative Hits	2.69 (.08)	3.09 (.12)	2.24 (.11)	2.87 (.12)
Elaborative Misattributions	2.74 (.17)	2.96 (.19)	1.82 (.12)	2.72 (.16)
Non-elaborative Hits	2.58 (.08)	3.05 (.13)	2.12 (.11)	2.69 (.14)
Non-elaborative Misattributions	2.35 (.11)	2.97 (.20)	1.94 (.15)	2.71 (.18)
Experiment 2 (Past)				
Elaborative Hits	3.14 (.08)	3.48 (.09)	2.33 (.12)	3.04 (.15)
Elaborative Misattributions	2.53 (.13)	3.21 (.11)	2.05 (.12)	2.80 (.13)
Non-elaborative Hits	2.98 (.08)	3.36 (.10)	2.22 (.10)	3.02 (.13)
Non-elaborative Misattributions	2.52 (.13)	3.22 (.13)	2.24 (.12)	2.84 (.15)

Notes. YA = younger adults; OA = older adults; SEM = standard error of the mean.

Misattributions are to studied lures. Ratings were on a scale from 1 (low) to 4 (high).

Table 3

Mean Proportion Recognized as a Function of Age and Test Type in Experiment 2

Test Type	Younger Adults		Older Adults	
	<i>M</i>	<i>SEM</i>	<i>M</i>	<i>SEM</i>
Elaborative-past Test				
Elaborative Both Hit	.86	(.03)	.95	(.02)
Elaborative Past Hit	.91	(.02)	.95	(.01)
Future Misattributions	.35	(.05)	.69	(.05)
New Misattributions	.03	(.01)	.20	(.04)
Non-elaborative-past Test				
Non-Elaborative Both Hit	.89	(.03)	.93	(.02)
Non-Elaborative Past Hit	.86	(.03)	.92	(.03)
Future Misattributions	.43	(.06)	.70	(.04)
New Misattributions	.05	(.02)	.19	(.05)

Notes. Standard error of the mean in parenthesis.