

False Recollection Induced by Photographs: A Comparison of Older and Younger Adults

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Looking at photographs constitutes an important everyday memory activity for older adults. The authors found that reviewing photographs of events seen earlier in a videotape increases the likelihood that both older and younger adults remember specific details from the reviewed event (W. Koutstaal, D. L. Schacter, M. K. Johnson, K. E. Angell, & M. S. Gross, 1997). In the present study, the authors report 2 experiments demonstrating that photo review can also produce false recollection in elderly adults: After reviewing photos of events that had not been shown earlier in a videotape, older but not younger adults were later more likely to "remember" that those events had been shown in the videotape. False recollection induced by photo review appears to reflect an age-related deficit in source-monitoring abilities.

Although memory can achieve extremely high levels of accuracy, people are sometimes susceptible to a variety of memory distortions and illusions (for recent reviews, see Johnson, Hashtroudi, & Lindsay, 1993; Roediger, 1996; Schacter, 1995, 1996). Several studies suggest that elderly adults may be especially prone to such false memories. For example, older adults are sometimes more likely than younger adults to mistakenly claim that a recently seen nonfamous name or face is famous (Bartlett, Strater, & Fulton, 1991; Dywan & Jacoby, 1990; see also Multhaup, 1995); they are also more susceptible than younger adults to false recall and recognition of semantic associates of recently presented words (Norman & Schacter, in press; Rankin & Kausler, 1979; Smith, 1975; Tun, Wingfield, Blanchard, & Rosen, 1996) and are more prone to the distorting influences of postevent suggestion than are younger adults (Cohen & Faulkner, 1989). This age-related increase in susceptibility to memory biases and illusions appears to be associated with older adults' impaired ability to remember the source of recently acquired information (cf. Craik, Morris, Morris, & Loewen, 1990; Ferguson, Hashtroudi, & Johnson, 1992; Hashtroudi, Johnson, & Chrosniak, 1989; Johnson, De Leonardi, Hashtroudi, & Ferguson, 1995; McIntyre & Craik, 1987; Schacter, Kaszniak, Kihlstrom, & Valdiserri, 1991; Schacter, Osowiecki, Kaszniak, Kihl-

trom, & Valdiserri, 1994; Spencer & Raz, 1995). Feelings of familiarity, in the absence of clear source information, may be attributed to an incorrect source, thereby creating memory distortion (cf. Ceci, 1995; Dywan & Jacoby, 1990; Jacoby, Kelley, Brown, & Jasechko, 1989; Johnson et al., 1993; Schacter, 1995; Schacter & Curran, 1995).

There have been few attempts to explore the implications of elderly adults' impaired source-monitoring abilities and enhanced susceptibility to memory distortion for their everyday memory activities. One important everyday memory pursuit engaged in by older adults involves looking at photographs of past events. Several studies have shown that older adults highly value family photographs; they rank photographs among their most cherished possessions, whereas younger people rank photos as relatively less important (e.g., Csikszentmihalyi & Rochberg-Halton, 1981; Kamptner, 1991). The primary reason that older adults value family photographs derives from their potency as retrieval cues: Elderly adults report using photographs as aids to reconstructing and recollecting past events and experiences (Redfoot & Back, 1988; Sherman, 1991; Wapner, Demick, & Redondo, 1990). In light of previous findings on age-related increases in memory distortion, an important and as yet unexplored question arises: Might exposure to a photograph alter an older adult's recollection of a past experience or even create a memory of an event that never occurred? For instance, some childhood memories may be based on a frequently viewed photograph rather than on recollection of an actual childhood experience. Similarly, older adults might come to believe that they had taken part in an episode when, in fact, they had only viewed a photograph of the event involving other people. A related kind of memory misappropriation appears to have occurred to Ronald Reagan, who as President "remembered" a war anecdote about an episode that apparently occurred only in a film (Wills, 1987).

Little is known about the effects of viewing photographs on subsequent memory performance in either older or younger

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adults. In a recent series of experiments (Koutstaal, Schacter, Johnson, Angell, & Gross, 1997), we examined the issue by showing older and younger adults two videotaped sequences of everyday activities (one involving a professor performing a series of actions in an office, the other involving two persons meeting in a park), and then exposing them to photographs of some of the events from each videotape. Later, we assessed recall and recognition of all the events from the videotapes, including events that had, and events that had not, been reviewed by the photographs. Both older and younger adults recalled and recognized more of the events that had been reviewed previously through photographs than events that had not been reviewed. To probe qualitative aspects of recollective experience, we used the remember-know procedure (Tulving, 1985), in which individuals are instructed to provide a *remember* response when they recollect specific details about the prior occurrence of an event and a *know* response when they feel that an event is familiar but do not recall any specific details concerning it (for discussion of the measurement and interpretation of remember-know data, see Donaldson, 1996, and Gardiner & Java, 1993). We found that recognition responses for brief verbal descriptions of objects involved in the videotaped events (e.g., "dictionary" and "park bench") were more often accompanied by judgments of remembering if participants had earlier reviewed those events by a photograph than if the events had not been shown in a photograph. By contrast, prior review of events through photographs had little or no effect on the number of know responses that accompanied recognition judgments. Equally important, although younger adults showed higher levels of episodic recollection overall, older and younger adults showed equivalent proportionate increases in the number of remember responses as a function of photograph review. These findings demonstrate that rehearsal of past events by using photographs constitutes one way to enhance the recollective experience of elderly individuals.

Nonetheless, in view of the previously discussed findings on age-related susceptibility to memory distortion, it is possible that the observed increases in elderly adults' remember responses after looking at photographs might also be observed when the photos do not depict an event that was part of the original videotape. If the photographs portrayed entirely novel events that occurred in the same general setting as the actually viewed events, older adults might incorrectly remember these events as having occurred during the videotape, mistaking the memory induced by the photograph for the recollection of an earlier (and differently situated) experience. For younger adults, by contrast, increases in remember responses as a function of photo exposure may only be observed for events that actually occurred in the videotape. The general idea is that encoding of an event that is depicted for the first time in a photograph will establish a novel representation of the event for both older and younger adults, but age-related source memory impairments will create special difficulties for older adults when they later try to remember whether the event had been part of the original videotape. If older adults are less able than younger individuals to monitor, or identify the source of, a sense of familiarity associated with an event exposed only in a photograph, or if they adopt looser criteria in evaluating source information, then they should be more likely than younger adults to claim that it ap-

peared in the initial videotape (cf. Dywan & Jacoby, 1990; Johnson et al., 1993; Norman & Schacter, in press).

To examine this hypothesis, we used a variant of the experimental paradigm developed by Koutstaal et al. (1997) to explore the effects of looking at photographs on memory for previously experienced events. Whereas Koutstaal et al. included only photographs of actually witnessed videotaped events (*true* photographs), the present experiments also included photographs of events that were not shown during the videotapes (*false* photographs). All participants initially viewed a videotape of a series of everyday events that unfold in a kitchen. Twenty minutes later, they reviewed a series of true photographs, which depicted events seen previously in the videotape, intermixed with false photographs, which depicted events in the same kitchen that had not been seen earlier in the videotape; for each photograph, participants rated how similar the photograph was to the events that they had watched during the videotape. Two days later, participants returned to the laboratory and were given a recognition test consisting of brief descriptions of objects. Participants were informed that some of the items had appeared in the videotape, some only in photographs, and some not at all. They were instructed to make a positive recognition response only when they specifically remembered that the object had appeared in the original videotape. Previous studies have shown that even when people are specifically instructed not to make positive recognition responses to postevent information that had been presented after a target episode, they will nonetheless do so when source memory fails (e.g., Jacoby, 1991; Lindsay, 1990). If older adults are less able than younger adults to recollect information about the source of a memory, then they should claim that events appearing only in photographs had appeared in the videotaped target episode.

To probe qualitative aspects of recollective experience, we used two procedures: remember-know judgments (cf. Gardiner & Java, 1993; Tulving, 1985) and subjective ratings on a Memory Characteristics Questionnaire (MCQ; cf. Johnson, Foley, Suengas, & Raye, 1988; Johnson, Nolde, & De Leonardi, 1996). Remember-know judgments indicate whether individuals recollect anything specific about an episode, and MCQ ratings assess the particular types of specific details they remember (e.g., perceptual, spatial, or emotional).

Experiment 1

Method

Participants

Participants were 32 elderly individuals (M age = 68.3 years, SD = 4.2, range = 60–75) and 32 younger individuals (M age = 17.8 years, SD = 1.5, range = 16–22). Elderly adults were initially recruited by various means, including posted flyers, newspaper advertisements, and word of mouth. Younger adults were primarily either secondary students enrolled in the Harvard Summer School program or in their first year of college and were recruited through sign-up sheets posted at Harvard University. Participants were paid for their involvement in the experiment.

All participants were native speakers of English. They were individually interviewed so as to exclude those with any of the following conditions: a history of alcoholism or substance abuse, cerebrovascular accident, recent myocardial infarction, present or previous treatment for

psychiatric illness, current treatment with psychoactive medication, metabolic or drug toxicity, primary degenerative brain disorders (e.g., Alzheimer's disease, Parkinson's disease, or Huntington's disease), and brain damage sustained earlier from a known cause (e.g., hypoxia). Also excluded were any older adults who obtained a score greater than one standard deviation above the mean reported for a normative geriatric sample on the Geriatric Depression Scale (Yesavage et al., 1983) and any younger adults who obtained a score greater than one standard deviation for their appropriate age group on the Depression subscale of the Brief Symptom Inventory (Cochran & Hale, 1985; Derogatis & Spencer, 1982).

Elderly adults had on average 15.5 years of formal education ($SD = 2.3$, range = 12–20); younger adults had on average 11.9 years of education ($SD = 1.3$, range = 11–17). A one-way analysis of variance (ANOVA) indicated that elderly adults had received more formal education than younger adults, $F(1, 62) = 60.58$, $MSE = 3.41$, $p < .0001$.

All participants completed the Vocabulary and Information subtests of the Wechsler Adult Intelligence Scale—Revised (WAIS-R; Wechsler, 1981). On the Vocabulary subtest elderly adults received a mean score of 60.3 ($SD = 5.4$, range = 45–68), whereas younger adults obtained a mean of 61.4 ($SD = 5.2$, range = 45–69). On the Information subtest elderly adults achieved a mean of 24.2 ($SD = 4.1$, range = 12–29), the corresponding average for younger adults was 23.5 ($SD = 3.3$, range = 15–29). The two age groups did not differ in their performance on either subtest ($F_s < 1$).

Stimulus Materials

Two 16-episode scripts were created, each involving two actors (a man and a woman of about 30 years of age). All of the episodes in both scripts took place in the same setting, were filmed on the same day, under similar lighting conditions, and with the actors wearing the same clothing for both videotapes.

The setting for the two scripts was a large kitchen. In addition to many typical kitchenlike items (e.g., cupboards, a microwave oven, and a large and smaller refrigerator), the kitchen had two doorways leading to other parts of the house, an outside exit, and a large closet. Many of the activities centered around the general theme of spring cleaning and tidying. For example, several items were found in the closet and were dealt with in some way: a large but tattered poster was torn and discarded, a markedly stained rug was taken outside to the trash, and a large garden hose was first disentangled and then taken outdoors. Other activities did not specifically adhere to the spring cleaning theme but were integrated into those activities. Examples of these other activities included finding a telephone number in a phone book and then calling a store to determine how late they were open, cutting and eating a piece of watermelon, and folding T-shirts that had been drying on the clothesline outside.

The events were filmed with a Sony Hi-8 video camcorder. All activities were filmed from the same location, with the camera mounted on a tripod. One of the films was approximately 7.5 min, the other was approximately 9 min.

The films were transferred to VHS videotape for viewing by the participants. The videotapes were presented on a 20 in. color television monitor, with the volume adjusted individually to a comfortable hearing level for each participant.

Thirty-two 3 in. \times 4 in. color photographs, depicting each of the 16 events from the two scripts, were made directly from the Hi-8 tape with a Sharp GZP21 Video Printer. The photographs were highly characteristic of each event or scene and were readily identifiable as portraying particular events, all of the activities having originally been chosen to involve large, clearly identifiable, and "photogenic" objects.

The photographs from each videotape were divided into two sets of eight photographs each (Sets A and B for Videotape Version 1; Sets C

and D for Videotape Version 2). Each set depicted every second event from one of the videotapes. Set A consisted of all the odd-numbered events from Version 1, whereas Set B consisted of all the even-numbered events; likewise for Sets C and D, respectively, for Version 2.

Photographs from the two videotapes were then intermixed, with four different combined sets being created—one for each of the four possible across-videotape pairings of Sets A and C, A and D, B and C, and B and D. Within each of these combined sets, the photographs were placed in a pseudorandom order such that no more than two photographs from the same videotape occurred consecutively and no photograph occurred in its proper temporal sequence relative to another photograph. These photos were then placed in the clear plastic protector sheets of four small photo albums. Each photograph was placed on a separate page, with a blank page intervening so that only one photograph could be viewed at a time. Finally, each of the photos was clearly numbered.

Design

The experimental design was a $2 \times 2 \times 2$ mixed factor factorial. There were two between-subjects variables, including age (old or young) and repetition of photo viewing (participants were shown the photographs either once or three times). The one within-subject variable (photo review) was applicable both to events that the participant actually watched on the videotape (studied items) and to events that the participant did not see on the videotape (nonstudied items). There were 16 people in each of the four between-subjects conditions. In each between-subjects condition, the particular videotape watched by the participants (Version 1 or Version 2) and the particular combined set of photographs shown during photo viewing (Sets AC, AD, BC, or BD) were counterbalanced across participants.

Procedure

The overall procedure involved several phases: (a) initial viewing of one of the videotapes; (b) exposure to two (intermixed) sets of photographs, including photographs drawn from the videotape that had been watched by the participant (true photographs) and photographs from the alternate videotape (false photographs); and (c) administration of a verbal recognition test.

All participants were tested individually. Participants first watched one of the two videotapes (either Version 1 or Version 2), with instructions to think about how enjoyable, how well acted, and how clearly filmed it was. After rating the film on these three dimensions, participants performed an unrelated task for 20 min. Then they were shown a set of 16 photographs. One half of these photographs were drawn from the videotape that they had watched 20 min earlier. However, the other half were drawn from the alternate videotape that they had not seen (e.g., if the participant had seen Version 1, 8 of the photographs were drawn from episodes in Version 1, and 8 were drawn from episodes in Version 2 that he or she had never seen). Participants were told that some of the photographs were taken from the videotape that they had watched earlier and that their task was to rate how similar each photograph was to an event or scene that they had viewed on the videotape. The photographs were presented in a different order from the events in the original script, and both true and false photographs were presented in a randomly intermixed fashion, but with the constraint that no more than 2 photographs of either type (true or false) could occur consecutively. Each photograph was presented for 20 s, with participants listening to an audiotaped recording that indicated when they were to turn to the next photograph.

Depending on the participants' assigned experimental condition with regard to the repetition factor (photographs shown once or thrice), they either now left the laboratory (individuals in the *once* condition), to return 2 days later, or remained in the laboratory for additional photo review (individuals in the *thrice* condition). Participants in the repeated

photograph review condition were shown the photographs a total of three times, with each viewing temporally separated from the prior viewing by 20 min. The photographs were shown in a different order each time. Specifically, the viewing orders were constituted such that no item occurred in the same place on all three occasions, and no more than two items from a given set (i.e., true or false) occurred consecutively. At the outset, participants were unaware that they would be shown the photographs more than once. Also, for the second and third viewings, they performed the same rating task as on the first viewing (i.e., rating how similar each photograph was to an event or scene depicted in the videotape that they had watched).

Two days later, participants returned to the laboratory (average delay interval = 47.7 hr, $SD = 2.1$, range = 42–54). They were then given a recognition test consisting of brief verbal descriptions of objects (e.g., "torn poster," "garden hose," and "watermelon"). The recognition test consisted of 40 such items, including 16 items that had been shown in the videotape (8 of which had also been reviewed by photographs and 8 of which had not been reviewed), 16 items from the alternate (nonpresented) videotape (8 of which had been presented during the photograph review phase and 8 of which were never presented), and 8 nonstudied and nonscored filler items.

Participants were instructed to designate as *old* only those items that they had seen in the videotape. The specific instructions read

Mark an item *old* if it appeared in the videotape that you watched earlier. Only call old those items that you believe actually appeared in the videotape. Do not call an item old if you think it appeared only in the photographs that you saw but did not also occur in the videotape.

Mark an item *new* if it did not appear in the videotape.

In addition, for those items that they designated as old, participants were asked to provide a remember or know judgment and to indicate from a number of options what led them to recognize each item as old. The instructions for the remember-know distinction were identical to those used by Koutstaal et al. (1997) and read

For each item which you mark as old, please indicate whether you consciously remember that the item was shown in the videotape, or whether you simply know, in some other way, that the item was in the videotape.

Mark *remember* if you can specifically remember something that happened or that you experienced at the time the item was shown—for example, where the item was, what someone said about the item, or what the item made you think about.

Mark *know* if you somehow just feel or know that the item was shown in the videotape—that is, it just feels familiar in some way—but you cannot remember anything specific about the item or its occurrence.

Finally, for each item that they marked as old, participants were also asked to complete a MCQ, indicating what it was that led them to recognize the item as old. Following each item were several options describing different reasons that participants might recognize an item from the videotape. Participants were asked to circle as many of these reasons as applied, including

- what the object looked like (abbreviated as *look*)
- what someone did with the object (*did*)
- what someone said about the object (*said*)
- where the object was located (*location*)
- what you felt or thought about the object (*feelings-thoughts*)
- strong feeling of familiarity—you're sure it's old (*strong familiarity*)

- vague feeling of familiarity—it's probably old (*vague familiarity*)
- other—reasons for recognition not included above (*other*).

At the conclusion of the experiment, participants were debriefed.

Results

Tables 1 and 2 present the results for the recognition test measures. Table 1 shows the outcomes for the three primary measures of recognition (overall recognition, remember responses, and know responses). Table 2 gives the outcomes for the several qualitative MCQ response measures that more specifically probed what it was that younger and older adults remembered concerning each item (e.g., did they remember the visual appearance or look of the object, did they remember what the person did with the object, and so forth). In both Table 1 and Table 2, the first two numerical columns show the proportion of correct responses for items from the viewed videotape that were or were not reviewed by photographs, whereas the last two columns show the proportion of false alarms (old responses) to items from the alternate videotape that were or were not shown in the photographs. The effects of age, photograph review, and repeated photograph review are examined first in relation to false alarms and then in regard to the likelihood of correct responses.

All analyses on proportions were performed after arcsine transformation (Snedecor & Cochran, 1989). Also, unless otherwise noted, all effects reported were based on $2 \times 2 \times 2$ mixed factor ANOVAs treating age (old vs. young) and repetition (once vs. thrice) as between-subjects variables and photograph review (reviewed vs. not reviewed) as a within-subject variable. Because the qualitative measures involve large numbers of largely exploratory analyses, to minimize the likelihood of Type I errors, we used a more stringent level of significance for these analyses ($p < .01$) than for basic analyses of hits and false alarms ($p < .05$).

False Alarms

Effects of age. Overall, and combining across the photograph review manipulation, older adults were only slightly more likely to make false alarms ($M = .15$) than were younger adults ($M = .10$), $F(1, 60) = 2.84$, $MSE = .03$, $p = .10$. Elderly adults were also slightly, but significantly, more likely to give false-recognition responses accompanied by judgments of remembering ($M = .05$) than their younger counterparts ($M = .02$), $F(1, 60) = 4.68$, $MSE = .01$, $p = .03$.

Effects of photograph review. False alarms were more than twice as common for nonstudied items that had been presented in photographs ($M = .17$) than for nonstudied items that were never presented ($M = .08$), $F(1, 60) = 20.96$, $MSE = .01$, $p < .0001$. Although false alarms accompanied by judgments of remembering were relatively infrequent, they were significantly more likely to occur for items that had ($M = .05$) than for items that had not ($M = .01$) been reviewed by photographs, $F(1, 60) = 18.08$, $MSE = .002$, $p < .0001$. A similar pattern was observed for false alarms accompanied by know responses ($M_s = .12$ and $.07$, respectively), $F(1, 60) = 8.83$, $MSE = .01$, $p = .004$. Most important, false alarms accompanied by remember

Table 1
Primary Recognition Measures for Experiment 1

Measure and condition	Correct responses				False alarms			
	Shown in photograph		Not shown in photograph		Shown in photograph		Not shown in photograph	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Overall recognition								
Old, once	.90	.11	.67	.19	.20	.16	.11	.14
Old, thrice	.91	.14	.62	.26	.21	.20	.09	.12
Young, once	.96	.08	.82	.12	.16	.16	.06	.08
Young, thrice	.95	.11	.76	.21	.10	.11	.08	.13
Remember responses								
Old, once	.85	.15	.56	.21	.05	.08	.00	.00
Old, thrice	.89	.17	.47	.27	.10	.10	.03	.10
Young, once	.93	.10	.73	.18	.03	.06	.00	.00
Young, thrice	.91	.16	.63	.24	.02	.04	.02	.04
Know responses								
Old, once	.05	.06	.11	.16	.15	.15	.11	.14
Old, thrice	.02	.05	.15	.12	.11	.14	.06	.09
Young, once	.03	.06	.09	.10	.13	.13	.06	.08
Young, thrice	.04	.06	.13	.14	.08	.11	.06	.11

Note. Mean proportions are shown as correct responses for recognition test items drawn from the viewed videotape; mean proportions are shown as false alarms for recognition test items drawn from the alternate videotape.

responses amongst older adults were more strongly elevated by exposure to the photographs than was true for the younger adults, as shown by a significant Age \times Photograph Review interaction, $F(1, 60) = 6.07$, $MSE = .002$, $p = .02$. There was no Age \times Review interaction for know responses.

The various qualitative measures likewise revealed modest but significant detrimental effects of photograph exposure on source-monitoring ability. If participants had earlier encountered an item during the photograph review phase, they significantly more often indicated that they could remember the visual appearance of the items to which they false alarmed, $F(1, 60) = 35.01$, $MSE = .003$, $p < .0001$, what action had been performed with the item, $F(1, 60) = 11.56$, $MSE = .01$, $p = .001$, and that it evoked a strong sense of familiarity, $F(1, 60) = 6.93$, $MSE = .004$, $p = .01$, than if they had not earlier encountered the item in the photographs.

Some of these effects of photograph review, too, were modified by an interaction with age, indicating an age-related increase in photo-induced false recognition. There were significant Age \times Photograph Review interactions for false alarms accompanied by look responses, $F(1, 60) = 7.06$, $MSE = .003$, $p = .01$, and strong familiarity responses, $F(1, 60) = 6.93$, $MSE = .004$, $p = .01$.

Effects of repeated photograph review. When collapsing over photograph review and age, repeated viewing of the photographs did not influence the number of false alarms overall ($F < 1$) and only slightly increased the likelihood of remember false alarms, $F(1, 60) = 2.52$, $MSE = .01$, $p = .12$. There were also no interactions of photograph review with repetition for these measures or for the MCQ response measures. There were trends toward a higher order interaction of photo review and repetition with age for overall false alarms, $F(1, 60) = 3.07$, $MSE = .01$, $p = .09$, and for remember false alarms, $F(1, 60)$

$= 2.45$, $MSE = .002$, $p = .12$. Whereas both overall and remember false alarms in the elderly adults tended to increase with repeated photograph viewing, the reverse tended to be true for the younger adults (cf. Zaragoza & Mitchell, 1996).

Correct Responses

Effects of age. Overall, when combining across both the photo review and repetition manipulations, younger participants correctly recognized more of the verbal descriptions of items from the videotape that they had watched ($M = .87$) than did their older counterparts ($M = .78$), $F(1, 60) = 7.46$, $MSE = .14$, $p = .008$. On the remember-know task, younger adults were also more likely to indicate that they specifically remembered episodic details concerning the events from the videotape that they recognized ($M = .80$) than were older adults ($M = .69$), $F(1, 60) = 5.52$, $MSE = .17$, $p = .02$. The two age groups did not differ in the likelihood of positive-recognition responses accompanied by judgments of knowing ($F < 1$).

Considering the qualitative queries of the MCQ probing what, more precisely, participants remembered concerning the items, older and younger adults did not differ significantly, with the exception of a trend indicating that younger adults ($M = .76$) were somewhat more likely than older adults ($M = .64$) to indicate that they remembered what the actors did with the objects, $F(1, 60) = 6.16$, $MSE = .16$, $p = .02$.

Effects of photograph review. Overall, participants were substantially more likely to correctly recognize items that they had earlier reviewed by looking at photographs ($M = .93$) than items that had not been reviewed ($M = .72$), $F(1, 60) = 112.54$, $MSE = .07$, $p < .0001$. This mnemonic benefit that was due to photograph review was strongly apparent for responses that were accompanied by judgments of remembering (means for

Table 2
Qualitative Recognition Response Measures for Experiment 1

Measure and condition	Correct responses				False alarms			
	Shown in photograph		Not shown in photograph		Shown in photograph		Not shown in photograph	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Look								
Old, once	.81	.19	.52	.24	.07	.06	.01	.03
Old, thrice	.85	.20	.44	.32	.12	.10	.02	.04
Young, once	.73	.32	.55	.30	.06	.06	.02	.04
Young, thrice	.84	.22	.48	.23	.03	.07	.01	.03
Did								
Old, once	.79	.18	.50	.24	.08	.10	.01	.03
Old, thrice	.81	.21	.44	.26	.07	.13	.01	.03
Young, once	.86	.14	.71	.16	.03	.06	.02	.04
Young, thrice	.86	.18	.60	.21	.02	.05	.01	.03
Said								
Old, once	.45	.20	.34	.24	.02	.05	.01	.03
Old, thrice	.38	.32	.26	.27	.01	.03	.00	.00
Young, once	.52	.17	.45	.18	.00	.00	.01	.03
Young, thrice	.31	.21	.36	.23	.00	.00	.00	.00
Location								
Old, once	.73	.28	.48	.25	.09	.13	.02	.06
Old, thrice	.63	.37	.33	.31	.06	.13	.03	.10
Young, once	.63	.31	.55	.22	.05	.08	.02	.04
Young, thrice	.77	.25	.48	.23	.02	.07	.02	.05
Feelings—Thoughts								
Old, once	.21	.34	.14	.25	.05	.14	.01	.03
Old, thrice	.25	.37	.16	.25	.03	.07	.02	.04
Young, once	.31	.37	.27	.29	.05	.16	.01	.03
Young, thrice	.34	.32	.23	.21	.01	.03	.00	.00
Strong familiarity								
Old, once	.84	.14	.52	.21	.06	.13	.00	.00
Old, thrice	.55	.41	.24	.26	.06	.10	.00	.00
Young, once	.58	.39	.45	.32	.01	.03	.01	.03
Young, thrice	.52	.42	.27	.22	.01	.03	.01	.03
Vague familiarity								
Old, once	.03	.06	.08	.09	.11	.12	.09	.13
Old, thrice	.05	.09	.13	.12	.09	.13	.06	.12
Young, once	.04	.06	.09	.11	.13	.14	.05	.08
Young, thrice	.08	.10	.20	.23	.08	.11	.06	.11

Note. Mean proportions are shown as correct responses for recognition test items drawn from the viewed videotape; mean proportions are shown as false alarms for recognition test items drawn from the alternate videotape.

reviewed and nonreviewed items were .90 and .60, respectively), $F(1, 60) = 136.69$, $MSE = .08$, $p < .0001$. Correspondingly, there was also a reverse effect on know judgments, with nonreviewed items more frequently accompanied by judgments of knowing ($M = .12$) than were reviewed items ($M = .04$), $F(1, 60) = 23.10$, $MSE = .01$, $p < .0001$.

Four of the seven qualitative MCQ measures also revealed beneficial effects of photograph review. Participants more often indicated that they remembered the visual appearance of the objects involved in reviewed events, $F(1, 60) = 150.63$, $MSE = .06$, $p < .0001$, what actions were performed with them, $F(1, 60) = 112.05$, $MSE = .06$, $p < .0001$, what they felt or thought concerning them, $F(1, 60) = 12.73$, $MSE = .04$, $p = .0007$, and that they evoked a strong sense of familiarity, $F(1, 60) = 80.86$, $MSE = .07$, $p < .0001$, than was true of nonreviewed items. Also, an inverse effect of photograph review was ob-

served on vague familiarity responses, with nonreviewed items more often accompanied by vague familiarity than were reviewed items, $F(1, 60) = 17.83$, $MSE = .01$, $p < .0001$.

On the primary recognition measures, the beneficial effects of photograph review did not interact with age: overall recognition, $F < 1$; remember responses, $F < 1.6$; and know responses, $F < 1$. There were also no significant interactions of age with photograph review for the qualitative measures.

Effects of repeated photograph review. There was no effect of repeated viewing of the photographs on any of the primary measures of correct recognition (F s < 1 for overall recognition, remember responses, and know responses). Repetition also did not interact with age on these measures (F s < 1). As discussed below, ceiling effects made it difficult to draw any conclusions about the impact of repetition on correct recognition.

Repeated viewing of the photographs produced trends for two

of the qualitative response measures: Both strong familiarity, $F(1, 60) = 5.55$, $MSE = .32$, $p = .02$, and vague familiarity, $F(1, 60) = 5.28$, $MSE = .02$, $p = .03$, responses were more frequently given for items that had been reviewed three times than for items that had been reviewed only once. There was a significant interaction of repetition with photograph review on the look measure, $F(1, 60) = 7.18$, $MSE = .06$, $p = .01$, reflecting the fact that repeatedly reviewing events by photographs led to greater mnemonic gains than did a single viewing.

Corrected Recognition Scores

Examination of the corrected recognition scores (i.e., hits minus false alarms) for overall recognition revealed significant effects of age, $F(1, 60) = 8.55$, $MSE = .18$, $p = .005$, and of photograph review, $F(1, 60) = 20.51$, $MSE = .07$, $p = .0001$. A similar pattern was apparent for the corrected remember response scores (i.e., remember responses minus remember false alarms), with significant effects of age, $F(1, 60) = 10.74$, $MSE = .16$, $p = .002$, and photograph review, $F(1, 60) = 94.97$, $MSE = .07$, $p < .0001$.

Photograph Encoding Task

Participants rated the photographs that were drawn from the videotapes that they had, in fact, actually watched as considerably more similar to the videotape than photographs depicting events from the alternate videotape that they had not watched. This difference was apparent for both younger and older participants. On a scale with responses ranging from 1 (*the photograph was not at all similar to an event or scene from the videotape*) to 5 (*the photograph was extremely similar to an event or scene from the videotape*), the average ratings for younger and older adults on their first viewing of the photographs for true photographs were 4.77 and 4.58, respectively. The comparable means for false photographs were 1.17 and 1.20, respectively. A similar difference remained apparent after repeated photograph review, with both younger and older participants' ratings on their second and third encounters with the photographs almost identical to those on their first encounter.

Discussion

Experiment 1 revealed that exposure to a photograph of a recently experienced event increased the likelihood that both older and younger adults would later remember that event when given a brief verbal description relating to it (cf. Koutstaal et al., 1997). More important, older adults were more likely than younger adults to falsely remember descriptions of events that they had seen only in photographs, even though all participants were explicitly warned that some descriptions referred to incidents depicted only in the photographs and that they should not make a positive-recognition response unless they actually remembered an event from the initial videotape. In addition, responses on the MCQ indicated that false recognitions in older adults were more often accompanied by recollections of the appearance of objects, and by a sense of strong familiarity,

than in younger adults. By contrast, when making recognition judgments about descriptions of events that had appeared both in photographs and in the original videotape, or only in the original videotape, older adults made fewer remember responses than did younger adults and showed similar levels of performance on the qualitative MCQ measures mentioned above that showed age-related differences for false alarms.

These latter findings lend support to the idea that the age-related differences we observed in susceptibility to false recognition reflect impaired source-monitoring abilities in the elderly group. Older adults appear less able than younger adults to recollect whether an event occurred in the original videotape or was shown only in a photograph. Thus, younger adults are more likely than older adults to successfully override or oppose the sense of familiarity or recollection associated with an event seen only in a photograph by recalling and using additional differentiating contextual information about the source of the event.

It is possible, however, that younger adults might also show susceptibility to false recollection of events depicted in photographs under conditions in which the difficulty of source monitoring is increased. In Experiment 1, the encoding task (to rate the videotape according to how enjoyable, how well acted, and how clearly it was filmed) required participants to engage in elaborate encoding of the taped events. Moreover, when reviewing the photographs, participants were instructed to think back to the study episode and rate how similar the photographs were to events that they had watched in the videotapes. Both of these features of the design may have allowed participants, particularly younger ones, to segregate effectively the "false photos" from the "true photos" drawn from the videotape.

To examine the reliability and generality of the age-related differences in photo-induced false recollection observed in Experiment 1, we conducted an additional experiment in which we attempted to create conditions more conducive to the development of false recognition. Specifically, we altered the videotape encoding task so that it involved less extensive elaborative processing than in Experiment 1. In addition, we altered the photograph rating task performed before testing so that it did not encourage participants to explicitly label the photographs as old (i.e., drawn from the viewed videotape) or new (i.e., never presented), which may well have occurred during the similarity rating task used in Experiment 1. Finally, we also increased the delay between the study and test sessions and presented photographs during the second (i.e., test) session rather than during the study session.

Experiment 2

Method

Participants

Both older and younger participants were initially recruited and then screened for the same medical and neuropsychological conditions as in the first experiment. Sixteen older (M age = 68.1 years, $SD = 4.3$, range = 60–75) and 16 younger individuals (M age = 19.2 years, $SD = 1.7$, range = 17–24) participated.

Older adults had on average 16.9 years of formal education ($SD = 2.6$, range = 12–20); younger adults had on average 13.2 years of

education ($SD = 1.2$, range = 12–16). A one-way ANOVA indicated that elderly participants had received more years of formal education than had younger participants, $F(1, 30) = 27.36$, $MSE = 4.11$, $p < .0001$.

All participants completed the Vocabulary and Information subtests of the WAIS-R (Wechsler, 1981). On the Vocabulary subtest elderly participants received a mean score of 59.8 ($SD = 6.4$, range = 45–68), whereas younger participants obtained a mean of 62.7 ($SD = 3.9$, range = 54–68). On the Information subtest elderly adults achieved a mean of 24.3 ($SD = 3.3$, range = 15–28); the corresponding average for younger adults was 25.2 ($SD = 2.3$, range = 21–29). The two age groups did not significantly differ in their performance on the Vocabulary subtest ($F < 2.4$) or on the General Information subtest ($F < 1$).

Procedure

Although the overall procedure was similar to that for the first experiment, four specific alterations were made with the aim of increasing the number of false alarms induced through exposure to the false photographs. First, the task that participants were asked to perform during their initial viewing of the videotapes was changed. Rather than asking participants to rate how enjoyable, how well filmed, and how well acted the videotape was, they were asked to mentally keep track of the number of times that either the man or the woman entered or exited from the room. (This happened a total of approximately 15 times in each videotape, or with sufficient frequency to make this a reasonably attention-demanding task.)

Second, the task that participants were asked to perform during their encounter with the photographs was also changed. Rather than rating how similar the event or scene depicted in each of the photographs was to something that had been shown in the videotape—a task that may have encouraged labeling some photos as true and some as false—older and younger adults were asked to evaluate the extent to which the different elements in the photographs presented a pleasing overall composition. Participants were asked to look carefully at each photograph and then determine whether it constituted a pleasing array, considering such factors as “the relation of the person or persons pictured to background objects, the angle and distance at which persons and objects are shown, and whether individuals or objects are cut off by the picture.” Because this task does not require episodic reference to the videotape, we ex-

pected that the degree to which participants separately encoded the true and false photographs would be reduced. The photographs were shown once each.

Third, rather than showing participants the photographs during their initial visit to the laboratory and within the same experimental session as the videotape itself, the photographs were shown on participants' return visit to the laboratory. Moreover, in contrast to Experiment 1, in which the delay between the initial videotape viewing and the recognition test was 2 days, the delay between the two sessions was increased to 2 weeks (average = 14.3 days, $SD = 1.2$, range = 13–18). We expected that these last two changes would act to reduce participants' memory for the videotape at the time of their encounter with the photographs, thereby possibly decreasing the likelihood that the true and false photographs would easily be identified as such.

In summary, the procedure involved the following five steps, in which participants (a) watched one of the videotapes (either Version 1 or Version 2) while performing the entries-and-exits counting task, (b) left the laboratory and returned 2 weeks later, (c) were shown photographs drawn from both the previously watched videotape and the alternate videotape and rated the photographs' compositional pleasingness, (d) performed an unrelated task for 20 min, and (e) were given the verbal recognition test (with remember-know judgments and qualitative responses).

Results

Tables 3 and 4 provide the results for the recognition test measures. Table 3 shows the outcomes for the three primary measures of recognition (overall recognition, remember responses, and know responses). Table 4 gives the outcomes for the qualitative response measures that more specifically probed what it was that participants remembered concerning each item that they designated as old. In both Table 3 and Table 4, the first two numerical columns show the proportion of correct responses for items that were or were not reviewed by photographs, whereas the last two columns show the proportion of false alarms to items that were or were not shown in the photographs. The effects of age and photograph review on false

Table 3
Primary Recognition Measures for Experiment 2

Measure and condition	Correct responses				False alarms			
	Shown in photograph		Not shown in photograph		Shown in photograph		Not shown in photograph	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Overall recognition								
Old	.69	.29	.49	.24	.40	.29	.28	.24
Young	.88	.13	.81	.14	.22	.17	.22	.17
Remember responses								
Old	.51	.31	.35	.27	.27	.26	.11	.14
Young	.69	.25	.55	.23	.04	.08	.05	.09
Know responses								
Old	.18	.16	.14	.11	.13	.13	.17	.18
Young	.20	.15	.26	.16	.17	.14	.17	.18

Note. Mean proportions are shown as correct responses for recognition test items drawn from the viewed videotape; mean proportions are shown as false alarms for recognition test items drawn from the alternate videotape.

Table 4
Qualitative Recognition Response Measures for Experiment 2

Measure and condition	Correct responses				False alarms			
	Shown in photograph		Not shown in photograph		Shown in photograph		Not shown in photograph	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Look								
Old	.48	.30	.32	.27	.23	.25	.12	.13
Young	.54	.28	.44	.26	.06	.08	.02	.05
Did								
Old	.38	.28	.28	.21	.12	.13	.11	.17
Young	.64	.22	.61	.18	.08	.11	.05	.08
Said								
Old	.15	.13	.16	.15	.08	.11	.06	.10
Young	.31	.18	.30	.20	.03	.06	.00	.00
Location								
Old	.42	.25	.29	.24	.18	.20	.10	.17
Young	.51	.34	.44	.29	.07	.11	.07	.10
Feelings-Thoughts								
Old	.19	.19	.10	.17	.04	.08	.02	.05
Young	.14	.19	.10	.12	.02	.04	.01	.03
Strong familiarity								
Old	.47	.31	.29	.23	.23	.26	.10	.20
Young	.46	.30	.40	.29	.02	.04	.01	.03
Vague familiarity								
Old	.17	.16	.16	.18	.16	.14	.15	.15
Young	.17	.13	.21	.15	.16	.15	.15	.18

Note. Mean proportions are shown as correct responses for recognition test items drawn from the viewed videotape; mean proportions are shown as false alarms for recognition test items drawn from the alternate videotape.

alarms are considered first, followed by the effects of these factors on correct responses.

False Alarms

Effects of age. Overall, and combining over false alarms accompanied by remember responses and know responses, elderly adults were more likely to give false-alarm responses ($M = .34$) than were young adults ($M = .22$), $F(1, 30) = 3.95$, $MSE = .08$, $p = .06$. In addition, older adults were markedly more likely to give remember false-recognition responses ($M = .19$) than were the younger adults ($M = .04$), $F(1, 30) = 10.09$, $MSE = .04$, $p = .003$, whereas the two age groups did not differ in the likelihood of giving know false-recognition responses ($F < 1$). Elderly adults were also more likely to indicate that they remembered the visual appearance of the objects that they falsely recognized, $F(1, 30) = 9.74$, $MSE = .03$, $p = .004$, and that those objects were strongly familiar, $F(1, 30) = 11.56$, $MSE = .04$, $p = .002$, than was true of young participants.

Effects of photograph review. When combining across both age and type of recollective judgment (remember or know), false-recognition responses were not significantly more frequent for reviewed than for nonreviewed items ($F < 1.7$). However, as is apparent from Table 3, elderly participants showed a strong numerical tendency toward greater false alarms for items that were previously exposed in the photographs ($M = .40$) than for items that were not so exposed ($M = .28$), $F(1, 15) = 1.97$,

$MSE = .06$, $p = .18$. Furthermore, when considering only those false alarms accompanied by judgments of remembering, false alarms were more frequent for those items that had been presented in photographs ($M = .15$) than for those that had not been thus presented ($M = .08$), $F(1, 30) = 4.46$, $MSE = .03$, $p = .04$. Of importance, however, this effect was modified by a significant interaction with age, $F(1, 30) = 5.36$, $MSE = .03$, $p = .03$. Whereas elderly adults were more than twice as likely to give false-recognition responses accompanied by remember judgments for items presented in the photographs ($M = .27$) than for items not presented ($M = .11$), there was essentially no difference as a function of photograph presentation for the young ($M_s = .04$ and $.05$, respectively). Analyses performed on the young and elderly age groups separately revealed a significant effect of photograph review in the elderly group, $F(1, 15) = 5.17$, $MSE = .05$, $p = .04$, but not in the young group ($F < 1$). There was no effect of photograph review on false alarms accompanied by know responses ($F < 1$).

When considering participants' MCQ responses, no effects attained the $p < .01$ level of significance, although when combining across the two age groups, there were trends for older and younger adults to indicate more often that they remembered the visual appearance of objects that they incorrectly recognized, $F(1, 30) = 4.52$, $MSE = .02$, $p = .04$, and what was said in conjunction with the object, $F(1, 30) = 4.86$, $MSE = .002$, $p = .04$, for reviewed than nonreviewed items. There were no interactions of age and review on the qualitative measures (all $F_s < 2$).

Correct Responses

Effects of age. Overall, young adults recognized significantly more of the items from the videotape that they had watched ($M = .84$) than did elderly adults ($M = .59$), $F(1, 30) = 14.71$, $MSE = .19$, $p = .0006$. A similar trend was apparent in both remember responses, with young participants tending to give more remember responses ($M = .62$) than elderly participants ($M = .43$), $F(1, 30) = 3.75$, $MSE = .22$, $p = .06$, and in know responses, although the differences that were due to age in know responses were considerably smaller in magnitude (means for younger and older adults were .23 and .16, respectively), $F(1, 30) = 2.26$, $MSE = .03$, $p = .14$. When considering the MCQ measures, younger adults more often indicated that they remembered the action that was involved with the objects, $F(1, 30) = 12.48$, $MSE = .17$, $p = .001$, and what the actors had said concerning the object, $F(1, 30) = 9.20$, $MSE = .05$, $p = .005$, than was true for older adults.

Effects of photograph review. Strong effects of photograph review were apparent in overall recognition, with significantly more items recognized after prior photograph review ($M = .79$) than without such review ($M = .65$), $F(1, 30) = 18.72$, $MSE = .06$, $p = .0002$. These mnemonic gains that were due to reviewing events through photographs were nearly entirely carried by remember responses (means for reviewed and nonreviewed items were .60 and .45, respectively), $F(1, 30) = 15.75$, $MSE = .06$, $p = .0004$; know responses were unaffected by photograph review ($F < 1$).

MCQ responses also revealed strong effects of photograph review. Participants more often indicated that they remembered the visual appearance, $F(1, 30) = 10.48$, $MSE = .06$, $p = .003$, and location, $F(1, 30) = 8.17$, $MSE = .04$, $p = .008$, of reviewed than nonreviewed objects and more often indicated that they had a sense of strong familiarity for those items, $F(1, 30) = 10.66$, $MSE = .04$, $p = .003$. There were no significant interactions of age with photograph review (all F s < 2).

Corrected Recognition Scores

Analyses of the corrected recognition scores (i.e., hits minus false alarms) for overall recognition of verbal descriptions revealed a significant effect of age, $F(1, 30) = 16.77$, $MSE = .18$, $p = .0003$. The effect of photograph review in the corrected scores was just shy of significance, $F(1, 30) = 3.70$, $MSE = .06$, $p = .06$. Both the main effect of age, $F(1, 30) = 12.75$, $MSE = .20$, $p = .001$, and the effect of photograph review, $F(1, 30) = 5.47$, $MSE = .05$, $p = .03$, were significant in the corrected remember response scores (i.e., remember responses minus remember false alarms). There was also a marginal interaction of age and photograph review in the corrected remember scores, $F(1, 30) = 3.41$, $MSE = .05$, $p = .07$. This trend reflected the fact that, after taking the level of false alarms into account, elderly adults' level of remember responding was identical for reviewed and nonreviewed items, whereas younger adults still showed a mnemonic benefit for reviewed items relative to those they had not reviewed.

Videotape Encoding Task

Elderly participants did not differ from younger participants in their counts of the number of times that the man entered or

left the room during the videotape (means for old and young were 5.6 and 6.0, respectively; $F < 1$) or in their determinations of the number of times that the woman did so (means for old and young were 6.7 and 7.6, respectively; $F < 2.2$).

In summary, Experiment 2 replicated and extended the finding from Experiment 1 that older adults are more prone to remember incorrectly that an event they viewed only in a photograph was part of a videotaped sequence. Although our attempt to increase the difficulty of source monitoring produced generally higher levels of false alarms than in Experiment 1 for both older and younger adults, there was no evidence of photo-induced false recollection in younger adults.

General Discussion

Previous research has shown that older adults often exhibit difficulties remembering the source of recently acquired information (Ferguson et al., 1992; Hashtroudi et al., 1989; McIntyre & Craik, 1987; Schacter et al., 1991, 1994), which is likely to make them more susceptible to false recognition than younger adults (Norman & Schacter, in press; Rankin & Kausler, 1979; Tun et al., 1996). The two experiments reported in this article show that older adults are also much more likely than younger adults to mistakenly claim that they remember an event from a videotaped sequence of events when, in fact, they only saw it in a photograph. The age-related increase in susceptibility to false recollection was observed in both experiments, despite a variety of procedural differences between them motivated by our attempt in Experiment 2 to create conditions more conducive to false recollection in younger adults.

Although we refer to an age-related increase in photo-induced false recollection, our experiments did not demonstrate that older adults construct totally false memories of events that never happened. Rather, our data showed that older adults sometimes confuse the origin of distinct events that did happen, leading to an incorrect or false claim of recollection. This effect occurred even though we specifically instructed participants to respond "old" only when they remembered an event from the videotape, directed them not to call old events that were portrayed only in photographs (cf. Lindsay, 1990), and required them to focus on and report qualitative details of their memories for each event that they designated as old (cf. Multhaup, 1995).

To understand the origin of these mistaken memories, first consider differences between younger and older adults in their true memories. Overall, compared with younger adults, older adults recognized fewer true events and assigned fewer remember responses to old items. However, older adults' remember responses were increased as much as those of younger adults from exposure to photographs of events that had occurred previously in the videotape, relative to remember responses for events not shown in photographs. On the basis of participants' responses on the MCQ, the greater number of remember responses by young adults was associated, at least in part, with greater reported memory for actions (Experiments 1 and 2) and for what was said (Experiment 2). Now consider the false recognitions. Viewing photos from the alternative tape increased older adults' false remember responses but did not consistently affect false recognition of younger adults. In both experiments, the MCQ data suggested that older adults' false remember re-

sponses were associated with photo-induced increments in memory for what things looked like and a strong sense of familiarity. It appears that older adults were likely to take remembered details (created by the photos) as evidence that the target event was part of the original video. Presumably, the greater amount or more varied detail available to younger adults allowed them to better specify the source of any particular test item. In short, compared with older adults, younger adults had access to more detailed source information or they considered more of the source information that was available to them. That is, what allows one to avoid source misattributions is the ability to offset (or "oppose") familiarity or ambiguous source information with more complete or detailed source information.

This latter point leads to an important question regarding the basis of the photo-induced false-recognition effect that we observed in older adults: Does it reflect a specific memory impairment amongst elderly adults—a source-monitoring error arising from inadequate or misplaced recollection of episodic details—or is it largely attributable to elderly participants' overall impairment in memory compared with the young? Older adults exhibited less accurate recognition memory than younger adults in both experiments, and it is possible that photo-induced false recollections in elderly adults may be an expression of a generally weak or degraded level of memory. Perhaps if younger adults were tested under conditions that yielded similar levels of recognition performance they, too, would exhibit false recollections to events depicted only in photographs. Similar issues have arisen in previous studies of source memory in elderly and brain-damaged populations (cf. Ferguson et al., 1992; Janowsky, Shimamura, & Squire, 1989; Schacter, Harbluk, & McLachlan, 1984; Schacter et al., 1991, 1994).

In Experiment 1, overall recognition accuracy of the younger participants exceeded that of the elderly participants but, in absolute terms, the magnitude of this age advantage, particularly in the relevant shown photograph condition, was quite small: difference of 5%, $F(1, 60) = 3.31$, $MSE = .10$, $p = .07$, for two-way analysis on overall recognition for the shown photographs condition alone, treating age and photo repetition as between-subjects variables. In Experiment 2, however, the difference between old and young in overall recognition accuracy for the shown photograph condition was much more pronounced: difference of 19%, $F(1, 30) = 6.66$, $MSE = .15$, $p = .02$. Given that it was also in Experiment 2 that elderly participants were most markedly prone to giving remember false-recognition responses for items that they had seen during photograph review, the possibility that the effect is primarily attributable to generally weaker memory in the old than the young clearly merits consideration. However, several aspects of our data provide evidence against the idea that photo-induced false recognition in older adults is simply an expression of a generally low level of memory performance.

Examination of individual elderly adults' performance in Experiment 2 revealed that a few of the participants obtained especially low-recognition accuracy scores in the shown photograph condition, identifying 50% or fewer of these reviewed items as old. Excluding these elderly participants ($n = 5$) and considering again correct responses in the shown photograph condition revealed that the age difference in correct recognition responses for this cell was essentially eliminated: Older adults achieved a

mean of 85% compared with a mean of 88% by the young ($F < 1$). Likewise, the proportion of remember responses in old and young was now nearly identical (65% vs. 69%, $F < 1$). The key question is whether eradication of the age difference in recognition accuracy also eliminates the age difference in false-recognition responses.

The results indicated that, rather than diminishing or eliminating the difference in remember false alarms, matching the recognition accuracy performance in the shown photograph condition of the old and the young instead slightly increased the difference in false alarms. Whereas the matched elderly participants were four times more likely to indicate incorrectly that they remembered items as having occurred in the videotape if they had earlier been shown a photograph of an event (32%) than in the absence of photograph review (8%)—the likelihood that younger participants would make remember false alarms was entirely unaffected by such review (4% vs. 5%). A two-way analysis on these data revealed a significant effect of age, $F(1, 25) = 9.56$, $MSE = .04$, $p = .005$, a significant main effect of photograph review, $F(1, 25) = 6.72$, $MSE = .02$, $p = .02$, and—most important,—a significant interaction of age and rehearsal, $F(1, 25) = 11.34$, $MSE = .02$, $p = .003$.

We also reversed the method of matching by bringing younger participants' level of overall recognition accuracy down to the level of the old, and this procedure yielded a very similar conclusion. After excluding any younger adults who achieved 100% in overall recognition in the shown photograph condition ($n = 7$), the means for the original old group and the matched young groups in this condition were .69 and .73, respectively ($F < 1$). This manner of matching left the pattern of remember false alarms virtually unaffected ($M_s = .04$ in both the shown photograph and not-shown photograph conditions for the young compared with .27 vs. .11, respectively, for the old). A two-way ANOVA revealed significant main effects of age, $F(1, 23) = 5.97$, $MSE = .05$, $p = .02$, and of photograph review, $F(1, 23) = 4.96$, $MSE = .03$, $p = .04$, and a trend toward an interaction, $F(1, 23) = 2.79$, $MSE = .03$, $p = .11$.

Taken together, these additional analyses provide little reason to believe that the distinctive vulnerability to source-monitoring errors manifested by older participants in these experiments can be attributed to globally or generally weaker memory. However, because we engaged in post hoc selection of participants on the basis of their performance on a specific measure, a procedure that is potentially susceptible to regression-to-the-mean artifacts, future research should examine the "weak memory" issue further. Such studies could delineate conditions that yield equivalent levels of recognition performance in older and younger adults and assess whether the age-related susceptibility to photo-induced false recognition documented in our experiments can still be observed.

Nonetheless, because neither of our post hoc matching procedures yielded even a hint of evidence favoring the weak memory hypothesis, our data are consistent with the hypothesis that the age-related false-recognition effects we observed are specifically attributable to impaired source-monitoring processes. Looking at photographs of events that were in some respects similar to events that they had actually experienced but that were in other—quite central—respects very different, led older participants to mistake what had been experienced by a photo-

graph for what had been experienced during an earlier session in a different format (a videotape). In the elderly adults, but not in the younger adults, photographs evoked a form of source-monitoring error involving the misplaced recollection of episodic details wherein events that were merely seen in a photograph were taken to have been experienced at an earlier time and under different conditions. A variety of observations from studies of brain-damaged patients (Schacter et al., 1984; Janowsky et al., 1989), as well as behavioral (Craik et al., 1990; Glisky, Polster, & Routhieux, 1995) and electrophysiological (Dywan, Segalowitz, & Williamson, 1994) studies of elderly adults, suggests that source memory problems are associated with age-related dysfunction in the vicinity of prefrontal cortex. Recent neuroimaging findings also indicate that age-related impairments in frontal lobe function are associated with behavioral impairments in strategic recall processes (Schacter, Savage, Alpert, Rauch, & Albert, 1996). Future studies will be necessary to determine whether the false-recollection effects we have observed are specifically associated with age-related impairments in frontal lobe functions.

Our results fit well with an earlier study by Cohen and Faulkner (1989), which showed that older adults are more susceptible than younger adults to the effects of misleading suggestions in the well-known postevent *misinformation paradigm* developed by Loftus and colleagues (e.g., Loftus, Miller, & Burns, 1978). Recent research has provided strong evidence that the detrimental effects of misleading postevent information in this paradigm are largely attributable to source-monitoring errors (Lindsay, 1990; Zaragoza & Lane, 1994). In the misinformation paradigm, elderly adults are more likely than younger adults to claim that inaccurate verbal information presented in a postevent narrative was part of the original videotaped event. In view of these findings, it is possible that older adults would exhibit false recollection in our paradigm even when presented with verbal descriptions of an event, rather than actual photographs of it, during the postevent review phase of our procedure. Indeed, Koutstaal et al. (1997) found that reviewing brief verbal descriptions of events that had appeared in an initial videotape produced largely similar facilitatory effects on subsequent recall and recognition performance as were found after review of photographs. Thus, we do not want to imply that the false-recognition effect we observed is specifically attributable to reviewing photographs or that reviewing photographs is necessary to produce the effect.

Although future research will be needed to determine whether reviewing photographs produces greater or lesser amounts of false recognition than reviewing verbal descriptions of events, the fact that photo review does have robust effects may have implications for how researchers think about the effects of photographs on older adults' everyday recollections. As noted in the introduction, older adults tend to value family photographs more highly than do younger people, in part because of their memory cuing functions. Our results suggest that viewing photos may not only reinstate or strengthen older adults' memories of an initial event, but it may also (or instead) create a new memory representation that refers to the event depicted in the photograph. When older adults view photographs in which they appear, or which refer to events in which they were actually participants, the dangers of creating false recollections are mini-

mal. Nonetheless, it is still possible that older adults may misremember details of what actually occurred in the original event as they review photos of it, which in turn may become incorporated into subsequent recollections of the event.

By contrast, in light of our results, it is possible that when elderly adults view photographs in which they do not appear, and which refer to events in which they were not participants, some individuals may later mistake their memories of the photograph for a memory of an event that never occurred. Future studies of the relations among photograph review, source monitoring, and false recognition in elderly adults should provide important insights into aspects of aging memory that are revealing theoretically and also have important implications for everyday life.

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