Effective Cue Utilization Reduces Memory Errors in Older Adults

Ayanna K. Thomas and John B. Bulevich
Colby College

When compared with younger adults, older adults typically manifest poorer episodic memory. One hypothesis for the episodic memory deficit is that older adults may not encode contextual information as well as younger adults. Alternatively, older adults may use contextual information at retrieval less effectively when compared with younger adults. If older adults encode context less well than younger adults, then manipulations that affect context should have little effect on memory performance. To evaluate these 2 hypotheses, the authors used manipulations that promoted effective contextual cue utilization at retrieval. Retention interval and instructions at retrieval were manipulated within the imagination inflation paradigm. Results suggest that older adults encode contextual cues useful in improving memory performance but have difficulty accessing and using those cues.

Keywords: contextual cues, false memories, imagination inflation, older adults

It has long been known that older adults have difficulty remembering peripheral contextual and perceptual information (for a review, see Kausler, 1994). For example, older adults are less likely than younger adults to report that they consciously recollect contextual details surrounding a remembered event (Mäntylä, 1993; Maylor, 1995; Parkin & Walter, 1992; Spencer & Raz, 1995). These findings would suggest that older adults have difficulty remembering the source of their memories (e.g., Hashtroudi, Johnson, & Chrosniak, 1989; McIntrye & Craik, 1987). While the general finding that older adults are less accurate in reporting source information is reliable, research has not clearly identified the locus of that effect. That is, research has not distinguished between errors that result from an inability to encode source-specifying information (i.e., the cue-encoding deficit hypothesis) as opposed to an inability to effectively use source-specifying information at retrieval (i.e., the cue utilization deficit hypothesis).

The present study sought to differentiate between the two aforementioned alternatives. In so doing, we used a paradigm designed to generate confusion between sources of information. The imagination inflation paradigm (Goff & Roediger, 1998) was designed to promote similarity between perceptual and contextual cues associated with performed and imagined actions. Research using the imagination inflation paradigm has consistently found that repeated imagination leads to an increase in false *did* responding, whereby individuals erroneously claim that actions were performed (Goff & Roediger, 1998; Thomas & Loftus, 2002; Thomas, Bulevich, & Loftus, 2003). By using this paradigm, we were able to investigate whether manipulations constructed to enhance cue utilization at retrieval would benefit both older and younger adult memory performance. Additionally, the imagination inflation paradigm was used because of the use of participant-performed action

events. Performance of action events provide a more rich perceptual and contextual experience compared with relatively impoverished verbal stimuli. In using this paradigm, the present study sought to examine to what extent older adults would make source errors after repeated imagination and whether source errors could be reduced in younger and older adults through manipulations designed to increase utilization of source-specifying cues.

Source-Monitoring Deficits in Older Adults

Memories for complex events include multiple kinds of information. Information that was of central interest to the observer is included, as well as perceptual and contextual peripheral information, such as the time and place at which the event occurred, associated emotions, and item parameters such as color and size (Johnson, Hashtroudi, & Lindsay, 1993). Research has demonstrated that older adults are less likely to remember various contextual features, such as color or print style of materials (Kausler & Puckett, 1981a; Light, La Voie, Valencia-Laver, Owens, & Mead, 1992; McIntyre & Craik, 1987), the gender of the presenter (Ferguson, Hashtroudi, & Johnson, 1992; Kausler & Puckett, 1981b), the location of items (Light & Zelinski, 1983; Park, Puglisi, & Sovacool, 1983; Pezdek, 1983), or whether a test item came from a videotape or from photographs (Schacter, Koutstaal, Johnson, Gross, & Angell, 1997). Older adults are less accurate in remembering whether they saw or generated a word (Mitchell, Hunt, & Schmitt, 1986) and in deciding whether words were thought or spoken out loud (Hashtroudi et al., 1989).

Age differences in source monitoring also extend to self-performed action events (R. L. Cohen, Sandler, & Schroeder, 1987; Guttentag & Hunt, 1988; Kausler, Lichty, & Freund, 1985). For example, researchers have demonstrated that older adults were less likely to recall and recognize performed actions when compared with younger adults and had more difficulty identifying whether actions had been performed, imagined, or planned when compared with younger adults (Guttentag & Hunt, 1988; Kausler et al., 1985). Further, G. Cohen and Faulkner (1989) found that after performing, watching, or imagining simple actions, older

---

Ayanna K. Thomas and John B. Bulevich, Department of Psychology, Colby College.

adults were more likely to claim that imagined actions had been watched and that watched actions had been performed as compared with younger adults. This pattern of errors reflects a failure to distinguish between internal and external sources of information.

In an effort to explain the source-monitoring deficits found in older adults, researchers have gone as far as to propose that older adults may suffer from source amnesia (i.e., McIntyre & Craik, 1987). For example, when older and younger adults were taught facts about Canada, older adults were less likely to correctly report the source of those learned facts when tested 1 week later. Source amnesia may arise because any one or more of a memory's features may not have been encoded and therefore may be unavailable (Chalfonte & Johnson, 1996). Researchers have hypothesized that older adults may not encode a rich context that contains perceptual and conceptual details associated with an event (Burke & Light, 1981). This encoding deficit would result in a more general, less distinctive record of the event and an inability to remember features. Alternatively, a disruption in the processes important for binding may account for age difference in source memory. Thus, perceptual and contextual cues may be encoded but may not be appropriately bound to the target event (Chalfonte & Johnson, 1996). These alternative accounts would suggest that deficits in source memory may be caused by either the inability to encode features or the inability to bind features to the target event. Younger adults may efficiently encode and use comparatively rich and detailed perceptual information to make accurate source-monitoring decisions.

Although many researchers have suggested that age-related deficits in source monitoring may result from a cue-encoding deficit, several studies have demonstrated that older adults can effectively use source-specifying cues. The use of such cues would suggest that older adults do encode perceptual and contextual cues. For example, Naveh-Benjamin and Craik (1995) demonstrated that when attention was explicitly directed to perceptual context, older adults showed comparable levels of memory for the context (i.e., voice and font information). While these findings suggest that older adults may encode perceptual cues, more recent research suggests that older adults show improvement in memory when specific contextual cues are manipulated. Specifically, research has demonstrated that older adults are better able to use conceptual source information (i.e., truth of statements) as compared with perceptual source information (i.e., speaker information) to improve memory (Rahhal, May, & Hasher, 2002). Thus, although contextual cues may be encoded, the nature of those cues may play a role in how those cues are used.

The Present Study

The present study was designed to assess whether older adults are able to encode perceptual and contextual features. Within the context of the imagination inflation paradigm, this study examined whether manipulations designed to enhance utilization of cues would improve source memory performance in younger and older adults. In two experiments younger and older adults first either performed or imagined performing simple actions during an encoding session. Twenty-four hours later, in Session 2, participants returned and imagined both previously presented and new actions. In previous imagination inflation studies, recognition and source

memory were assessed 2 weeks after the imagination session (Goff & Roediger, 1998; Lampinen, Odegard, & Bullington, 2003; Thomas & Loftus, 2002; Thomas et al., 2003). Studies within this paradigm have consistently found that source memory is impaired as a function of number of Session 2 imaginings. That is, as the number of imaginings in Session 2 increases, the proportion of correct and false *did* responses also increases. These results suggest that repetition in imagination may lead to confusion between source information used to distinguish between actual performance and imagination (Goff & Roediger, 1998).

The goal of Experiment 1 was to demonstrate whether older adults could effectively use source cues in the imagination inflation paradigm. However, pilot research revealed a large difference in recognition memory performance between younger and older adults within this paradigm.[1] These recognition memory differences would suggest that older adults are less likely to remember target events after a long retention interval when compared with younger adults. In fact, research suggests that older adults may forget information faster than younger adults (Wheeler, 2000). Researchers have proposed that the degree of forgetting of a target event can affect susceptibility to distortions in memory (Belli, Windschitl, McCarthy, & Winfrey, 1992; Loftus, Miller, & Burns, 1978). If the target event is forgotten, the increase in false *did* responses within the imagination inflation paradigm would not necessarily be due to confusion between encoded contextual and perceptual cues but rather to confusion as a result of repetition (i.e., Thomas et al., 2003, Experiment 2). Because of the potentially significant age difference in the ability to recognize the target action event, we compared younger and older adults at the standard 2-week retention interval and a reduced 2-day retention interval. Our goal was to equate younger and older adults' recognition memory performance to effectively examine memory for source features.

Experiment 2 was designed to further test whether older adults could effectively use perceptual and contextual cues. If older adults do encode source information but have difficulty using that information, then it is possible that older adults can be directed to effectively use these cues to make accurate source judgments. In Experiment 2, we manipulated the instructions at retrieval. This manipulation can be likened to directing attention to source information at encoding (i.e., Naveh-Benjamin & Craik, 1995), because we directed participants to use source information. However, in the present study the assumption that older adults encode source features was made; thus directions as to how to use source cues were given at retrieval. In previous research (Naveh-Benjamin & Craik, 1995; Rahhal et al., 2002), the theoretical question was whether older adults actually encode source-specifying cues. The

---

[1] A pilot experiment was conducted comparing older and younger adults in the standard imagination inflation paradigm. Recognition results from this pilot study indicated that older adults were significantly less accurate than younger adults at the baseline comparison condition (no intervening Session 2 imaginings). These results suggest that older adults may more quickly forget the target information as compared with younger adults. Because the primary interest was to examine whether older adults encode and can use perceptual and contextual peripheral information, we decided to compare younger and older adults in both the standard and reduced retention interval condition. A reduction in retention interval was used to reduce forgetting of target information.

goal of Experiment 2 was to investigate how older adults used those encoded cues.

Researchers have demonstrated that young adults are able to take advantage of explicit warning instructions given prior to encoding to reduce false memories in the Deese–Roediger–McDermott (DRM) paradigm (Gallo, Roberts, & Seamon, 1997; Gallo, Roediger, & McDermott, 2001). Warnings informed individuals that false memories could be elicited in the DRM paradigm via presentation of associates of a single nonpresented critical theme word. Similarly, McCabe and Smith (2002) found that warnings at encoding reduced false recognition in the DRM paradigm in both younger and older adults. Older adults have also been shown to reduce false memories when they were instructed to engage in more careful scrutiny of the items at retrieval that discouraged designating items as old simply on the basis of general similarity to studied items (Koutstaal, Schacter, Galluccio, & Stofer, 1999).

Experiment 2 capitalized on these findings by giving older adults explicit and detailed instructions at retrieval on how to effectively utilize source-specifying information. The instructions participants received in Experiment 2 share certain similarities with the warning given by McCabe and Smith (2002). McCabe and Smith's study and the present study both used support at retrieval; however, rather than informing participants of the mechanics of how the study was constructed, we presented them with instructions on how to make accurate source judgments based on phenomenological details. Participants had to flexibly apply those instructions across the memory test. The manipulations used in Experiments 1 and 2 were designed to facilitate effective utilization of perceptual and contextual information associated with actions presented during the encoding session of those experiments.

Experiment 1

While researchers have compared younger and older adults' susceptibility to imagination inflation for nonverifiable childhood events (Pezdek & Eddy, 2001), no study, to our knowledge, has examined imagination inflation in older adults with verifiable memories.[2] In this experiment, both groups performed or imagined simple unusual action statements during the encoding session. Twenty-four hours later, participants returned and imagined old and new actions one or five times. We were interested in examining whether repeated imagination in Session 2 would lead to an increase in false *did* responses in older adults. Performance after a 2-week retention interval and performance after a 2-day retention interval were compared in older and younger adults. The 2-day retention interval was implemented to equate older and younger adults' access to the target action events, and thus source cues associated with those events. By equating access, we then sought to examine whether older adults could use source information at a level comparable with younger adults.

Method

Participants

Participants were 54 older adults with a mean age of 75.29 years ($SD = 4.5$), with an average of 14.6 ($SD = 3.9$) years of education. All older adults completed the Vocabulary subtest of the Wechsler Adult Intelli-

gence Scale—Revised (WAIS–R; Wechsler, 1981). They obtained a mean score of 58.0 ($SD = 2.5$). Fifty-four younger adults, with a mean age of 23.1 years ($SD = 2.4$), also participated. Younger adults had an average of 13.7 ($SD = 1.1$) years of education. The Vocabulary subtest of the WAIS–R was administered to young adults, and they obtained a mean score of 57.2 ($SD = 3.6$).

Design

The experiment was based on a $3 \times 3 \times 2 \times 2$ mixed design. The within-subjects variables were initial presentation condition of the action statement (performed, imagined, not presented) and number of imaginings (0, 1, 5) in the second session. The between-subjects variables were age (younger, older) and retention interval (2 weeks, 2 days). The dependent variables were recognition and source-monitoring accuracy.

Materials and Procedure

Forty-five unusual simple actions were used in this experiment. from Thomas et al. (2003), and 25 new unusual actions were generated. An action was unusual or bizarre if it consisted of common objects manipulated in a bizarre fashion. For example, participants may have been asked to "Kiss the frog" or "Imagine stepping into the plastic bag." Actions were rated for bizarreness by an independent group of 30 participants. Action statements chosen for this experiment were all given bizarreness ratings of 5 or higher on a scale of 1 to 7 ($M = 6.2$), with 1 = *not bizarre at all* and 7 = *extremely bizarre*. Unusual actions were used to minimize the spontaneous performance of those actions in participants' day-to-day activities.

Session 1: Encoding of events. Participants were tested individually. They were seated at a table that was divided by a partition. The experimenter stood behind the partition. After signing informed-consent forms, participants were told that they would be asked to perform or imagine simple actions. They were further instructed that the experimenter would place objects in front of the partition to be used in the act of performance. Objects were placed in front of the partition for actions that were to be imagined as well as performed. Participants were told, "If you are presented with the action, *Put the staples in the picture frame*, and you are instructed to perform or imagine performing this action, I will place in front of this partition the staples and the picture frame."

Participants were further told that if they were instructed to imagine actions, they should close their eyes and imagine performing those actions. The actions that were to be imagined were prefaced with the word *imagine*. The actions that were to be performed were prefaced with the word *do*. Participants were given 15 s to perform or imagine performing each action. They were instructed to continue to perform or imagine performing the action for the entire 15 s.

In Session 1, 15 actions were performed and 15 actions were imagined. During Session 1, participants were randomly assigned to one of nine counterbalancing conditions to control for the possibility of presentation order effects and to ensure that each action statement was performed, imagined, or not presented during the first session and imagined zero, one, or five times during the second session.

---

[2] Our study examined episodic memory for recent events primarily because these events are easily verified and are under the control of the experimenter. That is, participants are presented with simple actions to either perform or imagine during an initial encoding session, and memory for this initial session is later tested. Our motivation in using this particular methodology was to eliminate the possibility that imagination of fictitious childhood events may have only made more accessible true memories about the past instead of leading to the development of false memories about the past. A similar argument was made in Goff and Roediger (1998) and Thomas and Loftus (2002).

Session 2: Imagination. Participants returned 24 hr later for the second session. In this session, all actions were imagined, and participants were instructed as follows:

> In this part of the experiment, I am going to ask you to imagine various action statements. This task is similar to the imagination task you performed in Session 1. For example, I may ask you to imagine yourself getting up and opening the door. I may also ask you to imagine how the door handle feels in your hand and the sound the door makes as it is opened. Once I state the action to be imagined, you must close your eyes and imagine yourself performing that action. You will have 15 seconds to imagine the action. Please continue to imagine the action for the full 15 seconds, with your eyes closed. At the end of the 15 seconds I will tell you to "stop." At this time you will rate how vivid the imagination was to you. If you give the imagination a rating of one that means the imagination was not vivid. A rating of five means the imagination was extremely vivid.

An example of an actual action to be imagined in Session 2 is as follows: "Imagine kissing the frog. Imagine the color of the frog. Imagine the feel of the frog against your lips." As in Session 1, the objects necessary to perform the action were placed in front of the participant.

Session 3: Testing. Two days or 2 weeks later, participants returned and were given several measures designed to assess memory for Session 1 activity. All of the 45 critical actions were presented in a fixed random order. Participants were given explicit instructions to answer questions based solely on what they remembered from Session 1. For each action, participants indicated whether the action was presented during Session 1. If they indicated the action was presented, participants then made source-monitoring judgments indicating whether the action had been performed or imagined during Session 1.

Results

Recognition

As can be seen in Table 1, recognition performance was better when participants were tested after 2 days than when tested after 2 weeks. Participants in the 2-day condition ($M = 2.48$) were far more accurate than participants in the 2-week condition ($M =$

Table 1
Experiment 1 Mean Recognition Accuracy (d') of Whether an Action Was Presented During Session 1

Variable	No. of imaginings					
	0		1		5	
	M	SE	M	SE	M	SE
2-week retention interval						
Performed						
Older	2.62	0.20	2.10	0.20	0.31	0.11
Younger	3.50	0.22	2.38	0.17	1.88	0.31
Imagined						
Older	1.49	0.29	0.83	0.40	−0.90	0.31
Younger	1.65	0.24	1.65	0.23	1.21	0.41
2-day retention interval						
Performed						
Older	2.98	0.20	2.81	0.13	2.60	0.29
Younger	3.88	0.19	3.34	0.14	2.54	0.23
Imagined						
Older	2.33	0.15	1.53	0.14	1.68	0.29
Younger	2.46	0.19	1.97	0.16	1.66	0.29

1.56). A 3 (number of imaginings: 0, 1, 5) × 2 (presentation: performed, imagined) × 2 (age: older, younger) × 2 (retention interval: 2 week, 2 day) mixed analysis of variance (ANOVA) performed on recognition accuracy found a main effect of retention interval, $F(1, 104) = 48.46$, $MSE = 2.45$. Additionally, younger adults ($M = 2.23$) were more accurate than older adults ($M = 1.70$), $F(1, 104) = 21.87$, $MSE = 2.45$. The interaction between age and retention interval was significant, $F(1, 104) = 4.42$, $MSE = 2.45$, indicating that the age difference in recognition accuracy increased when the retention interval was lengthened. Also as the number of Session 2 imaginings increased, recognition accuracy decreased, $F(2, 208) = 30.49$, $MSE = 4.60$. The three-way interaction between age, retention interval, and number of imaginings was also significant, $F(2, 208) = 4.10$, $MSE = 2.30$, indicating that as the number of imaginings increased, the gap in recognition accuracy between older and younger adults became more pronounced in the 2-week retention condition as compared with the 2-day retention condition.

When recognition accuracy for actions performed were compared with accuracy for actions imagined in Session 1, we found that participants were more accurate at recognizing performed actions, $F(1, 104) = 109.21$, $MSE = 1.63$. Again, the three-way interaction between age, type of presentation, and number of imaginings was significant, $F(2, 208) = 6.91$, $MSE = .46$. Older adults demonstrated a larger decrease in recognition accuracy for performed actions as the number of imaginings increased than for imagined actions. The three-way interaction between retention interval, number of imaginings, and type of presentation was also significant, $F(2, 208) = 6.01$, $MSE = 0.47$. No other interactions were significant ($F < 1$).

One of our goals for adding the 2-day condition was to try to equate older and younger adults on recognition performance. With equated recognition performance, we would be better able to understand the differences between older and younger adults in their ability to effectively use perceptual and contextual cues. To determine whether older and younger adults demonstrated similar patterns in recognition performance, we compared younger adults in the 2-week retention interval condition with older adults in the 2-day retention interval condition. Although we found a main effect of number of imaginings and type of presentation, $F(2, 104) = 5.75$, $MSE = 2.9$ and $F(1, 52) = 83.55$, $MSE = 1.02$, no main effect of age was found. After 2 weeks, younger adults were as accurate in recognition judgments as older adults after 2 days. On the basis of this information, we can assume that older adults in the 2-day condition and younger adults in the 2-week condition had access to similar features that allowed them to produce similar patterns of recognition responses.

Source Monitoring

Actions never presented in Session 1. As can be seen in the first section of Table 2, after a 2-week retention interval both older and younger adults increased false *did* responding as a function of imagination. In addition, we found that after a 2-day retention interval younger adults did not make, and older adults were less likely to make, false *did* responses. To analyze these results statistically, we performed a 3 (number of presentations: 0, 1, 5) × 2 (age: older, younger) × 2 (retention interval: 2 week, 2 day) ANOVA on *did* responses to actions that were never presented in

Table 2

Experiment 1 Mean Proportion of "Did" Responses for Actions Not Presented, Imagined, or Performed in Session 1

Variable and no. of imaginings	2-week retention interval				2-day retention interval			
	Older		Younger		Older		Younger	
	M	SE	M	SE	M	SE	M	SE
Not presented in Session 1								
0	.04	.03	.03	.01	.01	.01	.00	.00
1	.17	.05	.10	.02	.08	.01	.01	.01
5	.41	.07	.20	.06	.17	.05	.01	.01
Imagined in Session 1								
0	.14	.04	.04	.02	.04	.02	.00	.00
1	.39	.06	.11	.03	.16	.05	.02	.01
5	.46	.06	.23	.05	.27	.05	.01	.01
Performed in Session 1								
0	.48	.06	.68	.06	.92	.02	.94	.02
1	.76	.05	.87	.04	.96	.02	.98	.01
5	.89	.02	.89	.04	.98	.02	.97	.04

Session 1. A main effect for age was found, indicating that older adults ($M = 0.15$) were more susceptible to the imagination inflation effect as compared with younger adults ($M = 0.06$), $F(1, 104) = 11.21$, $MSE = 0.04$. In addition, a significant main effect for number of imaginings was found, demonstrating that as the number of Session 2 imaginings increased, the proportion of false *did* responses also increased (from $0 M = 0.02$ to $1 M = 0.09$ to $5 M = 0.20$), $F(2, 208) = 23.02$, $MSE = 0.03$. The interaction between number of imaginings and age was significant, demonstrating that older adults (from $0 M = 0.03$ to $1 M = 0.13$ to $5 M = 0.29$) produced more false *did* responses than younger adults (from $0 M = 0.02$ to $1 M = 0.06$ to $5 M = 0.11$), as the number of imaginings in Session 2 increased, $F(2, 208) = 4.86$, $MSE = 0.03$.

Of interest in this experiment was the effect a shorter retention interval would have on false *did* responses. As expected, participants were less likely to make theses errors in the 2-day condition ($M = 0.05$) than in the 2-week condition ($M = 0.16$), $F(1, 104) = 30.59$, $MSE = 0.04$. Further, the interaction between number of imaginings and retention interval was significant, $F(2, 208) = 7.73$, $MSE = 0.03$, indicating that repeated imaginings in Session 2 were more likely to lead to false *did* responses in the 2-week condition (from $0 M = 0.04$ to $1 M = 0.14$ to $5 M = 0.31$) as compared with the 2-day condition (from $0 M = 0.01$ to $1 M = 0.05$ to $5 M = 0.09$). The shorter retention interval eliminated false *did* responding in younger adults ($F < 1$). On the other hand, the imagination inflation effect was still present in older adults tested after 2 days. A 3 (number of imaginings: 0, 1, 5) × 2 (age: older, younger) ANOVA performed on false *did* responses made after a retention interval of 2 days found a main effect of number of imaginings, a main effect of age, and a significant interaction between number of imaginings and age, $F(2, 104) = 4.58$, $MSE = 0.02$; $F(1, 52) = 8.25$, $MSE = 0.01$; and $F(2, 104) = 2.93$, $MSE = 0.01$.

Actions imagined in Session 1. Table 2 also illustrates the false *did* responses made to actions imagined in Session 1. One interesting aspect of these data is that the pattern of results found for actions not presented in Session 1 in this experiment is similar to

the pattern obtained for actions imagined in Session 1. To explore these results, we performed a 3 (number of imaginings: 0, 1, 5) × 2 (age: older, younger) × 2 (retention interval: 2 week, 2 day) ANOVA on false *did* responses made to actions imagined in Session 1. A main effect of number of imaginings was found, $F(2, 208) = 22.67$, $MSE = 0.03$. We also found a main effect of age, $F(1, 104) = 11.21$, $MSE = 0.04$. The interaction between age and number of imaginings was also significant, $F(2, 208) = 5.25$, $MSE = 0.03$.

Turning our attention to retention interval, we found that as with actions not presented in Session 1, when the retention interval was reduced from 2 weeks ($M = 0.23$) to 2 days ($M = 0.08$), the proportion of false *did* responses also was reduced, $F(1, 104) = 30.59$, $MSE = 0.04$. We also found an interaction between retention interval and number of imaginings, $F(2, 208) = 8.17$, $MSE = 0.04$. As with actions not presented in Session 1, repeated imagination had a greater effect in the 2-week condition (from $0 M = 0.09$ to $1 M = 0.25$ to $5 M = 0.35$) as compared with the 2-day condition (from $0 M = 0.02$ to $1 M = 0.09$ to $5 M = 0.14$). Finally, as with actions not presented in Session 1, the 2-day retention interval condition eliminated false *did* responses to imagined actions in younger adults; however, older adults continued to produce these errors, though the error production was reduced, $F(2, 52) = 4.04$, $MSE = 0.03$.

Actions performed in Session 1. The shorter retention interval also affected correct *did* responses for actions that were performed in Session 1. Table 2 illustrates that with only a 2-day retention interval, both younger and older adults were quite likely to remember having performed actions. To analyze these results statistically, we performed a 3 (number of imaginings: 0, 1, 5) × 2 (age: older, younger) × 2 (retention interval: 2 week, 2 day) ANOVA on correct *did* responses. Main effects of age and number of imaginings were found, $F(1, 104) = 4.59$, $MSE = 0.05$ and $F(2, 208) = 27.28$, $MSE = 0.03$. The interaction between these two variables was also significant, $F(2, 208) = 3.29$, $MSE = 0.03$.

Examining the effect of different retention intervals on correct *did* responses, we see that participants were more likely to correctly remember performing actions in the 2-day retention interval condition ($M = 0.96$) than in the 2-week retention interval condition ($M = 0.76$), $F(1, 104) = 4.59$, $MSE = 0.05$. The interaction between number of imaginings and retention interval was also significant, indicating that repeated imagination had a greater influence on correct *did* responses in the 2-week condition (from $0 M = 0.58$ to $1 M = 0.82$ to $5 M = 0.89$) than in the 2-day condition (from $0 M = 0.93$ to $1 M = 0.97$ to $5 M = 0.98$); however, this finding is likely due to ceiling effects in the 2-day condition. In addition, the interaction between age and retention interval was marginally significant, $F(1, 104) = 2.93$, $MSE = 0.05$, $p = .06$. Less of an age difference existed in the 2-day condition as compared with the 2-week condition.

Discussion

The primary goal of Experiment 1 was to investigate whether older adults could improve their source memory performance if item memory for Session 1 activity was equated with younger adults. We hypothesized that after 2 days, older adults could use contextual cues that would allow them to perform better on both recognition and source-monitoring tests. In fact, a shorter retention

interval led to better recognition performance in both older and younger adults. Although both groups improved, a main effect of age was still found. Younger adults demonstrated better recognition performance than older adults in both retention interval conditions. However, when recognition accuracy of older adults in the 2-day condition was compared with recognition accuracy of younger adults in the 2-week condition, no age difference emerged. These results suggest that participants in these groups were similarly able to discriminate between actions that were presented in Session 1 versus actions that were imagined in Session 2.

Turning our attention to the source-monitoring assessment, we see that after only a 2-day delay younger adults did not produce false *did* responses. Older adults remained susceptible to these kinds of memory errors, with a significant increase in false *did* responses to actions imagined and never presented in Session 1. However, upon visual inspection of these data it is evident that older adults tested after 2 days are similarly susceptible to memory errors as compared with younger adults tested after 2 weeks. An ANOVA making this comparison found no age difference ($F < 1$). One possible explanation for these findings is that younger adults in the 2-week condition and older adults in the 2-day condition were able to similarly utilize cues that influenced source-monitoring decisions. That is, perceptual and contextual cues associated with Session 1 activity were effectively used by both age groups. This suggests that memory for features encoded in Session 1 is important in reducing the imagination inflation effect in older and younger adults. These results also suggest that older adults do encode perceptual and contextual information and can use that information to make source-monitoring decisions.

While we argue that cue utilization is the dominant explanation for older adults' reduction in false *did* responses in the 2-day condition, alternative accounts do exist. For example, when the retention interval was reduced, we also reduced nonspecific interference (Jenkins & Dallenbach, 1924). Research has demonstrated that older adults are more susceptible to interference effects (Kausler, 1991). By reducing the retention interval, we also reduced this type of interference. While this potentially explains why older adults were less likely to manifest memory errors in the 2-day condition, the recognition data would suggest that nonspecific interference does not drive the false *did* responding. Specifically, when younger and older adults' false *did* responses were compared at zero imaginings for nonpresented actions or baseline, there was no difference between the groups. If nonspecific interference played an important role in the age differences in the false *did* responding, we would expect to see differences between younger and older adults at this level.

Another possible explanation for our pattern of results is that the retention interval manipulation increased access rather than utilization. If memory for features or context is important in buffering against false memories that arise through repeated imagination, then when those features are made highly accessible, older and younger adults should produce fewer source errors. Indeed, that is the pattern that was observed. However, it is entirely possible that the retention interval manipulation conflated cue accessibility with cue utilization. From these data, it is impossible to discern between the two possibilities. The confound between cue accessibility and cue utilization is discussed further in the General Discussion. Although we endorse the cue utilization interpretation of Experiment 1, Experiment 2 was designed to further test the hypothesis that older adults can use perceptual and contextual information to improve memory performance.

Experiment 2

In Experiment 2, a retrieval support condition was added. In this condition participants were told what information to use when making source-monitoring decisions. Older adults in both retention intervals were either given instructions that directed them to search memory for specific contextual or perceptual features or given instructions that did not contain additional strategic information. We hypothesized that when older adults were told how to make source-monitoring decisions, they would try to utilize that information and thus reduce false *did* responding. This finding would provide additional evidence that older adults do encode perceptual and contextual cues but have difficulty automatically using that information when making memory decisions. Younger adults were tested only at the 2-week retention interval in Experiment 2 because when tested after 2 days, younger adults were unlikely to demonstrate errors in memory; therefore the effect of retrieval support could not be effectively examined in this condition.

Method

Design

In this experiment, our primary manipulation was instruction at test. Therefore, we used a design similar to that used in Experiment 1; however, we included an instruction manipulation (no support, support), and we eliminated the younger adult 2-day condition. Older and younger adults were compared only at the 2-week retention interval. The dependent variable was source-monitoring accuracy. The recognition and source-monitoring tests were combined into one assessment for this experiment.

Participants

Participants were 216 older adults with a mean age of 78.6 years ($SD =$ 4.6), with an average of 15.2 ($SD = 2.7$) years of education. All older adults completed the Vocabulary subtest of the WAIS–R (Wechsler, 1981). They obtained a mean score of 61.3 ($SD = 1.7$). Younger adults were 108 Washington University undergraduates with a mean age of 19.8 years ($SD = 2.0$). Younger adults had an average of 13.1 ($SD = 1.6$) years of education. The Vocabulary subtest of the WAIS–R was administered to young adults, and they obtained a mean score of 56.9 ($SD = 3.5$).

Materials and Procedure

The same actions used in Experiment 1 were again used in Experiment 2. Encoding of events in Experiment 2 did not differ from the previous experiment. Participants performed or imagined simple action statements. Session 2 activity was the same in Experiment 2 as in Experiment 1. In Session 3, participants were given a source-monitoring test in which they were asked to indicate whether an action had been performed, imagined, or not presented at all during Session 1. In addition, half of the participants were given instructions similar to those given in the previous experiment. Specifically, these participants were told, "Please complete the following memory test. For each action statement, indicate whether the action statement was performed, imagined, or never presented during Session 1 of the experiment. Base your answers only on your memory for Session 1 activity." The experimenter gave instructions orally, and participants were presented with each action one at a time via computer. Participants pressed the *P* key if they believed an action was performed, the *I* key if they

believed the action was imagined, and the *N* key if they believed the action was not presented.

Participants in the retrieval support condition were given detailed instructions as to how to make memory decisions. Participants were told to base the report only on information from Session 1. In addition, participants were told the following:

> Research has determined that accurate memory judgments are made when one tries to remember not only the event or action but also the context in which the action was presented. Memory for perceptual and contextual information is a useful indicator of whether an action was performed, imagined, or never presented during the first session of the experiment. For example, if you remember performing an action, you may also remember how an object felt in your hand, or how something looked or smelled. You may remember the color of an object, or even how you felt performing that action. If an action was imagined in Session 1 you may have different contextual information associated with that memory of imagination. For example, you may remember closing your eyes or the sound of the experimenter's voice when the action was read. You may even remember the action that preceded or followed. If an action was never presented during Session 1, then the cues associated with memory for those actions would have been generated solely in Session 2.

Participants in both instruction groups were also informed that some actions that were not presented in Session 1 were imagined repeatedly in Session 2 and that they should take special care in distinguishing between information presented in Session 2 and information presented in Session 1. After being instructed, participants began the computerized test.

Results

Because a separate yes/no recognition test was not given in Experiment 2, only source-monitoring responses are reported for Experiment 2. Although recognition scores can be (and were) computed from source-monitoring decisions, we decided not to include those scores for the sake of clarity of the important findings and brevity in the reporting of results. In addition, the recognition results for Experiment 2 mirrored those of the previous experiment, and retrieval supportive instructions did not differentially affect recognition performance.

Actions Never Presented in Session 1

As Table 3 illustrates, when older adults were explicitly given a strategy for making source-monitoring decisions, they are able to reduce the imagination inflation effect in both the 2-week and 2-day retention interval conditions. Specifically, after five imaginings in the 2-week condition, older adults decreased false *did* responding from 0.46 (no retrieval support) to 0.31 (retrieval support given). The question we were primarily concerned with answering in this experiment was whether older adults would be differentially affected by supportive instructions when compared with younger adults. In this experiment, older adults were tested at both the 2-week and 2-day retention interval. Because younger adults were able to eliminate false *did* responding when tested after 2 days, younger adults in this experiment were tested only at the 2-week retention interval. As such, this experiment was not fully crossed. Therefore, to analyze these data, we compared older adults tested at 2 weeks with younger adults tested at 2 weeks in one ANOVA and older adults tested at 2 days with younger adults tested at 2 weeks in a second ANOVA.

Table 3

Experiment 2 Mean Proportion of "Did" Responses for Actions Not Presented, Imagined, or Performed in Session 1

Variable and no. of imaginings	2-week older		2-week younger		2-day older	
	M	*SE*	*M*	*SE*	*M*	*SE*
No retrieval support						
Not presented in Session 1						
0	.04	.03	.02	.01	.02	.02
1	.19	.05	.10	.02	.11	.03
5	.46	.07	.20	.06	.20	.04
Imagined in Session 1						
0	.07	.02	.04	.01	.02	.01
1	.24	.04	.12	.02	.14	.02
5	.50	.05	.24	.05	.30	.04
Performed in Session 1						
0	.47	.04	.69	.04	.95	.01
1	.75	.04	.90	.03	.97	.01
5	.92	.02	.91	.03	.99	.01
Retrieval support						
Not presented in Session 1						
0	.04	.03	.02	.01	.01	.01
1	.13	.03	.09	.02	.04	.02
5	.31	.06	.19	.06	.06	.02
Imagined in Session 1						
0	.06	.02	.04	.01	.03	.01
1	.18	.03	.13	.02	.06	.01
5	.37	.04	.24	.05	.12	.02
Performed in Session 1						
0	.50	.04	.68	.04	.94	.02
1	.73	.04	.87	.03	.97	.01
5	.89	.03	.89	.03	.99	.03

To begin with, we performed a 3 (number of imaginings: 0, 1, 5) $\times$ 2 (type of instructions: standard, retrieval support) $\times$ 2 (age: older, younger) ANOVA on the false *did* responses made by older and younger adults in the 2-week retention interval condition. As expected, we found main effects for number of imaginings and for age, $F(2, 424) = 108$, $MSE = 0.05$ and $F(2, 212) = 19.43$, $MSE = 0.06$. However, more interesting was the three-way interaction among number of imaginings, type of instructions, and age, $F(2, 424) = 9.23$, $MSE = 0.05$. While type of supportive instructions influenced older adult memory errors (typical instructions: $M = 0.23$; supportive instructions: $M = 0.16$), it did not have an effect on younger adults (typical instructions: $M = 0.11$; supportive instructions: $M = 0.10$), and this effect of instructions became apparent as the number of Session 2 imaginings increased. There were no additional significant effects ($F < 1$).

A similar analysis was performed comparing older adults at the 2-day retention interval and younger adults at the 2-week retention interval. Again, main effects for type of imaginings and for age were found, $F(2, 424) = 61.26$, $MSE = 0.03$ and $F(2, 212) = 6.07$, $MSE = 0.03$. These findings suggest that older adults are more likely to make false *did* responses than younger adults even when they are tested after only 2 days. Additionally, a main effect for type of instructions was found, $F(1, 212) = 7.09$, $MSE = 0.03$. That is, participants who received supportive instructions ($M = 0.07$) made fewer false *did* responses than those who received standard instructions ($M = 0.11$). While supportive instructions reduced false *did* responding, as is evident in Table 3 and the

previous analysis, younger adults were unaffected by these instructions. Older adults benefited significantly more from supportive instructions (typical instructions: $M = 0.11$; supportive instructions: $M = 0.04$) than did younger adults, and this benefit became increasingly apparent as the number of imaginings increased. This conclusion is supported by the three-way interaction between number of imaginings, age, and type of instructions, $F(2, 424) = 3.03$, $MSE = 0.03$.

Actions Imagined in Session 1

A 3 (number of imaginings: 0, 1, 5) $\times$ 2 (type of instructions: typical, supportive) $\times$ 2 (age: older, younger) ANOVA was performed on false *did* responses for participants tested after 2 weeks. Main effects for number of imaginings and age were found, $F(2, 424) = 92.38$, $MSE = 0.05$ and $F(2, 212) = 26.08$, $MSE = 0.06$. We also found a number of Imaginings $\times$ Age interaction, $F(2, 424) = 8.56$, $MSE = 0.05$. Finally, an interaction between age and type of instructions was also found, $F(1, 212) = 4.12$, $MSE = 0.06$. Whereas younger adults were unaffected by the instructions manipulation (typical instructions: $M = 0.13$; supportive instructions: $M = 0.14$), older adults were able to reduce false *did* responding if given supportive instructions (typical instructions: $M = 0.27$; supportive instructions: $M = 0.20$). There were no additional significant effects ($F < 1$).

A 3 (number of imaginings: 0, 1, 5) $\times$ 2 (type of instructions: typical, supportive) $\times$ 2 (age: older, younger) ANOVA was performed comparing false *did* responses made to actions imagined in Session 1 by older adults tested after 2 days and younger adults tested after 2 weeks. Again, a main effect of number of imaginings was found, $F(2, 424) = 59.39$, $MSE = 0.03$. However, a main effect of age was not found ($F < 1$). This finding is consistent with those of Experiment 1, in that older adults tested after 2 days were not more likely to produce false *did* responses that younger adults tested after 2 weeks. A main effect of type of instructions was also found, $F(1, 212) = 8.27$, $MSE = 0.03$. Participants who received supportive instructions ($M = 0.10$) were less likely to produce false *did* responses than participants who received typical instructions ($M = 0.14$). Further, the Age $\times$ Type of Instructions interaction was significant, $F(1, 212) = 9.28$, $MSE = .03$. Older adults produced fewer false *did* responses when given supportive instructions (typical instructions: $M = 0.15$; supportive instructions: $M = 0.07$), whereas younger adults showed no difference in false *did* responding as a function of type of instructions. Finally, the three-way interaction among age, type of instructions, and number of imaginings was significant. No other effects were significant ($F < 1$).

Actions Performed in Session 1

As in the previous sections, we performed two separate ANOVAs comparing older and younger adults. A 3 (number of imaginings: 0, 1, 5) $\times$ 2 (type of instructions: typical, supportive) $\times$ 2 (age: older, younger) ANOVA was performed comparing correct *did* responses made by participants tested after a 2-week retention interval. Main effects of number of imaginings and age were found, $F(2, 424) = 105.98$, $MSE = 0.06$ and $F(1, 212) = 24.31$, $MSE = 0.09$. Further, the interaction between age and number of imaginings was significant, $F(2, 424) = 11.42$, $MSE =$

0.06. This interaction suggests that as the number of imaginings increased, older adults increased correct *did* responding (from 0 $M = 0.49$ to 1 $M = 0.74$ to 5 $M = 0.91$) more so than younger adults (from 0 $M = 0.78$ to 1 $M = 0.87$ to 5 $M = 0.90$). Finally, no other effects were significant ($F < 1$). This suggests that while type of instructions helped older adults reduce false *did* responding, it had no effect on correct *did* responding.

A 3 (number of imaginings: 0, 1, 5) $\times$ 2 (type of instructions: typical, supportive) $\times$ 2 (age: older, younger) ANOVA was performed comparing correct *did* responses made by older adults tested after 2 days and younger adults tested after 2 weeks. Again, main effects of number of imaginings and age were found, $F(2, 424) = 26.46$, $MSE = 0.04$ and $F(1, 212) = 88.98$, $MSE = 0.04$. However, the differences between younger and older adults were due to better performance by older adults tested after 2 days ($M = 0.97$) than by younger adults tested after 2 weeks ($M = 0.82$). Finally, the interaction between age and number of imaginings was significant, $F(2, 424) = 15.16$, $MSE = 0.04$. As the number of imaginings increased, younger adults increased correct *did* responding at a faster rate than did older adults. No other effects were significant ($F < 1$). As in the 2-week condition, older adults tested after 2 days did not differentially benefit from supportive instructions. Supportive instructions had no effect on correct *did* responding for either older or younger adults.

General Discussion

To briefly review our main results, in Experiment 1, we found that older adults were more likely than younger adults to claim that actions that were never presented in Session 1 were performed. Further, older adults were far less likely to claim they performed actions that were never presented when the memory test occurred after a 2-day retention interval as compared with a 2-week retention interval. In Experiment 2 we found that when older adults were given supportive instructions that reminded them of what cues are typically associated with performance and imagination, they were far less likely to erroneously remember performing actions. We also found that repeated imagination improved memory accuracy for actions performed in Session 1. Both older and younger adults were more likely to correctly indicate that an action had been performed as the number of Session 2 imaginings of that action increased. These findings suggest that imagination has both positive and negative consequences for memory and is consistent with previous findings (Goff & Roediger, 1998; Thomas et al., 2003; Thomas, Hannula, & Loftus, in press; Thomas & Loftus, 2002). More important, the findings from both experiments support the conclusion that older adults encode perceptual and contextual cues that are helpful in improving memory performance.

Findings from both experiments indicate that the often-found source-monitoring deficit in older adults can be attenuated. These findings suggest that under certain circumstances older adults may gain access to contextual information associated with actions presented during the encoding session. In this study, one of those circumstances was a shortened retention interval. When the 2-day condition was compared with the 2-week condition, older adults not only showed a decrease in false *did* responding but also a significant increase in veridical memory of performance. In the 2-week condition, older adults may not have been effectively using contextual cues to make source decisions. The retention interval

manipulation was designed to increase more effective utilization of contextual cues. However, it is possible that by reducing the retention interval, contextual cues were merely made more accessible. When the retention interval was reduced, accessibility to those cues may have increased, which would have affected both true and false memories. Although the results of Experiment 1 do not allow for a distinction between this cue accessibility account and the cue utilization account, we posit that cue utilization is contingent on cue access. Although alternative interpretations of these results exist (i.e., differential effects of interference, changes in memorial representations of events), Experiment 2 adds additional support to the hypothesis that older adults can effectively use contextual information. Specifically, when older adults were informed at retrieval how to effectively use contextual cues, we found a reduction in false *did* responding.

Our findings are consistent with those of other researchers who have investigated memory distortion in older adults. For example, Multhaup, de Leonardis, and Johnson (1999) demonstrated that older adults were less susceptible to misleading information when making source judgments as compared with yes/no recognition judgments. Multhaup (1995) found that when older adults were encouraged to adopt more stringent decision criteria, they were less likely to call old nonfamous names famous. Similarly, Koutstaal, Schacter, Johnson, and Galluccio (1999) found that when older adults were required to make more fine-grained recognition decisions, they were less likely to call related lures old. Specifically, at the time of retrieval, older adults were asked to classify items as falling into one of three categories: items that were old and identical, items that were new but related, and items that were new and unrelated. By using this classification, older adults were less likely to indicate that related lures were old and identical (Koutstaal, Schacter, Galluccio, & Stofer, 1999). These findings suggest that when older adults are required to more stringently evaluate their memory decisions at retrieval, they can increase their memory performance.

Research has suggested that when older adults are asked to evaluate recognition test items more closely, they may try to determine if a given item possesses any specific perceptual features that they had also noticed during the study phase and that would serve to vouch for its status as an old and identical item. These possibilities are similar to those proposed by Johnson and colleagues (Dodson & Johnson, 1993; Johnson et al., 1993; Norman & Schacter, 1997; Schacter, Norman, & Koutstaal, 1998) that suggest that compared with simple yes/no recognition, source-monitoring tests may require participants to use different criteria—perhaps stricter, but also possibly qualitatively different—in providing their judgments. Thus, forcing participants to make source judgments will lead to improved memory performance. The present study takes this process one step further. In testing cue utilization, Experiment 2 provided older and younger adults with instructions as to how to effectively make source-monitoring decisions. We would argue that this is a markedly different procedure than compelling participants on an item-by-item basis to attend to source or contextual information as is done in standard source-monitoring judgments or the fine-grained recognition decisions used by Koutstaal, Schacter, Johnson, and Galluccio (1999). The instructions given to participants in the present study were done so at the begin-

ning of the testing session, and participants had to remember and apply those instructions to each judgment made. In our study, older adults had to flexibly and strategically apply the instructions throughout the course of the memory test.

This study, and in particular Experiment 2, demonstrate that older adults do encode source features, and if directed to use those features, older adults can develop a successful strategy to use throughout the source-monitoring test. General warning manipulations, which are similar to the supportive instructions of Experiment 2, have also been successful in reducing false memories in older adults (McCabe & Smith, 2002). However, general warnings have only been shown to be effective in older adults when those warnings were given at encoding. In addition, warning manipulations that have been used in the DRM paradigm have presented participants with information about how semantically related lists are constructed and the nature of the lures, rather than providing phenomenological information that can be used to differentiate between two highly accessible sources. Thus, our study synthesizes components from source-monitoring experiments and warning experiments to determine whether older adults can use information about phenomenological differences to make accurate source-monitoring decisions.

If participants did benefit from the supportive instructions because those instructions served as a reminder of contextual cues, then we might have expected those instructions to increase correct *did* responses. However, participants who received supportive instructions did not show an increase in these correct responses when compared with participants in the nonsupportive condition. One possible explanation for why this expected increase in correct responding was absent is that there may be separate and possibly independent processes that govern memory for performance and imagination. Research comparing memory for performance with memory for imagination has consistently shown that memory for performed acts is better (for a review, see Nilsson, 2000). There are a number of possibilities why memory for performance differs from memory for imagined acts. One possibility is that memory for participant-performed tasks includes physical movement (Engelkamp & Zimmer, 1983, 1984, 1985). Others have proposed that it is the integration of the movement and the object that is the crucial cause of the enactment effect (Kormi-Nouri, 2000). Because of these differences in how imagined and performed acts are encoded, it is plausible that instructions designed to remind participants of context may have more of an effect on less accessible contexts, such as those associated with imagination.

As an alternative, or perhaps in addition to the previous account, older adults may not increase correct *did* responding because they may already be efficiently using accessible cues associated with performance as an indicator of performance. However, they may not strategically compare cues associated with performance with those associated with imagination. When they engage in this process of comparison, they then are able to reduce the false *did* responding. Finally, it should be noted that younger adults neither reduced memory errors nor increased veridical memory as a result of supportive instructions. This finding suggests that younger adults efficiently use contextual cues when making source-monitoring decisions; however, effective utilization of contextual cues lessens as a function of aging.

Conclusion

Countless studies have demonstrated that memory declines as a function of age (for a review, see Balota, Dolan, & Duchek, 2000). Older adults are less likely to correctly remember events. However, the question as to why memory declines as a function of age remains a highly contentious problem. The present study addresses this question by demonstrating that older adults do encode contextual and perceptual cues but have difficulty using those cues effectively. Older adults' difficulty in using these cues effectively at retrieval may be due to inaccessibility or even to inefficient binding of context to the target event (see Mitchell, Johnson, Raye, & D'Esposito, 2000). This study also adds to the small body of research comparing older and younger adults' memory for action events and how memory for action events changes as a function of subsequent mental activity (G. Cohen & Faulkner, 1989; Koutstaal, Schacter, Johnson, & Gallucio, 1999). Finally, this study supports the conclusion that older adults' increased susceptibility to memory distortions may partly result from an inability to effectively use source information rather than an inability to encode source information.

We argue that the present study provides evidence that older adults suffer from a cue utilization deficit, and this deficit contributes to the age-related susceptibility in the imagination inflation paradigm. We believe that this hypothesis provides a useful platform for both additional theoretical exploration and for applied memory training and rehabilitation. With regard to the former, current research within cue utilization has not adequately differentiated between cue access and cue utilization. Specifically, while both the reduced retention interval and the supportive instructions reduced memory errors in older adults, only in conjunction was the greatest benefit produced. In the present study, it is impossible to determine whether cues were accessible but not used or if they were not accessible to be used. Future research will seek to disentangle this issue.

With regard to applications to successful aging, we believe this research can contribute to older adult memory training. In Experiment 2, older adults were able to reduce false memories by 15% through only a single simple instruction. Granted, this type of instruction may be limited to this particular experimental setting; however, we argue that training older adults with instructions that emphasize contextual and perceptual information could lead to better memory performance in more applied settings.

References

Balota, D. A., Dolan, P. O., & Duchek, J. M. (2000). Memory changes in healthy older adults. In E. Tulving & F. I. M. Craik (Eds.), *The Oxford handbook of memory* (pp. 395–409). London: Oxford University Press.

Belli, R. F., Windschitl, P. D., McCarthy, T. T., & Winfrey, S. E. (1992). Detecting memory impairment with a modified test procedure: Manipulating retention interval with centrally presented event items. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18,* 356–367.

Burke, D. M., & Light, L. L. (1981). Memory and aging: The role of retrieval processes. *Psychological Bulletin, 90,* 513–546.

Chalfonte, B. L., & Johnson, M. K. (1996). Feature memory and binding in young and older adults. *Memory & Cognition, 24,* 403–416.

Cohen, G., & Faulkner, D. (1989). Age differences in source forgetting: Effects on reality monitoring and on eyewitness testimony. *Psychology and Aging, 4,* 10–17.

Cohen, R. L., Sandler, S. P., & Schroeder, K. (1987). Aging and memory for words and action events: Effects of item repetition and list length. *Psychology and Aging, 2,* 280–285.

Dodson, C. S., & Johnson, M. K. (1993). Rate of false source attributions depends on how questions are asked. *American Journal of Psychology, 106,* 541–557.

Engelkamp, J., & Zimmer, H. D. (1983). Zum Einflu-S von Wahrnehmen und Tun auf das Behalten von Verb–Objekt-Phrasen [The influence of perception and performance on the recall of verb–object phrases]. *Sprache & Kognition, 2,* 117–127.

Engelkamp, J., & Zimmer, H. D. (1984). Motor programme information as a separable memory unit. *Psychological Research, 46,* 283–299.

Engelkamp, J., & Zimmer, H. D. (1985). Motor programs and their relation to semantic memory. *German Journal of Psychology, 9,* 239–254.

Ferguson, S. A., Hashtroudi, S., & Johnson, M. K. (1992). Age differences in using source-relevant cues. *Psychology and Aging, 7,* 443–452.

Gallo, D. A., Roberts, M. J., & Seamon, J. G. (1997). Remembering words not presented in lists: Can we avoid creating false memories? *Psychonomic Bulletin & Review, 4,* 271–276.

Gallo, D. A., Roediger, H. L., III, & McDermott, K. B. (2001). Associative false recognition occurs without strategic criterion shifts. *Psychonomic Bulletin & Review, 8,* 579–586.

Goff, L. M., & Roediger, H. L., III. (1998). Imagination inflation for action events: Repeated imaginings lead to illusory recollections. *Memory & Cognition, 26,* 20–33.

Guttentag, R. E., & Hunt, R. R. (1988). Adult age differences in memory for imagined and performed actions. *Journals of Gerontology, 43,* P107–P108.

Hashtroudi, S., Johnson, M. K., & Chrosniak, L. D. (1989). Aging and source monitoring. *Psychology and Aging, 4,* 106–112.

Jenkins, J. G., & Dallenbach, K. M. (1924). Obliviscence during sleep and waking. *American Journal of Psychology, 35,* 605–612.

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin, 114,* 3–28.

Kausler, D. H. (1991). *Experimental psychology, cognition, and human aging* (2nd ed.). New York: Springer-Verlag.

Kausler, D. H. (1994). *Learning and memory in normal aging.* San Diego, CA: Academic Press.

Kausler, D. H., Lichty, W., & Freund, J. S. (1985). Adult age differences in recognition memory and frequency judgments for planned versus performed activities. *Developmental Psychology, 21,* 647–654.

Kausler, D. H., & Puckett, J. M. (1981a). Adult age differences in memory for sex of voice. *Journal of Gerontology, 36,* 44–50.

Kausler, D. H., & Puckett, J. M. (1981b). Modality memory and frequency of occurrence memory for young and middle-aged adults. *Experimental Aging Research, 7,* 235–243.

Kormi-Nouri, R. (2000). The role of movement and object in action memory: A comparative study between blind, blindfolded and sighted subjects. *Scandinavian Journal of Psychology, 41,* 71–75.

Koutstaal, W., Schacter, D. L., Galluccio, L., & Stofer, K. A. (1999). Reducing gist-based false recognition in older adults: Encoding and retrieval manipulations. *Psychology and Aging, 14,* 220–237.

Koutstaal, W., Schacter, D. L., Johnson, M. K., & Galluccio, L. (1999). Facilitation and impairment of event memory produced by photograph review. *Memory & Cognition, 27,* 478–493.

Lampinen, J. M., Odegard, T. N., & Bullington, J. L. (2003). Qualities of memories for performed and imagined actions. *Applied Cognitive Psychology, 17,* 881–893.

Light, L. L., LaVoie, D., Valencia-Laver, D., Owens, S. A., & Mead, G. (1992). Direct and indirect measures of memory for modality in young and older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18,* 1284–1297.

Light, L. L., & Zelinski, E. M. (1983). Memory for spatial information in young and old adults. *Developmental Psychology, 19,* 901–906.

Loftus, E. F., Miller, D. G., & Burns, H. J. (1978). Semantic integration of verbal information into a visual memory. *Journal of Experimental Psychology: Human Learning and Memory, 4,* 19–31.

Mäntylä, T. (1993). Knowing but not remembering: Adult age differences in recollective experience. *Memory & Cognition, 21,* 379–388.

Maylor, E. A. (1995). Remembering versus knowing television theme tunes in middle-aged and elderly adults. *British Journal of Psychology, 86,* 21–25.

McCabe, D. P., & Smith, A. D. (2002). The effect of warnings on false memories in young and older adults. *Memory & Cognition, 30,* 1065–1077.

McIntyre, J. S., & Craik, F. I. (1987). Age differences in memory for item and source information. *Canadian Journal of Psychology, 41,* 175–192.

Mitchell, D. B., Hunt, R. R., & Schmitt, F. A. (1986). The generation effect and reality monitoring: Evidence from dementia and normal aging. *Journal of Gerontology, 41,* 79–84.

Mitchell, K. J., Johnson, M., K., Raye, C. L., & D'Esposito, M. (2000). fMRI evidence of age-related hippocampal dysfunction in feature binding in working memory. *Cognitive Brain Research, 10,* 197–206.

Multhaup, K. S. (1995). Aging, source, and decision criteria: When false fame errors do and do not occur. *Psychology and Aging, 10,* 492–497.

Multhaup, K. S., de Leonardis, D. M., & Johnson, M. K. (1999). Source memory and eyewitness suggestibility in older adults. *Journal of General Psychology, 126,* 74–84.

Naveh-Benjamin, M., & Craik, F. I. M. (1995). Memory for context and its use in item memory: Comparisons of younger and older persons. *Psychology and Aging, 10,* 284–293.

Nilsson, L. -G. (2000). Remembering actions and words. In E. Tulving & F. I. M. Craik (Ed.), *The Oxford handbook of memory* (pp. 137–148). New York: Oxford University Press.

Norman, K. A., & Schacter, D. L. (1997). False recognition in younger and older adults: Exploring the characteristics of illusory memories. *Memory & Cognition, 25,* 838–848.

Park, D. C., Puglisi, J. T., & Sovacool, M. (1983). Memory for pictures, words, and spatial location in older adults: Evidence for pictorial superiority. *Journal of Gerontology, 38,* 582–588.

Parkin, A. J., & Walter, B. M. (1992). Recollective experience, normal aging, and frontal dysfunction. *Psychology and Aging, 7,* 290–298.

Pezdek, K. (1983). Memory for items and their spatial locations by young and elderly adults. *Developmental Psychology, 19,* 895–900.

Pezdek, K., & Eddy, R. M. (2001). Imagination inflation: A statistical artifact of regression toward the mean. *Memory & Cognition, 29,* 707–718.

Rahhal, T. A., May, C. P., & Hasher, L. (2002). Truth and character: Sources that older adults can remember. *Psychological Science, 13,* 101–105.

Schacter, D. L., Koutstaal, W., Johnson, M. K., Gross, M. S., & Angell, K. E. (1997). False recollection induced by photographs: A comparison of older and younger adults. *Psychology and Aging, 12,* 203–215.

Schacter, D. L., Norman, K. A., & Koutstaal, W. (1998). The cognitive neuroscience of constructive memory. *Annual Review of Psychology, 49,* 289–318.

Spencer, W. D., & Raz, N. (1995). Differential effects of aging on memory for content and context: A meta-analysis. *Psychology and Aging, 10,* 527–539.

Thomas, A. K., Bulevich, J. B., & Loftus, E. F. (2003). Exploring the role of repetition and sensory elaboration in the imagination inflation effect. *Memory & Cognition, 31,* 630–640.

Thomas, A. K. Hannula, D., & Loftus, E. F. (in press). How self-relevant imagination affects memory for behavior. *Applied Cognitive Psychology.*

Thomas, A. K., & Loftus, E. F. (2002). Creating bizarre false memories through imagination. *Memory & Cognition, 30,* 423–431.

Wechsler, D. (1981). The psychometric tradition: Developing the Wechsler Adult Intelligence Scale. *Contemporary Educational Psychology, 6,* 82–85.

Wheeler, M. A. (2000). A comparison of forgetting rates in older and younger adults. *Aging, Neuropsychology, & Cognition, 7,* 179–193.

E-Mail Notification of Your Latest Issue Online!

Would you like to know when the next issue of your favorite APA journal will be available online? This service is now available to you. Sign up at http://watson.apa.org/notify/ and you will be notified by e-mail when issues of interest to you become available!