False Memories: Young and Older Adults Think of Semantic Associates at the Same Rate, but Young Adults Are More Successful at Source Monitoring

Hedwige Dehon and Serge Brédart
University of Liège

Two experiments explored whether the higher vulnerability to false memories in the DRM (J. Deese, 1959; H. L. Roediger & K. B. McDermott, 1995) paradigm in older compared to young adults reflects a deficit in source monitoring. In both experiments, adding together the number of falsely recalled critical lures and the number of critical lures produced on a post-recall test asking participants to report items that they had thought of but did not recall, indicated that the critical lures were activated during the experiment equally often in young and older adults. However, older adults were more likely than young adults to say that they had actually heard the lures. When strongly encouraged to examine the origin of memories (Experiment 2), the warning substantially reduced false recall in young but not older adults. These results are consistent with the idea that older adults have more difficulty later identifying the source of information that was activated as a consequence of intact semantic activation processes.

Several studies have shown that older adults are more prone to memory distortions than younger adults on various laboratory tasks, and show a higher rate of false recall and/or false recognition (for a review see Schacter, Koutstaal, & Norman, 1997), even when levels of correct performance are quite similar in both age groups (Balota et al., 1999; Norman & Schacter, 1997; Schacter et al., 1997).

One such laboratory task used to study false memories is the DRM paradigm, originally created by Deese (1959) and later revived by Roediger and McDermott (1995) in which participants are presented with lists of thematically related words converging on associated nonpresented lures (e.g., thread, pin, eye, sewing, sharp, point, for which the nonpresented lure is *needle*). This procedure has been shown to robustly elicit high rates of false recall and false recognition (for a review, see Roediger, McDermott, & Robinson 1998) of the nonpresented critical lure (CL). In addition, those false memories are quite compelling as participants are very confident that the CL has occurred and are able to provide descriptions and details regarding its presentation although it was never presented (see Mather, Henkel & Johnson, 1997; Norman & Schacter, 1997; Roediger et al., 1998).

False memories in this paradigm are thought to occur because, during the presentation of the list, the CL is activated as a result of a spreading of activation in an associative network that subsequently results in its easier accessibility (McDermott & Watson,

2001; Roediger & McDermott, 1995; but see also the fuzzy trace theory in Brainerd & Reyna, 1998). During retrieval, this activation must be correctly attributed to the participant's own thoughts and not to the item's occurrence in the list through a successful "reality-monitoring" process (Johnson, Hashtroudi, & Lindsay, 1993; Johnson & Raye, 1981). In other words, the participants must distinguish prior real experience from thoughts in deciding whether or not the activated CL actually belonged to the previously studied list. If the participant fails, this means that his or her prior thoughts were mistaken for actual prior perceptions. Conversely, if the participant attributes correctly, erroneous recall of the critical lure will not occur. However, another possibility for the nonoccurrence of a false memory for a particular list is that, basically, the list failed to activate the CL in the participant's mind. Hence, when a false memory does not occur in this paradigm, the reason may be found either in a CL activation failure or may be due to successful source monitoring. A recent study (Brédart, 2000) explored this issue with a modification added to the original paradigm to test whether the CL had been activated or not. After the memory test, participants were asked to say if, during the learning phase or the recall phase, a word came to mind, but they did not write it down during the recall task because they thought the experimenter had not said it. The experimenter then presented the participants successively with their own word lists produced during the recall phase and asked them to write down any other words they had thought when producing that list. This modification allowed the examination of the distribution of the CLs throughout the experiment and to determine the best explanation for why, at some trials, false memories do not occur (i.e., a monitoring success vs. an activation failure). Specifically, failure to recall a CL either in the initial recall phase or during the added phase suggests that the list failed to evoke it. On the other hand, the reporting of a CL during the added phase for a list that did not initially produce a false memory is indicative of successful monitoring. Using this additional phase in the DRM paradigm with young adults, Brédart obtained results that were more consistent

Hedwige Dehon and Serge Brédart, Department of Cognitive Sciences, University of Liège.

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Correspondence concerning this article should be addressed to Hedwige Dehon, Department of Cognitive Sciences (B-32), University of Liège, B-4000 Liège, Belgium. E-mail: Hedwige.dehon@ulg.ac.be

with the second explanation: Young adults frequently reported CLs during this third phase that they had not intruded during the list recall phase. Hence, these results suggest that some of the CLs that have been activated may not produce false memories, but also highlight the importance of source-monitoring abilities (Johnson et al., 1993) in the resistance to false memories. The experiments here used this modified procedure to investigate age-related differences in false recall in the DRM paradigm.

Experiment 1

Young and older participants' performance was examined using Brédart's (2000) modified procedure. The question addressed was whether the higher rates of false memories in the older adults occurred because they were less likely to monitor the source of the CL during remembering. Previous data suggest that thinking of the CL is presumably the consequence of spreading activation in a semantic network (see McDermott & Watson, 2001), and there is some reason to believe that this is relatively unaffected by aging (Balota et al., 1999; Tun, Wingfield, Rosen, & Blanchard, 1998). However, several lines of evidence have shown that older adults experience difficulties in source-monitoring tasks (for a meta-analysis, see, e.g., Hashtroudi, Johnson, & Chrosniak, 1989; Spencer & Raz, 1995).

Therefore, in line with previous literature, older adults, relative to young adults, were expected to recall fewer studied items and more CLs during the initial recall test. In addition, if aging affects source-monitoring processes, older adults should be less likely to recall the CL during the additional phase compared to young adults. However, no effect of aging on the activation of the CL is expected, and the rates of produced CLs should then be no different between the two age groups. Therefore, according to our predictions, the summed proportions of CLs recalled at test and CLs produced during the additional phase should be equal in young and older adults, but the number of false recalls should be greater in older adults, and the number of CLs produced during the additional phase should be higher in younger adults.

Method

Participants. Thirty younger adults and 30 older adults (15 women and 15 men in each group) participated in the experiment. All the participants were in good health and free from a history of alcohol or drug abuse, cerebrovascular etiology, myocardial infarction, psychiatric treatment or

psychotropic medication, or head injury (descriptive data are given in Table 1).

Material. Participants were presented with six French DRM word lists of 15 items (see Appendix). These lists came from a larger pool that was initially constructed to obtain DRM materials in French. In an initial pilot study, participants ($n = 20$) were presented with the lists and had to rate the degree of association between each word on the list and the target on a 7-point scale from 1 (*the word is not associated with the target*) to 7 (*the word is strongly associated with the target*). The words (common nouns, adjectives, or verbs) were then rearranged with the strongest associations presented first in a decreasing order. In a second pilot study, another group of participants ($n = 20$) was asked to try to determine what was the word that ties all the words together. Results showed that, for all the lists, the CL was identified by all of the participants.

Procedure. This study used Brédart's (2000) procedure, albeit with one modification: a 30-s interval between the learning phase and the recall phase was added in order to avoid recency effects. Participants were tested individually and were told that the experimenter would read six lists of words and that they would be tested on each list after having counted backward by threes for 30 s. The six lists were presented in random order for each participant. The words were read aloud by the experimenter at the rate of 1 word/1.5 s. For each recall phase (Phase 1), participants were instructed to recall as many words as possible from the list they had just heard. They were then asked to write down the words on a sheet of paper in any order, but without guessing. They were given 90 s to complete each recall phase. After having recalled all the lists, a first post-recall task was administered to the participants. In this task (Phase 2), they were instructed to rate their confidence in having heard the word in the list that had just been read to them on a 5-point scale from 1 (*not very confident*) to 3 (*fairly confident*) to 5 (*extremely confident that the experimenter produced the word*). In a second post-recall phase (Phase 3), they were instructed to say if, during the learning phase or during the recall phase, a word had come to mind but they did not write it during the recall task because they thought the experimenter had not said it. Then, the participants were presented successively with the word lists they recalled in the first phase and were asked to write down (with a different colored pen) any other words they had thought of for that list. In this phase, participants were instructed to write down only words they remembered having thought of during the presentation of the lists and not to infer or to guess the words from the current instructions. During a final, fourth phase, they were asked to assign a rating reflecting their confidence in not having heard the experimenter produce that word on a 5-point scale from 1 (*not very confident*) to 3 (*fairly confident*) to 5 (*extremely confident that the experimenter did not produce the word*). Participants were also asked to complete a French language adaptation of the Mill-Hill Vocabulary Scale (Deltour, 1993) at the end of the testing. Finally, the participants were fully debriefed.

Table 1
Participants' Descriptive and Demographic Data

Group	Experiment 1				Experiment 2			
	Younger		Older		Younger		Older	
	<i>M</i>	(<i>SD</i>)	<i>M</i>	(<i>SD</i>)	<i>M</i>	(<i>SD</i>)	<i>M</i>	(<i>SD</i>)
Age	22.57	(1.43)	70.67	(2.68)	23.10	(3.22)	71.90	(5.98)
Range (in years)	20–26		66–75		18–31		60–83	
Mill-Hill ^a	36.86	(2.81)	40.03	(2.82)	35.89	(4.01)	38.37	(3.65)
Educational level	13.01	(2.47)	13.00	(1.52)	15.00	(2.17)	14.80	(1.29)
Range (in years)	12–20		11–17		12–21		12–19	

^a Score out of 44.

Results and Discussion

Descriptive data are presented in Table 2; alpha level was set at .05.

Performance in recall (Phase 1) and confidence. The mean proportion of veridical items and CLs recalled by each participant across the lists was computed in both groups. A 2 (group: young vs. old) $\times$ 2 (item type: studied vs. CL) analysis of variance (ANOVA) with repeated measures on the last factor was then carried out on the proportions of response. A significant effect of the item type, $F(1, 58) = 49.99$, $MSE = 0.03$ was obtained showing that, overall, participants recalled significantly higher proportions of studied items than CLs. The main effect of group was not statistically significant, $F(1, 58) = 1.07$; however, a significant Group $\times$ Item Type interaction was obtained, $F(1, 58) = 33.77$, $MSE = 0.03$. As expected, the influence of aging on veridical and false recall was obtained: Older adults recalled significantly fewer studied items than younger adults and recalled more CLs. In addition, the proportions of studied items were significantly higher than the proportions of CLs in younger adults, whereas both proportions were similar in older adults. The mean proportions of noncritical intrusions recalled by each participant (no. of intrusions/6 lists $\times$ 15), were very low and were not submitted to statistical analyses (see Table 2).

A two-way ANOVA, 2 (group: young vs. old) $\times$ 2 (item type: studied vs. CL), was then carried out in order to compare the mean confidence ratings assigned to the different kinds of items. A significant effect of group was obtained, $F(1, 49) = 9.90$, $MSE = 0.55$, showing that the older participants assigned globally higher confidence ratings to their responses than younger participants. A significant effect of item type, $F(1, 49) = 23.20$, $MSE = 0.53$, was also obtained. Planned comparisons showed that the confidence ratings assigned to the studied items were significantly higher than the confidence ratings assigned to the CLs. The Group $\times$ Item Type interaction was also significant, $F(1, 49) = 6.05$, $MSE = 0.53$. Planned comparisons showed that, in the younger group, the confidence ratings assigned to studied items were significantly higher than the confidence ratings assigned to CLs, whereas the

confidence ratings assigned to both kinds of responses were similar in the older group.

Production of CLs during Phase 3 and confidence. The percentage of CLs produced during the third phase was computed for each participant across all lists. In agreement with our predictions, the analysis showed that the older adults recalled fewer CLs during this phase, $t(58) = 3.81$, than the younger participants. However, no difference between the two age groups was obtained with respect to the confidence ratings assigned to CLs recalled during the third phase, $t(50) = -0.83$. These confidence ratings, which reflect how confident the participant was that the word had not been said by the experimenter (on a 5-point scale), were quite high in both groups.

In addition, in agreement with our predictions, the total proportion of activated CLs on Phase 1 and Phase 3 were not different, $t(58) = -0.83$, between both age groups (.84 and .81 for younger and older adults, respectively). However, as shown previously, young adults were found to recall fewer CLs during the recall phase (Phase 1) and to produce more CLs in Phase 3, whereas older adults presented the reverse pattern of performance. This suggests that older adults were as prone as younger adults to think of the CLs, and that the monitoring explanation is a likely account for the nonoccurrence of a false memory in younger, but not in older, adults.

Experiment 2

Several reasons could account for the observed source-monitoring reduction in older adults. For example, it has been shown that older adults sometimes improve their source-monitoring performance with the use of a more fine-grained judgment (resulting in more stringent response criteria), suggesting that they might fail to use strategies spontaneously that could help them avoid memory errors (Craig & Jennings, 1992; Koutstaal, Schacter, Galluccio, & Stofer, 1999; Multhaup, 1995). However, Norman and Schacter (1997) failed to reduce DRM false memories when asking both younger and older participants to examine carefully the characteristics of their memories, and suggested that the age-related deficit shown by the older adults might be the result of general/indistinct encoding (see also Chalfonte & Johnson, 1996; Mitchell, Johnson, Raye, Mather, & D'Esposito, 2000). Therefore, in this second experiment, we explored whether a failure to engage source-monitoring processes spontaneously could account for older adults' pattern of performance in this paradigm. Strong warnings before the encoding phase were used in order to elicit the use of strategic processes in both older and younger adults, enabling them to adopt more conservative decision criteria.

Method

Participants. Fifty-six younger adults (32 women and 24 men) and 56 older adults (38 women and 18 men) participated in the experiment (descriptive and demographic data are given in Table 1).

Material. We used the same material as in the first experiment except that a female voice saying the list words was recorded and digitalized. Lists were presented in random order using a computer. The duration of the recorded lists ranged from 34 to 37 s and, as in Experiment 1, the interval between items was 1.5 s.

Table 2
Mean Proportion of Recall as a Function of Experimental Phase, Response Type, and Age Group (Experiment 1)

Phase and response type	Age group			
	Younger		Older	
	<i>M</i>	(<i>SD</i>)	<i>M</i>	(<i>SD</i>)
Phase 1				
Studied	0.69	(0.10)	0.51	(0.08)
Confidence	4.78	(0.26)	4.86	(0.16)
Critical lures	0.24	(0.23)	0.48	(0.21)
Confidence	3.69	(1.36)	4.52	(0.69)
Noncritical intrusions	0.02	(0.02)	0.04	(0.03)
Confidence	2.82	(1.41)	3.63	(1.03)
Phase 3				
Critical lures	0.60	(0.30)	0.33	(0.24)
Confidence	4.00	(0.83)	4.21	(1.02)

Note. Mean confidence ratings assigned to the various kinds of responses are in boldface type.

Table 3
Mean Proportions of Recall as a Function of Experimental Phase, Response Type, and Age Group (Experiment 2)

Phase and response type	Age group							
	Younger				Older			
	Unwarned		Warned		Unwarned		Warned	
	<i>M</i>	(<i>SD</i>)	<i>M</i>	(<i>SD</i>)	<i>M</i>	(<i>SD</i>)	<i>M</i>	(<i>SD</i>)
Phase 1								
Studied	0.63	(0.09)	0.64	(0.10)	0.40	(0.09)	0.40	(0.10)
Confidence	4.78	(0.21)	4.76	(0.30)	4.86	(0.14)	4.83	(0.22)
Critical lures	0.16	(0.19)	0.04	(0.08)	0.34	(0.21)	0.39	(0.25)
Confidence	3.84	(0.90)	3.20	(1.80)	4.78	(0.48)	4.41	(1.18)
Noncritical intrusions	0.02	(0.03)	0.01	(0.01)	0.03	(0.02)	0.03	(0.03)
Confidence	3.04	(1.46)	3.24	(1.17)	3.76	(1.20)	3.90	(1.00)
Phase 3								
Critical lures	0.61	(0.29)	0.85	(0.18)	0.40	(0.29)	0.28	(0.29)
Confidence	4.13	(1.20)	4.74	(0.55)	4.42	(0.88)	3.73	(1.56)

Note. Mean confidence ratings assigned to the various kinds of responses are in boldface type.

Procedure. The procedure was the same as in Experiment 1 except that, in each age group, half of the participants were randomly assigned to the unwarned or warned condition. In both conditions, the procedure was similar except that, in the warned condition, participants received a strong warning before the beginning of the procedure and were given a list similar to those used in the experiment. They were told that the lists were not constructed randomly, that each list was associated with a theme word, and that all the words belonging to a list were associated with another common noun that would never be presented in that list (e.g., tea, drink, hot, black, milk, sugar, cup, for which the nonpresented theme word is *coffee*). They were told that sometimes people mistakenly remember the critical word that links all the others together (e.g., *coffee*), even if it was not presented and even if they were asked not to make this error. For each list, they were told to figure out which word tied all the words together and to be sure that it had not been presented.

Results and Discussion

Descriptive data are presented in Table 3; alpha level was set at .05.

Performance in recall (Phase 1) and confidence. The mean proportions of veridical items and CLs recalled by each participant across the lists were computed in both groups. A 2 (group: young vs. old) $\times$ 2 (condition: unwarned vs. warned) $\times$ 2 (item type: studied vs. CL) ANOVA with repeated measures on the last factor was carried out on the proportions of response. This analysis revealed no main effect of group, ($F < 1$), no main effect of condition, $F(1, 108) = 1.02$, but a significant effect of item type, $F(1, 108) = 158.25$, $MSE = 0.03$, showing that, overall, participants recalled significantly higher proportions of studied items than CLs. The Group $\times$ Condition interaction was statistically significant, $F(1, 108) = 4.15$, $MSE = 0.02$. Yet, post hoc HSD Tukey tests revealed no effect of age on the proportions of recalled items whatever the condition, and no effect of condition whatever the age group. No Condition $\times$ Item Type interaction was found, $F(1, 108) = 1.09$; however, a significant Group $\times$ Item Type interaction, $F(1, 108) = 121.60$, $MSE = 0.03$, was observed. Planned comparisons showed that, as expected, older adults re-

called significantly lower proportions of studied items and higher proportions of CLs in comparison with younger adults. In addition, younger adults recalled significantly higher proportions of studied items than CLs, but the proportions of studied items and CLs were similar in older adults. The Group $\times$ Condition $\times$ Item Type interaction was also statistically significant, $F(1, 108) = 4.29$, $MSE = 0.30$. Planned comparisons revealed that warnings had no effect on the proportions of studied items in younger and older adults. However, the application of warnings significantly reduced the proportions of CLs in younger adults but had no significant effect on the proportions of recalled CLs in older participants. As in Experiment 1, the mean proportions of noncritical intrusions (no. of intrusions/6 lists $\times$ 15) were very low and were not submitted to statistical analyses (see Table 3).

A 2 (age: young vs. old) $\times$ 2 (condition: unwarned vs. warned) $\times$ 2 (item type: studied vs. CL) ANOVA with repeated measures on the last factor was performed on the mean confidence ratings assigned to the different kinds of items.¹ A significant effect of age was obtained, $F(1, 66) = 13.63$, $MSE = 0.54$, showing that older participants assigned globally higher confidence ratings to their responses than younger participants, even if both were quite high. A marginally significant effect of condition, $F(1, 66) = 3.41$, $MSE = 0.54$, $p = .07$, showed that unwarned participants gave higher confidence ratings than warned participants. The main effect of item type was significant, $F(1, 66) = 27.80$, $MSE = 0.47$. Planned comparisons showed that the mean confidence rating assigned to correct items was significantly higher than the confidence rating assigned to CLs. The Age $\times$ Item Type interaction was also significant, $F(1, 66) = 12.55$, $MSE = 0.47$. Planned comparisons showed that, as in Experiment 1, the

¹ The degrees of freedom for this analysis were lower than those for the recall analyses because some participants did not produce any critical lure. Consequently, these participants did not provide confidence ratings for CLs.

confidence ratings assigned to studied items were significantly higher than the confidence ratings assigned to CLs in the younger group, whereas the confidence ratings assigned to both kind of responses were not significantly different in the older group. The Condition $\times$ Item Type interaction, $F(1, 66) = 2.43$, and the other interactions were not statistically significant ($F_s < 1$).

Production of CLs during Phase 3 and confidence. The proportion of recall of CLs during the third phase was computed for each participant. A 2 (age: young vs. old) $\times$ 2 (condition: unwarned vs. warned) ANOVA was carried out on those mean proportions and revealed a significant main effect of age, $F(1, 108) = 62.73$, $MSE = 0.06$, showing that, globally, younger adults produced more CLs during the third phase than did older adults. There was no significant main effect of condition, $F(1, 108) = 1.28$. However, a significant Age $\times$ Condition interaction was obtained, $F(1, 108) = 13.19$, $MSE = 0.06$. Tukey post hoc tests showed that, although younger adults produced significantly more CLs during the third phase, strong warnings still improved their performance but had no significant influence in the older adults. In addition, a 2 (age) $\times$ 2 (condition) ANOVA was performed on the mean confidence ratings assigned to the CLs produced during the third phase. The analysis revealed a tendency to assign higher confidence ratings in younger adults than in older adults, $F(1, 95) = 2.82$, $MSE = 1.12$, $p = .09$. There was no significant effect of condition ($F < 1$), but there was a significant Age $\times$ Condition interaction, $F(1, 95) = 9.11$, $MSE = 1.12$. Tukey post hoc tests showed that in the warned condition, the younger participants rated confidence higher than older participants. In the unwarned condition, there was no difference between the two age groups.

A 2 (age) $\times$ 2 (condition) ANOVA was conducted on the proportion of activated CLs (CLs recalled during the memory test plus CLs produced during the third phase). A significant effect of age group was obtained, $F(1, 108) = 10.58$, $MSE = 0.04$, showing that the proportion of activated CLs was higher in the younger group (.83) than in the older group (.70). The effect of condition was not statistically significant ($F < 1$). However, a significant Age $\times$ Condition interaction was found, $F(1, 108) = 6.23$, $MSE = 0.04$. As in Experiment 1, the total proportions of activated CLs on Phase 1 and Phase 3 in the unwarned condition were not different between both age groups (.77 and .74 for younger and older adults, respectively). However, younger adults were found to recall fewer CLs during the recall phase and to produce more CLs in Phase 3, whereas the reverse was obtained in older adults. This is an additional support to the idea that both age groups were as prone to think of the CLs, and that the monitoring explanation is a likely account for the nonoccurrence of a false memory in younger adults but not in older adults. Conversely, in the warned condition, the proportion of activated CLs was higher for the younger participants (.89) than for the older adults (.66).

It might be argued that providing warnings to older adults might have made the memory task quite difficult for them. Indeed, participants were required to try to determine what the critical lure was, to keep it in mind, and to avoid producing it during the subsequent memory test while memorizing the other words from the lists. This would be close to a dual-task situation and would be a likely explanation for the failure to observe any effect of warnings in older adults. Nevertheless, if warnings made the task more difficult for the older adults, one would also expect a decrease of correct recall in the warned condition. Results are not consistent

with this interpretation. Indeed, the rates of correct recall were similar for the two older groups (warned vs. unwarned).

General Discussion

In agreement with previous studies, the well-documented effect of normal aging on true and false recall using the DRM paradigm was replicated in both experiments. That is, older adults recalled fewer studied items and were more likely to falsely intrude the CLs than were younger adults (Balota et al., 1999; Tun et al., 1998). Second, in both experiments, we replicated previous data (Brédart, 2000; McKelvie, 2001; Read, 1996): assigned confidence ratings were higher for studied items than for critical lures, suggesting that confidence ratings might sometimes be useful in discriminating correct performance (i.e., the confidence ratings seemed to vary, as did accuracy; see also Busey, Tunnicliff, Loftus, & Loftus, 2000; McKelvie, 2001).

However, when the confidence ratings assigned to both responses were compared in both age groups, a different pattern emerged for the older adults. Indeed, there were no differences between the confidence ratings assigned to studied and critical items, suggesting that older adults were equally confident that those items had occurred. These results parallel the evidence (i.e., faster recognition responses and fewer contextual details for critical lures than for studied items), suggesting that it is more difficult for older adults to discriminate between both kinds of items (Norman & Schacter, 1997; Tun et al., 1998). On the other hand, because older adults tended to rely more on indistinct/thematic information, one might also argue that they preferentially based their confidence judgments on semantic closeness/similarity. On the basis of this hypothesis, critical lures would therefore be very strong semantic associates and would also receive high confidence ratings. Again, this latest suggestion would fit well with measured reaction times for the acceptance of the critical lure during a recognition test (Tun et al., 1998). Further work is needed in order to understand better the origins of confidence ratings in younger and older adults.

Brédart's (2000) results—that younger adults were able to avoid producing the CLs through efficient source-monitoring processes—were replicated in both experiments here. However, the main finding from these two experiments is the observation that younger and older adults were as likely to think of the CLs, but older adults preferentially recalled them during the initial recall test whereas younger adults recalled them during the third phase. These results are important because they support the view that false recall in the DRM paradigm comes from a failure to monitor efficiently the origins of the memories (Johnson et al., 1993; Johnson & Raye, 1981, 2000). Because of the necessary delay between the study of a list and the start of Phase 3 for that list, one might argue that older adults were as likely as young adults to note the nonoccurrence of the CL, but more likely to forget that they had noted it. However, such a differential forgetting does not seem to have played a major role in the reported experiments. Indeed, it would then be hard to explain why older adults falsely remembered a higher percentage of CLs on the recall test, or why the sum of CLs produced in the recall test in Phase 1 and in Phase 3 did not differ for young and older adults.

In Experiment 2, it was shown that strong warnings were beneficial to younger adults and enabled them to improve memory

accuracy. However, consistent with Norman and Shacter's (1997) findings, older adults were not able to profit from the warnings, suggesting that the age-related increase in false recall was not mainly attributable to a deficit in the spontaneous use of monitoring processes.

Overall, our results support the idea that a source-monitoring deficit in older adults is the main factor responsible for the occurrence of false memories in the DRM paradigm. According to the source-monitoring framework (Johnson et al., 1993; Johnson & Raye, 2000), several reasons may explain this observed reduction in source-monitoring efficiency in older adults. For example, older adults might have difficulties in accessing distinctive information during retrieval (Schacter et al., 1997) and/or in encoding information less distinctively (Chalfonte & Johnson, 1996; Schacter et al., 1997). Indistinct encoding in older adults would have made the characteristics of their true and false memories more similar to each other (see also Norman & Schacter, 1997). The fact that deficits in the recollective experience in old age disappeared once encoding differences were accounted for (Perfect & Dasgupta, 1997) supports this hypothesis. Further work is needed to investigate the relative contributions to age-related differences in source-monitoring accuracy of encoding deficits and retrieval and evaluation deficits (e.g., see Mitchell et al., 2000).

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Appendix

Critical Lures With List Items 1–15

Translations of French words are listed in parentheses.

Fruit: pomme (apple), orange, banane (banana), poire (pear), kiwi, citron (lemon), jus (juice), macédoine (fruit salad), légume (vegetable), baie (berry), passion, mûrir (to ripen), défendu (forbidden), corbeille (basket), sorbet.

Maison (house): toit (roof), demeure (home), habitat (accommodation), residence, adresse (address), foyer (hearth), famille (family), appartement (apartment), cheminée (chimney), jardin (garden), confort (comfort), chalet, abri (shelter), chaumière (thatched cottage), cabane (hut).

Araignée (spider): toile (web), mygale (trapdoor spider), tisser (to weave, to spin a web), tarentule (tarantula), pattes (legs), insecte (insect), velu (hairy), animal, grenier (attic), peur (fear), mouche (fly), affreux (hideous), venin (venom), morsure (bite), ramper (to creep).

Lion: rugir (to roar), crinière (mane), félin (feline), fauve (big cat), féroce (ferocious), jungle, savane (savannah), dompteur (tamer), cirque

(circus), tigre (tiger), cage, prédateur (predator), horoscope, chasse (hunting), antre (den).

Musique (music): note, instrument, son (sound), orchestre (orchestra), classique (classical), concert, symphonie (symphony), piano, radio, rythme (rhythm), chanter (to sing), art, mélodie (melody), air (tune), groupe (band).

Arbre (tree): tronc (trunk), feuille (leaf), branche (branch), forêt (forest), racine (root), bois (wood), écorce (bark), cime (top), sapin (fir tree), fruitier (fruit tree), souche (stump), bucheron (woodcutter), généalogique (genealogical), plante (plant), graine (seed).

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