

Illusory Recollection in Older Adults and Younger Adults Under Divided Attention

Erin I. Skinner and Myra A. Fernandes
University of Waterloo

The authors investigated the effect of divided attention, study-list repetition, and age on recollection and familiarity. Older and younger adults under full attention and younger adults under divided attention at study viewed word lists highly associated with a single unstudied word (critical lure) once or three times, and subsequently performed a remember-know recognition test. Younger adults made fewer false remember responses to critical lures from repeated study lists, whereas younger adults under divided attention and older adults both showed an increase with repetition. Findings suggest older adults' susceptibility to illusory memories is related to a deficit in available attention during encoding.

Keywords: aging, false memory, divided attention, illusory recollection, remember-know

Research shows that there are diverse changes in memory function associated with aging, including an increased susceptibility to report memories for events that did not occur (known as false memories; Jacoby, 1999). One of the most powerful paradigms used to produce false recognition experimentally is the Deese-Roediger-McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995). In this method, participants view a list of semantically related words (e.g., candy, sour . . .) that converge on a related semantic associate, the critical lure (e.g., sweet). On a subsequent memory test, participants frequently state, incorrectly, that the critical lure was present on the study list.

Remarkably, false memories for the critical lure often contain vivid details of the event. For example, participants often mistakenly attribute sensory details associated with studied items to the critical lure (Lampinen, Neuschatz, & Payne, 1999). The remember-know paradigm (Tulving, 1985) has been used in other work to assess the contextual detail and vividness associated with items on a recognition test. In this paradigm, participants make a distinction between items for which they recollect specific details from the study phase (remember response) and those that are memorable (known) but that lack specific episodic details from initial study. Studies that have used this method in conjunction with the DRM paradigm show that participants often claim to remember the critical lure, demonstrating that the false memories for these items can contain vivid details, such as thoughts, perceptual features, and list context (Norman & Schacter, 1997; Payne, Elie, Blackwell, & Neuschatz, 1996).

According to the activation/monitoring framework (Roediger, Watson, McDermott, & Gallo, 2001), DRM list words activate the critical lure at study either automatically, through spreading activation in the lexical/semantic system, or consciously, through elaborative processing. This activation makes the critical lure appear familiar on a recognition test, and participants must monitor the source of the familiarity to correctly reject the item. Monitoring can occur at encoding to, for example, encode distinctive features of study items or mark lure items as self-generated (Pérez-Mata, Read & Diges, 2002),¹ and at retrieval, when participants engage in source monitoring to distinguish real from nonperceived events (Roediger et al., 2001). Other theories suggest that false memories come to contain vivid but false details (termed *illusory recollections*) when participants mistakenly attribute imagined features to the critical lure (Gallo & Roediger, 2003) or “borrow” features from true memories of corresponding list words (Lampinen et al., 1999).

Susceptibility to false memories using the DRM paradigm has been shown to increase with age: Older adults both falsely recall and falsely recognize the critical lure at higher rates than younger adults (Norman & Schacter, 1997; Tun, Wingfield, Rosen, & Blanchard, 1998). The activation/monitoring framework accounts for this finding by proposing that spreading activation is relatively automatic and spared with age, whereas monitoring requires controlled processes that are impaired with age, resulting in more false recognitions (Balota et al., 1999; Norman & Schacter, 1997). Work specifically examining illusory recollections, however, shows more varied results, with some studies showing no change (Gallo & Roediger, 2003; Norman & Schacter, 1997) and others showing an increase (Intons-Peterson, Rocchi, West, McLellan, & Hackney, 1999) in illusory recollections with age.

Erin I. Skinner and Myra A. Fernandes, Department of Psychology, University of Waterloo, Waterloo, Ontario, Canada.

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Correspondence concerning this article should be addressed to Erin I. Skinner, Department of Psychology, 200 University Avenue West, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada. E-mail: eiskinne@watarts.uwaterloo.ca

¹ Although the use of the term *monitoring* in the activation-monitoring framework was not originally conceptualized to include such general encoding processes, we have broadened the term for clarity, as done in previous work (Pérez-Mata et al., 2002).

In the current study, we used the DRM paradigm to examine the role of attention at encoding and aging in producing illusory recollections. Craik (1983) hypothesized that normal aging is associated with a reduction in the amount of attentional resources available for cognitive processing required to engage in controlled encoding and retrieval processes. Evidence in support of this view shows that younger adults who study words under divided attention (DA) conditions show similar memory performance as older adults studying words under full attention (FA) conditions (Anderson, Craik, & Naveh-Benjamin, 1998; Craik, 1982). With respect to false memories, controlled processes may be required at encoding to identify distinctive features of studied items, to monitor the list theme, or to mark items as self-generated, all of which help participants successfully reject the critical lure on a memory test (Pérez-Mata et al., 2002). Pérez-Mata et al. (2002) found that DA at study increased the number of critical lures recalled (Experiments 1 and 2) and subsequently given remember responses (Experiment 2). Similarly, Dehon (2006) found that younger adults under DA at study and older adults under FA were more likely to recall a critical lure from a DRM list relative to younger adults under FA conditions. This finding suggests that attentional resources are required at study to successfully monitor incoming items and that older adult's inflated false memory performance stems from a deficit in attentional resources. Other work, however, has shown that DA at study produces either no change (Seamon et al., 2003) or a decrease in false memories for critical lure items (Dewhurst, Barry, Swannell, Holmes, & Bathurst, 2007; Knott & Dewhurst, 2007). Thus, the role of attention at study in reducing false alarms to critical lures is currently under debate.

We adopted a paradigm used by Benjamin (2001). In his study, younger and older adults studied DRM word lists either once or three times. On a later recognition test, younger adults were less likely to falsely recognize the critical lure when the related lists were presented three times, as compared to once. Older adults, however, produced more false memories for critical lures from lists presented three times. Benjamin suggested that list repetition simultaneously increases familiarity (activation) of the critical lure and knowledge of the study set (used to improve monitoring). These two effects were thus stated to work in opposition: Whereas younger adults were able to engage in controlled processes (increased knowledge of repeated study items) to oppose the increased activation of lure items, the older adults were not.

In the current study, we aimed to extend Benjamin's (2001) findings. First, we examined whether age-related increases in false memories with repetition of study lists is reflected specifically in illusory recollections. We expected that this might be true because avoiding illusory recollections would likely require controlled monitoring processes, which are deficient in older adults. We predicted that younger adults under FA conditions would report fewer false remember responses for lures from repeated study lists and that older adults would show the opposite pattern. Second, we examined whether age-related deficits in controlled monitoring of critical lures arises because attentional resources are reduced at study. To this end, we compared memory in older adults and younger adults working under FA to younger adults working under DA conditions at study. Participants studied DRM lists either once or three times and performed a remember-know recognition test. By studying the effect of study-list repetition and DA at encoding on memory, we can identify whether older adult's propensity to

falsely endorse critical lures is related to a deficit in monitoring, or controlled processing, at encoding.

Method

Participants

Forty-eight healthy younger adult participants (25 women) recruited from the University of Waterloo (Waterloo, Ontario, Canada) and 24 healthy older adults (14 women) recruited from the Waterloo Research in Aging Pool at the University of Waterloo participated in the experiment. Participants received course credit or token monetary remuneration for participation. The Waterloo Research in Aging Pool is a database of healthy seniors in the Kitchener-Waterloo area recruited by means of newspaper ads, flyers, and local television segments. There were three experimental groups: younger adults and older adults performing the task under FA, and younger adults performing the task under DA at encoding; each group consisted of 24 participants. All participants were fluent English speakers and had normal or corrected-to-normal hearing and vision.

There was no significant difference in years of education across groups, $F(2, 69) = 2.61, p > .05$. We administered the National Adult Reading Test—Revised to allow an estimate of full-scale IQ based on pronunciation errors during vocabulary reading (Nelson, 1982). Full-scale IQ estimates (see Table 1) differed significantly across groups, $F(3, 60) = 9.57, p < .001$, with higher estimates in the older adult group relative to both the younger adult group, $t(46) = 4.47$, and the DA group of younger adults, $t(46) = 2.78$ ($ps < .05$). We administered the Trail-Making Test to establish an estimate of executive functioning (Reitan & Wolfson, 1985). The mean time to complete Trails A and Trails B (see Table 1) both differed significantly across groups, $F(2, 69) = 43.68$, and $F(2, 69) = 37.23, ps < .001$, respectively. The older adult group performed significantly slower than the younger adult, $t(46) = 7.28$, and DA, $t(46) = 7.20$, groups on the Trails A test and significantly slower than the younger adult, $t(46) = 6.54$, and DA, $t(46) = 6.75$, groups on the Trails B test ($ps < .05$). Mean reaction times on the Trail-Making Test were in the normal range for each age group (Spreen & Strauss, 1998) and are in line with the expected deficit in executive functioning in older adults. The two younger adult groups did not differ reliably from each other in age, full-scale IQ, Trails A, or Trails B scores. Older adults were also administered the Mini-Mental State Exam (Folstein, Folstein, &

Table 1
Mean Age, Years of Education, FSIQ, and Time to Complete Trails A and Trails B in the Younger Adult Full Attention, Divided Attention at Encoding, and Older Adult Groups

Measure	Younger adult	Divided attention	Older adult
Age	19.13 (1.19)	19.04 (1.55)	74.00 (6.91)
Years of education	13.75 (0.85)	14.67 (1.40)	14.29 (1.79)
FSIQ	105.25 (7.00)	108.37 (7.11)	113.63 (5.96)
Trails A (RT)	20.16 (3.91)	19.66 (4.92)	34.58 (8.88)
Trails B (RT)	38.36 (9.88)	36.88 (10.67)	69.72 (21.30)

Note. Standard deviations are in parentheses. FSIQ = full-scale IQ; RT = reaction time in seconds.

McHugh, 1975). All had Mini-Mental State Exam scores of greater than 27/30 ($M = 28.95$, $SD = 0.95$), indicating they were free from major cognitive and neurological impairments.

Materials and Procedure

We selected 10 DRM lists shown to elicit high levels of false recognitions for the study list (Stadler, Roediger, & McDermott, 1999). The first 8 words on the list (highest semantic associates) were used as study items. Test lists consisted of 40 studied words (4 randomly chosen from each of the 10 lists), 30 unstudied distracter items (Items 9–11 from each list), and the 10 critical lure words. We chose 40 semantically unrelated words for the practice phase from Celex, a lexical database (Baayen, Piepenbrock, & Gulikers, 1995).

The distracter task for the DA group was an auditory digit-monitoring task. An audiotape, with 207 odd and even two-digit numbers, generated pseudorandomly with 57 sets of three odd numbers in a row, was used, with one number spoken every 2 s. A 20-item list was also created for practice, and a 76-item list, with 13 sets of three odd numbers in a row, was created to examine baseline (FA) performance. Responses were recorded by the experimenter.

Participants were tested individually and completed the study in 45 min. Testing began with the National Adult Reading Test—Revised, and older adults were also administered the Mini-Mental State Exam. Participants then began the practice recognition memory task. Participants in the younger adult and older adult groups viewed a list of 20 words on the computer screen with instructions to memorize the words for an upcoming memory test. Remember-know instructions were then given (see below) and participants performed a remember-know test of 20 recognition trials (10 old). The DA group performed the same practice session except that they performed two study practice sessions consisting of 10 words each: one performed under FA and the other performed concurrently with the digit-monitoring task. This was done to familiarize the group to the DA task.

For the remember-know recognition task, participants were told that they would see some words that were from the study list and others that were not. If they thought the word was not from the study list, they were instructed to respond *N* for *new* by pressing the 3 key on the numerical keypad of a computer keyboard. They were told to report *R* (*I* key) for *remember* if they believed the word was old and they could recall specific details associating that word with the study episode. Examples given of such details were an image, thought, or feeling associated with the word during study. If they believed the word was old but they did not have such details, they were asked to say *K* (2 key) for *know*. We clarified the *K* response by giving the example of meeting someone on the street that the participant knew he or she had met before but was unable to determine the specific instance in which the two had met. After practice, participants gave the details accompanying an *R* and *K* response to the experimenter to ensure they understood the task and were not responding on the basis of response confidence.

Participants then viewed the 10 DRM lists, with instructions to study the words for a test. A 3-s cue preceded each list, indicating the start of a new list and the number of repetitions. Lists were presented randomly, with half of the lists presented once and half presented three times. Within each list, items were presented from

highest to lowest semantic associate, with no break between repetitions. Words were presented in the center of the screen in 24-point black Courier font for 3 s, with a 1-s interval between words. Half of the participants from each group had the lists *smell*, *rough*, *soft*, *sleep*, and *anger* repeat three times, and the other half had the lists *cold*, *cup*, *wish*, *window*, and *trash* repeat three times (list order factor).

After study, participants performed the Trail-Making task and solved arithmetic problems until 5 min had passed. They were then given the recognition test. Words from the test list were presented in a pseudorandom order such that each block of eight items contained four studied items, three distracters, and one critical lure. Words were presented in the same format as study and remained on the screen (no time limit) until participants made a response.

Participants in the younger adult and older adult group performed both the study and test under FA conditions. Participants in the DA condition were asked to simultaneously perform the digit-monitoring task during study. They then performed the recognition test under FA conditions. Participants were encouraged to divide their attention equally between the two tasks during the DA condition and to respond to the digit-monitoring task as quickly and accurately as possible. Participants in the DA group also performed the digit-monitoring task under FA.

Results

We analyzed data using a 2 (repetition) \times 3 (group) \times 2 (list order) analysis of variance. Since list order produced nonsignificant main effects and interactions, we collapsed data across this variable and analyzed them in a 2 \times 3 analysis of variance, with the first factor a within-subject variable and the second factor a between-subjects variable. Table 2 shows the mean for each memory measure, in each repetition condition, for each group. Unless otherwise noted, all results are reliable at the $\alpha = .05$ level.

The overall hit rate (divided by 20 for lists viewed one and three times) showed a main effect of repetition, $F(1, 69) = 94.68$, $MSE = 0.91$, with higher performance for words viewed three times as compared to one time during study. There was also a main effect of group, $F(2, 69) = 8.01$, $MSE = 0.22$, and Tukey's post hoc tests showed that the DA group had a significantly lower hit rate than the younger adult and older adult groups. The interaction was not significant.

The analysis of remember hit rate showed a main effect of repetition, $F(1, 60) = 41.16$, $MSE = 0.45$, with higher performance for words viewed three times as compared to one time. The main effect of group and the interaction were not significant. The same pattern emerged in the analysis of know responses, but there was also a significant Group \times Repetition interaction, $F(2, 69) = 3.18$, $MSE = 0.04$. Planned comparisons showed that the know hit rate was higher for lists viewed three times as compared to one time only in the DA group, $t(23) = 3.10$.

The analysis for overall false alarms to lures (divided by five for lists viewed one and three times) showed no effect of repetition or group but a significant interaction, $F(2, 69) = 5.91$, $MSE = 0.29$. Planned *t* tests showed that the younger adult group reduced the number of false alarms to critical lures from lists viewed three times as compared to one time, $t(23) = 2.03$, $p = .05$. The older adult group, however, increased false alarms to critical lures from lists viewed three times as compared to one time, $t(23) = 2.07$, $p =$

Table 2
Mean Probability of Saying “Old” to Studied, Lure, and Distracter Words From DRM Lists Presented One Time (1x) or Three Times (3x) During Study, in Each Group

Response	Studied 1x	Studied 3x	Lure 1x	Lure 3x	Distracter 1x	Distracter 3x
Younger adults						
Overall	.72 (.17)	.87 (.11)	.67 (.30)	.50 (.31)	.18 (.11)	.14 (.12)
Remember	.43 (.27)	.60 (.27)	.43 (.36)	.27 (.27)	.03 (.04)	.05 (.08)
Know	.28 (.21)	.27 (.21)	.24 (.20)	.23 (.21)	.14 (.12)	.09 (.11)
Older adults						
Overall	.75 (.13)	.89 (.11)	.66 (.27)	.77 (.23)	.20 (.18)	.15 (.11)
Remember	.41 (.30)	.49 (.36)	.34 (.33)	.48 (.36)	.09 (.15)	.06 (.08)
Know	.34 (.25)	.49 (.22)	.32 (.28)	.29 (.30)	.11 (.12)	.09 (.09)
Divided attention at encoding						
Overall	.60 (.16)	.78 (.13)	.63 (.27)	.73 (.22)	.21 (.15)	.26 (.15)
Remember	.30 (.21)	.39 (.28)	.23 (.29)	.34 (.27)	.08 (.12)	.10 (.12)
Know	.30 (.19)	.40 (.22)	.41 (.26)	.39 (.27)	.14 (.10)	.16 (.13)

Note. Standard deviations are in parentheses. DRM = Deese–Roediger–McDermott paradigm.

.05, and the DA group showed a trend in this direction, $t(23) = 1.86, p < .08$ (see Figure 1).

The analysis of remember responses to lure words also showed no effect of repetition or group but a significant interaction, $F(2, 69) = 8.35, MSE = 0.32$. The younger adult group decreased their remember false alarms to critical lures from lists presented three times as compared to one time, $t(23) = 2.13$, whereas the older adults and DA groups showed the opposite pattern, increasing false alarms to lures from lists presented three times, $t(23) = -2.71$, and

$t(23) = -2.80$, respectively (see Figure 1). The analysis for know responses to lure words showed no effect of repetition but a main effect of group, $F(2, 69) = 3.10$, and Tukey’s post hoc tests indicated that know responses to lure words were higher in the DA as compared to the younger adult group. The interaction was not significant.

The analysis of overall false alarm rate to distracter words (out of 30) showed no effect of repetition, $F(1, 69) = .01$, group, $F(2, 69) = 2.59$, and no interaction, $F(2, 69) = 2.88$. Similar results

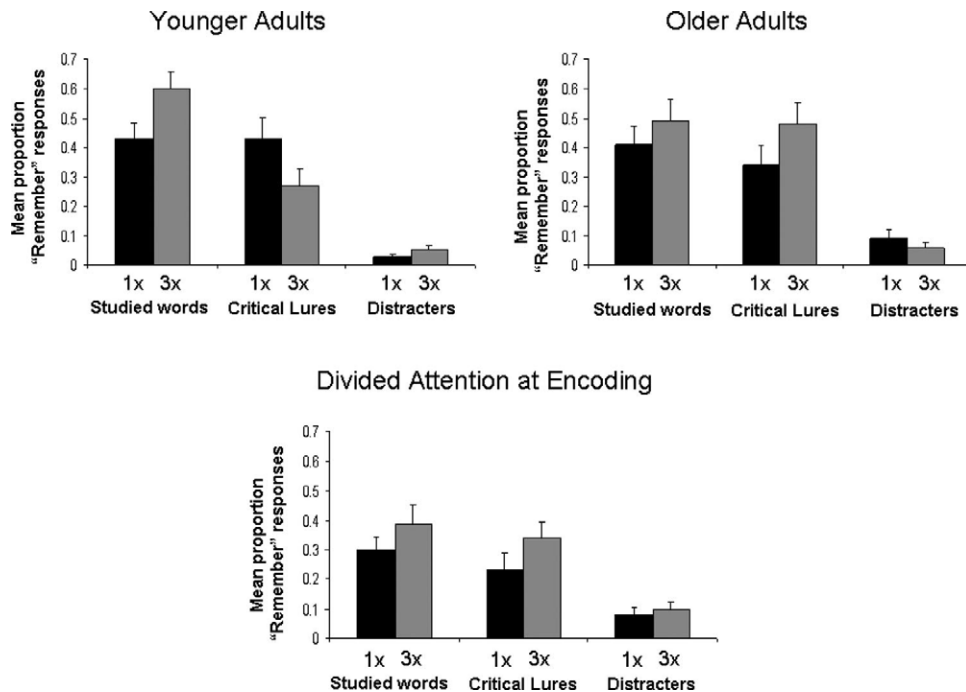


Figure 1. Proportion of studied, critical lure, and distracter words given remember responses by younger adults under full attention, older adults under full attention, and younger adults under divided attention at encoding. Error bars show the standard error of the mean.

were found for remember and know responses. Mean accuracy (measured as hit rate minus false alarm rate) for the digit task under baseline (FA) conditions was .94 ($SD = .12$) and under DA was .84 ($SD = .15$).

Discussion

We examined whether the age-related increase in false memories for critical lure words from repeated study lists (Benjamin, 2001) is reflected specifically in illusory recollections and whether this increase is related to a reduction in attentional resources at study. We replicated Benjamin's (2001) findings, showing that younger adults reduced the number of false alarms given to critical lures from lists studied three times, as compared to once, whereas older adults showed the reverse effect, increasing false recognitions with increasing repetition. We additionally extended this finding in two ways. First, we showed that the effect is specific to words given remember responses, or illusory recollections. Second, we showed that younger adults under DA at encoding mimicked the performance of the older adult group, increasing remember responses to critical lures from repeated study lists.

Critically, this pattern of false memory performance was not replicated for the distracter words, indicating that the results are not due to a general change in false memory performance but rather relate specifically to the ability of those groups to use controlled processes at study to monitor the activation of related but nonpresented words. The results suggest that older adults are unable to use increased knowledge of repeated study sets to reject critical lure words because they lack the attentional resources required for controlled monitoring operations at encoding.

We also found that all participant groups had higher recognition performance for words from lists studied three times, as compared to once, in line with Benjamin's (2001) claim that repetition increases familiarity of the study set automatically. This effect was also specific to remember responses, as shown in previous work (Gardiner, Kaminska, Dixon, & Java, 1996), and we also found this effect extended to know responses when under DA at study.

Only one other study has compared false memory in older adults and younger adults under DA using the DRM paradigm. Dehon (2006) found that older adults under FA and younger adults under DA at encoding, retrieval, or both were more likely to falsely recall critical lures than were younger adults under FA conditions. The younger adults under FA reported thinking about the critical lures, however, suggesting that successful monitoring processes, rather than a failure to activate the critical lure, improved their memory performance. In line with this finding, Pérez-Mata et al. (2002) found that DA at encoding increased false recall of lure items. They argued that the distracter task prevented participants from engaging in monitoring processes at study, such as encoding distinctive information, monitoring list theme information, and detecting/marketing critical lures as self-generated, which allow for successful source monitoring at retrieval. Our results align with these works, suggesting that DA at encoding and normal aging interfere with participants' ability to perform successful monitoring at encoding.

In contrast, Dewhurst et al. (2007) found that DA at study increased or decreased false memory depending on the type of memory test: DA at study increased false alarms to critical lures during free recall but decreased false remember responses given to

critical lures on a recognition test. They suggested that whereas participants adopted a lower threshold for calling an item old during free recall, they were also prevented from creating semantic associations at study, decreasing lure recognition. We found that DA at study increased false alarms to critical lures from repeated study lists on a recognition test. It is unlikely that this result is accounted for by a criterion shift, since participants are generally unwilling to change their decision criterion within the course of a single test (Wixted & Stretch, 2000). Rather, our results suggest that participants under DA at study were unable to use controlled processes to successfully monitor critical lure items under repeated study conditions.

We did not find the overall age-related decrease in remember responses to studied words, reported by Perfect and Dasgupta (1997), or overall age-related increase in false recognition or illusory recollections, reported by Intons-Peterson and colleagues (1999). However, other work shows that age-related deficits in recollection are specific to an elevated false alarm rate, rather than a decreased hit rate (Skinner & Fernandes, 2008), and age-related changes in illusory recollections under unrepeated study conditions are not always found (Gallo & Roediger, 2003; Norman & Schacter, 1997). In addition, as noted by Koutstaal, Schacter, Galluccio, and Stofer (1999), "the overall magnitude of age differences in the susceptibility to false recognition in the converging associates paradigm is typically small and not always observed (cf. Norman & Schacter, 1997, Experiment 1; Tun et al., 1998, Experiment 1)" (p. 220).

In conclusion, the current study showed that younger adults under FA reduced the number of illusory recollections they reported to critical lures when their associated lists were presented three times, as compared to once, at study, whereas older adults under FA and younger adults under DA at encoding showed the opposite effect. Results suggest that older adults' susceptibility to illusory recollections for lure words from repeated study lists is related to a lack of available attentional resources to perform successful controlled monitoring at encoding.

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