

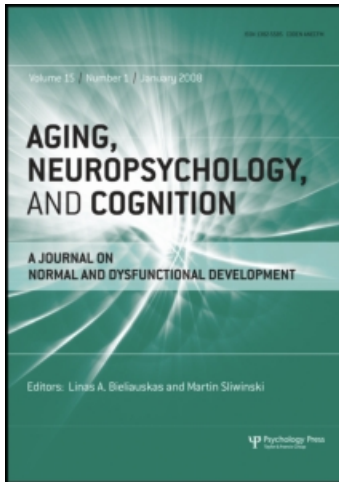
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### The Influence of Distinctive Processing Manipulations on Older Adults' False Memory

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# The Influence of Distinctive Processing Manipulations on Older Adults' False Memory

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## ABSTRACT

Covertly generating item-specific characteristics for each studied word from DRM (Deese–Roediger–McDermott) lists decreases false memory in young adults. The typical interpretation of this finding is that item-specific characteristics act as additional unique source information bound to each studied item at encoding, and at retrieval young adults can use the absence of this type of information to reject non-presented associated words that might otherwise be falsely remembered. In two experiments, we examined whether healthy older adults could use this strategy to reduce their false memories in the DRM paradigm. In Experiment 1, low frontal lobe functioning was associated with increased false memory in the item-specific strategy condition. Experiment 2 found more memory intrusions under item-specific encoding and the same amount of false memory in auditory and visual presentation conditions, i.e., no modality effect, even with 8 s of encoding time. Both findings are consistent with impaired distinctive processing by older adults.

**Keywords:** False memory; Distinctive processing; Neuropsychological; Source memory; Frontal lobes.

## INTRODUCTION

Episodic memory is a combination of veridical memory for the experienced events and the constructions that we impose on the episode. Such constructions can lead to false memory, which is memory for information that was

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never presented (e.g., Bransford & Franks, 1971; Spiro, 1980). A popular and reliable method of eliciting false memories is the Deese/Roediger–McDermott paradigm (DRM paradigm; Deese, 1959; Roediger & McDermott, 1995). In this paradigm participants are presented with lists of words that share a strong association with a critical theme word that is not presented on the list (Roediger, Watson, McDermott, & Gallo, 2001). On recall and recognition tests, participants often incorrectly remember the highly associated but not presented theme word, and often with high levels of confidence (e.g., Roediger & McDermott, 1995). In addition, the perceptual and conceptual characteristics attributed to the ‘memory’ of a non-presented theme word are similar to those recalled for actually studied items (e.g., Norman & Schacter, 1997; Roediger & McDermott, 1995).

Critically for present purposes, after studying lists of highly associated words (e.g., dream, pillow, snore, wake), older adults are less likely to recall the studied words but more likely to recall a highly associated non-presented word than younger adults are (e.g., sleep; Balota et al., 1999; Butler, McDaniel, Dornburg, Price, & Roediger, 2004; Intons-Peterson, Rocchi, West, McLellan, & Hackney, 1999; Norman & Schacter, 1997; Tun, Wingfield, Rosen, & Blanchard, 1998). Findings from other paradigms converge on the observation that older adults are less likely to remember the details of experienced events, but more likely to report memory for constructed components of memory representations (see Gallo, 2006, for a review).

Theoretically, age-related increases in false memory have been related to age-related declines in the ability to encode or to utilize source information at retrieval (e.g., Butler et al., 2004; Norman & Schacter, 1997). Younger and older adults are equally likely to think of the non-studied associate during encoding, but older adults have more difficulty during recall distinguishing studied words from words they only thought about (Dehon & Brédart, 2004). In order to distinguish studied from covertly generated items, unique source information that is not present for covertly generated items, such as the perceptual characteristics of the studied items, must be retrieved during remembering and utilized to decide whether a word was actually studied. This may be especially challenging for older adults either because retrieval processes are compromised (e.g., Craik, 1986; Koutstaal, 2003), or because they fail to encode the perceptual and contextual details initially (Smith, Lozito, & Bayen, 2005), or both. Underscoring age-related decline in detailed encoding, Norman and Schacter (1997) found that older adults reported less difference between the qualitative characteristics of studied items and critical items than younger adults did (see Rabinowitz, Craik, & Ackerman, 1982, for evidence of encoding deficits for semantic detail). Further, even when older adults are asked to use perceptual characteristics to enhance memory performance, age differences in false memory are still observed (Norman & Schacter, 1997).

In light of these findings, it is important to understand the conditions under which false memories can be reduced for older adults, for both theoretical and practical reasons. Though older adults may not spontaneously encode source information necessary to distinguish target items from non-presented associated items (as suggested by the findings outlined previously), it might be the case that encouraging older adults to engage strategic encoding processes to distinguish generated material from studied material would prove beneficial. The current study focused on whether older adults could avoid false memories when instructed in a memory encoding strategy that has previously been shown to decrease false memory in the DRM paradigm.

One straightforward and theoretically sensible approach to reducing false recall is to either provide participants with distinguishing source information at encoding or to encourage participants to encode distinctive features of studied items. Both of these approaches encourage distinctive processing of studied items at encoding by supporting processing of differences among studied items (Hunt, 2006). At retrieval, the source monitoring of the discriminative information produced by processing differences (among studied items) may also be used to distinguish presented words from covertly generated (non-studied) associates. Specifically, access to the distinctive encodings of studied words theoretically can be used to accept these items as studied, whereas the absence of discriminative (distinctive) information for non-studied associates can be used to reject non-studied items. In Experiments 1 and 2 we instructed older adults to engage in distinctive processing of studied items, and in Experiment 2 we manipulated the amount of distinctive perceptual information to examine whether distinctive processing manipulations help older adults to reduce false memory.

For younger adults, promoting distinctive processing has produced positive results. In one line of work using the DRM paradigm, visual presentation of list items has substantially reduced the rate of false recall relative to auditory presentations (Cleary & Greene, 2002; Gallo, McDermott, Percer, & Roediger, 2001; Kellogg, 2001; Smith & Hunt, 1998). The explanation for this *modality effect* is that visual presentation supports more distinctive processing than auditory presentation. Visual presentation allows encoding of more distinctive perceptual information than auditory presentation, and more distinctive perceptual information leads to better discrimination of studied items from critical non-presented items. Similarly, increasing the amount of visual detail by presenting pictures instead of words reduces false recall (Hege & Dodson, 2004). McCabe, Presmanes, Robertson, and Smith (2001, 2004) more directly encouraged distinctive processing of studied items by instructing participants to think of a unique feature of each item on the study list. As expected, this technique reduced young adults' false recall and recognition with DRM materials.

In the present study, we used the item-specific encoding technique of McCabe et al. (2004) to investigate whether asking older adults to focus on distinctive features of the target items would produce a reduction in older adults' false recall similar to the reduction McCabe et al. observed for younger adults. Distinctive processing was encouraged by asking participants to say out loud one unique characteristic for each word they studied. False memory in the distinctive processing condition was compared to false memory under a standard instruction condition. As we develop next, the outcome is far from certain, with important implications for the nature of age-related deficits in episodic memory.

On the one hand, some studies suggest that older adults are deficient in processing distinctive features of target information. For instance, in an isolation paradigm, in which all of the items except one are similar on some dimension (e.g., the isolated item might be the word 'table', whereas the other items are types of fish) younger but not older adults show superior recall when target words were isolated in a list relative to when targets were not isolated (Cimbalò & Brink, 1982; see also Geraci, McDaniel, Manzano, & Roediger, 2009, showing a significant but muted isolation effect for older adults). In studies using DRM word lists, Thomas and Sommers (2005) showed that presenting DRM words as the last words of unique sentential contexts was sufficient to reduce false recall of the critical theme word for younger adults but not older adults. In a similar vein, Smith et al. (2005) reported that visual presentation of study items in the DRM paradigm did not reduce false recall in older adults relative to auditory presentations.

Still, there are reasons to expect that older adults could profit from McCabe et al.'s (2004) distinctive-encoding technique. Age differences in source memory errors are reduced when sources are easily distinguished, e.g., internally generated thoughts versus externally observed events (Hashtroudi, Johnson, & Chrosniak, 1989). Supporting encoding of distinctive features of list items through overt generation may allow older adults to more easily distinguish studied items from thoughts of non-studied associates, for which distinctive features are not explicitly encoded. In addition, the previously observed deficits in distinctive processing may reflect a spontaneous encoding deficit, not necessarily a deficit in distinctive-processing competence. For instance, older adults do not appear to spontaneously encode perceptual details of verbal material but can do so when instructed (e.g., voice of auditory material; Naveh-Benjamin & Craik, 1995). Likewise several other studies have suggested that when adequate environmental support is provided, older adults can reduce their false memories (see Dodson & Schacter, 2002; Koutstaal, Schacter, Galluccio, & Stofer, 1999; McCabe & Smith, 2002; Taconnat, Clarys, Vanneste, & Isingrini, 2006; Thomas & Sommers, 2005; Watson, McDermott, & Balota, 2004).

Accordingly, in the present experiments older adults were instructed to use an explicit distinctive encoding technique. To assess the ability of older adults to implement this strategy we had them say out loud their item-specific characteristics as they studied each word. In Experiments 1 and 2 we categorized their responses to allow us to observe the degree to which older adults were able to implement the strategy. We believed that this was an improvement over the McCabe et al. (2004) procedure not only because it allowed us to assess strategy use directly, but because we assumed it would have made it easier for older adults to recall the distinctive information that they generated and to discriminate studied words with additional source information from theme words without generated information. Additionally, following McCabe et al. (2001, 2004), we used more generous presentation rates (5 s/word in Exp. 1 and 8 s/word in Exp. 2) than is typically used in DRM studies, to provide sufficient time for older adults to produce distinctive encodings.

## EXPERIMENT 1

The issue of using encoding strategies to reduce false recall in older adults becomes even more intriguing when neuropsychological aspects of cognitive aging are considered. Geraci, McDaniel, Manzano, and Roediger (2007, Experiment 2) reported that the absence of the von Restorff effect (distinctive processing) in older adults was limited to older adults assessed as low frontal functioning (through neuropsychological testing). Though preliminary, this result suggests that low frontal older adults have particular difficulty encoding information distinctively (cf. Glisky, Rubin, & Davidson, 2001). Supporting this idea, Butler et al. (2004) reported that low, but not high, frontal older adults showed less correct recall and higher false recall than younger adults in the DRM paradigm, and Thomas and McDaniel (2007) reported similar patterns for low and high frontal older adults for false recognition in the DRM paradigm.

Accordingly, in this experiment we followed the neuropsychological methods of Butler et al. (2004), Geraci et al. (2007), and Thomas and McDaniel (2007; all based on Glisky and colleagues' techniques; Glisky & Kong, 2008, Glisky, Polster, & Routhieaux, 1995, Glisky et al., 2001), to gauge the relative level of frontal lobe (FL) functioning of our older adults. Further, to be able to more clearly conclude that any associations between FL functioning, false recall, and the effects of the distinctive feature encoding technique are related to frontal processes (rather than general neuropsychological functioning), we also gauged levels of medial-temporal lobe (MTL) functioning. Based on initial neuropsychological findings regarding aging, false recall, and distinctive processing (see Roediger & McDaniel, 2007, for a review), we expected that levels of FL but not MTL functioning

would be associated with the effects of the distinctive-feature encoding strategy on older adults' false recall. Whether low-frontal functioning older adults would be aided or not by the encoding strategy was uncertain, for reasons detailed previously.

## Method

### *Participants*

Thirty-six older adults participated in this experiment. They were all community-dwelling individuals from the Albuquerque, NM area. They provided their own transportation to campus and were compensated \$10/h for their participation. Specific means and standard errors for all demographic data are provided in Table 1. On average they had a few years of post-secondary education and higher than average scores on the Shipley Vocabulary Test (Zachary, 1986). Their working memory capacity, as measured by the Computation Span task, was similar to other older adult samples (Salthouse & Babcock, 1991). Older adults had completed neuropsychological testing within the last 1.5 years in our lab and were selected for participation based on their neuropsychological functioning as described below. All of the older adults were screened for depression and dementia. Anyone scoring 10 or above on the Geriatric Depression Scale was excluded from the analysis for possible depression (Brink, Yesavage, Lum, Heersema, & Adey, 1982). Anyone scoring 25 or below on the Mini-Mental State Exam was excluded from the analysis for possible dementia (MMSE; Folstein, Folstein, & McHugh, 1975).

### *Neuropsychological Assessments*

Frontal lobe (FL) and medial-temporal lobe (MTL) functioning were assessed using the battery of tests developed by Glisky and colleagues (Glisky et al., 1995). The five measures used to calculate the composite FL function scores were the number of categories achieved on the modified Wisconsin

**TABLE 1.** Demographic information from Experiment 1

	Mean	SE
Age	74.9	0.86
Educ.	15.6	0.44
Vocab.	36.4	0.43
Computation span (set size)	2.5	0.18
Computation span (problems correct)	6.6	0.45
Frontal lobe score	-0.09	0.09
Medial-temporal lobe score	-0.05	0.12

Card Sorting Test (Hart, Kwentus, Wade, & Taylor, 1988), the total number of words generated for the letters F, A, and S on the Controlled Oral Word Association Test (Spreen & Benton, 1977), the Arithmetic score from the Wechsler Adult Intelligence Scale–R (Wechsler, 1981), and the Mental Control and Backward Digit Span scores from the Wechsler Memory Scale-III (WMS-III; Wechsler, 1997). The five measures used to calculate the composite MTL function scores were Logical Memory I, Faces I, and Verbal Paired Associates I from the WMS-III (Wechsler, 1997), Visual paired associates II from the Wechsler Memory Scale – R (Wechsler, 1987), and Long-Delay Cued Recall from California Verbal Learning Test (Delis, Kramer, Kaplan, & Ober, 1987). For each participant, composite measures of FL and MTL function were calculated by calculating age-adjusted  $z$ -scores for each measure and then averaging the  $z$ -scores for each set of the five tests, measuring FL and MTL. Age-adjusted  $z$ -scores were calculated using equations that were derived in the same way as has been reported previously (Glisky et al., 1995, 2001; McDaniel, Glisky, Rubin, Guynn, & Routhieaux, 1999), but using a normative sample tested with the WMS-III in Glisky’s laboratory (B. Glisky, personal communication, October, 2001). FL and MTL scores are reported in Table 1.

Using a composite score of 0 as the boundary between high and low functioning, we attempted to select an equal number of older adults from each of the four neuropsychological groups (high FL-high MTL, high FL-low MTL, low FL-high MTL, and low FL-low MTL). However, due to the constraints of the test battery and our sample we were unable to do this. First, as we have previously reported (Butler et al., 2004), our subject pool is lower functioning, on average, than the normative sample that Glisky used to generate the equations for calculating FL and MTL functioning scores. Thus, there were fewer high than low functioning older adults in our subject pool. Further, unlike Glisky et al. (1995), we have found that FL and MTL function scores in our older adult subject pool are correlated,  $r = .34$ . Thus, there are fewer individuals in our subject pool that are high functioning on one dimension, but low functioning on the other. Our final sample for this study consisted of 12 high FL-high MTL, 6 high FL-low MTL, 7 low FL-high MTL, and 11 low FL-low MTL older adults. Within this sample, FL and MTL function scores were not correlated,  $r = .02$ . However, because of the population correlation and the small  $n$  in some of the cells of the  $2 \times 2$  design, we chose to examine the effects of FL and MTL function using regression analyses rather than group comparisons.

### **Materials**

Thirty-six DRM lists of 15 words each were chosen from the Stadler, Roediger, and McDermott (1999) norms. The normative data indicated that these lists had probabilities of false recall ranging from .10 to .65 when

studied words were presented auditorally for 2 s each. The lists were separated into 4 sets of 9 lists such that each set of lists had similar average probabilities of false recall, from .37 to .41. The lists were counterbalanced across encoding conditions and new vs. old items on the recognition test. Recognition tests were constructed for each set of lists. The 72 items on each test consisted of 27 studied items (from positions 1, 8, and 10 of each list), 9 theme words (from studied lists), and 36 new items (words from positions 1, 8, and 10 and themes from 9 unstudied lists).

### *Procedure*

Testing was conducted in two sessions that were scheduled 1 week apart. To eliminate the possibility of contaminating standard encoding with prior item-specific encoding instruction, the standard encoding condition was always conducted in Session 1 with the item-specific encoding condition occurring in Session 2. In Session 1, participants were told that they would be participating in a study of how strategy use influences memory performance and consent to participate was obtained. Participants began by completing a demographic questionnaire. Then, they were told that they would be studying lists of words for a later memory test. Participants practiced the study and recall procedure with a list of US States and were encouraged to ask questions. Then they studied and were tested on the nine experimental lists. Words were presented visually, one at a time, for 5 s each. This study time was longer than is typically given to allow time to utilize the distinctive characteristic strategy in Session 2. For each list, words were presented in order from strongest to weakest associative strength. Following each list's presentation, participants were given 2 min to write down as many words as they could recall. They were told to write down words they were reasonably sure they had studied on the list and not to guess. After studying and recalling each of 9 lists, participants completed an unrelated, 5-min attention task and then completed a 72-item recognition test, at their own pace. Session 1 lasted about 1 h.

When participants returned for Session 2, they once again were asked to remember words from nine new DRM lists with the same presentation and recall times as in Session 1; however, in this session, participants were asked to use a specific strategy to rehearse the words. Participants were asked to think of one unique characteristic for each word that was presented and to say this characteristic out loud so that their response could be recorded by the experimenter. For example, participants were told that if they saw the word DOG they might say Oscar, their dog's name, or if they saw the word CAT they might use the word ALLERGIC to describe their reaction to cats. Then participants practiced this technique using the LONG theme list of words. For each word on the practice list, participants were told whether their item-specific characteristic was appropriate or not and when

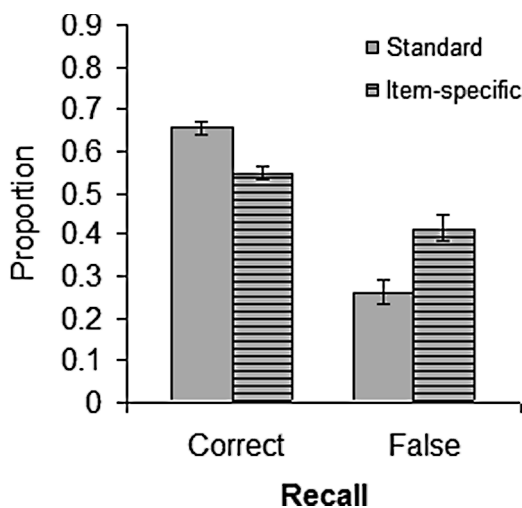
the characteristic was not appropriate they were given an example of an appropriate characteristic. The specific wording of the instructions and the practice list with appropriate unique characteristics are presented in the Appendix. No feedback was given during the experimental trials and participants were told to go on to the next item if they were unable to generate a characteristic within the allotted time. Following presentation of all lists, participants once again completed an unrelated attention task and a recognition test. They then completed the Computation Span task followed by the vocabulary test. Session 2 lasted about 1.5 h.

## Results

For all analyses, the rejection level for inferring statistical significance was set at .05. Prior to reporting the analyses focusing on the influence of FL and MTL functioning on the patterns of performance, we first examine the impact of the item-specific encoding strategy on the recall and recognition tests using separate within-subjects (standard vs. item-specific encoding) ANOVAs.

Mean proportions of correct and false recall are presented in Figure 1 by encoding condition. The item-specific encoding strategy decreased correct recall compared to the standard encoding instructions ( $M = 0.55$  and  $0.66$ , respectively),  $F(1, 35) = 56.76$ ,  $MSE = 0.004$ . Of more importance, the item-specific encoding strategy increased false recall of non-presented theme words compared to the standard encoding condition ( $0.42$  vs.  $0.26$ , respectively),  $F(1, 35) = 20.85$ ,  $MSE = 0.02$ .

FIGURE 1. Mean proportion correct and false recall in Experiment 1 as a function of encoding condition. Error bars represent  $\pm 1$  standard error from the mean.



We also measured an additional source of false memories: intrusions of non-studied words other than the theme word (noncritical intrusions). Like false recall of theme words, the average number of noncritical intrusions per list was also affected by encoding condition,  $F(1, 35) = 51.62$ ,  $MSE = 0.04$ . Older adults made fewer noncritical intrusions in the standard ( $M = 0.15$  intrusions/list,  $SE = 0.03$ ) than item-specific encoding conditions ( $M = 0.49$  intrusions/list,  $SE = 0.05$ ). To examine whether the source of these intrusions might yield some insight into the difficulty posed by the item-specific encoding instructions for older adults' memory, noncritical word intrusions were categorized into four types following Balota et al. (1999): (1) semantic associate to studied word, (2) phonological associate to studied word, (3) part of an item-specific characteristic generated during encoding (item-specific encoding condition only), and/or (4) interlist intrusion from a previously studied or practiced list. Intrusions could be coded into more than one category. For example, many of the semantic associates to studied words were produced as part of the item-specific characteristics as well. Semantic and previous list intrusions were more frequent in the item-specific condition ( $M = 0.35$  and  $0.15$  intrusions/list,  $SE = 0.04$  and  $0.03$ , respectively) than in the standard encoding condition ( $M = 0.12$  and  $0.03$  intrusions/list,  $SE = 0.03$  and  $0.01$ , respectively),  $t(35) = -5.92$  and  $-4.82$ , respectively. Intrusions from generated characteristics were also common in the item-specific encoding condition ( $M = 0.24$ ,  $SE = 0.03$ ). Phonological intrusions were rare ( $M = 0.03$  intrusions/list) and did not differ by encoding condition  $t(35) = 1.07$ .

### **List Position Analysis**

To determine if the greater frequency of false memory under item-specific instructions varied across the testing session we compared false recall on the first four studied lists to false recall on the last four studied lists in a repeated measures ANOVA that included encoding condition. There was no main effect of list position on false memory ( $F < 1$ ), but list position interacted with encoding condition,  $F(1, 35) = 9.62$ ,  $MSE = 0.04$ . The item-specific encoding condition increased false recall primarily for the last four lists studied ( $M = 0.20$  and  $0.45$  for standard and item-specific, respectively); false recall for the first four lists studied showed only slight differences between the encoding conditions ( $M = 0.32$  and  $0.36$ , for standard and item-specific, respectively).

### **Recognition Memory**

Correct recognition was high (Hits:  $M = 0.90$ ,  $SE = 0.01$ ) and did not differ by encoding condition ( $F < 1$ ). Critical items were less likely to be falsely recognized after standard encoding (False Alarms:  $M = 0.73$ ,  $SE = 0.04$ ) than item-specific encoding ( $M = 0.79$ ,  $SE = 0.03$ ), though this difference was



between lists that elicited the critical theme during item-specific generation and those that did not,  $F < 1$  ( $M = 0.40$  for both groups of lists). Theme-generation did produce dramatic increases in false recall though; when the theme had been generated false recall averaged 0.49 ( $SE = 0.04$ ) but when it had not been generated false recall dropped to 0.20 ( $SE = 0.04$ ),  $F(1, 29) = 21.41$ ,  $MSE = 0.06$ . Although the proportion of false recall when no theme had been generated is less than the proportion observed when the item-specific strategy was not used ( $M = 0.26$ ), the difference was not significant in a paired sample  $t$ -test,  $t(29) = 1.00$ . To determine if theme generation was related to the 10% decrease in correct recall observed with the item-specific strategy, correct recall was also compared by whether a theme was generated at study or not, but the difference between lists where the theme was generated and those where it was not was not significant,  $F < 1$ .

Finally, we coded whether the characteristics being produced were distinctive or not using a two step process. First, if the characteristic evoked a specific instance, image, or example of the studied word and was different from the critical theme, other studied words, and other characteristics, it was coded as distinctive (e.g., Saying 'my bed' as an item-specific characteristics for the studied word 'bed' evokes a particular instance of a bed and therefore was coded as distinctive). Sometimes this judgment was difficult because only a single word was generated as a characteristic. In these cases we used word association norms to make the judgment. Specifically, if the word was present on the association norms and related to the theme word it was not coded as distinctive; otherwise it was coded as distinctive. High associates to 443 of the possible studied items were determined by using the Nelson, McEvoy, and Schreiber (1999) word association norms. The associates for the remaining 97 possible studied words were taken from the work of Roediger et al. (2001). These associates were collected in the same manner as the Nelson et al. (1999) norms.

Using these criteria the number of generations that were distinctive on each list was calculated. As can be seen in Table 2, older adults generated distinctive encodings for 6.81 of the 15 items studied on each list. If producing distinctive attributes lowered older adults' false remembering than those individuals with a greater proportion of distinctive attributes should show less false remembering in the item-specific encoding condition. Further, if the correlation reflected more than just an individual difference in the ability to prevent false remembering, then the correlation should be reduced or eliminated for the standard encoding condition. Nominally the correlations followed this pattern, although none was significant (False recall:  $r = -.21$ ,  $p = .23$  in the item-specific condition and  $r = -.04$ ,  $p = .86$  in the standard condition; False recognition:  $r = -.22$ ,  $p = .20$  and  $r = -.17$ ,  $p = .32$ , respectively).

**Neuropsychological Predictors**

To determine whether FL or MTL functioning might be related to older adults' false memory in the item-specific encoding condition, linear regression analysis was performed using FL and MTL function scores as predictor variables. As can be seen in Table 3, this model was significant,  $R^2 = .17$ ,  $F(2, 35) = 3.35$ . FL function score was a significant predictor of false recall in the item-specific encoding condition,  $\beta = -.33$ ,  $t(33) = -2.08$ , but MTL function score was not. In a separate analysis of false recall in the standard encoding condition, FL and MTL function scores did not predict memory errors,  $R^2 = .05$ ,  $F < 1$ . In contrast, correct recall was predicted by MTL function score in both the standard,  $\beta = .39$ ,  $t = 2.42$ , and item-specific encoding conditions,  $\beta = .54$ ,  $t = 3.67$ , but FL function score was not a significant predictor in either analysis,  $-0.15 < t < 0.36$ ,  $p > .72$ .<sup>1</sup> The models predicting noncritical intrusions from FL and MTL function scores were not significant in either encoding condition ( $R^2 = .013$  in the standard and .134 in the item-specific encoding conditions), although FL function scores were

**TABLE 3.** Neuropsychological predictors of older adults memory and strategy performance

	$R^2$	B	SE B	$\beta$
Standard encoding				
Correct recall	.154			
FL		0.01	0.03	.06
MTL		0.05	0.02	.39*
False recall	.045			
FL		-0.05	0.05	-.18
MTL		-0.02	0.04	-.11
Noncritical Intrusions	.013			
FL		-0.06	0.57	-.10
MTL		-0.27	0.41	-.11
Item-specific encoding				
Correct recall	.290*			
FL		0.00	0.03	-.02
MTL		0.07	0.02	.54*
False recall	.169*			
FL		-0.12	0.06	-.33*
MTL		-0.06	0.04	-.24
Noncritical Intrusions	.134			
FL		-1.72	0.79	-.35*
MTL		-0.34	0.58	-.09
Distinctive Attributes	.100			
FL		0.08	0.05	.25
MTL		0.04	0.04	.19

Note: \* denotes significant model or predictor at the  $p = .05$  level.

related to noncritical intrusions in the item-specific encoding condition,  $\beta = -.35$ ,  $t = -2.17$ .

As a final test of whether older adults' higher level of false recall using the distinctive encoding strategy might have been due to poor implementation of the strategy, we examined whether FL and MTL function scores would predict (1) failure to produce an item-specific characteristic, (2) generation of the critical theme, or (3) generation of distinctive attributes. Separate regression analyses for each dependent measure found that FL and MTL function scores were not significant predictors of the measures of item-specific encodings ( $F < 1.9$ ).

## Discussion

After studying associated words for 5 s, older adults demonstrated high levels of false recall and recognition (see also, Norman & Schacter, 1997, Butler et al., 2004). When older adults were asked to use an item-specific encoding strategy, their correct recall declined by 10%. More important, older adults false recall rose dramatically under item-specific encoding instructions, particularly for individuals with lower frontal-lobe functioning. The dramatic increase in false recall was more pronounced for lists studied later in the session and limited to lists where the theme had been overtly produced as an item-specific encoding for a studied word.

McCabe et al. (2004) reported that requiring younger adults to covertly generate an item-specific characteristic for each studied word reduced false memory of the theme items relative to generating relational characteristics of the list items. Although our instructions on how to generate item-specific characteristics were similar to those used by McCabe et al., the effect of the instructions on false recall were quite different. Unlike McCabe et al.'s study with younger adults, we asked older adults to overtly generate the characteristics to allow us to evaluate their content. On average, older adults produced distinctive characteristics for half of the studied words and they produced critical theme words, as all or part of their encodings, for almost two studied words. Because young adults from the McCabe et al. study covertly generated their characteristics it is not clear whether this proportion is sufficient to reduce false memory. Theoretically, distinctive characteristics should act to provide additional source information for studied items that will not be present for theme and other intruded words, thus allowing false memories to be rejected at test because the discriminating information is not available. If that discriminating information is only present for half of the items on the list it may not be useful for discriminating studied words or for discriminating studied from related non-studied items. Indeed, the negative, but not significant, correlations between the proportion of distinctive characteristics a subject generated and false remembering in the item-specific condition in addition to the attenuation of those correlations for false remembering in the

standard encoding condition is consistent with the idea that a greater number of distinctive characteristics may lead to lower levels of false memory.

Another possibility is that older adults generated distinctive item-specific characteristics that were adequate, but the additional information at encoding led to more source interference during retrieval. Specifically, generating additional information during study may have further challenged older adults at retrieval because they presumably had to distinguish the current list of studied items from non-studied items and from overtly generated information (item-specific characteristics). This pattern is consistent with the increase in both theme and noncritical word intrusions as well as the decrease in correct recall and the more pronounced increase in false recall later in the testing session. Further, this idea is consistent with our finding that the negative impact of generating characteristics is greater for those with lower frontal functioning scores. Indeed, this is consistent with findings that patients with frontal lobe dysfunction are more susceptible to source confusion (e.g., Shimamura, Jurica, Mangels, & Gershberg, 1995).

In sum, the detailed analyses of the older adults' implementation of the item-specific encoding strategy suggests that the unexpected increases in false recall might have been produced because older adults could not perform the strategy effectively within the time allowed, or because of possible increases in source interference during retrieval.

## EXPERIMENT 2

To further investigate whether producing distinctive attributes might reduce false memories in older adults, in Experiment 2 we gave older adults more time to produce distinctive attributes (8 s instead of 5 s), and we also enhanced the strategy instructions and provided additional practice to improve the quality of the generated item-specific characteristics. Under these conditions we expected that the item-specific encoding strategy might reduce false memories, particularly for individuals who were better at producing distinctive attributes.

On the other hand, if generating distinctive characteristics created more source confusion, the quality of the characteristics would not affect the frequency of false memories. According to this view, an increase in false memories and decrease in correct recall would still be observed in the item-specific encoding condition.

In addition to the modifications described above, this experiment was also designed to examine the degree to which older adults could exploit perceptually based distinctive information to reduce false memory. Previous work has shown that younger adults' false recall is attenuated following visual compared to auditory presentation of the word lists (Gallo et al., 2001; Smith & Hunt, 1998). Pertinent to current concerns, this modality effect in

false recall can be viewed as a distinctiveness effect. The idea is that visual, but not auditory, perceptual components of presented words would be useful in distinguishing presented items from non-presented thematically related words that are internally activated (Smith & Hunt, 1998). However, using very fast presentation times of 1.5 s/word, Smith et al. (2005) found that visual presentation did not reduce false recall in older adults (relative to auditory presentation). Yet, because of cognitive slowing in older adults (Salthouse, 1996), fast presentation rates may not allow older adults time to sufficiently encode perceptual features. Accordingly, in this experiment, we used relatively long presentation times of 8 s per item.

We reasoned that if older adults are capable of encoding (cf. Naveh-Benjamin & Craik, 1995) and using perceptual information as distinctive features, then with this slower presentation rate older adults should be able to exploit visual presentations to reduce false memory (relative to auditory presentations). Alternatively, on the view that older adults are generally deficient in distinctive processing (Smith et al., 2005; see also Smith, 2006) then, even with the slower presentation rates used in the present experiment, older adults would not be able to capitalize on the visual presentation modality. In this case, we would expect that the levels of false memory in older adults would be equivalent for auditory and visual presentation.

To accommodate the longer encoding times while avoiding possible floor effects in false recall further modifications were made to the procedure. In Experiment 1, each studied list was immediately followed by the recall test. In this experiment, sets of two lists were studied prior to a 1 m math distraction task and the recall test. Participants recalled both lists together.

## Method

### *Participants*

Twenty-four older adults between the ages of 65 and 90 were recruited from the Washington University in St. Louis Older Adults subject pool. Screening procedures were similar to those used in Experiment 1, but did not include an assessment of depression. Time and resource limitations prevented us from assessing FL and MTL functioning in this sample.

### *Materials*

Twenty-four experimental lists of 15 words each were chosen from the Stadler et al. (1999) norms. The normative data indicated that these lists had probabilities of false recall ranging from .34 to .65 when studied words were presented auditorally for 2 s each. The lists were separated into 4 sets of 6 lists such that each set of lists had similar average probabilities of false recall, from .46 to .48 and occurred equally often in each encoding by modality condition. Two sets were studied in each session. The sets and lists

within each set were always presented in the same order. In each session, one set of lists was presented auditorally and the other was presented visually. The order of the presentation modality was counterbalanced across participants and across sessions. Four practice lists were chosen from the same source and the 8 words of highest associative strength were presented. The probability of false recall for the practice lists ranged from .23 to .27.

### *Procedure*

Testing was conducted in two sessions that were scheduled one week apart. Like Experiment 1, to eliminate the possibility of contaminating standard encoding with prior item-specific encoding instructions, the standard encoding condition was always conducted in Session 1 with the item-specific encoding condition occurring in Session 2. In Session 1, participants were told that they would be participating in a study of how strategy use influences memory performance and consent to participate was obtained. Then participants were told that they would be studying lists of words and that some of the lists would be presented on the computer screen and some of the lists would be presented auditorally. Participants practiced the study procedure with four lists of 8 words presented visually and were encouraged to ask questions. Then they studied the first two experimental lists, a total of 30 words. One word was presented every 8 s. In the auditory condition the word was read aloud once by the experimenter; in the visual condition the word remained on the screen for the entire 8 s. To allow participants to prepare for the presentation of a new word, a beep sounded 1 s before the stimulus changed. For each list, words were presented in order from strongest to weakest associative strength. Following the study period, participants completed simple multiplication problems (e.g.,  $45 \times 6$ ) for 1 m and then recalled the studied words from both lists for 2 m. Participants were told to write down words they were reasonably sure they had studied and not to guess. This procedure was repeated for the next 4 lists, then there was a brief break to prepare for the word presentation in the other modality and the procedure was repeated for the remaining 6 lists.

When participants returned for Session 2, they were asked to remember words again from 12 new lists with the same presentation and recall procedures as in Session 1; however, in this session, participants were asked to use a specific strategy to rehearse the words. Specifically, for every word that was presented they were asked to come up with a distinctive, unique attribution, characteristic, or thought about that word. They were told that their goal was to make that word as different and distinctive from all the other words that might appear on the list as they could. Further, it was explained that they should not define the words or categorize them by what they like or dislike. The experimenter then modeled the strategy by producing item-specific characteristics for each of 8 words on a practice list. For

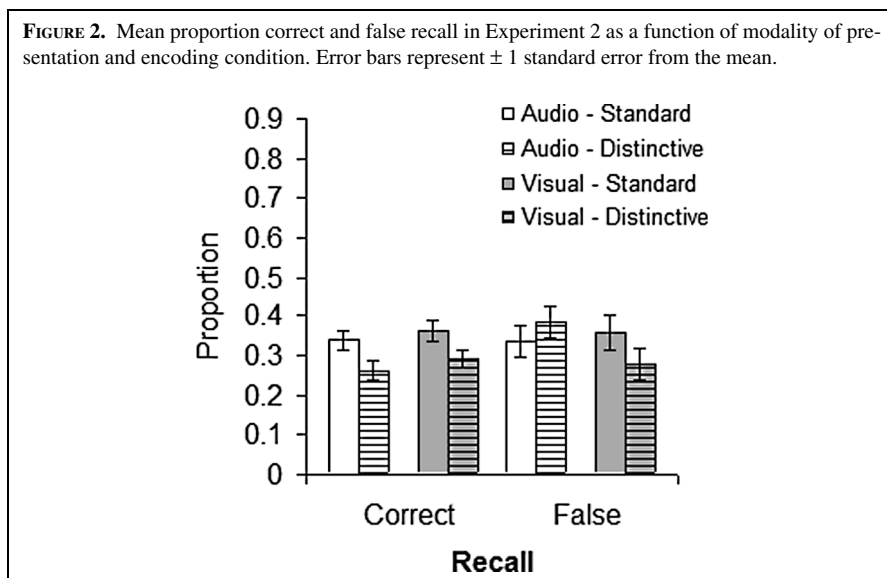
example, for the word ‘pocket’, the experimenter would say ‘I had to empty out my pockets at the airport’. Then participants practiced this technique on three lists of eight words. Feedback was given on the appropriateness of the unique characteristics as they were produced. After practicing the strategy, the experimental trials began. No feedback was given during the experimental trials and participants were told to go on to the next item if they were unable to generate a characteristic within the allotted time. Like Experiment 1, the study session was recorded. Session 1 and 2 each lasted about 1 h.

## Results

The impact of an item-specific encoding strategy on older adults’ performance was analyzed by submitting correct and false recall proportions to separate 2 (encoding: standard and item-specific)  $\times$  2 (modality: auditory and visual) ANOVAs, with both variables as within subjects variables. Mean proportion of correct and false recall are presented in Figure 2 by encoding condition and modality.

### Correct Recall

As was observed in Experiment 1, a significant effect of encoding condition indicated that correct recall was lower for lists studied with item-specific encoding ( $M = 0.28$ ) than those studied with standard encoding conditions ( $M = 0.35$ ),  $F(1, 23) = 11.90$ ,  $MSE = 0.01$ . In addition, visually presented items ( $M = 0.33$ ) were more likely to be recalled than auditorally presented items ( $M = 0.30$ ),  $F(1, 23) = 4.79$ ,  $MSE = 0.007$ . Encoding condition and modality did not interact ( $F < 1$ ).



### ***False Recall – Theme Words***

The main effects of encoding condition and modality were not significant,  $F < 1.5$ . These variables did interact to affect false recall of theme words,  $F(1, 23) = 5.06$ ,  $MSE = 0.02$ . To test for effects of the strategy manipulation, paired sample  $t$ -tests contrasted the encoding conditions separately for each modality. For auditorally presented lists, false recall was as high following item-specific ( $M = 0.36$ ) as standard encoding ( $M = 0.34$ ),  $t(23) = -0.49$ . In contrast, for lists presented visually, false recall was lower following item-specific ( $M = 0.28$ ) than standard encoding ( $M = 0.38$ ),  $t(23) = 2.27$ . To test the effects of the modality manipulation, paired sample  $t$ -tests contrasted the modality conditions separately for each encoding condition. In neither test was false recall lower for the visual than the auditory condition,  $t(23) = -1.15$  for the standard encoding and 1.59 for the item-specific encoding conditions.

### ***False Recall – Noncritical Words***

As in Experiment 1, there was a significant increase in the number of noncritical-word intrusions following item-specific encoding ( $M = 0.68$ ,  $SE = 0.11$  intrusions/list) compared to standard encoding ( $M = 0.41$ ,  $SE = 0.06$  intrusions/list),  $F(1, 23) = 4.98$ ,  $MSE = 0.36$ . In addition, intrusions were more common in the recall of auditorally ( $M = 0.62$ ,  $SE = 0.07$  intrusions/list) than visually ( $M = 0.47$ ,  $SE = 0.07$  intrusions/list) presented lists,  $F(1, 23) = 5.58$ . The two variables did not interact, ( $F < 1$ ).

As in Experiment 1, intrusions were categorized into four different types. Semantic intrusions ( $M = 0.28$ ,  $SE = 0.04$  intrusions/list) were not influenced by encoding condition or modality. The encoding condition did enter into a marginally significant interaction with modality,  $F(1, 22) = 3.29$ ,  $MSE = 0.17$ ,  $p = .083$ . The means suggest that for auditory lists semantic intrusions were nearly equivalent in the standard ( $M = 0.31$ ,  $SE = 0.05$  intrusions/list) and item-specific ( $M = 0.29$ ,  $SE = 0.06$  intrusions/list) conditions,  $t(23) = 0.43$ , but for visual lists semantic intrusions were greater for item-specific ( $M = 0.34$ ,  $SE = 0.06$ ) than standard ( $M = 0.19$ ,  $SE = 0.06$ ) encoding,  $t(23) = -2.14$ . Phonological intrusions were infrequent ( $M = 0.06$ ,  $SE = 0.01$  intrusions/list) and were not affected by any variables nor entered into any interactions,  $F < 1.33$ . Intrusions of words that had been studied or practiced on previous lists were more likely with item specific encoding ( $M = 0.37$ ,  $SE = 0.09$  intrusions/list) than with standard encoding ( $M = 0.13$ ,  $SE = 0.04$  intrusions/list),  $F(1, 22) = 6.04$ ,  $MSE = 0.70$ , and more frequent following auditory presentation ( $M = 0.30$ ,  $SE = 0.05$  intrusions/list) than visual presentation ( $M = 0.19$ ,  $SE = 0.05$  intrusions/list),  $F(1, 22) = 7.05$ ,  $MSE = 0.11$ . The interaction of encoding and modality conditions was not significant,  $F < 1$ . Intrusions of words that were part of the generated item-specific characteristics

occurred less often than semantic and previous list intrusions,  $M = 0.12$ ,  $SE = 0.02$ , and were not affected by modality,  $F < 1.3$ . A list position analysis like that reported for Experiment 1 was not conducted on these data because list position was confounded with the modality manipulation.

### ***Encoding Responses***

To evaluate the generated responses we used the same measures as we used in Experiment 1. First we examined the number of trials for which characteristics were NOT produced. The presentation modality had a marginally significant effect on whether a characteristic was omitted,  $F(1, 22) = 3.32$ ,  $p = .082$ . As outlined in Table 2, more responses tended to be omitted for auditorally presented lists than visually presented lists. To examine whether older adults were better able to generate characteristics in this study compared to Experiment 1 we compared the number of omitted generations in Experiment 1 to the number of omitted generations in the visual condition of this experiment. Older adults were less likely to omit the generation of a characteristic in this experiment than in Experiment 1,  $F(1, 60) = 11.01$ ,  $MSE = 0.665$ .

Next we examined the quality of the item-specific characteristics using the two measures described above, how often the (1) critical theme words and (2) distinctive characteristics were generated on each list (see Table 2). Each measure was submitted to an ANOVA with modality as a within subjects variable. More critical theme words were part of the characteristics for auditorally presented lists than for visually presented lists,  $F(1, 22) = 18.20$ ,  $MSE = 0.28$ . The number of critical theme words generated in the visual condition is a reduction from the proportion observed in Experiment 1,  $F(1, 60) = 12.57$ ,  $MSE = 0.002$ .

As in Experiment 1, false recall and normative false recall for lists that had a theme generated were compared to lists with no theme generated. Critical theme words were generated on 8.54 of the 12 lists that were studied ( $SE = 0.41$ ). Modality was also included as a variable in the ANOVA. Seven individuals were excluded because they did not have observations in one or more of the cells (one did not generate themes on any of the visual lists, two generated themes on every list, two generated themes on all of the visual lists and two generated themes on all of the auditory lists). As with Experiment 1, there was no difference between the average normative false recall for lists where themes were and were not generated,  $F < 1$ . For false recall, the main effect of theme generation was not significant,  $M = 0.34$  for theme-generated lists and 0.23 for no-theme-generated lists,  $F = 2.07$ . Theme generation interacted with modality,  $F(1, 16) = 5.26$ ,  $MSE = 0.05$ . Unlike Experiment 1, false recall following visual presentation of lists was not affected by whether the theme had been generated as part of the characteristics,  $M = 0.29$  and 0.30 for the theme-generated and no-theme-generated

lists. However, when the lists were presented auditorally false recall was influenced by whether the theme was generated,  $M = 0.40$  and  $0.17$ , respectively. In the auditory presentation condition, false recall on lists where no theme was generated was lower than false recall observed under standard encoding instructions ( $M = 0.32$ ),  $t(16) = 2.31$ .

Distinctive attributes were produced 8.55 times/list ( $SE = 0.47$ ). This number did not differ by modality ( $F = 2.72$ ,  $p = 0.12$ ). The encodings in Experiment 2 tended to be more distinctive than those in Experiment 1 ( $M = 6.81$  trials/list), a difference that was significant,  $F(1, 60) = 9.08$ ,  $MSE = 4.82$ . Like Experiment 1, the correlation of false recall and number of distinctive characteristics generated on each list was not significant for the visual modality ( $r = -.25$ ,  $p = .24$ ) but was in the expected direction. However, for the auditory modality the correlation was positive, although not reliable, ( $r = .30$ ,  $p = .16$ ).

## Discussion

Longer study times (8 s) and more practice and feedback using an item-specific encoding strategy improved the item-specific characteristics that older adults generated; their quantity increased, from 14.0 to 14.7 generations/list, and their quality increased from 13.13 to 13.71 generations without themes/list and from 52 to 57% distinctive generations/list. Like Experiment 1, correct recall declined in the item-specific encoding strategy condition. In addition, intrusions of noncritical words increased under item-specific encoding. These effects were observed in both presentation modalities. Unlike the dramatic increase in false recall of theme words observed in Experiment 1, false recall of themes words from visually presented lists declined by 10% with item-specific encoding in this experiment. However, in the auditory presentation condition false memory was not affected by item-specific encoding. In sum, when the impact of the item-specific encoding strategy on all three measures of older adults' memories is considered, the strategy impaired performance (auditory presentation) or had some benefits with significant costs (visual condition). Finally, a modality effect was not observed in either encoding condition. These results will be discussed further below.

## GENERAL DISCUSSION

Across two experiments we examined whether older adults could decrease false remembering through enhanced distinctive processing of studied items by using an item-specific encoding strategy (Experiments 1 and 2) and by processing the perceptual characteristics of studied items presented in different modalities (Experiment 2). Item-specific encoding and the modality manipulation had somewhat different effects on older adults' performance,

though the central outcome is that distinctive processing consistently did not attenuate false memory. Generally, distinctive processing through item-specific encoding was detrimental to both correct recall and false memory of themes and/or noncritical words of older adults, while distinctive processing through the presence of visual information was not effective for reducing false memories. These findings are consistent with the view that older adults are deficient in distinctive processing (Smith, 2006), an idea we develop further below.

### **Item-Specific Encoding Effects on Veridical Memory**

In both Experiments 1 and 2 veridical recall was lower when an item-specific encoding strategy was used as compared to standard encoding (by 11% in Experiment 1 and 7% in Experiment 2). Typically distinctively processing all items in a list does not affect recall of those items (e.g., McCabe et al., 2001; Smith et al., 2005). However, Thomas and Sommers (2005) reported that when encoding of DRM lists was embedded in sentential contexts, one for each DRM word, correct memory was impaired relative to the standard encoding condition for both younger and older adults. They suggested that the sentential contexts increased the working memory demands at encoding and/or retrieval leading to lower correct memory. In our study, requiring the item-specific characteristics to be spoken aloud and making participants aware that their characteristics would be evaluated may similarly have required additional working memory resources. If so, then resources available for focusing on target items could have been reduced, thereby penalizing veridical recall. It is also possible that generating item-specific characteristics disrupted relational processing that would have otherwise supported higher veridical recall (Hege & Dodson, 2004; McCabe & Smith, 2006).

The production of characteristics during encoding may have also led to greater interference at retrieval for older adults. In essence, the strategy manipulation may have increased the size of the search set during recall, resulting in more failures to retrieve studied words (Watkins & Watkins, 1975). The increase in intrusions of noncritical words under item-specific encoding instructions in both experiments is consistent with this idea.

### **Item-Specific Encoding Effects on False Recall**

The major finding in these experiments is that older adults' false memory of theme and noncritical words was not reduced by the generation of distinctive encodings and, under some conditions, was dramatically increased. Our interpretation of these results is that the items generated for the item-specific encoding task created additional source monitoring demands for older adults, who typically show poor performance on source memory tasks (e.g., Craik, Morris, Morris, & Loewen, 1987; Naveh-Benjamin & Craik,

1995; for a review see Zacks, Hasher & Li, 2000). The idea is that the words generated for the distinctive feature task created additional source interference for the older adults because they were faced with three possible sources for candidate items that might be recalled: presented words, words generated during encoding, and non-presented thematic associates of presented words. Dehon and Brédart (2004) and Dodson, Bawa, and Slotnick (2007) present evidence consistent with this idea.

Four findings support the source confusion explanation. First, the dramatic increase in false memory under item-specific encoding in Experiment 1 appears to have increased across the testing session. Second, the intrusion data also converge with the idea that source confusions increased after item-specific encoding. Specifically, previous list intrusions of noncritical words increased under item-specific encoding and there were significant number of noncritical intrusions from generated characteristics in both studies. Third, when the theme was not generated as part of *any* encoding for a particular list, false recall of that theme was lower than when the theme was generated (in Experiment 1 and for the auditorially presented lists in Experiment 2).

Finally, the possibility that source confusion led to a failure of the distinctive encoding strategy dovetails with our finding in Experiment 1 that the increase in false recall in the strategy condition was associated with FL functioning. FL functioning is thought to be important in supporting source discrimination, with past research showing source memory deficits especially for low frontal older adults (Glisky et al., 1995, 2001). The negative correlation we observed between FL function score and false recall in the item-specific encoding condition suggests that FL functioning may have determined the degree to which older adults could encode or use source information, when an additional encoding demand was present (generating the distinctive semantic characteristics). This is consistent with the idea that higher FL functioning older adults were not as confused by the increase in source information created by generating additional information at study as lower FL functioning older adults were; or perhaps higher FL functioning older adults processed the studied items in the item-specific encoding condition in a way that was similar to their processing under the standard encoding condition (including some encoding of the visual characteristics of the words), but lower FL functioning adults were unable to do so.

Our finding that the FL functioning of older adults plays a critical role in the appearance of negative effects of an item-specific encoding strategy (developed to attenuate memory illusions in younger adults) in Experiment 1 appears to have some generality. Thomas and McDaniel (2007) modified the typical DRM procedure so that target words would be more richly encoded with elaborative detail and thus presumably more distinguishable from the non-presented themes (using sentential contexts such as ‘The weary worker laid down on the bed’). They found that both young adults and high frontal

older adults showed substantially reduced false recognition and substantially increased discriminability ( $d'$ ) with sentence elaboration relative to the standard word-only presentation. In contrast, the low frontal older adults had nominally *higher* false recognition and *lower* discriminability when the targets were presented in elaborative sentence contexts (that preserved an interpretation of the target thematically related to the critical theme) than when presented in isolation. These findings converge on the idea that supportive encoding techniques that reduce memory illusions in younger adults can have the opposite effect on low-frontal, but not necessarily high-frontal, older adults.

An alternative to the source confusion explanation is that older adults could not perform the item-specific encoding strategy effectively, or even that the strategy engendered more associative-based processing of the non-studied critical items (cf. Roediger et al., 2001). Older adults' strategy implementation was far from perfect. On average, for 1–2 items on each list the generation contained the non-presented critical item and for almost half of the studied words on each list the generation was an associate to a word that was semantically consistent with the theme of the list (i.e., not distinctive).

Notably, however, it is not clear how often distinctive information must be generated to observe a benefit of item-specific encoding on reducing false memory because the distinctive characteristics in the McCabe et al.'s (2001, 2004) studies were covertly generated. Younger adults might have only generated distinctive information for half the studied items (similar to the older adults in the present study). Certainly some non-distinctive generations would be expected. Consider that when the first word of a list is presented (e.g., bed) the individual has no context to distinguish it from yet presented words and consequently, naming a specific object (e.g., pillow or even an activity like sleep) associated with the first word could be related to the rest of the list (e.g., things related to sleep). Further, countering the idea that the older adults' proportion of distinctive generations undercut the strategy's effectiveness, in Experiment 1 the neuropsychological functioning of the older adults was not associated with the proportion of distinctive generations, yet it was associated significantly with the negative consequences of the strategy. Finally, in neither study was the proportion of distinctive characteristics produced significantly correlated with false recall, suggesting that generating a large proportion of distinctive attributes does not lead to less false recall.

Giving older adults more time to generate item-specific characteristics and more practice with feedback in Experiment 2 did increase the number of distinctive attributes generated for each list compared to Experiment 1 (8.6 and 7.9, respectively). The improvement in the distinctiveness of generated features was accompanied by the elimination of the dramatic increase in false memory of themes that had been observed in Experiment 1. Although

this cross-experiment comparison might be taken as support for the view that more distinctive characteristics were needed to see reductions in false remembering, other procedural differences (like 8 s of encoding time and longer retention intervals) might account for the difference. For these reasons we favor the source confusion explanation.

Another alternative explanation for the false memory findings is that the item specific encoding task introduced additional processing demands at encoding, which led to the impaired performance of older adults (e.g., Anderson, Craik, & Naveh-Benjamin, 1998). Earlier in this discussion, we suggested a similar explanation for the reduction in veridical recall after item-specific encoding. Yet, two lines of evidence argue against this interpretation. First, additional processing demands per se do not typically penalize older adults if that processing encourages encoding that is mnemonically beneficial for younger adults. For example, orienting tasks that direct older adults toward deeper levels of processing produce better performance than a standard no-orienting control (Erber, Herman, & Botwinick, 1980; Mitchell & Perlmutter, 1986). The orienting tasks presumably demand additional processing over the no orienting control, yet they increase performance for older adults. Similarly, when older adults are given encoding conditions that require generation, memory improves even though generation increases processing demands (Mitchell, Hunt, & Schmitt, 1986; see also McDaniel, Ryan, & Cunningham, 1989). Second, an additional processing demands account has difficulty explaining why, in Experiment 1, the increase in false memory was observed for the last four studied lists, but not the first four list. Why would the processing demands of item specific encoding increase across the study session? Indeed, practice utilizing the technique across the session should decrease the processing demands. Therefore, the view that additional orienting task demands in the item-specific condition reduced the memory performance of older adults does not fully account for our data.

The negative effects of item specific generation may generalize to other encoding conditions that require overt generation. If asked to say aloud thoughts during study under standard encoding instructions, the theme word is likely to be generated more often than we observed with item-specific instructions (e.g., Dehon & Brédart, 2004). Because in this study false memory increased when the theme word was part of the item-specific generation, it is likely that more frequent generation of the theme would lead to even greater increases in false memory. We had thought that asking older adults to say aloud their characteristics would aid source discrimination processes because studied words that were read internally would be easier to distinguish from thoughts that were also spoken than from thoughts that were not spoken aloud (Hashtroudi et al., 1989). Perhaps additional source discrimination instructions, to focus their attention on the visual source information,

are necessary for older adults to use the item-specific generations to improve memory performance (e.g., Thomas & Sommers, 2005).

Our study also suggests an important qualification to the view that age-related differences in false memory are due to a deficiency in self-initiated distinctive processing (Tacconat et al., 2006). In our study, simply asking older adults to initiate distinctive processing was not sufficient to reduce their false memory. Tacconat et al.'s procedure differed in many ways from our own, but perhaps the two most important procedural differences for explaining the discrepancy between these studies is that Tacconat et al. (1) used lists of studied words that were unrelated to each other and (2) guided the distinctive processing to specific features of studied items that distinguished them from non-presented themes. In our study, the combination of related studied items converging on the same false item, and the absence of guidance on *how* to distinguish each item from the theme, might have overtaxed the limited ability of older adults' to engage in distinctive processing that would have otherwise been adequate to reduce false memory.

Another important result in this study was that providing additional perceptual information (visual presentation) that might be used later to distinguish experienced from thought-about words did not decrease false memory for older adults, even with 8 s/word to encode the distinctive visual information (Experiment 2). This finding extends the generality of Smith et al.'s (2005) results (with older adults) for visual presentations with short presentation rates (1.5 s/word) and reinforces the conclusion that older adults are generally unable to utilize the greater perceptual detail in visual presentation compared to auditory presentation to reduce false recall of theme words.

The absence of a modality effect (even in the standard encoding condition) on older adults' false memory contrasts with findings that older adults can use a distinctiveness heuristic on a recognition test to reduce false memory (e.g., Schacter, Israel, & Racine, 1999). As discussed by Smith et al. (2005), recognition tests typically used in studies of the distinctiveness heuristic may provide adequate support for older adults to use distinctiveness to reduce false memory whereas the recall tests used here and in Smith et al. were not sufficient. This argument converges with work on false recognition of pictures finding that older adults showed as much priming for the visual details of studied pictures as younger adults, but unlike younger adults did not use this information to distinguish studied from new perceptually similar pictures (Koutstaal, 2003). Similarly, with long encoding times older adults might encode more perceptual information with visually presented word lists, but fail to recall that information to reject non-presented theme words. Note however that if recognition tests support the retrieval of distinctive information the results of Experiment 1 suggest that this support is not universal, for all types of distinctive information. In Experiment 1 where the distinctive processing was more semantic rather than perceptual, older adults

tended to falsely recognize more critical theme words following distinctive processing than standard processing, the same pattern that was observed on the recall test.

In conclusion, our findings add to a growing list of presentation techniques that attenuate false memory (in DRM paradigms) for younger but not older adults (e.g., see Smith et al., 2005; Thomas & Sommers, 2005). In two experiments, an item-specific encoding strategy shown previously to reduce younger adults' false memory of theme words (McCabe et al., 2001, 2004) at best had no impact on older adults' false memory (when considering both critical theme and noncritical intrusions) and at worst, led to dramatic increases in older adults' false memory and decreases in correct recall. In addition, slow visual presentation of the word lists did not reduce false memory relative to auditory presentation for older adults, even though visual presentations allow younger adults to reduce false memory (Smith & Hunt, 1998). These findings lend converging support to the emerging view that older adults are generally deficient in distinctive processing (see Smith, 2006), such that older adults have deficits in encoding distinctive information or in using that information at retrieval to reduce false memory or both. Particularly noteworthy is that this putative distinctive processing deficit in older adults remained even when support was provided for encoding the distinctive information (visual presentation, extensive training at item-specific encoding, along with slow presentation rates).

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## APPENDIX

### Instructions for Item-Specific Encoding Condition

While the words are being presented I want you to think of one, and only one, unique characteristic for each word that you see. So if you see DOG you might think that your dog's name is Oscar. If the next word you see is CAT you might think that you are allergic to cats. If you then see MOUSE, you might think of a computer mouse. If you see BOAT, you might think of GOAT since the words rhyme.

The purpose of this experiment is to study how this type of rehearsal strategy influences memory, so it is very important that you use the specific strategy we ask you to use while reading the lists. PLEASE do not use any other strategy!

Now, you will see a list of words to give you a chance to practice using the rehearsal strategy. After you see each word, please tell me aloud the unique characteristic you will use to rehearse the word.

List of practice study words and possible unique characteristics that were used to illustrate an appropriate item-specific characteristic if the participant did not generate a unique characteristic.

Practice study word	Item-specific characteristic
Short	One of the seven dwarves
Fellow	He's a jolly good fellow
Narrow	A balance beam
John	My best friend John Smith
Time	The look of my granddad's pocket watch
Far	Far Side comic
Hair	I found a hair in my soup
Island	Gilligan
Road	<i>The yellow brick road</i>
Thin	Rhymes with sin
Underwear	Victoria's Secret
Distance	I see the sunset off in the distance
Line	New Line Cinema
Low	'Swing low, sweet Chariot'
Rope	Soap on a rope