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Why Do Pictures, but Not Visual Words, Reduce Older Adults' False Memories?

Rebekah E. Smith, **R. Reed Hunt**, and **Kathryn R. Dunlap**
Department of Psychology, The University of Texas at San Antonio

Abstract

Prior work shows that false memories resulting from the study of associatively related lists are reduced for both young and older adults when the auditory presentation of study list words is accompanied by related pictures relative to when auditory word presentation is combined with visual presentation of the word. In contrast, young adults, but not older adults, show a reduction in false memories when presented with the visual word along with the auditory word relative to hearing the word only. In both the case of pictures relative to visual words and visual words relative to auditory words alone, the benefit of picture and visual words in reducing false memories has been explained in terms of monitoring for perceptual information. In our first experiment we provide the first simultaneous comparison of all three study presentation modalities (auditory only, auditory plus visual word, and auditory plus picture). Young and older adults show a reduction in false memories in the auditory plus picture condition, but only young adults show a reduction in the visual word condition relative to the auditory only condition. A second experiment investigates whether older adults fail to show a reduction in false memory in the visual word condition because they do not encode perceptual information in the visual word condition. In addition, the second experiment provides evidence that the failure of older adults to show the benefits of visual word presentation is related to reduced cognitive resources.

Keywords

false memory; monitoring; divided attention; source memory; aging

Considerable evidence exists suggesting that older adults are more susceptible to false memories, illusory recollection of events that never occurred, than are younger adults (see Pierce, Simons and Schacter, 2004 for a review). Much of this research used the associatively related list paradigm originally reported by Deese (1959) and subsequently revived by Roediger and McDermott (1995). The critical feature of these lists is that each word in the list is associatively related to a critical word, which is not present in the list. Participants falsely recall and falsely recognize the critical non-presented item, with older participants often producing even more false memories than younger participants.

Correspondence should be addressed to: Rebekah E. Smith, Department of Psychology, One UTSA Circle, San Antonio, TX 78249, 210-458-7301, Rebekah.smith@utsa.edu.

Although the resilience of false memory in the associative list paradigm is quite impressive (see Gallo, 2006, for review), some variables have been discovered to reduce false memory in this paradigm and related paradigms. Predominant among these is the use of pictures in the study list (e.g., Schacter, Israel, & Racine, 1999; see Gallo, Cotel, Moore, & Schacter, 2007 for comparison of pictures and words using different materials). For example, in Schacter et al.'s (1999) experiment, the study lists were presented auditorially. In one condition, a picture of the object appeared simultaneously with the spoken word while in another condition the written word accompanied the spoken word. In a recognition test in which the test items were presented auditorially, picture presentation at study reduced false memory for the critical non-presented word by 33% compared to auditory plus word study. Importantly, the effect of picture presentation on false memory in elderly participants was essentially identical to that in young participants. Not all studies report equivalent effects of pictures on false recognition abatement in young and older participants, but all studies do report a reduction in false recognition following picture presentation with older participants.

This result contrasts with the effects of another variable known to reduce false memory, study modality. Smith and Hunt (1998) reported that visual presentation of associatively related lists reduced false recall and recognition relative to auditory presentation of the lists, a result that has been replicated many times (Cleary & Greene, 2002; Gallo, McDermott, Percer, & Roediger, 2001; Gallo & Roediger, 2003; Hunt, Smith, & Dunlap, 2011; Kellogg, 2001; Smith & Engle, 2011; Smith, Hunt, & Gallagher, 2008; Smith, Lozito, & Bayen, 2005). However, unlike pictures, visual presentation of study words does not reduce false recall for elderly participants. Smith, et al. (2005) asked young and older participants to recall associatively related lists that had been studied visually or auditorially. Younger participants showed the standard modality effect, but older participants falsely recalled critical items at the same rate following visual and auditory presentation, a finding replicated by Butler, McDaniel, McCabe, and Dornburg (2010).

As noted by Smith et al. (2005), interpretation of the differential effects of picture presentation and visual presentation of words is complicated by a confounding with type of test. The studies that have used the DRM materials that have included a manipulation of study modality for young and older adults are summarized in Table 1. The only study of the effect of picture presentation on older participants' false memory in the DRM paradigm used recognition tests whereas two of the prior studies on the effect of modality use recall. In the one study of modality that did use a recognition test, Gallo and Roediger (2003) found no age difference in the modality effect on a recognition test. However they note that this result should be interpreted cautiously because the size of the modality effect for their younger subjects was much smaller than is usually found (Gallo & Roediger, 2003, Footnote 1). A subsequent reanalysis of the data as a function of executive functioning as measured by the frontal lobe battery (e.g., Glisky, Rubin, & Davidson, 2001) revealed that only high functioning older adults showed the modality effect (Gallo, personal communication, June 11, 2004). Low functioning older participants did not show a reduction in false recognition for visually presented words. This outcome is consistent with the fact that only low functioning older adults are prone to exaggerated levels of illusory memory (Butler, McDaniel, Dornburg, Roediger, & Price, 2004; see also Thomas & McDaniel, 2004). Taken together, the existing studies show that the older adult population that is subject to elevated levels of illusory recollection does not benefit from the modality effect on false recognition. As can be seen in Table 1, no prior study using the DRM materials has investigated whether pictures will reduce false recall in older adults, a question addressed by our first experiment.

The interpretations offered by Schacter et al. (1999) and by Smith and Hunt (1998) were broadly similar. The general idea was study of pictures or of visual words engages more elaborate sensory processing than does auditory processing of words. If information corresponding to that processing is included in memory for an item, that memory is more discriminable from non-presented test items than is memory for items studied auditorially. More specifically, Schacter et al. suggested that the encoding of pictures is distinctive in that their perceptual features are complex and unique relative to words, in accord with Nelson’s (1979) explanation of the picture superiority effect in memory. Thus the visual sensory processing of pictures at study yields a memory that is readily distinguished from representations produced by the amodal processing of non-presented critical lures (see Schacter & Wiseman, 2006 for a review). Of course, the picture effect could be due to some other aspect of picture processing, such as spontaneous imagery or additional semantic processing that could lead to a qualitatively different memory representation. Prior research in this area has not focused on this latter possibility, an issue that we will return to in the general discussion. The case for visual words, however, seems less open to alternative interpretation. There is no reason to believe that comprehension of a word will vary with modality of presentation. What is different is the quality of sensory processing. Smith and Hunt argued that the processing of visually presented words is less like the amodal processing of non-presented critical lures than is the processing of auditorially presented words.

The absence of a modality effect on false memory among older participants is potentially instructive about more general age differences in memory. Perhaps the data are pointing to important differences in the output monitoring process as a function of age, a hypothesis raised by other researchers (e.g., Koutstaal, 2003). As an interesting example, Dehon and Brédart (2004) asked younger and older participants to recall associatively related lists and then, following the recall test, participants examined their responses and reported any other items they thought of but did not report during the initial test. The elderly participants recalled more critical items on the initial test, the standard age effect on false memory, but when asked to report items that were accessed but not reported, the younger participants produced more critical items. The total critical items reported did not differ by age, suggesting that those items were equally likely to be activated at study, but less likely to be detected as wrong at test by elderly participants. In a second experiment, Dehon and Brédart found that warning participants about the critical items prior to study reduced false recall for younger participants but not for the elderly. Because the effectiveness of warnings is assumed to be due to detection of the critical items at study, the lack of effect on older participants was taken as evidence of reduced monitoring.

On the other hand, reasons exist to be skeptical of the monitoring deficit hypothesis. For one, warnings prior to study have been found to reduce false memory among older participants (McCabe & Smith, 2002; Watson, McDermott, & Balota, 2004). Although the reasons for the inconsistency between these studies and those of Dehon and Brédart (2004) are not obvious, the conflicting outcomes suggest caution in using studies of warnings to draw firm conclusion about monitoring processes in the elderly. In addition, the studies reporting positive effects of picture presentation on false memory in older participants uniformly attribute the reduction in false memory to the effect of picture presentation on monitoring. This interpretation presumes relatively intact monitoring processes.

A second idea about the age differences in the modality effect on false memory focuses on age differences in encoding. Specifically, it is possible that the contextual detail of modality of presentation is not encoded by elderly participants. A common finding in the field of memory and aging is that aging disproportionately disrupts memory for detailed source information relative to memory for the content of an event (see Zacks & Hasher, 2006, for a review). If the modality information is not encoded, obviously that information will not be available at retrieval to distinguish studied items from the critical non-studied item. But if aging impairs encoding of detailed information about sensory processing, why do older participants benefit from picture presentation, in many cases showing reduction in false memory comparable to that of younger participants? After all, the effect of pictures is presumed to be due to memory for details of sensory processing (e.g., Schacter et al., 1999).

The answer to this question appeals to Craik's (1983, 1986) notion of environmental support, which suggests that age differences in memory can be reduced when memory processes are supported by a rich encoding context. An example that is relevant to our question is Luo, Hendricks, and Craik's (2007) demonstration that when presented with pictures for encoding, older adults' recollection memory was comparable to the recollection memory of the younger participants. Thus pictures provide a material-based enriched encoding environment that supports detailed perceptual encoding by older adults. In contrast, normal processing of verbal material is focused on semantic analysis. Modality of presentation of such material is variable and usually of little consequence to the semantic analysis, leading to scant attention to the sensory modality in which the verbal information is presented. Spontaneous encoding of the details of sensory processing for words would thus add demands on capacity, thereby decreasing the probability of such processing by older adults.

This argument is essentially the speculative conclusion reached by Smith et al. (2005), who found visual presentation of words at study did not affect false recall of older participants. They interpreted this outcome as indicative of impoverished encoding of sensory processing details in the form of modality information. Appealing to Craik's (1983, 1986) idea of contextual support, Smith et al. suggested that the positive effect of pictures on false memory in elderly participants (e.g., Schacter et al., 1999) was due to the encoding of sensory details from pictures being relatively more obligatory than for words.

The purpose of the research reported here is to test the speculations of Smith et al. (2005) about age differences in false memory. The first experiment contrasts the effects of auditory only, auditory plus visual word, and auditory plus picture study presentations on recall of DRM lists as a function of age. Previous research examining the effects of pictures on false memory has compared auditory plus picture with auditory plus visual word whereas research concerned with the modality effect has compared auditory with visual word. We are not aware of any published studies directly comparing the three conditions. This comparison also will yield the first evidence on the effect of pictures on false recall in elderly participants. To anticipate, the results replicated previous findings for both picture and modality effects. To determine the locus of the age effect, the second experiment contrasted the effect of the same three conditions on the ability to identify the source of the items on the assumption that successful source identification requires encoding of information corresponding to the source modality.

Experiment 1

In the first experiment, younger and older participants studied associatively related lists for a free recall test. Three different study conditions were defined by the mode of list presentation. The auditory control condition simply heard each of the words. The auditory plus visual word condition heard each word and simultaneously saw the word. The auditory plus picture condition heard each word and simultaneously saw a line drawing of the word's referent. Following study, participants free recalled the words. Our principal interest is in the false recall of critical list items as a function of study condition and age.

Method

Participants and design—The experiment included 140 young adults (63 females), ranging in age from 17 to 29 years, and 106 older adults (69 females), ranging in age from 60 to 88 years. Young adults were introductory psychology students from the University of Texas at San Antonio (UTSA) participating for course credit or individuals recruited through newspaper advertisements and/or flyers participating for monetary compensation. Older adults, who were paid $20, also were recruited through advertisements and flyers. Participants were all healthy, native English speakers who came to the lab to complete the study. Means for age, vocabulary, and years of formal education for both young and older adults are shown in Table 2. Young adults had lower vocabulary scores and fewer years of formal education compared to the older adults, Fs > 153.7, ps < .001, η_p^2s > .38. Participants were assigned randomly to one of the three study conditions: auditory (A); auditory + visual (A+V); and auditory + picture (A+P). The number of participants assigned to each condition can be found in Table 3.

Materials—Six DRM lists taken from Israel and Schacter (1997) were used for this study. The 12 highest associates of each of the 6 critical items made up each associate list. The order of presentation of study words was held constant across the lists, with the highest associate presented first, followed by the remaining 11 in descending order of associative strength. For example, the list related to the critical non-presented word "sweet" was *sour, candy, sugar, bitter, good, taste, tooth, nice, honey, soda, chocolate, heart*. In the auditory condition, the auditory words were presented alone over headphones by a female voice. In the visual word condition, the auditory words accompanied the visual words, with the latter presented on the computer monitor, in black, Ariel, 24-point font in the center of a white screen. For picture presentation, the auditory words were accompanied by the corresponding black and white line drawings created by Israel and Schacter (http://www.wjh.harvard.edu/~dsweb/DRM/) and subsequently used in every study of the effect of pictures on false memory of DRM lists (e.g., Dodson & Hege, 2005; Hege & Dodson, 2004; Hicks & Starnes, 2006; Ghetti, Qin, & Goodman, 2002; Schacter, Cendan Dodson, & Clifford, 2001). Participants studied all six sets of associates presented as a single 72-item study list.

Procedure—Following informed consent procedures, participants put on headphones and a sound check was completed with adjustments to the volume as needed. Participants read instructions for the appropriate study phase, indicating that they would hear words one at a time. For the A+V condition participants were instructed that they would also see the visual word on the screen. In the A+P condition, instructions indicated that the auditory words would be presented with related pictures. All participants received intentional memory instructions. The list then was presented at a rate of 3 sec/item. In the A+V and A+P, the word or picture appeared on the monitor simultaneously with the auditory presentation. After all 72 words were presented, participants were given a sheet of paper and were asked to recall as many of the words as possible from the lists by writing the words on a sheet of paper. Participants were instructed to recall as many words as possible without guessing and were allowed up to 2.5 min for recall.

Results and discussion

Critical Item False Recall—The proportion of critical items falsely recalled can be found can be found in Table 3. The omnibus 2 (age group) × 3 (study condition) ANOVA produced a significant effect of study condition, $F(2,241) = 7.59$, $p = .001$, $\eta_p^2 = .06$. Although the interaction was not significant, $F(2,241) = 1.23$, $p = .294$, the pattern of results in Table 3 is quite different in the two age groups and planned comparisons were conducted to test predicted patterns of effects in the two age groups. Specifically, as expected based upon prior work (e.g., Smith & Hunt, 1998), young adults had higher false recall in the A condition relative to the A+V condition, but presentation of the visual word did not reduce false recall for older adults when compared to the auditory only condition, replicating Smith, et al. (2005). The current results also replicate prior demonstrations of lower false memory in the A+P condition relative to the A+V condition for both age groups (e.g., Schacter et al., 1999).

The new finding in this experiment is the demonstration that the A+P condition produced fewer false memories relative to the A condition in both age groups. This pattern was predicted based upon the pattern seen across previously published studies, but this is the first experiment to directly compare all three study modality conditions simultaneously as well as the first to report the effect of pictures on false recall of elderly participants. As noted in the introduction both the A+V and A+P provide additional information corresponding to sensory processing relative to the A condition, and previous explanations of the reduction in false memories in A+P conditions relative to A+V conditions rely heavily on this additional sensory information in explaining the reduction in false memories when pictures are presented at study in both age groups. Thus the current pattern of results raises questions about why the sensory information from pictures leads to reductions in false memories in both age groups, but the sensory processing information from visual words only benefits young adults. It is also possible that the presentation of pictures at encoding leads to a qualitatively, perhaps semantically richer memory representation. We return to this possibility in the discussion.

Correct recall—The proportion of study list items correctly recalled can also be found in Table 3. Not surprisingly, young adults recalled more than the older adults, $F(1,241) = 4,7.87$, $p < .001$, $\eta_p^2 = .17$. Consistent with prior studies, study condition did not affect correct recall, $F < 1$, $p = .387$. The variables did not interact, $F < 1$, $p = .421$.

Experiment 2

In Experiment 1, planned comparisons demonstrated that presenting pictures at study reduces false memories for both young and older adults; visual presentation of words, however, reduced false recall only for young adults, not for older participants. Smith et al., (2005) proposed that these findings, previously seen only across experiments, could be attributed to poorer encoding on the part of older adults relative to young adults of the information about sensory processing associated with words. Smith et al. (2005) hypothesized that the visual sensory processing that benefits pictures is obligatory in encoding a picture. (Parkin & Russo, 1990), allowing older adults to benefit from the presentation of pictures at study despite age-related declines in cognitive resource availability. Encoding and/or retrieval of perceptual information associated with words, however, is not obligatory, making it less likely that older adults will benefit from the visual word presentation. This hypothesis was supported by a study by Smith and Engle (2011) in which young adults in a divided attention condition no longer showed reduced false memory in the visual word condition relative to auditory only condition.

Another possibility is that the details of sensory processing associated with visual words are equally well encoded by young and older adults, but that older adults do not spontaneously use this information at the time of test. This possibility was investigated in Experiment 2 by having participants encode information in the A, A+V, or A+P conditions but instead of performing a recall test, participants completed a source identification test. The source identification test instructions used in this experiment eliminated the need to make an old/new decision and also directly ask participants to use source information. This experiment will answer the question of whether the lack of reduction in false memories in the A+V condition on the part of older adults is due to age-related differences in encoding and/or retrieval of modality specific information or alternatively if older adults do encode and retrieve modality information, but do not spontaneously use this information at the time of test.

Participants in the second experiment studied the same six DRM lists used in Experiment 1, but the manipulation of study presentation modality was now done within-subjects in order to allow for a source identification test. Two lists were presented in the A study condition, two in the A+V condition, and two in the A+P condition. For the source test, participants were asked to identify whether they heard the words only, heard and saw the words, or heard the word with the associated picture. In addition, we included a second group of young adults who performed a secondary divided attention task at study, to investigate the role of resource availability in performance on the source test. Simons, Dodson, Bell, and Schacter

(2004) proposed that "in aging, the availability of executive resources may be reduced to such an extent that older adults are less able to encode or retrieve contextual representations that are sufficiently distinct to allow discrimination between" sources unless the sources are sufficiently distinct (e.g., Bayen & Murnane, 1996).

Based upon prior findings of age-related differences in source memory (Dywan & Jacoby, 1990; McIntyre & Craik, 1987; Cohen & Faulkner, 1989; Rabinowitz, 1989; Brown, Jones, & Davis, 1995), young adults under full attention conditions are expected to outperform the older adults on the source test, however, given that pictures reduce false memories for both groups the age-related difference in source memory performance may be restricted to the A and A+V items. Young adults performing the divided attention task should show source memory performance more like that of the older adults. Assuming that encoding and/or retrieval of information specifying visual processing of studied words requires resource availability, we expect younger adults under divided attention and older participants to show poor discrimination between A and A+V study conditions. Assuming that encoding and/or retrieval of information specifying picture processing of studied words is obligatory, we expect much better discrimination between A and A+P study conditions in these same groups.

As previously noted, it is also possible that older adults encode sensory information for visual words as well as young adults, but that older adults fail to spontaneously use this information to avoid false memories at the time of test. If this is the case, then older adults should still be able to use this source information as well as young adults when directly asked to make these source decisions, resulting in a similar pattern of source judgments between the two age groups.

Method

Participants and design—The 62 (29 female) young adults ranged from 17 to 27 years of age and received credit towards a course requirement for their participation. The 30 (14 female) older adults ranged in age from 61 to 94 and received $20. All participants were native English speakers in good health who completed the study in the laboratory. Mean age in years, years of education, and vocabulary scores can be found in Table 2. Older adults had higher vocabulary scores and more years of formal education, Fs > 40.36, ps < .001, η_p^2s > .33. Young adults were randomly assigned to either the full attention (young FA, $n = 30$) or divided attention (young DA, $n = 32$) conditions. Study presentation condition was manipulated within-subjects but between-lists. Counterbalancing information is provided below.

Materials—The six DRM lists used in Experiment 1 were shown at study. The lists were counterbalanced across study condition such that each list occurred equally often in each condition across participants. The order of study presentation condition was also counterbalanced and an approximately equal number of participants received each counterbalancing order. As in the first experiment, in the A+V condition the visual words were shown in black, Ariel, 24-point font in the center of a white screen.

Half of the 72 study list words were shown during the source memory test. Specifically, words that had appeared in positions 1, 2, 6, 7, 11, and 12 in each study list were presented in a random order one at a time in white, Times New Roman, 40-point font in the center of a blue screen. Below each word in the source test, participants saw three boxes on the screen: one containing the phrase “heard only”, another with the phrase “heard and saw word”, and the third with the phrase “heard word and saw picture”. Participants made their responses by touching one of the boxes on the screen. The words in each response box were shown in black, Arial, 24-point font displayed on a white background. The test words and response boxes remained on the screen until a response was made.

Procedure—As in the first experiment, participants wore headphones and the experiment began with a sound check and any necessary adjustments to the volume. Participants were instructed that would study a series of word lists and that the words would always be presented auditorially over headphones. As in Experiment 1 they were given intentional memory instructions asking them to try to remember the words. They were also told that sometimes the words they heard would also be shown on the screen and that other times the words would be accompanied by a related picture on the screen. Participants were then informed that for each list of words the words in that list would all be presented in the same way. Prior to the presentation of each of the six lists, participants saw and heard the words “auditory”, “visual”, or “pictures”, notifying them of the modality for that list. Because we were interested in understanding the effects of visual word presentation and picture presentation in prior work, and that prior work did not involve directing participants to remember source at the time of encoding, participants were not told at the time of encoding that they would be asked about source at the time of test.

Young adults in the divided attention condition completed a finger tapping task as the secondary divided attention task. Left-handed participants placed the index, middle, and ring fingers of their right hand on buttons marked 1, 2, and 3 on a response box that was placed to the right of the computer keyboard. For right handed participants the response box was placed on the left side of the keyboard and participants placed the index, middle and ring fingers of their left hand on buttons 3, 4, and 5. Participants were asked to press the keys in the following order: index, ring, middle, index, ring, middle, etc. Participants were instructed to make their responses quickly and carefully. Participants were given a practice session in which they completed the finger tapping task in isolation. The practice session was repeated, if necessary, until participants achieved a combination of 90% accuracy and mean response time of less than 1000 msec. During the study phase, the mean accuracy was 97% (*SE* = 1%) with a mean response time of 294 ms (*SE* = 11 ms).

The source test followed presentation of the sixth study list. Participants were told that they would see individual words and that for each word they should identify whether they heard the word only (A), heard and saw the word (A+V), or heard the word and saw the associated picture (A+P) during the study presentation. Participants made their responses by touching the appropriate source designation on the touch screen.

Results and discussion

The first step in the analysis was to check for possible bias to respond by analyzing the mean proportion of test items receiving each of the three responses, regardless of the accuracy of the response. A 3 (group) × 3 (response type: A, A+V, A+P) mixed ANOVA produced neither a main effect of group nor an interaction, *F*s < 1, *p*s > .464. There was a significant effect of response type, $F(2,178) = 62.76$, $p < .001$, $\eta_{p2} = .41$, and simple contrasts showed that participants were more likely to respond A, *M* = .47, *SE* = .02, relative to either the A +V response, *M* = .26, *SE* = .01, or A+P response, *M* = .26, *SE* = .01, *p*s < .001.

To correct for the bias for the A response, we analyzed corrected hit rates as a measure of participants' ability to discriminate between study modalities. The number of incorrect source identifications was subtracted from the number of correct source identifications for each study modality. For example, the number of items that had been presented visually or as pictures that were incorrectly identified as having been presented auditorially only was subtracted from the number of items correctly identified as having been presented auditorially only.

The corrected hit rates are shown in Figure 1. As expected, a 3(group)×3 (study condition) produced a significant interaction, $F(2,178) = 2.65$, $p < .035$, $\eta_p^2 = .06$. Separate analyses for each group produced a significant effect of study condition in all three groups, all *p*s < . 001, and in all groups, corrected hits rates on the source test were better for items seen in the A+P condition relative to either the A or A+V condition, all *p*s < .001. Differences emerged across the three groups when comparing performance to chance.

In the young FA group, performance was above chance (i.e., the corrected hit rate for a given study condition was significantly different from zero) regardless of the original study condition, *t*(29)s > 5.10, *p*s < .001. For the A+P items, both the young DA, $t(31) = 8.05$, $p < .001$, and older, $t(29) = 12.81$, $p < .001$, groups had corrected hit rates on the source test that were above chance. The corrected hit rates for A items was not different from zero for either young DA, $t < 1$, $p = .433$, or older, $t(29) = 1.52$, $p = .138$, groups. Likewise, the corrected hit rates for A+V items did not differ from zero in either the young DA or older groups, *t*s < 1.60, $p > .121$. The finding that divided attention had a greater effect on some aspects of source monitoring than on others is consistent with prior research (Dodson, Holland, & Shimamura, 1998).

With respect to group comparisons, the young FA group outperformed the older group on identifying the correct source for A items, $t(58) = 2.15$, $p = .035$, and the young FA groups advantage relative to older adults approached significance for the A+V items, $t(58) = 1.97$, $p = .054$. This pattern is consistent with prior work showing an age-related difference in source memory in favor of young adults (Bayen & Murnane, 1996). The young FA and older groups did not differ in their ability to correctly identify the study modality for A+P items, $t(58) = 1.03$, $p = .305$. This combined pattern across the three study modalities is consistent with Smith et al.'s (2005) proposal that older adults do not show a reduction in false memory in the A+V condition relative to the A condition because they do not encode and/or retrieve the perceptual information associated with words as effectively as young adults. Furthermore, the fact that the young DA group and older group do not differ in their ability to correctly identify the source of A items, $t(60) = 1.65$, $p = .105$, and A+V, $t < 1$, $p = .803$, and that neither group differed from chance for these items indicates that the availability of cognitive resources contributes to the ability to benefit from the perceptual information in these cases. Finally, the finding of equivalent source identification for A+P items for the young FA and older groups is also consistent with the idea that encoding information associated with pictures is more obligatory than is encoding the corresponding information about visual processing of words.

General Discussion

Two experiments were conducted to investigate how pictures relative to visual words affect false memory in young and older adults. Experiment 1 provided the first simultaneous comparison of three study modality conditions: auditory only, auditory plus visual word, and auditory plus picture. The first experiment also provided the first investigation of the effects of pictures on older adult's false recall, as prior studies with older adults used recognition tests. In planned comparisons, young adults showed the expected decrease in false memories when presented with visual words relative to only hearing the study list words and showed a further reduction when pictures were presented at study, but older adults showed the reduction in false memory only for the picture condition. The second experiment provides important new information about why this pattern occurs. Two possibilities were investigated: 1) older adults do not encode sensory details of processing as easily in the visual word condition due to resource limitation and therefore this information is not available at the time of test for avoiding false memories or 2) older adults encode this source information but do not spontaneously use this information at the time of the memory test. The results of Experiment 2 support the first explanation. Older adults and young adults in a divided attention condition performed no better than chance at identifying the correct study modality for items heard only or heard with the visual word. In contrast, older adults were just as good as young adults in a full attention condition at identifying the study modality for items presented with pictures.

One point that deserves some discussion is the switch from a between-subjects manipulation of study condition in the first experiment to a within subjects manipulation in the second experiment. Our results yielded an effect of picture presentation in both a between-subject (Experiment 1) and a within-subject design (Experiment 2). A potential concern about the difference in the designs is that the original work on picture presentation reported that the reduction of false memory only occurred when pictures versus words was manipulated between-subjects (Schacter et al., 1999, described in Table 1). Subsequently, Schacter et al. (2001) also included a 50% picture condition in which half of the DRM lists were presented as words and half as pictures and found that within this condition the rates of false memory did not differ for lists that were shown as pictures and those lists that had been shown as words. However, overall levels of false memory for the 50% picture condition were no different from a condition in which all items were shown as pictures, and both of these conditions had lower false memory than a condition in which all items were shown as words. As noted by Schacter et al. (2001), this indicates that the presence or absence of distinctive information "need not be perfectly diagnostic" for participants to examine potential memory responses for the presence of distinctive memorial details. On the whole, our results are consistent with the overall reduction in the 50% condition of Schacter et al. (2001) and with subsequent work showing a reduction in false memory for young adults using a within-subject manipulation of pictures versus words in a different false memory paradigm (Dodson & Schacter, 2002 see also Thomas & McDaniel, 2012 for a within-subject manipulation of pictures versus words using categorized lists), as well as with within-subject manipulation of visual words versus auditory words in the DRM paradigm (Gallo et al., 2001).

The conclusion reached here initially appears to contradict a conclusion reached by Watson, McDermott, and Balota (2004). In the Watson et al., study, both young and older adults showed a reduction in false memories when provided with a warning at encoding. Watson et al. proposed that older adults do not spontaneously consider source in decisions about memory, but that they can engage in such processes when warned. In our second experiment participants were explicitly directed at the time of test to consider the source of information, which should engage the processes supposedly encouraged by warnings. Thus, our results indicate that it is not a question of failing to spontaneously engage these processes at test, but that the ability to make these decisions is impaired. It is possible that the warnings given by Watson et al at encoding encouraged additional processing at study that supported a later reduction of false memory.

A remaining question is whether the older adults' avoidance of false memories and greater source memory in the picture conditions is due entirely to details of sensory processing or to some other aspect of the encoding experience when presented with pictures in the DRM paradigm. Evidence exists that when false memory responses are made, older adults show a greater level of activity relative to young adults in the brain regions associated with semantic processing (Dennis, Kim, & Cabeza, 2008), but similar increased activation can also be found in other cognitive tasks (e.g. Madden et al., 2002) and increased semantic processing can be beneficial for true memory and for avoiding false memories. Hunt et al. (2011) showed that encouraging semantic processing at encoding through the use of a pleasantness rating task increased false memories (and true memories) relative to a non-semantic vowel counting task and at the same time pleasantness rating decreased false memories (without decreased correct memory) relative to intentional memory instructions. When pictures are presented at study in the DRM paradigm, the match between pictures and words is not always exact and this may encourage more elaborate semantic processing in the picture condition to relate the picture and the auditory word (Hunt & Smith, 2014). Perhaps it is enhanced semantic processing engaged by picture presentation that is responsible for reduced false memoires by older adults.

Future research is necessary to answer the question of whether it is memory for perceptual details or elaborative processing that accounts for the picture effect on false memory for both young and older adults. However, the current findings support the idea that differential effects of pictures and words on older adults' false memory are due to differences in encoding of information that is beneficial for identification of source and not due to a failure on the part of older adults to monitoring for that information at the time of test.

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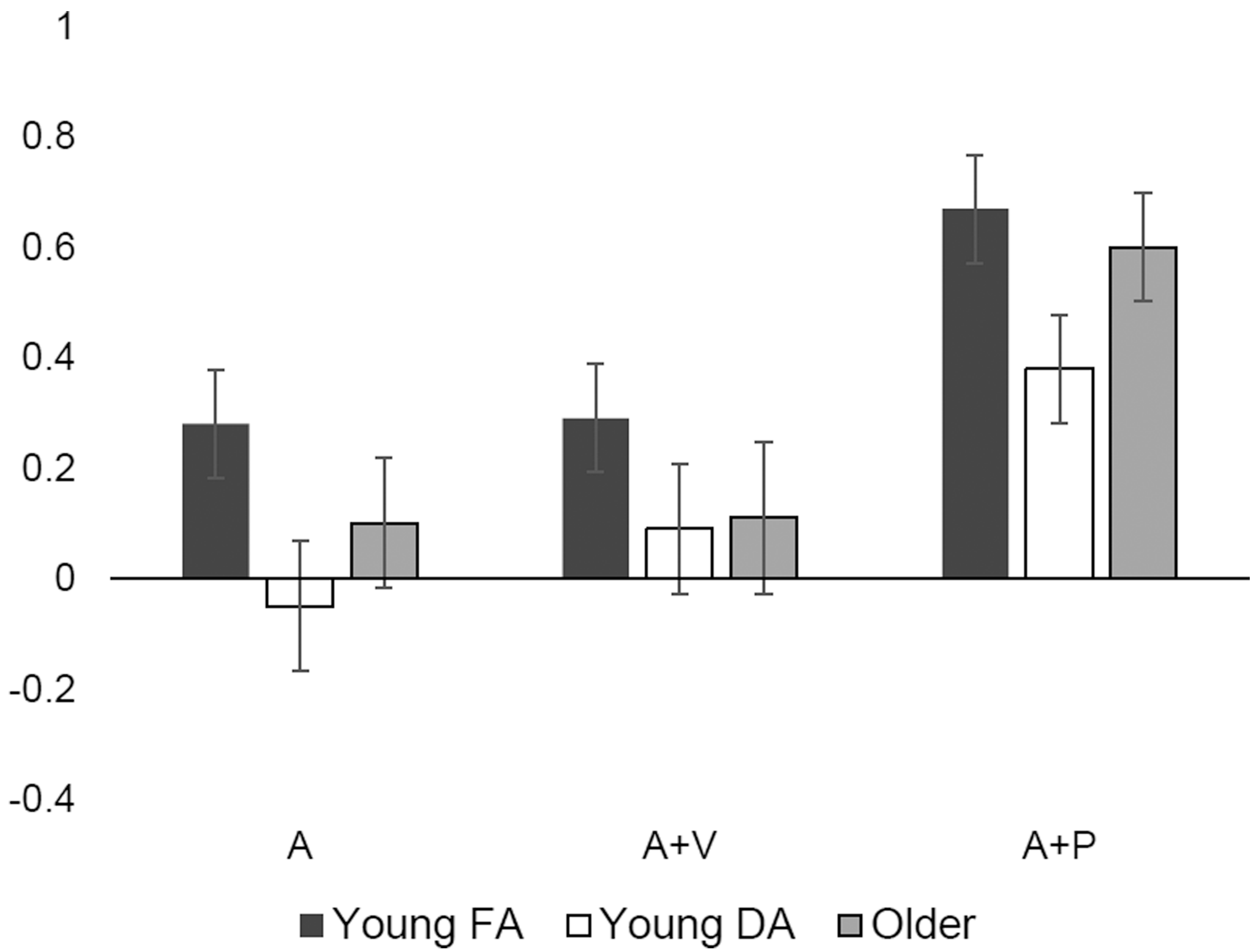

Figure 1.

Experiment 2: Corrected hit rates on the source memory test as a function of group and study modality. FA = full attention. DA = divided attention. A = words presented only auditorially during study. A+V = words presented auditorially and visually at study. A+P = words presented auditorially and with a picture during study. Error bars indicate 95% confidence intervals.

Table 1

Summary of DRM studies with older adults that include a manipulation of study modality.

Study		Manipulation of Modality	Study Modalities Included				Test Type	False Memory Reduction?	
			A	V	A + V	A + P		Young	Older
Schacter, Israel, & Racine (1999)	E 1	Between			X	X	Recognition[1]	Yes	Yes
	E 2	Within			X	X	Recognition[2]	No	No
Gallo, Bell, Beier, & Schacter (2006)		Between			X	X	Recognition[3]	Yes	No
Gallo & Roediger (2003)		Within	X	X			Recognition	Yes	Yes[4]
Smith, Lozito, & Bayen (2005)	E 1	Between	X	X			Recall	Yes	No
	E 2	Between	X	X			Recall	Yes	No
Butler, McDaniel, McCabe & Dornberg (2010)	E 2	Within	X	X			Recall	n/a	No
Current Study	E 1	Between	X		X	X	Recall	Pictures: Yes	Pictures: Yes
								Words: Yes	Words: No

A = DRM word lists heard alone, without accompanying visual presentation of either words or pictures. V = words presented visually without auditory presentation. A + V = words heard and seen. A + P = word heard with pictures.

[1] Schacter et al.'s first experiment included a within-subject manipulation of test modality: auditory only or auditory plus visual stimulus (either word or picture corresponding to the between-subjects study modality condition).

[2] Schacter et al.'s second experiment included a between-subject manipulation of test modality (auditory words with pictures or auditory words with visual words).

[3] Prior to recognition test, participants were shown a second list that could be used in a "recall-to-reject" strategy on the test. Gallo et al. (2006) suggested that this may have interfered with the use of the pictorial information by older adults.

[4] As described in text, the reduction in false memories for older adults in Gallo and Roediger (2003), following picture study presentation was limited to a subset of high functioning older adults who also did not show an overall increase in false memories relative to younger adults.

Table 2

Participant demographics

		Age in Years		Vocabulary		Education	
Experiment	**Age Group**	***M***	***SE***	***M***	***SE***	***M***	***SE***
1	Young	19.6	.18	11.6	.30	13.3	.08
	Older	69.5	.67	19.6	.55	15.5	.17
2	Young	20.1	.26	10.8	.51	13.3	.11
	Older	68.9	1.32	18.0	1.17	15.7	.31

Note: Vocabulary = number correct out of 30. Education = years of formal education.

Table 3

Experiment 1: Critical item false recall and correct recall as a function of study modality in each age group.

	Study		False Recall		False Recall: Planned comparisons			Correct Recall	
	Modality	***n***	***M***	***SE***	**A vs. A +V**	**A+V vs. A+P**	**A vs. A+P**	***M***	***SE***
Young	A	47	.29	.03	$t(92) = 2.00$	$t(91) = 1.91$	$t(91) = 3.80$	.28	.01
	A+V	47	.21	.03	$p = .024^{*}$	$p = .029^{*}$	$p < .001^{*}$	.26	.01
	A+P	46	.12	.02				.28	.01
Older	A	36	.23	.04	$t < 1$	$t(69) = 2.03$	$t(69) = 1.72$	.19	.02
	A+V	36	.24	.03	$p = .921$	$p = .023^{*}$	$p = .045^{*}$	.19	.02
	A+P	35	.16	.02				.20	.01

Note: A = auditory only, A+V = auditory plus visual word, A+P = auditory plus picture.

* One-tailed test of a priori directional prediction.