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False Recognition of Pictures Versus Words in Alzheimer's Disease: The Distinctiveness Heuristic

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False recognition of semantic associates can be reduced when older adults also study pictures representing each associate. D. L. Schacter, L. Israel, and C. Racine (1999) attributed this reduction to the operation of a *distinctiveness heuristic*: a response mode in which participants demand access to detailed recollections to support a positive recognition decision. The authors examined patients with probable Alzheimer's disease (AD) and older adults with this paradigm. Half of the participants studied pictures and auditory words; the other half studied visual and auditory words. Older adults who studied pictures were able to reduce their false alarms compared with those who studied words only. AD patients who studied pictures were unable to reduce their false alarms compared with those who studied words only and, in fact, exhibited trends toward greater false recognition. Implications for understanding semantic memory in AD patients are discussed.

Patients with probable Alzheimer's disease (AD) suffer from distortions of memory in addition to their failure to retrieve desired information (Förstl et al., 1994). Because patients may believe that they turned off the stove or took their medications when they have only thought about performing these activities, memory distortions may impair the ability of AD patients to live independently (Borson & Raskind, 1997). Clearly, memory distortions in AD patients are an important clinical problem; however, the etiology and treatment of such distortions remain largely unexplored.

AD patients have recently been examined using paradigms that allow measurement of a type of memory distortion known as false recognition. False recognition occurs when people incorrectly claim to have previously encountered a novel word or event. Recent experiments using a paradigm originally developed by Deese (1959) and revived and modified by Roediger and McDermott (1995) have demonstrated robust levels of false recognition in healthy adults. After studying lists of semantic associates (e.g., *candy*, *sour*, *sugar*, *bitter*, *good*, *taste*, etc.) that all converge on a nonpresented theme word or related lure (e.g., *sweet*), participants frequently intruded the related lure on free-recall tests (Deese, 1959) and made very high levels of false alarms to these words on recognition tests (Roediger & McDermott, 1995).

False recognition and false recall have been explored in AD patients with semantically associated words (Balota, Cortese, et al., 1999; Budson, Daffner, Desikan, & Schacter, 2000; Watson, Balota, & Sergent-Marshall, 2001), phonologically associated words (Watson et al., 2001), and perceptually related novel objects (Budson, Desikan, Daffner, & Schacter, 2001). These experiments have demonstrated that AD patients show either greater or lesser levels of false recognition and recall than healthy older adults depending on the particular paradigm and analysis used. For example, using corrected recognition scores to control for unrelated false alarms, Budson et al. (2001) found that AD patients exhibited lower levels of false recognition of perceptually related novel objects compared with older adults. Watson et al. (2001) demonstrated that AD patients and older adults showed similar rates of false recall of semantic associates, phonological associates (e.g., *code*, *told*, *fold*, *old*, and so forth for the related lure *cold*), and hybrid lists combining semantic and phonologic associates (e.g., *chill*, *told*, *warm*, *old*, and so forth for the related lure *cold*). More impaired AD patients, however, showed higher levels of false recall relative to their true recall performance when compared with the less impaired AD patients. Balota, Cortese, et al. (1999) found that overall, after controlling for false alarms to unrelated items, AD patients falsely recognized fewer

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related lures than did healthy older adults. These same patients falsely recalled similar numbers of related lures compared with the older adults; however, when these researchers controlled for rates of true recall by analyzing a subset of their participants, they found that AD patients falsely recalled more related lures than older adults.

Following the work of Kensinger and Schacter (1999) with younger and older adults and that of Schacter, Verfaellie, Anes, and Racine (1998) with amnesic patients, Budson et al. (2000) used a modification of the Deese/Roediger–McDermott (DRM) paradigm in AD patients that provides estimates of false recognition after single and multiple exposures to word lists. Using corrected recognition scores to control for unrelated false alarms, they found that compared with younger and older adults, AD patients showed lower levels of false recognition of semantic associates after a single study-test trial but higher levels of false recognition across five trials. Budson et al. (2000) interpreted their results on the basis of the idea that true and false recognition depend on memory for two different kinds of information: the specific details of a prior encounter with a particular item (item-specific recollection) and the general meaning, idea, or gist conveyed by a collection of items (gist information; cf. Reyna & Brainerd, 1995; Schacter, Norman, & Koutstaal, 1998). As the items are presented in the DRM paradigm, a gist representation is developed, which may result in an experience of recollection or familiarity when either a studied item or a related lure is presented on a later recognition test. Thus, in the DRM paradigm, accurate recognition of previously studied items probably depends on both item-specific and gist information, whereas false recognition of related lure words depends on remembering gist but not item-specific information (cf. Brainerd & Reyna, 1998; Payne, Elie, Blackwell, & Neuschatz, 1996; Schacter, Verfaellie, & Pradere, 1996). AD patients showed a steady increase in false recognition over the five trials. Budson et al. (2000) suggested that for these patients, the repeated study and testing of semantic associates creates an increasingly robust representation of the semantic gist that, when unchecked by item-specific recollection, produces increasingly elevated levels of false recognition (see Schacter, Verfaellie, et al., 1998, for similar findings and ideas concerning Korsakoff amnesic patients). In contrast, younger adults in both Budson et al. and Kensinger and Schacter (1999) showed a steady decrease in false recognition across the trials, suggesting that these younger adults were able to use increased item-specific recollection to reduce (or suppress) false recognition over the five study-test trials. Older adults exhibited an intermediate pattern: In the Kensinger and Schacter study, older adults showed a constant level of false recognition across all five trials, whereas in the Budson et al. study, older adults showed unchanging false recognition over the first three trials and some evidence of suppression on the final two trials. Suppression of false recognition in this repeated trials paradigm appears to require item-specific recollection (Kensinger & Schacter, 1999; Schacter, Verfaellie, et al., 1998). Younger adults demonstrated substantial item-specific recollection and were thus able to robustly suppress false recognition across trials. AD patients showed no item-specific recollection and were entirely unable to oppose increasing semantic gist. Healthy older adults developed a small degree of item-specific recollection and were therefore able to suppress false recognition only to a very limited extent.[1]

Schacter and colleagues (Israel & Schacter, 1997; Schacter, Israel, & Racine, 1999) have recently demonstrated a way in which healthy older adults, like younger adults, are able to robustly suppress false recognition. Israel and Schacter (1997) tested the idea that if false recognition in the DRM paradigm depends on participants' reliance on the common semantic features or gist of the study list, then it should be possible to reduce false recognition following study conditions that promote encoding of distinctive information about particular items. Israel and Schacter presented one group of younger adults with lists of semantic associates in which each word was presented auditorily and was also accompanied by a corresponding picture. A second group heard the same words auditorily but instead of an accompanying picture, they saw the visual presentation of the word. On the recognition test, half of the items were presented visually and auditorily, as in the study session; the other half of the items were presented as auditory words only. Israel and Schacter found that pictorial encoding yielded lower levels of false recognition to both semantically related and semantically unrelated lures than did word encoding alone.

To explore these issues further, Schacter, Israel, and Racine (1999) studied younger and older adults. They found that like younger adults, older adults were able to suppress their false recognition with pictorial encoding compared with those older adults who studied semantic associates without pictures. In contrast to their limited ability to suppress their false recognition in the repeated trials paradigm (Budson et al., 2000; Kensinger & Schacter, 1999), older adults were able to suppress false recognition after pictorial encoding to the same extent as younger adults. Using signal detection analyses, Schacter et al. (1999) found that both younger and older adults showed a more conservative response bias after picture encoding than after word encoding. Schacter et al. suggested that this more conservative response bias observed after picture encoding may depend on a general shift in responding on the basis of participants' metamemorial assessments of the kinds of information they feel they should remember (Strack & Bless, 1994). Because they had encountered pictures with each of the presented words, participants in the picture encoding condition used a general rule of thumb whereby they could demand access to detailed pictorial information to support a positive recognition decision; failure to gain access to such distinctive information when tested with related lures would tend to

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[1] It is noteworthy in this discussion that we have made the assumption that if individuals develop item-specific recollection, then it will be both available and accessible to them to reduce their false memories. However, this may not always be the case; see Balota, Cortese, et al. (1999) for example.

result in a negative recognition decision. Schacter et al. referred to the hypothesized rule of thumb used by the picture encoding group as a *distinctiveness heuristic* (c.f. Chaiken, Lieberman, & Eagly, 1989; Johnson, Hashtroudi, & Lindsay, 1993; Kahneman, Slovic, & Tversky, 1982). (For further evidence supporting the distinctiveness heuristic hypothesis, see Schacter, Cendan, Dodson, & Clifford, in press.)

The overall pattern of results from Schacter et al. (1999) indicates that younger and older adults were both able to demonstrate substantial suppression of false recognition by using the distinctiveness heuristic. In their previous study, Budson et al. (2000) demonstrated that AD patients were not able to suppress their false recognition over repeated study-test trials; because they were entirely unable to develop any item-specific recollection, AD patients' false recognition increased across trials. Younger adults showed increasing item-specific recollection over the five trials, thereby enabling them to strongly suppress false recognition, whereas older adults showed only limited ability to suppress false recognition because of diminished item-specific recollection in the repeated trials paradigm (Budson et al., 2000; Kensinger & Schacter, 1999). In the present study, we attempted to determine whether AD patients, like healthy older adults, can rely on the distinctiveness heuristic to suppress false recognition, despite their total inability to do so using item-specific recollection in the repeated trials paradigm.

We expected that because AD patients show deficits in memory for words (Becker, Lopez, & Butters, 1996) and pictures (Rizzo, Anderson, Dawson, & Nawrot, 2000), both AD patients who studied words alone and AD patients who studied words and pictures would make fewer "old" responses to studied items (true recognition) and more "old" responses to unrelated, nonstudied items. We also expected that after correcting for unrelated false alarms, AD patients would show lower levels of false recognition of related lure items compared with older adults, because we have shown that after a single study-test trial, AD patients are less sensitive to gist influences than older adults when shown semantically associated words (Budson et al., 2000) and perceptually related novel objects (Budson et al., 2001).

We also had some reasons to suspect that AD patients who encoded pictures would be unable to reduce or suppress false recognition compared with those who encoded words. Because AD patients show serious memory impairments, we expected that, in contrast to healthy older adults, AD patients who studied pictures would not demand access to detailed pictorial information to support a positive recognition decision. In other words, we did not expect the AD patients to depend on the same metamemorial assessments used by the healthy older adults. Some support for this expectation comes from informal observations concerning AD patients and the distinction between *remembering* (recollecting the specific details of previous experiences) and *knowing* (experiencing a sense of familiarity without recollection; Gardiner & Java, 1993; Tulving, 1985). Although AD patients appear able to understand the remember–know distinction, they are unable to apply these judgments, reporting that their memory does not support multiple levels of vividness (A. E. Budson, personal observation, from May through September 1998). When forced to choose between remember and know responses, AD patients typically make either all remember or all know responses. Consequently, in the picture encoding condition, we did not expect that AD patients would develop the rule of thumb or distinctiveness heuristic that healthy older adults are able to use to suppress their false recognition.

Method

Participants

Twenty patients with a clinical diagnosis of probable AD (National Institute of Neurological and Communicative Disorders and Stroke–Alzheimer's Disease and Related Disorders Association criteria used, McKhann, Drachman, Folstein, Katzman, & Price, 1984) and 16 healthy older adults were recruited for the experiment. AD patients were recruited from the clinical population at the Memory Disorders Unit, Brigham and Women's Hospital, Boston, Massachusetts. Older adults were recruited from participants in a longitudinal study of normal aging at Brigham and Women's Hospital, from spouses and friends (but not blood relatives) of the AD patients, and from flyers and posters placed in senior centers in and around Boston. Written informed consent was obtained from all participants and their caregivers (when appropriate). The study was approved by the human subjects committee of Brigham and Women's Hospital. Participants were paid $10 per hour for their participation. Older adults were all community dwelling and were excluded if they scored below 30 on category word fluency (animals, fruits, vegetables; Monsch et al., 1992) or below 27 on the Mini-Mental Status Examination (MMSE; Folstein, Folstein, & McHugh, 1975). Most AD patients showed mild to moderate impairment on the MMSE (though 1 scored in the normal range; $M = 22.1$, range = 16–27). Participants were excluded if they were characterized by clinically significant depression, alcohol or drug use, brain damage due to stroke, tumor, or traumatic head injury or if English was not their primary language. All participants had normal or corrected-to-normal vision and hearing. AD patients were impaired on tests of word fluency to letters (*F, A, S*: $M = 24.2$, $SD = 14.2$) and categories (animals, fruits, vegetables: $M = 19.5$, $SD = 13.1$; Monsch et al., 1992) and were also impaired on tests of naming (Boston Naming Test: $M = 37.3$ [out of 60], $SD = 13.1$; Kaplan, Goodglass, & Weintraub, 1983).[2] The AD patients were matched to the older adults on the basis of gender (5 male and 15 female AD patients, 4 male and 12 female older adults), age (AD patient $M = 74.7$ years, range = 58–85; older adult $M = 76.3$ years, range = 70–89), and education (AD patient $M = 13.1$ years, range = 7–20; older adult $M = 15.5$ years, range = 12–20). Those in picture versus word encoding conditions were also matched with respect to gender, age, education, and for the AD patients, MMSE score.

Materials and Design

Twenty-one study lists from Schacter et al. (1999) were used, each composed of 12 items using the Russell and Jenkins (1954) word-association norms and adapting some of the lists used by Roediger and McDermott (1995). The study lists were constructed

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[2] Word fluency and Boston Naming Test data were obtained in 19 and 13 of the AD patients, respectively.

by selecting the 12 highest associates that could be represented pictorially. Words on each list were presented in order of decreasing associative strength to the nonpresented related lure. The 21 lists were divided into three sets for counterbalancing purposes; within each set, lists were presented in the same order to all participants. Participants studied 14 lists and were given a 63-item recognition test. The test consisted of 28 studied items or *true targets* (drawn from the first and seventh list positions of each of the 14 studied lists), 14 new unrelated lures or *true target controls* (drawn from the first and seventh list position of each of the 7 unstudied lists), 14 related lures or *false targets* (the related lure on which all studied items semantically converge for each of the 14 studied lists), and 7 new unrelated lures or *false target controls* (the related lure for each of the seven unstudied lists).

In the picture encoding condition, each list item was presented as an auditory word with a corresponding picture; in the word encoding condition, each list item was presented as an auditory word with its corresponding visual word. Items on the recognition test were randomly assigned to a test presentation mode, visual plus auditory or auditory alone; no more than three items were presented consecutively in the same mode. In the picture encoding condition, the visual plus auditory test mode involved simultaneous presentation of a picture and an auditory word, whereas in the word encoding condition, the visual plus auditory mode involved simultaneous presentation of a visual word and an auditory word. The recognition test was counterbalanced so that (a) each type of item (i.e., true target, true target control, false target, and false target control) was presented equally often in each of the two presentation modes and (b) each type of item appeared equally often in the first and second half of the test. Furthermore, items taken from the same study list were at least eight positions apart on the recognition test, and no more than two items of the same type appeared consecutively.

The pictorial stimuli were black-and-white line drawings of list items and varied in size (ranging from approximately 3 × 3 cm to 17 × 18 cm, with a modal size of approximately 10 × 11 cm). In general, the drawings contained similar amounts of detail, although this feature was not systematically controlled. Pictures were scanned on a PowerMacintosh 7600/132 using VistaScan and a UMAX Vista-S6E scanner (UMAX Technologies, Inc., Fremont, CA). Auditory stimuli were recorded on a Macintosh Quadra 150 using SoundEdit Pro (Macromedia, Inc., San Francisco). Word stimuli were presented in uppercase in 55-point Geneva typefont. All stimuli were presented on an Apple Macintosh Powerbook 5300c computer, using PsyScope 1.2b2 (Cohen, MacWhinney, Flatt, & Provost, 1993). Participants heard auditory stimuli through headphones.

The main design consisted of two between-groups variables, group (older adults vs. AD patients) and encoding condition (word vs. picture) and two within-group variables, test mode (visual plus auditory vs. auditory alone) and item type (true target, true target control, false target, and false target control).

Procedure

Participants were tested individually. They were told that 14 lists of 12 items each would be presented and that each item was composed of an auditory and a visual component. Participants were instructed to pay careful attention to both parts of the item because they would be tested on the items later. Additionally, participants were told that they would have 1 min to work on a puzzle after presentation of each study list and that a beep would sound before presentation of the next study list (puzzles included simple math problems and mazes). The visual component of each study item was displayed for 1.5 s; all auditory components were presented simultaneously in a female voice. Approximately 1.5 s elapsed between each study item. Presentation of each list took approximately 40 s. Following presentation of all 14 lists, participants worked for 3 min on mazes.

After this filler task, participants were given instructions for the recognition test. Participants were asked to verbally indicate if each item was *old* (i.e., had appeared on one of the study lists) or *new* (i.e., had not appeared on the study lists). The experimenter then entered the appropriate response on the keyboard. When given both visual and auditory cues, participants were told to consider both components when making recognition judgments. Participants in the picture condition were also assured that an old picture would never be presented with a new auditory label and that a new picture would not be presented with an old auditory label. The recognition test was self-paced. When items were presented in auditory test mode, a cross-hair appeared in the center of the computer screen.

Results

Table 1 presents the proportion of old responses to true targets, true target controls, false targets, and false target controls as a function of test presentation mode in the word and picture encoding conditions for older adults and AD patients. Table 1 also presents corrected true recognition (obtained by subtracting the proportion of old responses to true target controls from the proportion of old responses to true targets) and corrected false recognition (obtained by subtracting the proportion of old responses to false target controls from the proportion of old responses to false targets) scores.

Because, compared with older adults, AD patients made significantly more false alarms to true target controls—effect of group, $F(1, 32) = 21.46$, $MSE = 0.040$, $p < .0005$—and false target controls—effects of group, $F(1, 32) = 11.36$, $MSE = 0.075$, $p = .002$—all analyses that directly compared AD patients and older adults were performed on corrected true and false recognition data (henceforth referred to simply as true and false recognition). However, the distinctiveness heuristic could be used to reject all nonstudied items—that is, the unrelated, nonstudied true and false target controls in addition to the related lure false targets. Thus, when examining the corrected recognition data, some effects of the distinctiveness heuristic may be removed when subtracting responses to unrelated target controls from related false targets. Accordingly, we performed additional analyses for studied and nonstudied items. Because these latter analyses necessarily use uncorrected data, we performed separate analyses on AD patients and older adults (note that use of the unqualified term *false alarms* always refers to false alarms for all nonstudied items).

True Recognition: True Targets Minus True Target Controls

AD patients showed a significantly lower level of true recognition compared with older adults. An analysis of variance (ANOVA) with group (AD patients vs. older adults) and encoding condition (word vs. picture) as be-

Table 1
Proportion of Old Responses on the Recognition Test as a Function of Item Type, Test Presentation Mode, Group, and Encoding Condition

	Encoding condition							
	Older adults				AD patients			
	Word		Picture		Word		Picture	
Item type and test presentation mode	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
True targets								
Auditory	.59	.14	.63	.13	.45	.27	.36	.17
Visual + auditory	.76	.15	.81	.09	.53	.27	.75	.19
True target controls								
Auditory	.11	.15	.18	.24	.33	.22	.21	.14
Visual + auditory	.25	.18	.05	.11	.41	.14	.51	.33
False targets								
Auditory	.71	.13	.55	.18	.41	.30	.53	.24
Visual + auditory	.68	.18	.45	.27	.54	.29	.67	.24
False target controls								
Auditory	.17	.14	.10	.15	.38	.27	.26	.25
Visual + auditory	.32	.16	.19	.27	.51	.36	.52	.38
True recognition (corrected)								
Auditory	.48	.19	.46	.24	.12	.19	.14	.12
Visual + auditory	.51	.12	.76	.11	.11	.28	.24	.33
False recognition (corrected)								
Auditory	.55	.25	.45	.16	.04	.40	.27	.20
Visual + auditory	.36	.23	.26	.20	.03	.35	.15	.37

Note. AD = Alzheimer's disease.

tween-subjects variables and with test mode (visual plus auditory vs. auditory alone) as a within-subject variable demonstrated a significant main effect of group, $F(1, 32) = 63.12$, $MSE = 0.045$, $p < .0005$, and a marginally significant effect of test mode, $F(1, 32) = 4.04$, $MSE = 0.048$, $p = .053$. The effect of test mode suggests that overall, participants tended to show higher levels of true recognition for test items presented in the visual plus auditory mode versus the auditory alone mode. There was a trend for participants in the picture encoding condition to show higher levels of true recognition compared with those in the word encoding condition, $F(1, 32) = 3.34$, $MSE = 0.045$, $p = .077$. There was also a trend toward a Test Mode × Encoding Condition interaction, $F(1, 32) = 3.31$, $MSE = 0.048$, $p = .078$. Pairwise comparisons show that this trend toward an interaction was present because those participants in the picture encoding condition showed higher levels of true recognition for test items presented in the visual plus auditory mode versus the auditory alone mode, $t(17) = 2.38$, $MSE = 0.078$, $p = .029$, whereas those participants in the word encoding condition did not, $t(17) < 1$. No other interactions approached significance: Test Mode × Group, $F(1, 32) = 1.39$, $MSE = 0.048$, $p = .247$; other Fs$(1, 32) < 1$.

False Recognition: False Targets Minus False Target Controls

AD patients showed a significantly lower level of false recognition compared with older adults, consistent with previous studies (Balota, Cortese, et al., 1999; Budson et al., 2000, 2001). Interestingly, the analysis of false recognition also revealed different patterns of responses in older adults and AD patients for picture versus word encoding (see Figure 1). An ANOVA demonstrated a main effect of group, $F(1, 32) = 18.85$, $MSE = 0.073$, $p < .0005$, and an Encoding Condition × Group interaction, $F(1, 32) = 4.54$, $MSE = 0.073$, $p = .041$. There were no other significant effects or interactions: test mode, $F(1, 32) = 2.96$, $MSE = 0.094$, $p = .095$; other Fs$(1, 32) < 1$.

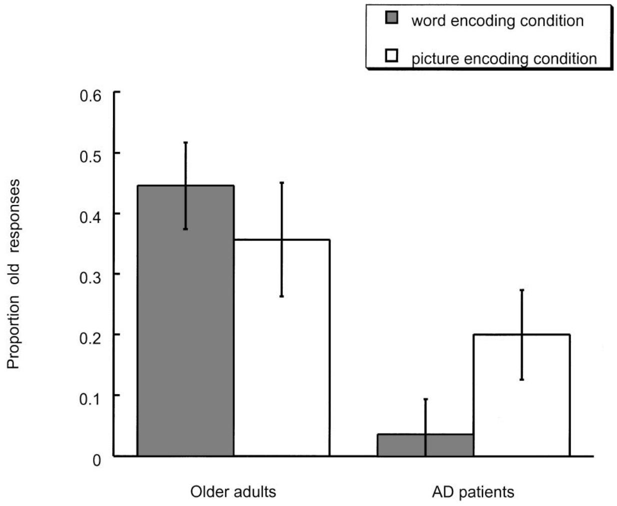

Figure 1. False recognition (mean proportion of old responses to false targets [related lures] minus false target controls) for older adults and Alzheimer's disease (AD) patients as a function of word versus picture encoding. Results are collapsed across test presentation mode. Error bars show the standard error of the mean.

The Encoding Condition × Group interaction demonstrates that older adults and AD patients showed different patterns of false recognition. Although not statistically significant, older adults in the picture encoding condition showed numerically lower levels of false recognition versus those in the word encoding condition (.35 vs. .45), whereas AD patients in the picture encoding condition showed numerically greater levels of false recognition compared with those in the word encoding condition (.21 vs. .04). An ANOVA on the older adults alone yielded an effect of test mode, $F(1, 14) = 7.83$, $MSE = 0.037$, $p = .014$, no effect of encoding condition, $F(1, 14) = 1.47$, $MSE = 0.052$, $p = .245$, and no interaction, $F(1, 14) < 1$. The effect of test mode indicates that older adults are more likely to correctly reject lure items when items are presented in the visual plus auditory mode versus the auditory alone mode. An ANOVA on the AD patients alone yielded a trend toward an effect of encoding condition, $F(1, 18) = 3.44$, $MSE = 0.090$, $p = .080$, no effect of test mode, $F(1, 18) < 1$, and no interaction, $F(1, 18) < 1$. The trend toward encoding condition suggests that AD patients were somewhat more likely to exhibit elevated levels of false recognition when they saw pictures at encoding compared with seeing words at encoding (see Figure 1).

Studied Items: True Targets

An ANOVA performed on the data from older adults with encoding condition (word vs. picture) as a between-subjects variable and with test mode (visual plus auditory vs. auditory alone) as a within-subject variable demonstrated a significant effect of test mode, $F(1, 14) = 20.18$, $MSE = 0.012$, $p = .001$, no effect of encoding condition, and no interaction, $Fs(1, 14) < 1$. The effect of test mode indicates that older adults were more likely to correctly respond “old” to studied items when they were presented in the visual plus auditory test mode versus the auditory alone mode.

The analogous ANOVA on AD patients yielded an effect of test mode, $F(1, 18) = 46.02$, $MSE = 0.012$, $p < .0005$, no effect of encoding condition, $F(1, 18) < 1$, and a significant Test Mode × Encoding Condition interaction, $F(1, 18) = 20.46$, $MSE = 0.012$, $p < .0005$. The effect of test mode indicates that overall, AD patients, like older adults, are more likely to correctly respond “old” to studied items when they were presented in the visual plus auditory test mode versus the auditory alone mode. However, pairwise comparisons show that this effect of test mode was mainly driven by those in the picture encoding condition, $t(9) = 16.15$, $MSE = 0.024$, $p < .0005$, and not those in the word encoding condition, $t(9) = 1.21$, $MSE = 0.065$, $p = .258$.

Nonstudied Items (False Alarms): True Target Controls, False Targets, False Target Controls

An ANOVA was performed on the results from older adults with encoding condition (word vs. picture) as a between-subjects variable and with test mode (visual plus auditory vs. auditory alone) and item type (true target controls, false targets, false target controls) as within-subject variables. This analysis demonstrated main effects of encoding condition, $F(1, 14) = 7.50$, $MSE = 0.046$, $p = .016$, and item type, $F(2, 28) = 71.86$, $MSE = 0.027$, $p < .0005$; there was also a marginally significant Test Mode × Item Type interaction, $F(2, 28) = 3.21$, $MSE = 0.023$, $p = .056$. There were no other significant effects or interactions: test mode, $F(1, 14) < 1$; Item Type × Encoding Condition, $F(2, 28) = 1.40$, $MSE = 0.027$, $p = .263$; Test Mode × Encoding Condition, $F(1, 14) = 1.78$, $MSE = 0.064$, $p = .204$; Item Type × Test Mode × Encoding Condition, $F(2, 28) = 1.12$, $MSE = 0.023$, $p = .342$.

The effect of encoding condition indicates that those older adults who saw pictures at study were less likely to false alarm to nonstudied items than those who saw words at study (see Figure 2). Thus, consistent with Schacter et al. (1999), our older adults were able to use the distinctiveness heuristic to reduce their false alarms to nonstudied words. Additional analyses show that the effect of item type is present because older adults made significantly more false alarms to related lure false targets than either the false target controls, $F(1, 14) = 100.74$, $MSE = 0.026$, $p < .0005$, or the true target controls, $F(1, 14) = 97.44$, $MSE = 0.033$, $p < .0005$; there were no differences between false alarms to true and false target controls, $F(1, 14) = 1.61$, $MSE = 0.023$, $p = .225$. The marginal Test Mode × Item Type interaction indicates a weak trend for older adults to make more false alarms to false target controls in the visual plus auditory versus auditory alone modality, $F(1, 14) = 3.24$, $MSE = 0.035$, $p = .094$, whereas no such differences were found for false targets or true target controls, $Fs(1, 14) < 1$.

In AD patients, an analogous ANOVA showed significant effects of test mode, $F(1, 18) = 7.76$, $MSE = 0.118$, $p = .012$, and item type, $F(2, 36) = 7.36$, $MSE = 0.043$, $p = .002$, but in contrast to the older adults, no effect of encoding condition, $F(1, 18) < 0.1$ (see Figure 2). There were no interactions: Item Type × Encoding Condition, $F(2, 36) = 1.94$, $MSE = 0.043$, $p = .159$; other $Fs(1, 18) < 1$ and $Fs(2, 36) < 1$. The effect of test mode indicates that AD patients exhibited an overall tendency to make more false alarms to items when presented in the visual plus auditory mode compared with the auditory alone mode (see Figure 3). As with the older adults, additional analyses show that the effect of item type is present because AD patients made significantly more false alarms to related lure false targets than to either the false target controls, $F(1, 18) = 6.94$, $MSE = 0.045$, $p = .017$, or the true target controls, $F(1, 18) = 16.62$, $MSE = 0.035$, $p = .001$; there were no differences between false alarms to true and false target controls, $F\ (1, 18) < 1$.

Discussion

Previous research has shown that healthy younger and older adults are able to suppress false recognition using the distinctiveness heuristic (Schacter et al., 1999). The present study has extended this earlier work to AD patients. Using corrected recognition measures to control for differing lev-

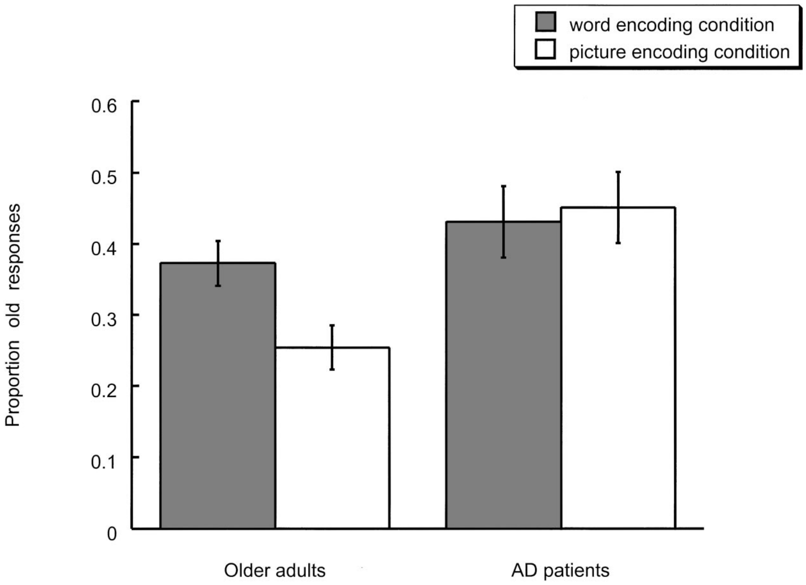

Figure 2. Mean proportion of old responses to all nonstudied items (true target controls, false targets, false target controls) by older adults and Alzheimer's disease (AD) patients as a function of word versus picture encoding. Results are collapsed across test presentation mode. Error bars show the standard error of the mean.

els of baseline false alarms, we found that older adults and AD patients showed different patterns of false recognition: Older adults showed numerically lower false recognition after picture encoding compared with word encoding, whereas AD patients showed the opposite effect—numerically greater false recognition after picture encoding compared with word encoding (see Figure 1). Furthermore, older adults who encoded pictures made fewer false alarms to all nonstudied items than those who encoded words; no such difference was seen in AD patients (see Figure 2). Lastly, AD patients (but not older adults) made more false alarms to nonstudied items when these items were presented in the visual plus auditory mode versus in the auditory only mode (see Figure 3).

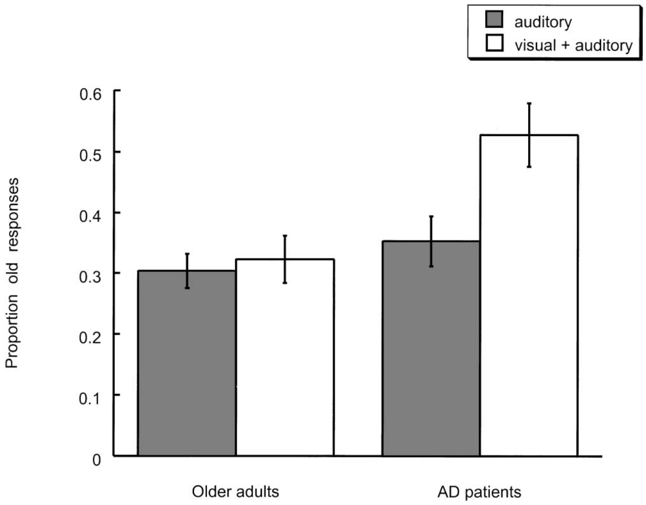

Figure 3. Mean proportion of old responses to all nonstudied items (true target controls, false targets, false target controls) by older adults and Alzheimer's disease (AD) patients as a function of visual plus auditory (visual + auditory) versus auditory only test mode. Results are collapsed across encoding condition. Error bars show the standard error of the mean.

As expected, AD patients exhibited lower true recognition compared with older adults. A marginally significant effect of test mode suggested that overall participants tended to show higher levels of true recognition for test items presented in the visual plus auditory mode versus in the auditory alone mode; this marginal effect was driven mainly by those participants in the picture encoding condition. Because the visual plus auditory mode reinstantiates the initial encoding condition, this effect is consistent with the principle of transfer-appropriate processing (Graf & Ryan, 1990; Roediger, Weldon, & Challis, 1989).

The false recognition analysis showed different patterns of responses in older adults and AD patients for picture versus word encoding (see Figure 1), as indicated by a significant Group × Encoding Condition interaction. Older adults showed numerically lower false recognition after picture encoding compared with word encoding, whereas AD patients showed numerically greater false recognition after picture encoding compared with word encoding. In addition, AD patients demonstrated lower levels of false recognition compared with older adults, consistent with previous studies of semantically related words (Balota, Cortese, et al., 1999; Budson et al., 2000) and perceptually related novel objects (Budson et al., 2001). Analysis of false recognition in older adults alone yielded a significant effect of test mode but not encoding condition. The effect of test mode indicates that older adults were more able to reject lure items when they were presented in the visual plus auditory mode at test, again consistent with transfer-appropriate processing. Analysis of the AD patients alone showed a trend toward encoding condition, suggesting that AD patients showed some tendencies toward increased levels of false recognition after picture encoding.

The analysis of studied items, performed separately in older adults and AD patients, yielded results similar to that of true recognition: Both groups showed an effect of test mode, making more old responses to items in the visual plus auditory mode versus in the auditory alone mode, consistent with transfer-appropriate processing. In the AD patients, this effect of test mode was primarily driven by responses from the picture encoding condition.

Nonstudied items were also analyzed separately in older adults and AD patients. In older adults, there was a significant effect of encoding condition indicating that those older adults who saw pictures at study made fewer false alarms than those who saw words at study (see Figure 2). This result suggests that our older adults, like those of Schacter et al. (1999), were able to use the distinctiveness heuristic to reduce their false alarms. There was no effect of test mode (see Figure 3).

The analysis of nonstudied items in AD patients yielded results that differed from those of the older adults. There was no effect of encoding condition, indicating that those AD patients who studied pictures and those who studied words made a similar amount of false alarms (see Figure 2). It is interesting to note that there was an effect of test mode, but in contrast to what would be predicted by transfer-appropriate processing, the AD patients made more false alarms to words in the visual plus auditory mode, which reinstantiated the initial encoding condition compared with the auditory alone mode (see Figure 3).

Thus, it is clear from the analysis of nonstudied items that our older adults, like those of Schacter et al. (1999), were able to use the distinctiveness heuristic to reduce their false alarms.[3] Can AD patients use the distinctiveness heuristic to reduce their false recognition? Looking at the corrected false recognition data (see Table 1 and Figure 1), it seems clear that AD patients in the word encoding condition are at floor, and thus their false recognition cannot be reduced any further. Nonetheless, the picture encoding group showed a trend toward increased levels of false recognition compared with the word group (see Figure 1). If these AD patients were able to use the distinctiveness heuristic, we would expect that the picture group would remain at floor rather than show increased levels of false recognition. Furthermore, the AD patients are not at floor in the analysis of the nonstudied items, yet the picture group shows near identical levels of false alarms to the word group—in sharp contrast to the older adults (see Figure 2). Thus, even though interpretation of the corrected false recognition data is not entirely straightforward, we suggest that unlike older adults, AD patients are unable to reduce false alarms using the distinctiveness heuristic.[4] In addition, we have observed several other notable findings.

First, in the present study we found several significant within-subject differences between the visual plus auditory test mode versus the auditory alone mode. These results suggest that participants may be able to increase their true recognition and decrease their false recognition when test items are presented in the visual plus auditory mode, which reinstantiated the initial encoding conditions, consistent with the transfer-appropriate processing principle. It is critical to note, however, that this use of distinctive information is subtly but importantly different than the distinctiveness heuristic as formulated by Schacter et al. (1999), which is revealed by between-subjects differences between picture versus word encoding. That the two processes may operate simultaneously is nicely illustrated by the fact that both the picture and the word encoding groups of older adults show a .19 decrease in false recognition between the auditory alone versus visual plus auditory modalities (see Table 1). Nonetheless, the older adults in the picture encoding group show numerically lower levels of false recognition (see Figure 1) and make significantly fewer false alarms overall (see Figure 2) than do older adults in the word encoding group.

Second, AD patients were more likely to respond “old” to items presented in the visual plus auditory test modality regardless of whether they were studied or nonstudied, compared with the auditory alone modality. For the studied items, this effect was greater in the picture encoding condition than in the word encoding condition, suggesting that the visual plus auditory modality reinstantiated the initial encoding conditions, consistent with the transfer-appropriate processing principle. This explanation could also be applied to the results from nonstudied items (see Figure 3). Seeing the visual image at test appears to shift the AD patients to a more liberal response bias in both the picture and the word encoding conditions, compared with only

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[3] That the analysis of false recognition (false targets minus false target controls) in older adults did not show an effect of encoding condition is likely because the distinctiveness heuristic may be used both to reduce the related lure false targets and to reduce the unrelated false target controls. Thus, the effect of the distinctiveness heuristic may be greatly reduced using this calculated measure.

[4] Given this conclusion concerning impaired use of the distinctiveness heuristic in AD patients, it is worthwhile to clarify some of the numerical trends seen in the true and false recognition data presented in Table 1. It may appear, for example, that the AD patients who studied pictures were able to use the distinctive information obtained from the pictures to reduce their false recognition in the visual plus auditory modality (.15) versus the auditory alone modality (.27). These differences were, however, nonsignificant, $t(9) < 1$. Furthermore, perusal of Table 1 shows the reason that levels of false recognition in the visual plus auditory modality were lower than that of the auditory alone modality. Whereas the false targets were actually somewhat higher for the visual plus auditory modality (.67) versus that of the auditory alone (.53), $t(9) = 1.37$, $MSE = 0.104$, $p = .203$, the false target controls in the visual plus auditory modality were double (.52) that of the auditory alone modality (.26), $t(9) = 2.24$, $MSE = 0.120$, $p = .052$.

hearing the words. It is as if the richer information in the visual plus auditory modality makes the items seem more familiar, perhaps by reinstating the general conditions of encoding. However, this finding in AD patients differs from results with the older adults, who made very similar numbers of old responses to nonstudied items in the visual plus auditory and auditory only modalities (see Figure 3). Exactly why AD patients, but not older adults, should show a liberal response bias when tested with items in both visual plus auditory modalities is unclear; research into this question may help us to understand why AD patients exhibit numerous memory distortions clinically.

A third finding that merits some commentary is that picture encoding may, in some respects, improve the gist memory of AD patients (note that this finding should be viewed as preliminary because, as discussed below, only nonsignificant numerical trends support it). In the analysis of false recognition for AD patients alone, there was a trend toward an effect of encoding condition because participants in the picture encoding group showed numerically greater levels of false recognition compared with those in the word encoding group (.21 vs. .04; see Figure 1). It may be that the additional information provided by picture encoding, although helping the older adults to reject false targets, enables the AD patients to build up and retain gist information. AD patients can then use this gist information to distinguish between related items and unrelated items. Evidence consistent with the hypothesis that the memory of AD patients may benefit from the addition of pictorial information at encoding comes from recent work involving patients with semantic dementia. These studies have found that perceptual information from studied pictures can support recognition memory even when semantic knowledge about target items is degraded, indicating that both semantic and perceptual information typically contribute to learning in episodic memory (Graham, Simons, Pratt, Patterson, & Hodges, 2000; Simons, Graham, Galton, Patterson, & Hodges, 2001). Future studies are needed to determine whether our preliminary finding is reliable.

One reason why encoding pictures (along with auditory words) might improve the gist memory of AD patients compared with encoding visual and auditory words may be attributable to the fact that the items are related through the semantic associations. In addition to their impairment in episodic memory, AD patients also show impairment on some tasks that draw on semantic memory. Such tasks include generating words from semantic categories (typically animals, fruits, vegetables; Monsch et al., 1992; Salmon, Heindel, & Lange, 1999) and judging word relatedness (Bayles, Tomoeda, & Cruz, 1999). However, AD patients perform normally on other tasks requiring intact semantic memory, including semantic priming (Balota & Duchek, 1991; Balota, Watson, Ducheck, & Ferraro, 1999) and instantiation of semantic categories in sentence comprehension (Nebes & Halligan, 1999). These seemingly contradictory data have led Balota and colleagues (Balota, Cortese, et al., 1999; Balota, Watson, et al., 1999; Watson et al., 2001) to postulate that the major problem with AD patients' semantic memory is not in the underlying semantic networks but rather in the attentional control system that provides access to those networks. This theory would explain why AD patients show normal performance on paradigms such as priming, which use relatively automatic activation processes, whereas they show impairment in paradigms that require effort and are heavily dependent on attentional control systems, such as category word generation. It may be that studying semantically related words alone in this paradigm (even in both visual and auditory modality) requires substantial activation of the attentional control system in order for the semantic associations between the words to be recognized, enabling a gist representation to be developed. If, because of inability to adequately activate the attentional control system, the semantic associations between the words are not recognized, a gist representation cannot form. The AD patients who studied visual and auditory words, with an impaired attentional control system governing semantic memory, may have difficulty developing a gist representation that they might later remember. Studying pictures along with the auditory words, however, may allow AD patients to bypass this impaired attentional control system; alternatively, studying pictures and words may activate the attentional control system more strongly than visual and auditory words. Either way, pictures may enable AD patients to develop and remember semantic gist information despite their impairment in semantic memory.

A related but somewhat different explanation of how pictures may enhance the semantic gist of AD patients is that the pictures may allow them to more easily gain access to the full meaning of the words. First, if the AD patients had simply forgotten the entire meaning of some of the words, then the pictures could serve to remind them. Second, Chan, Butters, Paulsen, et al. (1993) have found that AD patients not only exhibit impaired semantic memory but specifically that their semantic networks are disordered. For example, AD patients categorize animals by concrete (e.g., size) rather than abstract (e.g., domesticity) factors, unlike healthy older adults (Chan, Butters, Salmon, & McGuire, 1993; Chan et al., 1995). Chan, Butters, and Salmon (1997) have also shown that there is a correlation between dementia severity and the degree of disorder of the semantic network. Furthermore, they argue that as AD patients' knowledge decreases, they show an increased number of atypical semantic associations (or links), making their semantic network more chaotic. Important to note, as dementia severity increases, AD patients' semantic networks show progressively less similarity with that of older adults, indicating that the more common semantic links are weakened. Pictures might help to strengthen some of these weak links by reminding the AD patients of meanings or aspects of the words that are not readily apparent to them from seeing the words alone. For example, although we assume that older adults would immediately associate *honey* with the lure *sweet* and associate *bed* with the lure *sleep*, AD patients may not (they might instead associate these items only with more concrete factors like *cupboard items* and *furniture*, respectively). When the AD patients see a picture of *honey*, however, they may think that it looks *sweet*; when they see a picture of a *bed*, they may think how nice it would be to *sleep* in it. In this manner, the picture group may be able to make more semantic associations compared with the word group, and by making more semantic associations, the picture group may be more able to build up the semantic gist of the study lists.

Lastly, the above examples of *honey* and *bed* suggest that source memory confusion may also be relevant to explaining how pictures may increase false recognition and false alarms of AD patients and decrease them in older adults. Deese (1959) and others (e.g., Bousfield, Whitmarsh, & Danick, 1958; Roediger & McDermott, 1995; Underwood, 1965) have suggested that the high levels of recall intrusions seen in the original Deese paradigm may have been attributable to implicit associative responses. That is, participants may themselves spontaneously generate the nonstudied related lure word (e.g., *sweet*) during the study phase. For the AD patients, seeing the pictures during encoding may encourage this type of source monitoring error by facilitating implicit associative responses. In contrast, older adults may be able to use the distinctive information provided by the pictures to help them distinguish between a studied item (which would be associated with a picture) and an implicit associative response (which would not be associated with a picture). Thus, source monitoring may also provide an explanation of how the distinctive information of pictures can decrease false alarms in healthy older adults, whereas they can increase false recognition in AD patients.

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