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Metacognition and False Recognition in Alzheimer's Disease: Further Exploration of the Distinctiveness Heuristic

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The distinctiveness heuristic is a response mode in which participants expect to remember vivid details of an experience and make recognition decisions on the basis of this metacognitive expectation. The authors examined whether the distinctiveness heuristic could be engaged to reduce false recognition in a repetition-lag paradigm in patients with Alzheimer's disease (AD). Patients with AD were able to use the distinctiveness heuristic—though not selectively—and thus they showed reduction of both true and false recognition. The authors suggest that patients with AD can engage in decision strategies on the basis of the metacognitive expectation associated with use of the distinctiveness heuristic, but the patients' episodic memory impairment limits both the scope and effectiveness of such strategies.

Keywords: memory, metacognition, Alzheimer's disease

Although memory is often accurate, memory distortions and false memories frequently occur (Schacter, 1996). One type of memory distortion that has been studied extensively is false recognition, which occurs when people incorrectly claim to have previously encountered a novel word or event. The ability to minimize memory distortions such as false recognition is a critical part of normal memory function (Schacter, 1996, 2001). Methods of minimizing or reducing false recognition in the laboratory have been explored in healthy adults (Kensinger & Schacter, 1999) and in patients with various kinds of brain damage (Budson, Daffner, Desikan, & Schacter, 2000; Budson, Sullivan, et al., 2002; Schacter, Verfaellie, Anes, & Racine, 1998) through repeated presentations of study and test materials. These studies have contributed to the understanding of the neuropsychology of memory failure in specific brain diseases and the occurrence of clinically relevant memory distortions in certain patient populations, as well as aided to the understanding of normal memory function.

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Israel and Schacter (1997) investigated another method to reduce false recognition. They tested the idea that if false recognition of semantically related words 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 young 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, the group 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 unrelated lures than did word-encoding alone.

To better understand these issues, 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. Using signal detection analyses, Schacter et al. (1999) determined that both younger and older adults showed a more conservative response bias after picture encoding than after word encoding. They suggested that this more conservative response bias observed after picture encoding may depend on a general shift in responding based on 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 the detailed pictorial information associated with the words to support a positive recognition decision; failure to retrieve such distinctive information when tested with related lures would tend to result in a negative recognition decision. Of importance, Schacter et al. (1999) argued that suppression based on metamemorial assessments can function without access to list-specific distinctive information about studied items. They hypothesized that the suppression of false recognition observed in the picture-encoding group thus relied on a general expectation that a test item should elicit a vivid perceptual recollection if, indeed, it had been presented previously. Participants in the word-encoding group, in contrast, would not expect to retrieve distinctive representations of previously studied items and are thus much less likely to demand access to detailed recollections. Schacter et al. (1999) referred to the hypothesized rule of thumb used by the picture-encoding group as a *distinctiveness heuristic* (cf., Chaiken, Lieberman, & Eagly, 1989; Johnson, Hashtroudi, & Lindsay, 1993; Kahneman, Slovic, & Tversky, 1982).

Budson, Sitarski, Daffner, and Schacter (2002) investigated whether patients with Alzheimer's disease (AD) would be able to use this distinctiveness heuristic to reduce their false recognition of semantic associates. Using the same paradigm as that used previously with older adults (Schacter et al., 1999, Experiment 1), Budson, Sitarski, et al. (2002) found that the patients with AD who studied pictures were unable to reduce their false alarms compared with those who studied words only, and in fact, they showed trends toward greater false recognition. Thus, unlike older adults, patients with AD were unable to use the distinctiveness heuristic to reduce their false recognition in this paradigm consisting of lists of semantically related words. In the present study, we sought to explore whether patients with AD would be able to use the distinctiveness heuristic in the setting of a different experimental paradigm.

We undertook this exploration because we suspected that the patients with AD who studied pictures in Budson, Sitarski, et al. (2002) may have actually used the distinctiveness heuristic to reduce false recognition to a small extent, but two factors may have raised their false recognition to a greater extent. First, studying pictures that correspond to the semantically related words may have facilitated the patients' developing the general meaning, idea, or gist of the words and thus may have contributed to their making gist-based false alarms. Second, test items in this paradigm were presented in either the visual and auditory mode (as in the study session) or in the auditory mode alone. Patients with AD were more likely to respond "old" to items in the visual and auditory mode than in the auditory-only mode—whether or not the items were studied or unstudied—and this effect was somewhat stronger in the picture group compared with the word group. Thus, any small effect of the distinctiveness heuristic may have been overwhelmed by these two factors. Our goal in the present experiment was to determine whether patients with AD can use the distinctiveness heuristic in a paradigm with these factors removed.

To accomplish this goal, we used a repetition-lag paradigm, introduced by Underwood and Freund (1970) and modified by Jennings and Jacoby (1997) and Dodson and Schacter (2002c). In the modified version of this paradigm, participants study either a list of unrelated words or pictures and then make old–new recognition judgments about previously studied items and new words. Each new word occurs twice on the test, with a variable lag (i.e., a variable number of intervening words) between the first and second occurrence. Participants are instructed to say "old" to studied words only and to say "new" to nonstudied words, even when they repeat. Although participants are told explicitly that if a word occurs twice on the test they can safely conclude that it is a new word, participants in a word-only encoding condition nonetheless incorrectly respond "old" to many of the repeated new words, especially when they repeat at a long lag. Jennings and Jacoby (1997), in a similar condition involving only words, observed that older adults were extremely vulnerable to falsely recognizing repeated new words. Presumably, individuals mistake the familiarity of the repeated new words—derived from their earlier exposure on the test—for prior presentation in the study phase. By contrast, both older and younger adults reduced their false recognition rate to the repeated new words when they studied pictures of the items. Dodson and Schacter (2002c) argued that participants in the picture-encoding condition, like those in Schacter et al. (1999), used a distinctiveness heuristic during the test, inferring that test items are new when they fail to retrieve memory for pictorial information about the item.

Method

Participants

Thirty-six patients with a clinical diagnosis of probable AD (as determined by National Institute of Neurological and Communications Disorders and Stroke—Alzheimer's Disease and Related Disorders Association criteria; McKhann, Drachman, Folstein, Katzman, & Price, 1984) were recruited from the Memory Disorders Unit, Brigham and Women's Hospital (BWH), Boston, Massachusetts. Thirty-two healthy, community-dwelling older adults were recruited from participants in a longitudinal study of normal aging at BWH, from spouses and friends of the patients, and by the use of 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 BWH. Participants were paid $10 per hr for their participation. Older adults were excluded if they scored below 27 on the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975). Most patients with AD showed mild to moderate impairment on the MMSE (M = 23.6, range = 15–28). Participants were excluded if they were characterized by clinically significant depression, alcohol or drug use, or cerebrovascular disease or traumatic brain damage, or if English was not their primary language. All participants had normal or corrected-to-normal vision and hearing. The patients were matched to the older adults on the basis of gender (22 female patients, 22 female older adults; 14 male patients, 10 male older adults), age (patient: M = 75.5 years, range = 59–86 years; older adult: M = 74.3 years, range = 65–82 years), and education (patient: M = 16.3 years, range = 8–20 years; older adult: M = 15.8 years, range = 12–20 years). These variables were also matched between those in the word and picture conditions. For the patients, scores on the MMSE were also matched between those in the word (M = 23.9) and picture (M = 23.3) conditions, $F(1, 34) < 1$.

Study Design

We used a repetition-lag paradigm similar to that used by Dodson and Schacter (2002a, Experiment 1; see also Underwood & Freund, 1970; Jennings & Jacoby, 1997); the differences are described below. The stimuli consisted of 96 Snodgrass and Vanderwart (1980) pictures and their corresponding verbal labels. Forty-five items (plus 6 filler items, 3 at the beginning and 3 at the end) were studied, and the other 45 were the new items on the test. Fifteen of the new items repeated at Lag 0, another 15 repeated at Lag 4, and the last 15 repeated at Lag 24. Participants performed a pleasantness rating at study and saw either the picture (for the picture group) or the word (for the word group) visually presented along with the auditory presentation of the word. Test items for all participants were the visual words only. The test consisted of the 45 studied, 45 new, and 45 lag (0, 4, or 24) items. At the top of the screen, the phrase *Were you presented with this item at study?* was present. Participants were instructed to respond "yes" to studied words and were specifically warned to avoid responding "yes" to the repeated new words.[1]

Results

We note three points prior to presenting the results. First, because the question being answered in this experiment is whether the patients with AD are able to use the distinctiveness heuristic, the critical analysis is whether there is an effect of condition (picture vs. word encoding) within this patient group, particularly for Lag 24, because recollection may be used to counter false recognition of the shorter lags (Dodson & Schacter, 2002a; Jennings & Jacoby, 1997; see Discussion section for further explication). Second, because we were interested in determining not only when significant differences between groups and conditions were present but also when no differences were present, we have included measures of effect size, either η or r, with the results of the statistical tests. Third, as discussed in Budson, Sitarski, et al. (2002), the distinctiveness heuristic may be used to reduce false alarms to both lag items and new items. Thus, although correcting for novel false alarms is generally helpful in separating response bias from recognition when making comparisons between groups, this correction may obscure effects of the distinctiveness heuristic. The analyses below are therefore performed on uncorrected data; the corrected (along with the uncorrected) data can be found in Table 1.

Study Items

An analysis of variance (ANOVA) with group (patients vs. older adults) and condition (word vs. picture) as between-subjects variables for "yes" responses to study items yielded an effect of group, $F(1, 64) = 27.92$, $p < .0005$, $\eta = .551$; no effect of condition, $F(1, 64) = 2.18$, $p = .145$, $\eta = .181$; and a Group $\times$ Condition interaction, $F(1, 64) = 14.88$, $p < .0005$, $\eta = .434$. The effect of group indicates that older adults responded "yes" to study items more often than did the patients with AD. The interaction is present because patients with AD in the picture condition made fewer "yes" responses to studied items than did patients in the word condition, $F(1, 34) = 17.40$, $p < .0005$, $r = .715$, whereas older adults in the picture and word conditions did not differ, $F(1, 30) = 2.33$, $p = .137$, $r = .279$, and in fact, showed numerical trends in the opposite direction (see Table 1).

Table 1
Proportion of "Yes" Responses to Study, New, and Repeated Lag Items in Older Adults and Patients With AD in the Word and Picture Conditions

	Encoding condition							
	Older adults				Patients with AD			
	Word		Picture		Word		Picture	
Item type	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Study	.82	.25	.92	.05	.76	.22	.52	.09
New	.02	.03	.03	.04	.48	.26	.31	.21
Lag 0	.00	.02	.02	.03	.49	.31	.36	.21
Lag 4	.16	.16	.05	.08	.76	.26	.54	.20
Lag 24	.18	.14	.07	.04	.78	.26	.53	.20
Corrected study	.80	.25	.90	.06	.28	.17	.20	.20
Corrected Lag 0	−.02	.03	−.01	.04	.01	.15	.05	.10
Corrected Lag 4	.14	.15	.02	.05	.28	.23	.23	.24
Corrected Lag 24	.16	.12	.04	.05	.30	.17	.21	.23

Note. AD = Alzheimer's disease.

New Items

The analogous ANOVA for "yes" responses to new items revealed an effect of group, $F(1, 64) = 75.78$, $p < .0005$, $\eta = .736$; a trend toward an effect of condition, $F(1, 64) = 3.28$, $p = .075$, $\eta = .221$; and a Group $\times$ Condition interaction, $F(1, 64) = 4.23$, $p = .044$, $\eta = .249$. The effect of group is present because the patients with AD made many more false alarms to new items than did older adults. The trend toward a condition effect indicates that those in the picture group showed some tendency toward making fewer false alarms to new items than did those in the word group—supporting the third point raised at the beginning of the Results section. The interaction is again present because patients with AD in the picture condition made fewer "yes" responses to new items than did those in the word condition, $F(1, 34) = 4.35$, $p = .045$, $r = .357$, whereas older adults in the picture and word conditions did not differ, $F(1, 30) < 1$, $r = .149$ (see Table 1).[2]

Lag Items

An ANOVA with group (patients vs. older adults) and condition (word vs. picture) as between-subjects variables and lag (0, 4, 24) as a within-subject variable yielded effects of group, $F(1, 64) = 147.40$, $p < .0005$, $\eta = .835$; condition, $F(1, 64) = 10.54$, $p = .002$, $\eta = .375$; and lag, $F(2, 128) = 47.09$, $p < .0005$, $\eta = .651$; as well as interactions between lag and group, $F(2, 128) = 6.90$, $p = .001$, $\eta = .311$, and lag and condition, $F(2, 128) = 5.95$, $p = .003$, $\eta = .292$. There were no other interactions: Group $\times$ Condition was $F(1, 64) = 2.59$, $p = .113$, $\eta = .197$, and the three-way interaction was $F(2, 128) < 1$, $\eta = .004$. The effect of

[1] The first 16 patients with AD and the 12 older adults who performed the experiment moved to a different seat in the same room to increase the differences between the study and test phases. This seat manipulation was later judged to be unnecessary and was eliminated for the remaining 20 patients with AD and the 20 older adults. Because an ANOVA with group (patients vs. older adults), condition (word vs. picture), and seat manipulation (present vs. absent) as between-subject variables and item type ("yes" responses to study, new, or Lags 0, 4, and 24 items) as a within-subject variable yielded no effect of seat manipulation, $F(1, 60) < .1$, and no interactions with seat manipulation, $F(4, 240) < .2$, data from all 68 participants were analyzed together.

[2] Note, however, that floor effects were present in the older adults for the new items (and for the Lag 0 items discussed below). It is therefore possible that older adults in the picture condition, like the patients with AD, would have shown lower levels of false alarms to these items relative to those in the word condition if floor effects were not present. If this finding were present, it would suggest that older adults were also using the distinctiveness heuristic to reduce false alarms to these items, as discussed in Budson, Sitarski, et al. (2002).

group is present because patients with AD showed greater false recognition of the lag items than did older adults. The effect of condition is present because, overall, participants in the picture condition showed lower levels of false recognition of the lag items than did those in the word condition. It is important to note that—as expected given the lack of a Group × Condition interaction—the effect of condition was also present in separate ANOVAs conducted on the performance of the older adults, $F(1, 30) = 6.32$, $p = .018$, $\eta = .417$, and on the performance of the patients with AD alone, $F(1, 34) = 7.40$, $p = .010$, $\eta = .423$ (see Table 1). This suggests that both our older adults and our patients with AD were able to use the distinctiveness heuristic to reduce their false recognition to repeated lag items. The effect of lag is present because false recognition of Lag 0 items was less than that of Lag 4, $t(67) = 6.44$, $p < .0005$, and Lag 24, $t(67) = 8.21$, $p < .0005$; false recognition of Lags 4 and 24 did not differ, $t(67) < 1$. The Lag × Group interaction is present because the effect of lag was greater for the patients with AD, $F(2, 68) = 33.23$, $p < .0005$, $\eta = .703$, than for the older adults, $F(2, 60) = 17.47$, $p < .0005$, $\eta = .607$. The Lag × Condition interaction is present because the effect of lag was greater in the word condition, $F(2, 68) = 43.89$, $p < .0005$, $\eta = .750$, than in the picture condition, $F(2, 60) = 9.80$, $p < .0005$, $\eta = .496$.

Discussion

Previously, Budson, Sitarski, et al. (2002) found that patients with AD who studied pictures along with semantically related auditory words were unable to reduce false recognition relative to those who studied visual and auditory words, suggesting that patients with AD are unable to use the metacognitive expectation called the distinctiveness heuristic. In the present study, we further explored the distinctiveness heuristic in patients with AD using a modified repetition-lag paradigm. We found, for the first time, that patients with AD can engage in decision strategies on the basis of metacognitive expectation associated with use of the distinctiveness heuristic. However, our data also suggest that their episodic memory impairment limits both the scope and effectiveness of such strategies.

As discussed by Dodson and Schacter (2002a, 2002b), the modified repetition-lag paradigm used here is particularly helpful because it enables analysis of three potentially separable processes: familiarity, recollection of source information, and the distinctiveness heuristic. Familiarity of repeated new words contributes to false recognition when participants do not recollect their prior encounter with the word on the test and do not use the distinctiveness heuristic to reject these words. Recollection of the source, or item-specific, information of seeing the repeated new word earlier on the test may serve as a "recall-to-reject" mechanism, reducing false recognition when the new words repeat after short lag intervals (see Clark & Gronlund, 1996; Rotello & Heit, 1999; Rotello, Macmillan, & Van Tassel, 2000). In the present study, this recall-to-reject mechanism likely explains the older adults' low level of false recognition of Lag 0 items in both the picture and word groups. Recollection of the new words that repeat at longer intervals, such as Lag 24, is more difficult. Thus, false recognition of items at these lags was elevated relative to items at the shorter lags in our study because participants did not recollect seeing the word earlier in the test and mistakenly thought that the familiarity of the item was attributable to having seen it on the study list. Last, the distinctiveness heuristic may be invoked by the picture group when participants encounter a familiar test word and do not recollect source information about where they saw the item. In this situation, an item is presumed to be new when it does not elicit the expected memory information (of a picture corresponding to the word).

Our reexamination of the distinctiveness heuristic in patients with AD using the repetition-lag paradigm eliminated two potential confounds: (a) the contribution of gist-based false recognition being enhanced by studying pictures and (b) the tendency for these patients to be more likely to respond "old" to a picture versus a word at test, whether studied or unstudied. Using a repetition-lag paradigm, in this experiment we showed that, similar to healthy older adults (as in Dodson & Schacter, 2002a), patients with AD who studied pictures were able to reduce false recognition to repeated lag items, compared with those who studied words. However, these patients were not able to use the distinctiveness heuristic selectively to reduce false recognition. That is, the picture group reduced "yes" responses to all items—new, lag, *and* study items—compared with the word group (see Table 1). Use of the distinctiveness heuristic, therefore, will not allow patients with AD to distinguish true from false memories, although it shifts their response bias to be more conservative. Why should "yes" responses to study items be reduced by the use of the distinctiveness heuristic in patients with AD? Although further studies will be necessary to answer this question, we speculate that the reduction is attributable to the fact that the patients with AD are impaired in recollection, including recollection of pictures (Rizzo, Anderson, Dawson, & Nawrot, 2000). Patients in both the picture and word groups may experience familiarity without recollection for study items (Dalla Barba, 1997; Knight, 1998; Koivisto, Portin, Seinela, & Rinne, 1998; Smith & Knight, 2002; Tendolkar et al., 1999). Only the picture group, however, demands access to recollection of detailed pictorial information to support a positive recognition decision. The word group, by contrast, demands no such information and may make recognition decisions on the basis of familiarity alone. Although the older adults in the picture group demand the same information, their recollection of pictures is relatively unimpaired, so their hit rate will not be reduced.[3]

Combining the results of the present study with that of Budson, Sitarski, et al. (2002) leads us to the following conclusion: Patients with AD can engage in decision strategies on the basis of metacognitive expectation associated with use of the distinctiveness heuristic, but their episodic memory impairment limits both the scope and effectiveness of such strategies. In Budson, Sitarski, et al., these patients' tendencies toward making gist-based false alarms (and false alarms to pictures) overwhelmed any small effect

[3] Note that the pattern of results observed in the patients with AD are not driven merely by the results of patients with more impairments. An analysis of patients with milder impairments, who scored 25 or above on the MMSE (word, $n = 11$; picture, $n = 10$), yielded near-identical results. "Yes" responses to study items were significantly lower for those in the picture (.50) than in the word (.80) condition, $F(1, 19) = 20.13$, $p < .0005$, as they were to new items, picture (.23) and word (.52), $F(1, 19) = 11.01$, $p = .004$; and to lag items (picture and word, respectively): Lag 0 (.31, .58), Lag 4 (.58, .79), and Lag 24 (.56, .84); overall ANOVA, $F(1, 19) = 9.06$, $p = .007$.

of the distinctiveness heuristic in reducing false recognition, leading to no difference in total numbers of false alarms in either the picture or word groups. In the present study, the patients were able to engage the distinctiveness heuristic, but their episodic memory impairment led them to reduce "yes" responses to studied along with new items, thus preventing the patients with AD from being able to use the distinctiveness heuristic to improve their discrimination between study and new items. Thus, patients with AD can only use the distinctiveness heuristic imperfectly at best: They cannot use it selectively to reduce false alarms, nor can they use it to counteract gist-based false recognition.

The results of the present experiment may provide a better understanding of the neuropsychology of patients with AD. We agree with Dodson and Schacter (2002a, 2002c), who argued that the idea of the distinctiveness heuristic is consistent with Johnson et al.'s (1993) source monitoring framework, in which participants can recruit a variety of different decision strategies when making memory judgments. In previous studies, researchers have found that strategies similar to the distinctiveness heuristic are used when test items are attributed to a particular source (e.g., Anderson, 1984; Foley, Johnson, & Raye, 1983; Hashtroudi, Johnson, & Chrosniak, 1989; Hicks & Marsh, 1999; Johnson, Raye, Foley, & Foley, 1981; Kelley, Jacoby, & Hollinghead, 1989). One example is the "it had to be you" effect, which refers to a test bias in which individuals who heard some words and generated others are more likely to claim that falsely recognized words were heard rather than generated (Johnson et al., 1981). Presumably, this bias reflects the metamemorial belief that self-generated information is more memorable than heard information (Johnson & Raye, 1981), leading participants to judge a familiar item to be heard rather than generated because of the absence of recollection of having generated the item. This view of the distinctiveness heuristic is also consistent with the monitoring processes discussed by Schacter, Norman, and Koutstaal (1998) in their constructive memory framework and with the activation and monitoring account of Roediger, McDermott, and colleagues (e.g., McDermott & Watson, 2001; Roediger, Watson, McDermott, & Gallo, 2001). For example, Hicks and Marsh (1999) demonstrated that a decision strategy based on the absence of memory for expected source information allows participants to reduce their false recall of semantic associates. (For further discussion of the distinctiveness heuristic in relation to retrieval strategies, see Dodson & Schacter, 2002a, 2002b, 2002c). In summary, we believe the distinctiveness heuristic is a particular instance of the general class of metacognitive strategies in which the absence of memory for expected information is diagnostic that the item was not studied. Thus, our results are informative for understanding metacognitive processes in AD related to memory judgments (metamemory), in addition to understanding false recognition in this population.

Few researchers have explored metacognition in AD. Most of those researchers focused on whether patients with AD are aware of their memory impairments (McGlynn & Kaszniak, 1991) or have examined patients' prediction of future memory performance (e.g., "feeling-of-knowing" and "judgments of learning"; Moulin, Perfect, & Jones, 2000a, 2000b; Pappas et al., 1992; see also Gil & Josman, 2001). In the present study, we evaluated patients with AD for a different kind of metacognition that involves engaging in a particular decision strategy when making memory judgments. We found they were able to use the metamemorial belief that pictures are more memorable than words to alter their response bias to become more conservative, although their episodic memory deficits prevented this ability from improving their overall discrimination. Another way of stating this point is that although the patients are able to use the distinctiveness heuristic, their application of it is inappropriate given their episodic memory impairment. If the patients were more cognizant of their memory deficits, then they might be less likely to try to use such strategies, which depend on intact memory functioning. These findings suggest that although some aspects of metamemory may be intact in patients with AD (such as the ability to use metamemorial strategies), other aspects of it are impaired (such as knowing under what circumstances to apply these strategies).

In addition to aiding understanding of the neuropsychology of patients with AD, the findings in this study also have implications for understanding the distinctiveness heuristic in normal memory. One potential criticism of the concept of the distinctiveness heuristic is that it may reflect increased discrimination of the picture items rather than the expectation that a vivid memory will be recollected (see Schacter & Wiseman, in press, for discussion of this issue). The fact that patients with AD who studied pictures shifted their response bias without shifting their discrimination (compared with those who studied words) demonstrates that studying pictures may result in changes in responses that are not attributable to an increase in discrimination. Although our results do not show unequivocally that these changes are attributable to the distinctiveness heuristic, the present study provides additional evidence that the reduction of false recognition observed after studying pictures is not simply a consequence of improved memory for the study items.

Last, our results also have clinical implications for patients with AD. Although these patients are not able to use the distinctiveness heuristic to improve their discrimination, it may be used to shift their response bias to a more conservative one, reducing their false-alarm rate. This may be beneficial in circumstances in which reducing false memories is equally important as or more important than improving discriminability. For example, if taking medication could be made a more distinctive event, then patients might be less likely to falsely believe that they have taken their pills when they have not, and thus, they might be more likely to check their pill box to make sure they have taken their medication. Such an intervention may improve the lives of patients with AD.

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