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Implicit/explicit memory dissociation in Alzheimer's disease: The consequence of inappropriate processing?

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Abstract

Dual-process theories of recognition posit that perceptual fluency contributes to both familiarity-based explicit recognition and perceptual priming. However, the priming-without-recognition dissociation, as observed through the intact mere exposure effect and impaired recognition in patients with Alzheimer's disease (AD), might indicate that familiarity and perceptual priming are functionally distinct. This study investigated whether the AD patients' processing strategies at testing may explain this priming-without-recognition dissociation. Firstly, we replicated the priming-without-recognition effect in 16 patients who exhibited intact exposure effects despite null recognition. Secondly, we showed that, under identical conditions, inducing a holistic processing strategy during recognition testing increased AD patients' recognition – performance was similar for AD patients and healthy control participants. Furthermore, prompting analytic processing during both priming and recognition tasks decreased AD patients' performance in both tasks. These findings suggest that the extent to which AD patients use perceptual fluency in priming and recognition tasks is contingent on their processing approach. The choice of processing strategy may depend on how difficult patients perceive the task to be.

Keywords: Alzheimer's disease; Memory; Familiarity; Perceptual fluency; Mere exposure effect

Introduction

Perceptual priming seems to remain intact in Alzheimer's disease (AD) until the latest stages of the disease (AD), as do other facets of implicit memory; on the other hand, patients perform very poorly on standard explicit memory tasks, such as recall and recognition, quite early in the disease (for reviews, see Fleischman & Gabrieli, 1998; Meiran & Jelicic, 1995). For instance, we investigated the implicit *mere exposure effect* (i.e., enhanced positive attitude towards a stimulus that has been processed earlier; Zajonc, 1968) and explicit recognition in patients with AD and healthy elderly participants, using unfamiliar faces as stimuli (Willems, Adam, & Van der Linden, 2002; see also Winograd, Goldstein, Monarch, Peluso, & Goldman, 1999). In this study, unfamiliar faces were presented very rapidly. In a subsequent test phase, participants were presented with pairs of target-distracter stimuli and were asked either which was more pleasant or which was old. While explicit recognition was at the chance level in patients with AD – much poorer than in healthy elderly participants – both groups were much more likely to select the older stimuli than the new ones in the preference judgment. A well-established explanation of this implicit memory effect is that participants develop a preference bias because the prior encounter with a stimulus enhances its subsequent perceptual fluency (e.g., Bornstein & D'Agostino, 1994; Seamon, Brody, & Kauff, 1983a, 1983b; Whittlesea, 1993; Whittlesea & Price, 2001). In light of this background, the mere exposure effect falls into the same broad implicit memory category as perceptual priming, that is, the facilitation of or bias in the processing of a stimulus as a function of a recent encounter with that stimulus (Butler & Berry, 2004; Seamon et al., 1995). To explain this kind of implicit-explicit dissociation, some authors have proposed that perceptual priming may be mediated by a memory system (e.g., perceptual representation system or procedural memory system) separate from the system that mediates explicit memory (e.g., episodic or declarative memory system) (Cohen & Squire, 1980;

Graf & Schacter, 1985; Seamon et al., 1995; Squire, 1992; Tulving & Schacter, 1990). Along these lines, it has been shown that in AD the extrastriatal cortex – where reduced activation is often associated with perceptual priming in the visual modality – remains considerably less prone to neurofibrillary tangle formation than the multimodal association and limbic cortices, which are known to be critical to the memory system that mediates explicit memory performance (Arnold, Hyman, Flory, Damasio, & Van Hoesen, 1991; Pietrini et al., 1999).

However, the problem with this interpretation is that recognition can occur on either of two bases (for a review, see Yonelinas, 2002): a feeling of *familiarity* (feeling of "oldness" devoid of any specific recall of source information) or *recollection* (conscious retrieval of an event with all its episodic glory). Evidence from various kinds of neuropsychological studies suggests that patients with AD have a more significant impairment of recollection-based than familiarity-based recognition (Balota, Burgess, Cortese, & Adams, 2002; Budson, Desikan, Daffner, & Schacter, 2000; Gallo, Sullivan, Daffner, Schacter, & Budson, 2004; Knight, 1998; Koivisto, Portin, Seinela, & Rinne, 1998; Smith & Knight, 2002). In addition, there is now ample evidence that familiarity can be based on the priming effect of an earlier encounter with the stimulus (e.g., Jacoby & Dallas, 1981; Jacoby & Whitehouse, 1989; Kelley & Jacoby, 2000; Rajaram, 1993; Westerman, 2001; Whittlesea, 1993; Whittlesea & Williams, 1998, 2000, 2001a, 2001b). In other words, familiarity may be the result of priming-based experiences of perceptual (form-based) and conceptual (meaning-based) processing fluency. Specifically, this familiarity is rooted in an unconscious attributional process, whereby processing fluency is attributed to the prior encounter. Along these lines, this priming-fluency account is compatible with the relative preservation of both perceptual priming and familiarity-based recognition in patients with AD (see also Wolk, Schacter, Berman, Daffner, & Budson, 2005). Nevertheless, the priming-fluency account of familiarity seems to be contradicted by studies that found significant priming on an

implicit task in the complete absence of recognition (i.e., chance recognition). Very few studies have found such a striking implicit/explicit dichotomy. Nevertheless, as mentioned above, this precise pattern of *priming without recognition* was found in patients with AD by using the *mere exposure effect* paradigm (Willems et al., 2002). This kind of priming-without-recognition pattern has led some investigators to reject evidence that processing fluency can mediate familiarity-based recognition judgments and to suggest that the fluency process supporting perceptual priming is functionally and anatomically separate from that supporting familiarity-based recognition memory (e.g., Stark & Squire, 2000; Wagner & Gabrieli, 1998; Wagner, Gabrieli, & Verfaellie, 1997).

In line with Whittlesea and Price (2001), we suggest that positing separate memory systems for familiarity-based recognition and perceptual priming is not necessary to explain priming without recognition in patients with AD. Instead, we hypothesize that this neuropsychological dissociation can be understood as being the result of the different strategies that patients with AD employ in using their memory to perform different tasks. As discussed below, Whittlesea and Price (2001) examined the impact of strategies on recognition performance in healthy young people. In healthy participants, a rare example of the way in which knowledge may be inaccessible on a recognition test but accessible on an almost identical implicit test is seen once again in studies of the mere exposure effect. In particular, well-documented priming-without-recognition effects can be triggered with this paradigm by drastically shortening the presentation duration at the time of encoding (e.g., Bonnano & Stilling, 1986; Kunst-Wilson & Zajonc, 1980; Mandler, Nakamura, & van Zandt, 1987; Seamon et al., 1983a, 1983b). In these studies, while participants operated at chance levels in the recognition task, they were much more likely to choose the old than the new stimulus when making preference judgments.

To explain this pattern of results, Whittlesea and Price (2001) suggested that, due to the

characteristics of the encoding task and the material to be processed in the mere exposure effect paradigm, people may shift between different processing strategies in the preference and recognition conditions. Non-analytic processing corresponds to globally examining the stimulus as a whole. On the other hand, analytic processing corresponds to isolating certain distinctive parts of the stimulus. Whittlesea and Price point out that the perceived difficulty of the explicit recognition task would encourage participants to adopt a part-based processing strategy, which they judge to be more reliable, and treat the stimulus as a collection of separate, potentially recognizable features in order to claim recognition on the basis of recollection. Such perceived task difficulty can be induced when encoding opportunities are minimal (i.e., presentation is brief), when test stimuli are perceptually homogeneous (e.g., they belong to a single stimulus category, such as unfamiliar faces, geometric figures, or nonsense words), and when test stimuli are unfamiliar. However, in this context, an analytic strategy fails because the brief presentation and overall homogeneity prevent the effective encoding of distinctive features. Conversely, because participants may perceive preference tasks as easier and as purely subjective, they tend to process stimuli non-analytically. If the whole stimulus generates a feeling of fluency based on priming, then this feeling is attributed to pleasantness.

In line with this approach, the question addressed by our study was whether this dichotomy between strategies may also explain the priming-without-recognition phenomenon in patients with AD (Willems et al., 2002; see also Winograd et al., 1999). Indeed, even though patients often underestimate the severity of their cognitive deficits, we know that, despite their impaired episodic memory, patients with mild to moderately severe dementia may be partially aware of their cognitive deficits (Derouesné et al., 1999; Salmon et al, 2006). Thus, patients with AD who have integrated their memory problems may well perceive certain recognition memory tasks as a considerable challenge, just like healthy participants under the brief encoding

condition. In this context, patients with AD might paradoxically adopt an analytic strategy by attempting to recognize specific details of the stimuli. However, given the actual difficulty of the memory tasks (e.g., with a limited training phase, unfamiliar stimuli and a perceptual category resemblance) and their poor encoding abilities, patients with AD are unlikely to have encoded the specific details of particular stimuli to any great degree. In addition, an analytic strategy might block the experience of enhanced processing fluency and thus the feeling of familiarity. Indeed, Whittlesea and Price (2001) demonstrated that, even when a stimulus is presented in exactly the same way as it was processed earlier, if the participants had analyzed the stimulus into parts at testing, they did not experience the feeling of global fluency. Consequently, it appears that observed dissociations between implicit memory and explicit recognition in patients with AD need not inevitably be explained in terms of different forms of memory representations.

In this study, we first attempted to replicate the priming-without-recognition effect (Willems et al., 2002). Afterwards, we attempted to induce non-analytic or analytic strategies by means of instructions (Whittlesea & Price, 2001). For this purpose, three test days were organized with three versions of the tasks: (1) standard instructions (standard preference and recognition judgment tasks); (2) non-analytic instructions (standard preference and non-analytic recognition judgment tasks); (3) analytic instructions (analytic preference and recognition judgment tasks). There was no non-analytic preference instruction since the standard preference judgment involves a spontaneous global processing strategy (Whittlesea & Price, 2001). We suggest that, because of the greater perceived difficulty of recognition tasks than preference tasks, patients will be motivated to spontaneously process items analytically for recognition judgments, but non-analytically for preference judgments. We propose that the implementation of an analytic strategy for recognition prevents patients from experiencing the fluency that results from processing the item as a whole, and hence the feeling of familiarity. We therefore suggest that the induction of a

non-analytic process in recognition could increase familiarity-driven recognition in patients with AD. Patients with AD might perform better on non-analytic than on standard recognition tasks. Conversely, the induction of an analytic process could prevent familiarity-based recognition. The performance of patients with AD on an analytic recognition task should thus be equivalent to their performance on standard recognition tasks. In addition, if the analytic process prevents them from experiencing fluency, then we should also obtain no significant mere exposure effect with analytic instructions.

Methods

Participants

Two groups of participants took part in this study: patients with dementia of the Alzheimer type (AD) and healthy elderly participants. The AD group consisted of 16 participants (3 males and 13 females) who met the NINCDS-ADRDA criteria for probable Alzheimer's disease (McKhann et al., 1984). Table 1 displays the participants' characteristics. All patients had suffered from progressive worsening of cognitive problems for at least six months. The diagnosis was based on general medical, neurological and neuropsychological examinations. Exclusion criteria were a premorbid history of major psychiatric or neurological illness or drug or alcohol abuse. Their vision was normal or corrected. CT scans showed mild atrophy, at most. Mild leukoaraiosis could be observed, but there was no focal vascular lesion. Patients' scores ranged from 107 to 123 on the Mattis Dementia Rating Scale (DRS; Mattis, 1973) and from 18 to 25 on the Mini-Mental State Exam (MMSE; Folstein, Folstein, & McHugh, 1975). Sixteen normal elderly participants, matched for age, sex and educational level, served as controls. The normal controls were non-institutionalized, alert, and subject to the same exclusion criteria as the AD group. As shown in Table 1, these control participants did not differ from the patients with AD as to their age and their education level. All control participants had a total score superior to 130 on

the DRS, which constitutes the cut-off score to discriminate normal aging from dementia (Monsch et al., 1995). Their scores ranged between 134 and 144 on the DRS, and between 28 and 30 on the MMSE. As shown in Table 1, overall performance on the DRS and the MMSE was significantly lower for patients with AD than for control participants.

INSERT TABLE 1 ABOUT HERE

Material

Eighty-four line drawings of unfamiliar possible three-dimensional objects were used (see figure 1, Schacter, Cooper, & Delaney, 1990; Willems & Van der Linden, 2006; Williams & Tarr, 1997). Previous studies of normal participants showed a particularly robust mere exposure effect with these objects (e.g., Seamon et al., 1995; Willems & Van der Linden, 2006). During the various phases, each participant was presented with a different combination of 12 sets of 7 stimuli in order to counterbalance the stimuli for the studied/distracter sets and recognition/preference tasks but also for the Standard/Non-analytic/Analytic conditions. Because liking judgments can be influenced by many cues other than perceptual fluency due to pre-exposure (such as complexity, Lombardo, 1991; symmetry, Jones, Little, & Perrett, 2003; averageness, Rhodes, Sumich, & Byatt, 1999; etc.), these 12 sets of stimuli were homogenized in terms of their objective and subjective complexity. In a preliminary phase, each figure was rated by 30 undergraduate students on a 5-point Likert scale of "subjective complexity." Then, angles, elements, lines and segments were counted for each figure. Figures were assigned to 12 sets so that they would be equal on all these variables (*Ps* >.05). The material was presented using E-Prime software (Psychology Software Tools, Inc.) on a 15" color monitor running at 60 Hz, approximately 70 cm from the subject. Figures were about 6 cm high and 6 cm wide.

INSERT FIGURE 1 ABOUT HERE

Procedure

Three conditions were administered on three test days separated by seven to ten days. These conditions were identical except for the instructions given to participants. Each condition included one study phase followed by the preference and recognition tasks. The first day of testing included *Standard tasks. Analytic* and *Non-analytic tasks* were administered on the second or third day of testing. Half of the participants were presented with the Non-analytic condition on the second day and the Analytic condition on the third day. The other half of the participants were presented with the reverse order. The Non-analytic condition included the standard mere exposure paradigm and non-analytic recognition. The Analytic condition included the analytic mere exposure paradigm and analytic recognition. We decided to administer all three conditions to the same patients in order to avoid any effect of the neuropsychological heterogeneity of AD. Numerous studies have shown that both the nature of the defective processes and the progression of impairment can vary considerably from one patient with AD to another. Such heterogeneity can be seen both between cognitive functions (for example, between language and visuospatial abilities; Martin, 1990) and within a particular cognitive domain.

Study phases. Similar study phases were used on all three test days. Participants were told that they were going to see figures and have to make different judgments. In fact, participants were given four trials with the same set of stimuli, but with two judgment tasks (two trials by judgment). We selected this diversified encoding task procedure for two main reasons. Firstly, this procedure aimed to maintain participants' attention during the 54 trials and ensure complete perceptual encoding. Secondly, previous work on normal participants showed a robust perceptual priming effect with this kind of procedure (Williams & Tarr, 1999).

In the first encoding task, participants saw the stimuli in two random orders and were asked to decide whether each object looked like a tool or a spaceship. In the second, they again saw the stimuli in two random orders and rated how complex each object seemed (simple or complex). No mention was made of any subsequent memory test. Participants were then presented with 14 gray-on-black figures, four times each, in four random orders of 14.

Each study stimulus was presented at the center of the screen for only 1 s, followed by a 5-s interval. Brief exposure times plus unfamiliar and homogeneous material were used to make explicit recognition especially difficult and consequently to optimize the possible dissociation between explicit and implicit memory performance. Immediately following this study phase, participants received instructions for the preference or recognition judgment tasks. Half of the participants were given the preference task first and the recognition judgment afterwards. The other half were given the recognition task first and the preference judgment afterwards.

Explicit recognition tasks. In each recognition task, participants saw a random list of 7 studied and 7 new distracter objects. Figures were presented until the participant responded. The interstimulus interval was 2 s. In order to prevent the patients with AD from forgetting the instructions, complete recognition instructions were given twice in writing (at the start and after 7 items). In addition, each trial was accompanied by an oral question summarizing the instructions.

In the *Standard Condition*, for each figure, participants had to say whether they had seen it before (old versus new). Each figure was accompanied by the oral question, "Have you seen this figure before, during the first task, yes or no?"

In the *Non-analytic Condition*, we used Whittlesea and Price's (2001) instructions in order to induce global processing of the stimuli, thereby allowing participants to capitalize on the perceptual fluency advantage for studied objects over unstudied ones. We presented study and

test stimuli in the same way as in the Standard Condition. However, we falsely informed participants that none of the objects had been presented in the study phase, but that some of the stimuli resembled stimuli they had studied. In addition, participants were warned that these globally similar test stimuli did not possess all the same distinctive parts as the related studied stimuli. Thus, the oral question for each trial was, "Does this figure have an overall resemblance to a figure you have seen before, during the first task, yes or no?" In the Standard Condition, patients might sometimes attempt to isolate certain distinctive parts composing a stimulus to see whether any of them acted as a cue for recalling details of the context in which the stimulus had previously been encountered. In this condition, because they were falsely informed that these parts had been modified between the study and test phases, they would have no motive to attempt to isolate them. Indeed, this global resemblance instruction developed by Whittlesea and Price is intended to prompt participants to process stimuli non-analytically because of their global similarity, and to experience a global fluency feeling.

In the *Analytic Condition*, participants received the same global similarity instructions as in the Non-analytic Condition. However, for each "Yes, the object resembles one I saw before" response, participants were also instructed to justify their responses by pointing to the part of the object that they thought was particularly similar (Whittlesea & Price, 2001). Here, objects were presented with a vertical and a horizontal hairline, dividing them into four quadrants. Thus, participants were asked to justify their decisions by pointing to one of the four quadrants of the object. The oral question for each trial was, "Does this figure have an overall resemblance to a figure you have seen before, during the first task, yes or no? If you answer yes, we would like you to point to the part for which the resemblance is strongest." The analytic instructions could trigger the exclusive use of part-based processing. If this instruction caused participants to process the stimuli analytically, as suggested by Whittlesea and Price (2001), and if analytic

processing causes participants to experience less fluency, we should expect to observe recognition at the chance level in patients with AD.

Implicit preference tasks. In each preference task, participants saw a random list of 7 studied and 7 new distracter objects. The sequence of trials was identical to that described for the recognition task. Complete preference instructions were given twice, at the start and after 7 items.

In the *Standard* and *Non-analytic Conditions*, participants were told to decide whether "the object was pleasant, yes or no," as quickly as possible (standard preference judgment). Each figure was accompanied by the oral question, "Do you like this figure, yes or no?"

In the *Analytic Condition*, participants were instructed to justify their "pleasant" responses by pointing to one of the four quadrants which they thought was particularly pleasant (Whittlesea & Price, 2001). The question for each trial was "Do you like this figure, yes or no? If you answer yes, we would like you to point to the part which is most pleasant." As in the recognition task, the analytic instructions could trigger the use of part-based processing and cause participants to experience less fluency, in which case we should expect to observe no mere exposure effect in patients with AD or in healthy elderly controls.

Results

To detect the mere exposure effect and recognition, scores were computed as the proportion of "like" or "old" (Hit) responses for target categories minus the proportion of "like" or "old" (False Alarm) responses for the distracters. Means, standard deviations of the means, and effect sizes (Cohen, 1988) in each condition are reported in Table 2.

As task order (preference before or after recognition) and order of condition (Non-analytic before or after Analytic condition) had no effect on preference and recognition scores (*Ps* > .5), we did not consider this variable in the following analyses.

INSERT TABLE 2 ABOUT HERE

A three-way analysis of variance (ANOVA) was conducted on scores with Group (AD patients versus Controls), Task (Recognition versus Preference) and Condition (Standard, Non-analytic, and Analytic) factors. This analysis disclosed a main effect of Group, $F(1, 30) = 13.504$, $P < .001$, indicating that, overall, patients with AD discriminated old objects from distracters less efficiently than controls. There was also a main effect of Condition, $F(2, 30) = 3.25$, $P = .04$, with old objects being distinguished from new objects less efficiently in the Analytic Condition than in the Non-analytic Condition. We also found a main effect of Task, $F(1, 30) = 10.683$, $P = .002$, with more efficient discrimination in the recognition task than the preference task. Most importantly, the Condition X Group interaction was significant, $F(2, 60) = 4.578$, $P= .002$. Planned comparisons showed that the patients with AD were less able to discriminate between old objects and distracters than controls in the Standard and Analytic Conditions ($P <.001$), but not in the Non-analytic Condition ($P = .64$). The Task X Group interaction was also significant, $F(1, 30) = 36.300$, $P <.001$, with Groups differing only for the recognition task ($P <.001$) and not for the preference task ($P = .93$). Interestingly, planned comparisons also revealed that the patients with AD were less able to discriminate between old objects and distracters in the Standard ($F(1, 30) = 12.574$, $P =.001$) and Analytic ($F(1, 30) = 9,576$, $P =.004$) conditions than in Non-Analytic condition. This difference was not observed for controls ($P >.2$). Finally, we found a significant triple interaction effect, $F(2, 60) = 4.288$, $P = .018$, suggesting that old-new discrimination was contingent upon a combination of Group, Task and Condition. Interestingly, the Condition X Task interaction was not significant, $F(2, 60) = 1.091$, $P = .34$, suggesting that preference and recognition tasks were equally sensitive to instructional manipulation. In the remainder of this section, we will further describe the Group effect on preference and recognition

judgment scores within each condition.

Standard Condition

Regarding preference, old objects were more often assessed as pleasant than distracters (i.e., significant mere exposure effect), by controls, $t(15) = 3.993$, $d = .83$, $P = .001$, and by AD patients, $t(15) = 2.909$, $d = .67$, $P = .01$. Regarding recognition, the mean proportion of old objects correctly recognized (Hits) was not significantly different from the mean proportion of distracters selected as old (False Alarms) in patients with AD, $t(15) = -.074$, $d = .02$, $P = .94$ (i.e., recognition at chance), in contrast to controls, $t(15) = 12.649$, $d = 1.42$, $P < .001$. A two-way ANOVA was conducted on computed scores (old – new) with Group (AD patients vs. Controls) and Task (Recognition vs. Preference). The analysis revealed a significant interaction $F(1, 30) = 29.361$, $P < .001$, and a main effect of Group, $F(1, 30) = 1.982$, $P = .001$, but no effect of Task ($P = .41$). Planned comparisons broke down this interaction by indicating no significant Group difference in preference scores $F(1, 30) = .009$, $P = .92$, despite a significant Group difference in recognition scores, $F(1, 30) = 41.903$, $P < .001$. In fact, despite quite similar false alarm rates (.28 for patients with AD and .25 for controls), the AD patients' mean hit rate (.28) was much worse than the controls' hit rate (.82). Thus, we replicated the implicit/explicit dissociation with an intact mere exposure effect despite severely impaired explicit recognition in patients with AD.

Non-Analytic Condition

Regarding preference, targets were selected as pleasant more often than distracters, by controls, $t(15) = 3.058$, $d = .70$, $P = .008$, and by AD patients, $t(15) = 4.026$, $d = .82$, $P = .001$ (i.e., significant mere exposure effect). Regarding recognition in this condition, the mean proportion of Hits was significantly different from the mean proportion of False Alarms for patients with AD, $t(15) = 5.088$, $d = 1.01$, $P < .001$, and for controls, $t(15) = 8.783$, $d = 1.21$, $P < .001$. In fact, patients double their hit rate (from .28 in the Standard Condition to .56 in the Non-

analytic Condition), while their false alarm rate does not change (.28 and .25, respectively). In addition, we noted very large size effects for both patients with AD and controls. A two-way ANOVA was conducted on preference and recognition scores with Group and Task. Interestingly, the analysis revealed a significant main effect of Task, $F(1, 30) = 5.357$, $P = .02$, with more effective old-new discrimination in recognition than in preference, but there was no interaction nor was there a main effect of Group ($Ps > .1$). Thus, the false non-analytic recognition instruction seems to rule out the implicit/explicit dissociation observed with the mere exposure effect and recognition in the Standard Condition.

Analytic Condition

Regarding preference, AD patients selected distracters and targets equally often, $t(15) = 1.533$, $d = .38$, $P = .14$ (i.e., no significant mere exposure effect). Conversely, controls judged old objects to be pleasant more often than distracters, $t(15) = 2,972$, $d = 69$, $P = .01$. Regarding recognition, patients with AD performed at the chance level, $t(15) = 1.002$, $d = .25$, $P = .33$, but the effect was significant for controls, $t(15) = 9.585$, $d = 1.51$, $P < .001$. An ANOVA on computed scores revealed a significant interaction, $F(1, 30) = 14.122$, $P < .001$; a main effect of Group, $F(1, 30) = 16.919$, $P <.001$, with an advantage for controls; and a main effect of task, $F(1, 30) = 7.754$, $P = .009$, with better old-new discrimination in recognition than in preference judgments. The interaction indicates that the analytic instructions have a deleterious effect, especially on recognition scores in patients with AD in comparison to controls. Indeed, planned comparisons indicated no significant Group difference for preference scores, $F(1, 30) = .179$, $P = .68$, despite a significant Group difference for recognition scores, $F(1, 30) = 35.582$, $P < .001$.

Discussion

In this study, we first replicated our previous findings (Willems et al., 2002; see also Winograd et al., 1999) regarding the preservation of the mere exposure effect in AD in the

presence of chance-level recognition. These findings match those of a considerable number of studies that have found a dissociation between perceptual priming and explicit recognition memory in patients with AD (for reviews, see Fleischman & Gabrieli, 1998; Meiran & Jelicic, 1995) but also of the many experiments that have observed a dissociation between a robust mere exposure effect for stimuli presented so briefly at study that they were not recognized by normal young participants on a subsequent memory test (e.g., Kunst-Wilson & Zajonc, 1980; Mandler et al., 1987; Seamon et al., 1983a, 1983b). Together, these data could suggest that recognition and the mere exposure effect (possibly with other perceptual priming effects) are subserved by functionally and anatomically separable memory systems.

Nevertheless, we investigated another possible explanation of this dissociation (Whittlesea & Price, 2001) by exploring the impact of the processing strategy adopted by patients with AD in the preference and recognition conditions. In this context, we have shown that participants in preference and recognition tasks may adopt different decision strategies that determine the precise way in which earlier encounters with stimuli influence current performance. We propose that, in the preference task, by default, participants generally adopt a non-analytic strategy whereby processing fluency is experienced and is attributed to pleasantness (producing a mere exposure effect, Whittlesea & Price, 2001). On the other hand, we assume that, in the recognition task, they preferentially choose an analytic strategy in which the stimulus is analyzed into components.

We acquired direct experimental evidence of the fundamental role these strategies play in the performance of patients with AD by giving participants analytic or non-analytic instructions. With non-analytic recognition instructions that falsely informed them that they had never seen any of the test objects but that some objects would resemble a training object, patients with AD performed above chance level on the explicit recognition task. Moreover, in this condition, we

found an effect of previous exposure on recognition decisions of similar amplitude for patients and healthy controls. In other words, we did not observe any implicit/explicit memory dissociations.

In another condition, an analytic strategy was prompted with preference and recognition instructions similar to the non-analytic instructions (i.e., global similarity judgment) but participants were also asked to justify their decisions by pointing to the object part that they thought to be particularly similar or pleasant. In this last condition, we found a relatively similar tendency on both tasks, with a striking decline in AD patients' performance. Indeed, the patients performed at chance on both tasks and performed significantly worse than controls on the recognition task. The similarity of the recognition results in the Analytic and Standard conditions and the difference between the recognition results in the Standard and Non-analytic conditions indicate that patients with AD approached the recognition task with the same strategy in the Standard and the Analytic condition, spontaneously processing test stimuli analytically in the hope of detecting some distinctive feature that they could recognize. The Non-analytic condition demonstrates that absence of recognition is not a necessary consequence of an impairment of all the memory processes underlying recognition performance; instead, it is the result of the adoption of an inefficient approach for performing the task.

In conclusion, the dissociation between the intact mere exposure effect and impaired recognition in AD does not necessarily result from different forms of memory representation, but could well be the consequence of two different kinds of processing. We hypothesized that, due to some knowledge of their memory impairments, patients with AD would be likely to perceive recognition memory tasks as a real challenge, for example, when the material to be encoded is unfamiliar (e.g., unfamiliar faces, Willems et al., 2002; unfamiliar three-dimensional objects, in the present study), encoding opportunities are minimal (e.g., brief presentation and incidental

encoding instructions), and test stimuli are perceptually similar and belong to a single category (e.g., black-and-white photographs of young men from which contextual features have been removed, Willems et al., 2002; black-and-white drawings of unreal three-dimensional objects of the same size and complexity, in the present study). Nevertheless, further studies are required to clarify the links between the self-knowledge of progressively impaired memory capacities and the particular memory approach used in recognition tasks. In order to directly establish such links, the confidence level could be directly measured during the recognition task.

The improvement in recognition performance for patients with AD moving from the standard recognition condition to the non-analytic condition is striking. This has implications for both assessment and revalidation of memory performance. Indeed, an unfavorable analytic approach might be adopted by AD patients undergoing clinical memory assessment, given that these tests often involve very homogenized material (e.g., words of similar length and verbal frequency). This procedural characteristic may induce a feeling of being challenged in patients with AD, who might therefore adopt an analytic strategy in the forlorn hope of discovering some distinctive feature that they could recognize. However, that is exactly the wrong approach to take, because, given their poor memory, they are unlikely to have encoded any specific details. Thus, it could be interesting to explore the effect of induction of a holistic strategy by instruction during neuropsychological tests in order to investigate whether the standard tests underestimate the performance of patients with AD. In the same way, further studies could investigate the effect of this processing mode on everyday memory activities.

Nevertheless, it is important to emphasize that this improvement in the non-analytic condition was limited. We noted that patients with AD doubled their hit rate, while their false alarm rate did not change. However, the ratio of false positives/hits remained higher than for controls. In addition, we did not observe any similar improvement in control participants. We

suggest that a non-analytic approach based on the feeling of familiarity is probably less trustworthy than an analytic strategy. Given the similarity of the material, the difference in fluency when processing the various stimuli and the consequent differences in the feelings of familiarity might be limited. When test stimuli resemble each other, the feeling of familiarity is a weak discriminator. In contrast, the analytic mode leads to the recovery of encoded details of the original encounter. Thus, the success of recognition depends on the amount of details encoded. Two seconds of presentation at the study phase was probably enough for the encoding of some details by the control participants but not by patients with AD. In this context, analytic recognition might be superior, but only for controls.

Finally, further studies could investigate the various strategies that patients with severe memory impairment (e.g., amnesic patients with lesions of the medial temporal lobe) may use in different experimental paradigms. Indeed, some amnesic patients "remember" that they cannot remember (Klein & Kihlstrom, 1998; Klein, Loftus, & Kihlstrom, 1996), so an interesting question is whether this self-knowledge of amnesia may modulate the processing approach used by amnesic patients confronted with an explicit recognition task or an indirect memory task. Another interesting question concerns the replication of this study with other kinds of material and other implicit memory tasks, in order to determine whether we can generalize our results to other implicit/explicit memory dissociations.

References

Arnold, S. E., Hyman, B. T., Flory, J., Damasio, A. R., & Van Hoesen, G. W. (1991). The topographical and neuroanatomical distribution of neurofibrillary tangles and neuritic plaques in the cerebral cortex of patients with Alzheimer's disease. *Cerebral Cortex, 1,* 103–116.

Balota, D. A., Burgess, G., Cortese, M. J., & Adams, D. A. (2002). Memory for the infrequent in young, old, and early stage Alzheimer's disease: Evidence for two processes in episodic recognition performance. *Journal of Memory and Language, 46,* 199–226.

Bonnano, G. A., & Stilling, N. A. (1986). Preference, familiarity and recognition after repeated brief exposures to random geometric shapes. *American Journal of Psychology, 99*, 403–415.

Bornstein, R. F., & D'Agostino, P. R. (1994). The attribution and discounting of perceptual fluency: Preliminary tests of a perceptual fluency/attributional model of the mere exposure effect. *Social Cognition, 12*, 103–128.

Budson, A. E., Desikan, R., Daffner, K. R., & Schacter, D. L. (2000). When false recognition is unopposed by true recognition: Gist-based memory distortion in Alzheimer's disease. *Neuropsychology, 14,* 277–287.

Butler, L. T., & Berry, D. (2004). Understanding the relationship between repetition priming and mere exposure. *British Journal of Psychology*, *95*, 467–487.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Cohen, N. J., & Squire, L. R. (1980). Preserved learning and retention of pattern analyzing skill in amnesia: Dissociation of knowing how and knowing that. *Science, 210*, 207–210.

Derouesné, C., Thibault, S., Lagha-Pierucci, S., Baudouin-Madec, V., Ancri, D., & Lacomblez,

L. (1999). Decreased awareness of cognitive deficits in patients with mild dementia of the Alzheimer type. *International Journal of Geriatry and Psychiatry, 14,* 1019–1030.

Fleischman, D. A., & Gabrieli, J. D. E. (1998). Repetition priming in normal aging and Alzheimer's disease: A review of findings and theories. *Psychology and Aging, 13*, 88–119.

Folstein, M., Folstein, S., & McHugh, P. R. (1975). Mini-mental state: A practical method for grading the cognitive state of patients for clinician. *Journal of Psychiatric Research, 12*, 189–198.

Gallo, D. A., Sullivan, A. L., Daffner, K. R., Schacter, D. L., & Budson, A. E. (2004). Associative recognition in Alzheimer's disease: Evidence for impaired recall-to-reject. *Neuropsychology*, *18*, 556–563.

Graf, P., & Schacter, D. L. (1985). Implicit and explicit memory for new associations in normal and amnesic subjects. *Journal of Experimental Psychology: Learning, Memory and Cognition, 11*, 501–518.

Jacoby, L. L., & Dallas, M. (1981). On the relationship between autobiographical memory and perceptual learning. *Journal of Experimental Psychology: General, 110,* 306–340.

Jacoby, L. L., & Whitehouse, K. (1989). An illusion of memory: False recognition influenced by unconscious perception. *Journal of Experimental Psychology: General, 118*, 126–135.

Jones, B. C., Little, A. C., & Perrett, D. I. (2003). Why are symmetrical faces attractive? In S. P. Shohov (Ed.), *Advances in psychology research, Vol. 19.* (pp. 145–166). Hauppauge, NY: Nova Science Publishers, Inc.

Kelley, C. M., & Jacoby, L. L. (2000). Recollection and familiarity: Process-dissociation. In F. I. M. Craik and E. Tulving (Eds.), *The Oxford handbook of memory* (pp. 215–228). London: Oxford University Press.

Klein, S. B., & Kihlstrom, J. F. (1998). On bridging the gap between social-personality psychology and neuropsychology. *Personality and Social Psychology Review, 2*, 228–242.

Klein, S. B., Loftus, J., & Kihlstrom, J. F. (1996). Self-knowledge of an amnesic patient: Toward a neuropsychology of personality and social psychology. *Journal of Experimental Psychology: General, 125*, 250–260.

Knight, R. G. (1998). Controlled and automatic memory process in Alzheimer's disease. *Cortex, 34,* 427–435.

Koivisto, M., Portin, R., Seinela, A., & Rinne, J. (1998). Automatic influences of memory in Alzheimer's disease. *Cortex*, *34*, 209–219.

Kunst-Wilson, W. R., & Zajonc, R. B. (1980). Affective discrimination of stimuli that cannot be recognized. *Science, 207*, 557–558.

Lombardo, S. (1991). Event and decay of the aesthetic experience. *Empirical Studies of the Arts, 9*, 123–141.

Mandler, G., Nakamura, Y., & Van Zandt, B. J. (1987). Nonspecific effects of exposure to stimuli that cannot be recognized. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13*, 646–648.

Martin, A. (1990). Neuropsychology of Alzheimer's disease: The case for subgroups. In M. F. Schwartz (Ed.), *Modular deficits in Alzheimer-type dementia* (pp. 143–175). Cambridge, MA: MIT Press.

Mattis, S. (1973). *Dementia Rating Scale*. Windsor, ON: NFER-Nelson.

McKhann, G., Drachman, D., Folstein, M., Katzman, R., Price, D., & Stadlan, E. M. (1984). Clinical diagnosis of Alzheimer's disease: Report of the NINCDS-ADRDA work group under the auspices of department of health and human services task force on Alzheimer's

disease. *Neurology, 34*, 939–944.

Meiran, N., & Jelicic, M. (1995). Implicit memory in Alzheimer's disease: A meta-analysis. *Neuropsychology, 9,* 291–303.

Monsch, A. U., Bondi, M. W., Salmon, D. P., Butters, N., Thal, L. J., Hansen, L. A., et al. (1995). Clinical validity of the Mattis dementia rating scale in detecting dementia of the Alzheimer type. *Archives of Neurology, 52*, 899–904.

Pietrini, P., Furey, M. L., Alexander, G. E., Mentis, M. J., Dani, A., Guazzelli, M., et al. (1999). Association between brain functional failure and dementia severity in Alzheimer's disease: Resting versus stimulation PET study. *American Journal of Psychiatry, 156,* 470–473.

Rajaram, S. (1993). Remembering and knowing: Two means of access to the personal past. *Memory and Cognition, 21*, 89–102.

Rhodes, G., Sumich, A., & Byatt, G. (1999). Are average facial configurations attractive only because of their symmetry? *Psychological Science, 10*, 52–58.

Salmon, E., Perani, D., Herholz, K., Marique, P., Kalbe, E., Holthoff, V., Delbeuck, X., Beuthien-Baumann, B., Pelati, O., Lespagnard, S., Collette, F., & Garraux, G. (2006). Neural correlates of anosognosia for cognitive impairment in Alzheimer's disease. *Human Brain Mapping, 27*, 588–597.

Schacter, D. L., Cooper, L. A., & Delaney, S. M. (1990). Implicit memory for unfamiliar objects depends on access to structural descriptions. *Journal of Experimental Psychology: General, 119*, 5–24.

Seamon, J. G., Brody, N., & Kauff, D. M. (1983a). Affective discrimination of stimuli that are not recognized: Effects of shadowing, masking, and cerebral laterality. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 9*, 544–555.

Seamon, J. G., Brody, N., & Kauff, D. M. (1983b). Affective discrimination of stimuli that are not recognized II: Effects of delay between study and test. *Bulletin of the Psychonomic Society, 21*, 187–189.

Seamon, J. G., Williams, P. C., Crowley, M. J., Kim, I. J., Langer, S. A., Orne, P. J. (1995). The mere exposure effect is based on implicit memory: Effects of stimulus type, encoding conditions, and number of exposures on recognition and affect judgments. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 711–721.

Smith, J. A., & Knight, R. G. (2002). Memory processing in Alzheimer's disease. *Neuropsychologia*, *46*, 666–682.

Squire, L. R. (1992). Memory and the hippocampus: A synthesis from findings with rats, monkeys, and humans. *Psychological Review, 99*, 195–231.

Stark, C. E. L., & Squire, L. R. (2000). Recognition memory and familiarity judgments in severe amnesia: No evidence for a contribution of repetition priming. *Behavioral Neuroscience, 114*, 459–467.

Tulving, E., & Schacter, D. L. (1990). Priming and human memory systems. *Science, 247,* 301–306.

Wagner, A. D., & Gabrieli, J. D. E. (1998). On the relationship between recognition familiarity and perceptual fluency: Evidence for distinct mnemonic processes. *Acta Psychologica, 98*, 211–230.

Wagner, A. D., Gabrieli, J. D. E., & Verfaellie, M. (1997). Dissociations between familiarity processes in explicit recognition and implicit perceptual memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23*, 305–323.

Westerman, D. L. (2001). The role of familiarity in item recognition, associative recognition, and plurality recognition on self-paced and speeded tests. *Journal of Experimental*

Psychology: Learning, Memory, and Cognition, 27, 723–732.

Whittlesea, B. W. A. (1993). Illusions of familiarity. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19,* 1235–1253.

Whittlesea, B. W., & Price, J. R. (2001). Implicit/explicit memory versus analytic/nonanalytic processing: Rethinking the mere exposure effect. *Memory and Cognition, 29*, 234–246.

Whittlesea, B. W. A., & Williams, L. D. (1998). Why do strangers feel familiar, but friends don't? A discrepancy-attribution account of feelings of familiarity. *Acta Psychologica, 98*, 141–165.

Whittlesea, B. W. A., & Williams, L. D. (2000). The source of feelings of familiarity: The discrepancy-attribution hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26*, 547–565.

Whittlesea, B. W. A., & Williams, L. D. (2001a). The discrepancy-attribution hypothesis I: The heuristic basis of feelings and familiarity. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 27*, 3–13.

Whittlesea, B. W. A., & Williams, L. D. (2001b). The discrepancy attribution hypothesis II: Expectation, uncertainty, surprise, and feelings of familiarity. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 27*, 14–33.

Willems, S., Adam, S., & Van der Linden, M. (2002). Normal mere exposure effect with impaired recognition in Alzheimer's disease. *Cortex, 38*, 77–86.

Willems, S., & Van der Linden, M. (2006). Mere exposure effect: Consequence of direct and indirect fluency-preference links. *Consciousness and Cognition, 15*, 323–341.

Williams, P., & Tarr, M. J. (1997). Structural processing and implicit memory for possible and impossible figures. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23*, 1344–1361.

Williams, P., & Tarr, M. J. (1999). Orientation-specific possibility priming for novel three-dimensional objects. *Perception and Psychophysics, 61, 5*, 963–976.

Winograd, E., Goldstein, F. C., Monarch, E. S., Peluso, J. P., & Goldman, W. P. (1999). The mere exposure effect in patients with Alzheimer's disease. *Neuropsychology, 13*, 41–46.

Wolk, D. A., Schacter, D. L., Berman, A. R., Holcomb, P. J., Daffner, K. R., & Budson, A. E. (2005). Patients with Alzheimer's disease attribute conceptual fluency to prior experience. *Neuropsychologia, 43,* 1662–1672.

Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language, 46,* 441–517.

Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology: Monograph Supplement, 9*, 1–27.

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Table 1.

Participants Characteristics

	AD patients	Controls	t(30)
Female	13	13	
Male	3	3	
Age (years)			
M	80.7	82.3	–0.52
SD	7.8	6.5	
Education (years)			
M	8.5	8.9	0.64
SD	2.8	3.1	
DRS			
M	114.2	141.7	7.01*
SD	5.7	2.6	
MMSE			
M	21.1	29.2	7.26*
SD	2.2	0.7	

Notes. For both groups, $N = 16$; Mean (M) and standard deviation (SD); DRS = Mattis Dementia Rating Scale (Mattis, 1973); MMSE = Mini-Mental State Examination (Folstein et al., 1975); AD = Alzheimer's disease. *$P < .001$

Table 2.

Preference and Recognition Scores

Condition	AD patients			Controls		
	Hit	FA	*d*	Hit	FA	*d*
Standard						
Standard Recognition	.28 (.22)	.28 (.27)	.02	.82 (.16)	.25 (.12)	1.41**
Standard Preference	.66 (.26)	.42 (.26)	.67*	.59 (.20)	.36 (.13)	.83**
Non-analytic						
Non-analytic Recognition	.56 (.21)	.25 (.19)	1.01**	.82 (.12)	.39 (.16)	1.21**
Standard Preference	.61 (.16)	.33 (.21)	.82**	.57 (.23)	.34 (.27)	.70*
Analytic						
Analytic Recognition	.36 (.27)	.30 (.26)	.25	.84 (.23)	.34 (.16)	1.51*
Analytic Preference	.56 (.30)	.46 (.28)	.38	.41 (.19)	.27 (.14)	.69**

Notes. Values are proportions of "like" or "old" responses for old objects (Hit) and distracters (FA). All values are given with the standard deviation of the mean (SD). Effect sizes (*d*) of t-tests are provided with reference to the classification of effect sizes proposed by Cohen (1988): small $d = 0.20$, medium $d = .50$ and large $d = 0.80$. Statistically significant tests are indicated: * $P < .01$, ** $P < .001$.

Figure Titles

Figure 1. Examples of line drawings of unfamiliar three-dimensional objects

Figure 1