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Preserved conceptual implicit memory for pictures in patients with Alzheimer's disease

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Abstract

The current study examined different aspects of conceptual implicit memory in patients with mild Alzheimer's disease (AD). Specifically, we were interested in whether priming of distinctive conceptual features versus general semantic information related to pictures and words would differ for the mild AD patients and healthy older adults. In this study, 14 healthy older adults and 15 patients with mild AD studied both pictures and words followed by an implicit test section, where they were asked about distinctive conceptual or general semantic information related to the items they had previously studied (or novel items) Healthy older adults and patients with mild AD showed both conceptual priming and the picture superiority effect, but the AD patients only showed these effects for the questions focused on the distinctive conceptual information. We found that patients with mild AD showed intact conceptual picture priming in a task that required generating a response (answer) from a cue (question) for cues that focused on distinctive conceptual information. This experiment has helped improve our understanding of both the picture superiority effect and conceptual implicit memory in patients with mild AD in that these findings support the notion that conceptual implicit memory might potentially help to drive familiarity-based recognition in the face of impaired recollection in patients with mild AD.

Keywords

conceptual implicit memory; picture superiority effect; familiarity; Alzheimer's disease

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1. Introduction

Recent work has been directed at understanding which aspects of memory remain intact in patients with Alzheimer's disease (AD), with the intention of developing interventions that focus on using these intact processes to help improve the daily lives of these patients. While perceptual implicit memory seems to be relatively intact in patients with AD (Park et al., 1998; Fleischman, Wilson, Gabrieli, Schneider, Bienias, & Bennett, 2005), prior studies of conceptual implicit memory in patients with AD have been largely mixed (Gong, Tian, Cheng, Chen, Yin, Meng, et al., 2010; Fleischman et al., 2005; Fleischman, 2007). In general, tasks that require patients to utilize a cue to generate or produce a response often find impaired conceptual implicit memory, while tasks that require patients to identify previously presented stimuli often report intact conceptual implicit memory (Martins & Lloyd-Jones, 2006). However, there has been little investigation into memory for different types of conceptual information to see whether further breaking down the type of stimuli could determine more precisely what type of processing is preserved and impaired.

Several studies have suggested that there might be an important task-dependent aspect to conceptual processing tasks (Grondin, Lupker, & McRae, 2009; Taylor, Devereux, Acres, Randall, & Tyler, 2012). Taylor and colleagues have investigated the contribution of two different types of features to conceptual processing. They found that shared features facilitate identification of an item at a category level (e.g., "has four legs" facilitates a living/nonliving decision) whereas distinctive features facilitate identification of an item at a basic level (e.g., "long neck" facilitates giraffe). This distinction might be important to understanding the processes preserved and impaired in conceptual implicit memory in patients with mild AD.

Hamilton and Geraci (2006) proposed that the type of conceptual processing tested might be critical for examining conceptual implicit memory. Many studies have suggested that pictures are better remembered than words as a result of deeper and more elaborate conceptual processing than words (Nelson, 1979; Nelson, Reed, & Walling, 1976; Paivio, 1971; Weldon & Roediger, 1987; Weldon, Roediger, & Challis, 1989; but see Mintzer & Snodgrass, 1999). This picture superiority effect is also found in patients with amnestic mild cognitive impairment (aMCI) and AD in explicit recognition tasks (Ally, 2012; Ally, Gold & Budson, 2009; Ally, McKeever, Waring, & Budson 2009; Beth, Waring, Budson, & Ally, 2009; Deason, Hussey, Budson, & Ally, 2012; Embree, Budson, & Ally, 2012; O'Connor & Ally, 2010). Pictures may allow for greater activation of related concepts or may allow for deeper, more elaborate processing of conceptual features. For example, if a person is presented with the word "giraffe", they might activate the feature of long neck. But if they are presented with a picture of giraffe, the picture might spur activation of additional concepts such as "has spots", "vegetarian", "jungle", and "my daughter had a stuffed giraffe she carried around when she was young." The deeper conceptual activation that results from pictures leads to better memory performance. However these accounts would generally predict that a picture superiority effect should be found in both explicit and implicit memory tests in healthy young adults. While the benefit of pictures has been widely shown in explicit tasks, the findings using implicit memory tasks are more mixed (Hamilton & Geraci, 2006; Stenberg, 2006; Vaidya & Gabrieli, 2000; Weldon & Coyote, 1996).

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According to Hamilton and Geraci's *conceptual distinctiveness account*, the picture superiority effect results from conceptual processing of a picture's distinctive features rather than semantic information (also see Cree et al., 2006; Mirman & Magnuson, 2009). That is, pictures contain individuating characteristics that make them conceptually distinctive in memory. Hamilton and Geraci tested their conceptual distinctiveness hypothesis by using two types of conceptual implicit memory tasks. One task required subjects to simply access semantic knowledge, whereas the second task required subjects to specifically access the individuating characteristics of the picture or word. As an example, subjects studied the item "lemon" as a picture or word. The implicit test cue on the general semantic task asked, "What is a used car sometimes called?" In contrast, the implicit test cue on the distinctive conceptual information task asked, "What fruit is egg shaped?" Hamilton and Geraci reported that healthy young adult subjects demonstrated the picture superiority effect only for the implicit task assessing distinct conceptual information, providing evidence that the distinctive features of pictures provide diagnostic conceptual information that leads to superior memory.

The primary objective of the present investigation was to examine whether aspects of conceptual implicit memory might be preserved in patients with mild AD, particularly if different types of conceptual implicit memory are examined separately. To accomplish this goal, we used a modified version of Hamilton and Geraci's (2006) conceptual implicit memory paradigm. Healthy older adults and patients with mild AD studied both pictures and words followed by an implicit test section where they were queried regarding distinctive conceptual or general semantic information related to the items they had previously studied (or novel items). Participants then performed a short recognition test to see whether the more typical picture superiority effect in explicit recognition could also be demonstrated. Conceptual priming was measured when participants responded with items *that* had been previously studied more often than with unstudied items. If participants responded with previously encoded items more often when they had been studied as pictures rather than words, this demonstrated an implicit conceptual picture superiority effect. *According to the prior results of* Hamilton and Geraci (2006), *we predicted there would be conceptual priming and a picture superiority effect shown for the distinctive conceptual focused questions but not for the questions focused on more general semantic information for healthy older adults. While patients with mild AD have shown a preserved picture superiority effect in explicit recognition, there have been mixed results when examining conceptual implicit memory in this group. Often when patients as asked to generate a response, performance on conceptual implicit memory tasks is impaired. Potentially by examining different types of conceptual priming in the current experiment, we will learn more precisely what is preserved and impaired in mild AD.*

2. Methods

2.1 Participants

Fourteen healthy older adults (8 female/6 male, 5 run in Boston) with a mean age of 74.57 (range = 62–85) and education level of 15.36 years participated in this study. Fifteen patients with a clinical diagnosis of very mild AD (7 female/8 male, 11 run in Boston) with

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a mean age range of 76.27 (range = 63–85) and education level of 15.20 years participated in this study. Patients were recruited from the Vanderbilt University Cognitive Disorders Clinic and the Boston University Alzheimer's Disease Center (BU ADC). *Patients were each assessed by a neurologist and neuropsychologist in one of the Vanderbilt or Boston University clinics, and met criteria for mild AD described by the National Institute on Ageing and Alzheimer's Association workgroup criteria* (McKhann et al., 2011). Healthy older adults were recruited through online and community postings in Boston, MA and Nashville, TN and through online postings on the Vanderbilt University ResearchMatch.org website. Participants were excluded if they had a history of psychiatric illness, alcoholism, head injury, stroke, or diagnosed with another neurodegenerative disorder (e.g. Parkinson's disease). All participants had corrected to normal vision and were native English speakers. This study was approved by the Behavioral Science Committee of the IRB at Vanderbilt University, Nashville, TN and the Human Subjects committee at the Edith Nourse Rogers Memorial Veterans Hospital, Bedford, MA, Boston University, Boston, MA, and VA Boston Healthcare System, Boston, MA. Written informed consent was obtained from all participants and their caregivers, when appropriate. Participants were paid $10/hr for their time.

In order to evaluate current cognitive functioning, all participants completed a brief neuropsychological battery, which included the Mini Mental Status Exam (MMSE; Folstein, Folstein, & McHugh, 1975), the word list memory test from the Consortium to Establish a Registry for Alzheimer's Disease (CERAD; Morris et al., 1989), Trail Making Test Part A and B (Adjunct General's Office, 1944), Verbal Fluency to letters and categories (Monsch et al., 1992), and the 15-item Boston Naming Test (Mack et al., 1992). Table 1 details demographic and neuropsychological information for all participants.

2.2 Materials

The stimuli used in this study were the same as those used in Hamilton and Geraci's (2006) study. The stimuli were 80 pictures taken from the original Snodgrass-Vanderwart (1980) pictures and had a mean picture-label agreement of 93%. Each picture was associated with two questions: a question that probed its distinctive conceptual characteristics and a question that probed its semantic or categorical characteristics. The 80 pictures were divided into four lists of 20 items so as to allow for participants to study 20 items as words, 20 items pictures and the remaining 40 items from the remaining 2 lists to be used as novel items during the test phase. All items were counterbalanced throughout the experiment so that all items appeared as either a word or a picture and so that the distinctive conceptual characteristic questions and the semantic or categorical characteristic questions were asked about each item in each format (i.e., when it was studied as a word and as a picture). The novel test questions were also counterbalanced so that either type of question was presented.

2.3 Procedure

During the study phase, participants saw 40 items: 20 items presented as words and 20 items presented as pictures. The items were randomly inter-mixed and remained on the screen for a total of 3000 ms. Participants were instructed that they would see a series of both words and pictures presented on the screen one at a time. They were told that their

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memory for these items would be tested later on in the experiment. For words, participants were asked to read them silently and to try to remember them for later. For pictures, participants were asked to look at the picture carefully, silently name them, and try to remember them for later.

Once participants completed the study phase, a screen appeared which asked the participant if s/he would mind helping us in setting up another experiment by answering some questions for us. Using a strategy similar to one used by Hamilton and Geraci (2006), the experimenter would explain to the participant that if we gave them the memory test right away, they would do too well on it. Participants were told that a question would appear on the screen. Once the participant had an answer to the question, s/he was asked to press the space bar and to then tell the experimenter his/her answer. In order to orient participants to this task, they were given these two example questions: "What color is a stop sign?" and "What color is the sky on a sunny day?" All participants saw these same two questions in the exact same order.

During the test phase, participants were asked a total of 80 questions: 20 general semantic questions (which related to 10 words and 10 pictures from the study phase), 20 distinct conceptual questions (which related to the remaining 10 words and 10 pictures from the study phase), 20 general semantic questions (which related to 20 unstudied items), and 20 distinct conceptual questions (which related to the remaining 20 unstudied items). This resulted in 40 questions related to previously studied items (half previously presented as pictures, half previously presented as words) and 40 questions related to items not previously before. Test questions remained on the screen for 20 seconds before a blank screen would appear and participants were prompted for an answer by the experimenter. If participants answered before the 20-second timeframe, the screen would advance on to a blank screen to allow time for the participant to give the experimenter his/her answer. The experimenter wrote down all answers.

Once participants had answered all 80 test questions, they were told that they would now be tested on the words and pictures that they studied earlier. Participants were instructed to respond "Old" if they saw the item before or to respond "New" if they did not remember seeing the item before. The experimenter entered all responses for patients with aMCI and AD. Participants saw 20 studied items (10 words, 10 pictures) and 20 new items (10 words, 10 pictures) on which they made these old/new judgments. They had unlimited time to make these judgments and the item remained on the screen until they responded.

3. Results

3.1 Implicit conceptual priming

To examine performance on the conceptual implicit memory test for distinct conceptual information and general semantic information related to pictures and words, we examined both priming effects and the picture superiority effect for each type of questions (see Table 2 for accuracy rates per condition). First, to analyze priming effects, accuracy for unstudied items was subtracted from accuracy for studied items to create a difference score for each condition for each participant (see Figure 1). A repeated-measures ANOVA was conducted using a between-subjects factor of group (healthy older adults versus patients with mild AD)

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and within-subjects factors of item type (pictures versus words) and question type (distinct conceptual versus general semantic) to examine these priming effects. Overall, participants showed greater priming for pictures than for words ($F(1,27) = 19.89$, $p < .001$, $\eta^2 = 0.42$), suggesting an implicit memory picture superiority effect for both groups. There was also a three way interaction between item type, question type, and group ($F(1,27) = 4.34$, $p < .05$, $\eta^2 = 0.14$). To explore this interaction, a repeated-measures ANOVA was conducted using within subjects factors of item type and question type to examine the priming effects separately for AD patients and healthy older adults. For the healthy older adults, priming effects for pictures were greater than for words with no interaction with question type ($F(1,13) = 14.05$, $p < .01$, $\eta^2 = .52$). For the patients with mild AD, there was a significant effect of item type ($F(1,14) = 6.00$, $p < .05$, $\eta^2 = .30$) and a significant interaction between item type and question type ($F(1,14) = 10.03$, $p < .01$, $\eta^2 = .42$). *Although patients with mild AD showed an overall greater priming effect for pictures, this effect was driven by the large priming effect in the distinct picture condition compared to the general semantic conditions (between distinct and general semantic picture priming: $t(14) = 2.73$, $p < .05$; between distinct picture and general word: $t(14) = 3.53$, $p < .01$) as well as between the distinct picture condition and the distinct word condition ($t(14) = 4.32$, $p < .01$).*

3.2 Picture superiority effect

For the picture superiority effect, accuracy in the word condition was subtracted from accuracy in the picture condition for both the distinct conceptual and general semantic questions to isolate the benefit of encoding pictures (see Figure 2). A repeated-measures ANOVA was conducted using a between-subjects factor of group (healthy older adults versus patients with mild AD) and a within-subjects factor of question type (distinct conceptual versus general semantic) to examine the picture superiority effects. There was an interaction between question type and group ($F(1,27) = 4.34$, $p < .05$, $\eta^2 = .14$). To explore this interaction, follow-up t-tests were conducted for each group to see whether the picture superiority effect difference score was different from zero. For healthy older adults, priming was greater for pictures than for words for both question types (distinct: $t(13) = 3.39$, $p < .01$; general: $t(13) = 2.4$, $p < .05$). For patients with mild AD, priming was greater for pictures than for words only in the distinct conceptual information questions ($t(14) = 4.32$, $p < .01$). Further, the picture superiority effect was greater in the distinct conceptual condition compared to the general semantic condition ($t(14) = 3.17$, $p < .01$) for patients, whereas for the healthy older adults, there was no significant difference in picture superiority between question types ($t < 1$).

3.3 Explicit recognition

For the recognition test, a repeated-measures ANOVA was conducted using a between-subjects factor of group (healthy older adults versus patients with mild AD) and a within-subjects factor of item type (pictures versus words) to examine differences in discrimination (PR = Hit Rate – False Alarm Rate). *Most important, pictures (PR = .82) were better remembered than words (PR = .27; $F(1,22) = 98.29$, $p < .001$, $\eta^2 = .82$). Healthy older adults performed better overall than patients with AD (PR = .64 vs PR = .45; $F(1,22) = 6.90$, $p < .05$, $\eta^2 = .24$). There was no interaction between condition and group.*

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4. Discussion

The goal of the current study was to examine different aspects of conceptual implicit memory in patients with mild AD. Specifically, we were interested in whether priming of distinctive conceptual features versus general semantic information related to pictures and words would differ for the mild AD patients and healthy older adults. To accomplish this goal, healthy older adults and patients with mild AD studied both pictures and words followed by an implicit test section, where they were queried regarding distinctive conceptual or general semantic information related to the items they had previously studied (or novel items). Conceptual priming was measured when participants responded with items *that* had been previously studied more often than with unstudied items. Healthy older adults and patients with mild AD showed both picture priming and picture superiority effects in this conceptual implicit memory paradigm. Healthy older adults showed priming effects for pictures as well as a picture superiority effect in both the distinct conceptual and general semantic question conditions. Patients with mild AD showed priming for only pictures, not words, and a picture superiority effect only for the questions that highlighted distinctive conceptual information. After participants finished the implicit test, they took an explicit recognition test as well. *As expected, healthy older adults had better overall recognition than patients with mild AD.* Both healthy older adults and patients with mild AD showed a robust picture superiority effect in the explicit recognition test in addition to the effect shown in the implicit test.

4.1 Implicit conceptual priming

The current study adds evidence that aspects of conceptual priming remain intact in these patients. Prior studies have found that generally patients with AD show impaired conceptual priming in tasks where they are asked to use a cue to generate a response (Martins & Lloyd-Jones, 2006; for a review see Fleischman, 2007). The current paradigm asked an open-ended question that could be answered by implicitly recalling a picture or word seen previously and thus was a task that required the participants to generate a response rather than select among options. Despite this open-ended task, patients with mild AD showed intact picture priming when the question focused on distinctive conceptual information. Perhaps other studies have found impaired conceptual priming when patients were asked to generate a response because the tasks used focused on more general categorical decisions rather than on distinctive conceptual information. Also, the use of pictures as stimuli seemed to play a large role, as no priming was seen for words.

4.2 Picture superiority effect

In addition to successfully demonstrating preserved conceptual priming for pictures in patients with mild AD to an implicit memory task, our findings from the patients with mild AD and healthy older adults helps to expand this picture superiority effect to conceptual implicit memory. Hamilton and Geraci (2006) proposed that the distinctive conceptual information provided by pictures drives the picture superiority effect as they only found the effect for the distinctive questions in young adults. The healthy older adults in our experiment showed a picture superiority effect for both types of questions. There were several differences in the current paradigm that may have led to these results. Unlike

Hamilton and Geraci's paradigm, we manipulated the focus of the question (whether distinct or non-distinct) within subjects rather than between subjects. We also intermixed the presentation of words and pictures in the encoding phase. Perhaps, for healthy older adults, who have relatively intact memory processing, this intermixing of questions led to them activate distinct features even when the question was more general knowledge focused. In contrast, the patients with mild AD showed a picture superiority effect only for the questions focusing on distinct conceptual information. The lack of picture superiority effect for the general semantic condition in mild AD patients may have to do with the early deterioration of semantic memory (Mickes, Wixted, Fennema-Notestine, Galasko, Bondi, Thal, & Salmon, 2007; Wierenga et al., 2011) or it might be related to the conceptual distinctiveness hypothesis (Hamilton & Geraci, 2006). Several studies in patients with AD using verbal stimuli have posited that semantic memory is disrupted due to the loss of distinctive features (Giffard, Desgranges, Nore-Mary, Lalevée, Beaunieux, la Sayette, et al., 2002; Laisney, Giffard, Belliard, la Sayette, Desgranges, & Eustache, 2011; Rogers & Friedman, 2008; Wieranga et al., 2011). These findings might have predicted that the patients would be most impaired at using distinctive conceptual information rather than more general semantic information. However, given that patients with mild AD have difficulty with generating mental images from verbal stimuli (Borg, Thomas-Anterion, Bogey, Davier, & Laurent, 2010; Hussey, Smolinsky, Piryatinsky, Budson, & Ally, 2012; Tippet, Blackwood, & Farah, 2003), these previous studies may have been limited by using only verbal stimuli. In the current study, the use of pictures may have led to a different pattern of results offering new insight into the types of conceptual information preserved in patients with mild AD. These findings suggest that patients with mild AD can still generate a response when prompted by a question implicitly referring to a previously seen picture but only when the question focused on distinctive conceptual information.

One promising target for successful rehabilitations interventions to help patients with AD and aMCI is that these patients show better memory for pictures than for words, and this benefit of pictures over words can be even greater in magnitude for patients than for healthy older adults (Ally, 2012; Ally, Gold, & Budson, 2009; Ally et al., 2009; Beth et al., 2009; Deason et al., 2012; Embree et al., 2012; O'Connor & Ally, 2010). While it is well established that the picture superiority effect is intact in these patients, the processes underlying it, and whether they are distinct from those in healthy older adults, remain unclear.

Embree, Budson, and Ally (2012) sought to determine what types of memory processes might be underlying the picture superiority effect in patients with aMCI. Dual process theories of recognition memory suggest that two independent processes contribute to accurate recognition decisions: recollection and familiarity (Yonelinas, 2002). Recollection is specific recall of an event/item that brings to mind particular details. Familiarity is a more general sense of having encountered an event or item before without recall of the context. Using a receiver operating characteristics (ROC) paradigm based on confidence judgments, Embree et al. (2012) were able to obtain separate estimates of familiarity and recollection for picture and word recognition. They found that while patients showed impaired recollection for both words and pictures compared to healthy older adults, familiarity for pictures was similar between the two groups. The results of this study suggested that in the

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face of impaired recollection, patients with aMCI rely on familiarity to support recognition of pictures over words.

However, understanding exactly how familiarity might be enhanced for pictures but not for words in patients is poorly understood. One recent study addressed this question using a category-based retrieval task (Deason et al., 2012). In this study, patients with aMCI were asked to study three exemplar pictures or words from a specific basic-level category. Instead of being tested with a studied item, test probes were a fourth exemplar from the studied category or a novel category and subjects were asked to endorse items from studied categories as “old.” On this task, patients demonstrated a picture superiority effect of greater magnitude than healthy older adults. Given that the test cues had not actually been studied, Deason et al. (2012) posited that enhanced memory for pictures is likely the result of spared conceptually based familiarity from which patients can extract and utilize the conceptual gist information provided by pictures.

4.3 Relationship between implicit conceptual priming and picture superiority effect

Interestingly, there has been limited work examining the relationship of implicit memory processes and explicit recognition. Prior work examining explicit recognition of pictures versus words in patients with aMCI and AD have suggested that intact conceptually-based familiarity might be responsible for the preserved picture superiority effect in these patients (Ally, McKeever, et al., 2009; Deason et al., 2012). The current results support the assertion that distinct conceptual information – through conceptual implicit memory – may be driving familiarity-based recognition of pictures in patients (Ally, 2012). Using ERPs to investigate the picture superiority effect in patients with MCI, Ally, McKeever et al. (2009) found that the early frontal ERP effect was intact for pictures, but not for words, in patients with aMCI when compared with healthy older adults. Ally and colleagues (2009) suggested that intact familiarity processes reflected by the frontal ERP effect was supporting the robust picture superiority effect in patients. Recently, there has been a great deal of focus on separating out the contributions of familiarity and conceptual implicit memory. Voss and colleagues (Voss & Paller, 2009; Voss, Lucas, & Paller, 2010; Voss, Reber, Mesulam, Parrish, & Paller, 2008; for a review see Voss, Lucas, & Paller, 2012) have suggested that the early frontal ERP effect may reflect conceptual implicit memory processes rather than familiarity. They suggest that implicit memory may contribute more to explicit memory than we have been able to measure. Although we cannot be certain that the intact early frontal ERP effect in patients reflects intact conceptual implicit memory or intact memorial familiarity, the results of the current work certainly support the notion that conceptual implicit memory likely helps to drive familiarity-based recognition in the face of impaired recollection in patients with mild AD (Ally, 2012).

This experiment has helped improve our understanding of both conceptual implicit memory and the picture superiority effect in patients with mild AD. We found that patients with mild AD showed intact conceptual picture priming in a task that required generating a response (answer) from a cue (question) for cues that focused on distinctive conceptual information. Ultimately, better understanding the mechanisms of the picture superiority effect can help aid in the development of successful picture-based strategies for improving daily memory functioning. For example, learning techniques, such as errorless learning (which has shown modest benefit using words), can use pictures and be tailored to emphasize the distinctive conceptual details of the picture, since the results of this study suggest that might be more helpful than general semantic information.

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Highlights

- We examined different aspects of conceptual implicit memory in patients with mild AD.
- We examined priming differences for distinctive conceptual vs. general semantic cues.
- All participants showed conceptual priming and picture superiority for distinctive cues.
- Only healthy older adults showed these effects for general semantic cues.

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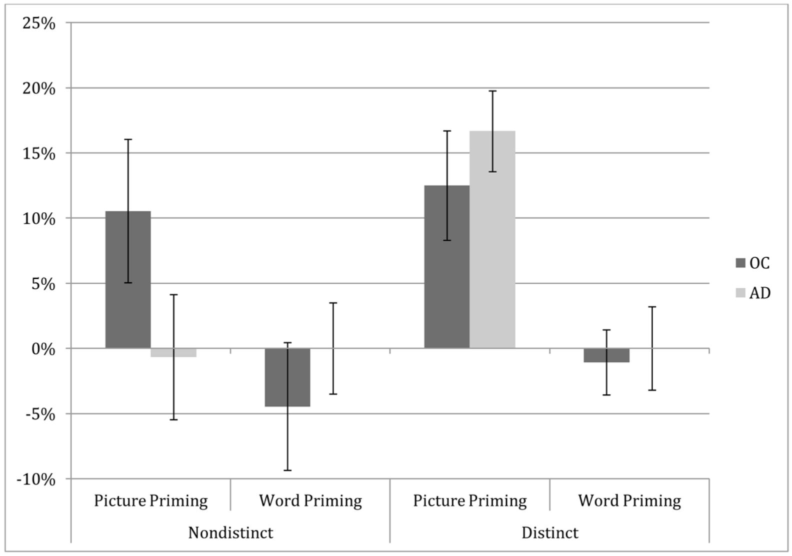

Figure 1.

Priming effects. Represented as the percent of priming benefit based on whether cue types were distinct conceptual or nondistinct general semantic for pictures and words. *(OC = healthy older controls; AD = mild AD patients)*

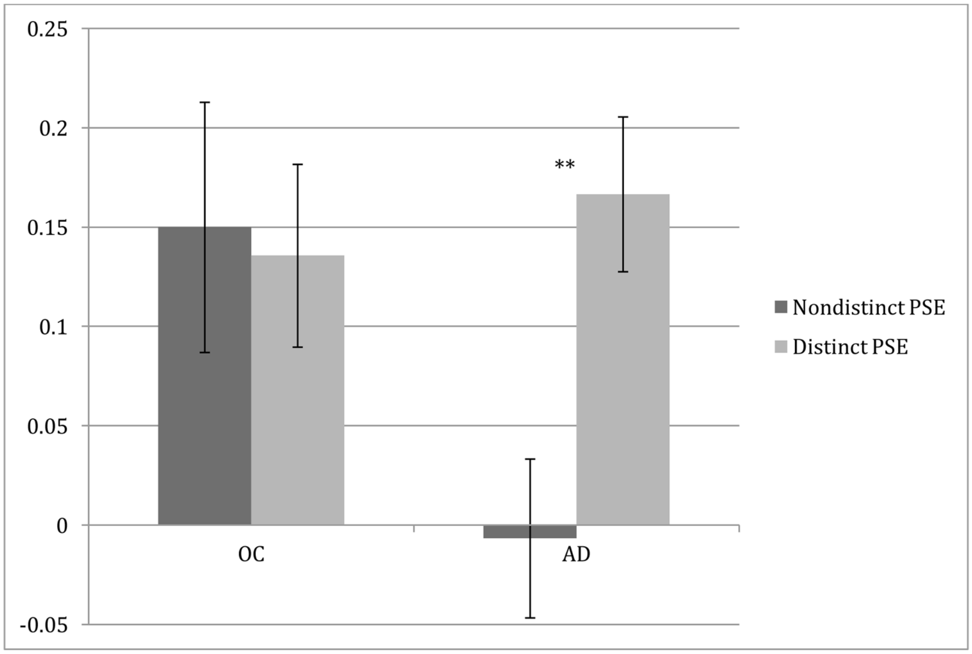

Figure 2.
Picture superiority effects *(PSE)*. Represented as the percentage of time that pictures were correctly recalled more than words for the distinct conceptual or nondistinct general semantic conditions. *(OC = healthy older controls; AD = mild AD patients; ** p < .01)*

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Table 1

Demographic and neuropsychological data.

Test	Healthy Older Adults Mean (SD)	Patients Mean (SD)
Age	74.6 (7.49)	76.3 (6.86)
Years of Education	15.4 (2.06)	15.2 (2.54)
MMSE	29.3 (0.73)	25.9 (3.16) *
CERAD		
Immediate	21.4 (3.56)	14.5 (4.34) *
Delayed	7.1 (1.66)	2.5 (2.20) *
Recognition	9.9 (0.27)	7.47 (2.56) *
Trails-B	74.8 (21.71)	209.8 (92.28) *
FAS	46.3 (13.67)	37.2 (12.7)
CAT	48.2 (8.16)	29.3 (11.1) *
BNT-15	14.4 (0.74)	13.0 (1.36) *

* indicates a significant difference ($p < .05$) between the healthy older adults and the patients with mild AD.

Table 2

Accuracy for each question type *for healthy older controls (OC) and mild AD patients (AD;* standard deviation in parenthesis).

	General Semantic			Distinct Conceptual		
	Pictures	**Words**	**Unstudied**	**Pictures**	**Words**	**Unstudied**
OC	55% (12.9)	40% (17.5)	44% (11.1)	54% (12.8)	40% (8.8)	41% (9.0)
AD	31% (15.0)	31% (15.5)	31% (13.8)	47% (15.4)	30% (10.0)	30% (7.8)

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