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False item recognition in patients with Alzheimer's disease

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ABSTRACT

Recent evidence suggests that patients with Alzheimer's disease (AD), as compared with normal individuals, exhibit increased false recognition by stimulus repetition in the Deese–Roediger–McDermott (DRM) task or associative recognition memory tasks, probably due to impaired recollection-based monitoring. However, because of possible alternative explanations for the findings of these previous studies, the evidence for impaired recollection-based monitoring in AD patients remains inconclusive. In this study, we employed stimulus repetition in old/new recognition judgments of single-item picture memory without a factor of association between the stimuli and examined whether AD patients showed increased false item recognition as compared with healthy controls. AD patients and healthy controls studied single-item pictures presented either once or three times. They were later asked to make an old/new recognition judgment in response to (a) Same pictures, pictures identical to those seen at encoding, (b) Similar lures, novel pictures similar to but not identical to those seen at encoding, and (c) Dissimilar lures, novel pictures not similar to those seen at encoding. For Same pictures, repeated presentation of stimuli increased the proportion of "old" responses in both groups. For Similar lures, repeated presentation of stimuli increased the rate of "old" responses in AD patients but not in control subjects. The results of the present study clearly demonstrated elevated false recognition by stimulus repetition in single-item recognition in AD patients. The present findings strongly support the view that AD patients are impaired in their ability to use item-specific recollection in order to avoid false recognition.

1. Introduction

One of the more prominent cognitive problems observed in Alzheimer's disease (AD) is the decline in episodic memory (Salmon and Bondi, 2009), the type of memory that allows one to remember past occurrences in one's life (Tulving, 2001). The episodic memory impairments observed in AD patients are mainly characterized by the failure to retrieve desired information, but at times, AD patients also suffer from memory distortion. The memory distortion in AD patients can sometimes be extreme, as in syndromes of delusional misidentification (e.g., Abe et al., 2007; for review, see Forstl et al., 1994). Therefore, an understanding of memory distortion in AD patients is clinically important; however, the underlying mechanisms remain to be fully elucidated.

One approach to evaluating memory distortion is assessment of false recognition in cognitive memory tasks. False recognition is a process whereby people incorrectly claim that they have recently seen or heard a stimulus that they have not actually encountered (Underwood, 1965). One of the most common tasks for assessment of false recognition is the Deese–Roediger–McDermott (DRM) task (Deese, 1959; Roediger and McDermott, 1995; for review, see Gallo, 2010) in which false recognition of non-studied lures is elicited by having subjects study lists of associates. For example, using a modified version of the DRM paradigm in which study and test trials were repeated five times, Budson, Daffner, Desikan, & Schacter (2000) reported that false recognition increased in AD patients, decreased in young adults, and fluctuated in older adults.

The findings of Budson et al. (2000) can be interpreted as indicating that impaired retrieval monitoring processes in AD patients would cause memory distortion (Schacter, Norman, & Koutstaal, 1998a). More specifically, recall-to-reject processes, where recall (or recollection) opposes familiarity in recognition memory tasks (see Yonelinas, 2002), might be impaired in AD patients. Here, "recall" refers to the ability to retrieve previously experienced information in response to some retrieval cue, and recollection is defined as the mental reinstatement of experienced events during which unique details of memory are recalled. Familiarity is a mental awareness that an event has been experienced previously without the unique details or mental reinstatement of the event (Gardiner,

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1988; Jacoby, 1991; Mandler, 1980; Skinner and Fernandes, 2007). In the study of Budson et al. (2000), owing to the multiple study/test sessions, control subjects may have increased their recollection of the studied items, determined that the related lures were not presented, and hence rejected these lures as non-studied items. AD patients might be unable to use such a recollection-based monitoring process to reduce false recognition. In line with this idea, some previous studies have reported that AD patients have impaired recall or recollection relative to familiarity. For instance, Bartok et al. (1997) reported that AD patients tend to be impaired more in recall than in recognition tests. Dalla Barba (1997) showed that recollection-based recognition is more affected than familiarity-based recognition in AD patients. These findings suggest that AD patients perform poorly on tasks in which recall or recollection is necessary to oppose familiarity-based false recognition.

However, as Gallo, Sullivan, Daffner, Schacter, & Budson (2004) have pointed out, there are other possible explanations, such as impairment of source memory (e.g., Dalla Barba, Nedjam, & DuBois, 1999; Multhaup and Balota, 1997; Smith and Knight, 2002). In the repeated study/test sessions, the subject needs to monitor several sources of information, including whether the related lure was in the study list, in the test list, or whether it was only imagined (Budson et al., 2002; Kensinger and Schacter, 1999; Schacter, Verfaellie, Anes, & Racine, 1998b). Another possible explanation would be the impairment in remembering the associations between items and list-contexts. If the subjects can successfully remember the list-context in which they studied the item, they may reject the unstudied related lures more effectively.

To test the impaired recall-to-reject hypothesis for false recognition in AD patients without contamination of deficits in source memory, Gallo et al. (2004) used an associative recognition memory task in which subjects studied pairs of unrelated words and were later asked to distinguish between these same studied pairs (intact) and new pairs that contained either rearranged studied words (rearranged) or non-studied words (non-studied). During the study period, the pairs were presented either once or three times. The results showed that repetition increased the hits to intact pairs in both AD and control groups, but repetition increased false alarms to rearranged pairs only in the AD group. Gallo et al. (2004) suggested that repetition increases the familiarity of the words in both rearranged and intact pairs; however, only the control subjects were able to counter this familiarity by recalling the originally studied pairs, which is consistent with the recall-to-reject hypothesis.

As Gallo et al. (2004) noted, however, their findings may also be explained by an impaired memory for associations, although they did not ascribe their findings to deficits in source memory. Repetition of word pairs during a study task may enhance familiarity for test words in both intact and rearranged pairs, such that the discrimination between intact and rearranged pairs depends on the memory for the specific association formed during the task. More specifically, in the task used by Gallo et al. (2004), subjects need to recollect associations between two words in order to make an accurate recognition memory judgment. Here, it should be noted that both of the tasks used in Budson et al. (2000) and Gallo et al. (2004) required the subjects to recollect some kind of associations, namely, item-to-list-context association in Budson et al. (2000) and item-to-item associations in Gallo et al. (2004). Thus, from the previous studies on false recognition in AD patients, the evidence for impaired recollection-based monitoring in AD patients remains inconclusive due to possible alternative explanations, especially associative memory account.

To provide strong evidence supporting the impaired recall-to-reject hypothesis, we investigated false recognition in AD patients using a different kind of item-recognition task from those used in previous studies. Prior studies have used semantically related word lists (Budson et al., 2000), phonologically related word lists (Budson, Sullivan, Daffner, & Schacter, 2003b), or categorized color photographs (Budson et al., 2003a). In the present study, we used previously presented pictures (Same pictures), novel pictures similar to previously presented pictures (Similar lures), and novel pictures not similar to previously presented pictures (Dissimilar lures) as experimental stimuli for the recognition memory task. The experimental paradigm using these stimuli, which have often been reported in previous studies (e.g., Garoff, Slotnick, & Schacter, 2005; Kensinger, Garoff-Eaton, & Schacter, 2007a, 2007b; Kensinger and Schacter, 2007), was suitable for our investigation because it allowed us to measure changes in the ability to discriminate Same pictures from Similar lures (i.e., item-specific recollection) by stimulus repetition without the element of source memory or associative memory. The aim of the present study was to determine whether AD patients would show increased false recognition in response to Similar lures by stimulus repetition and to provide strong evidence supporting the impaired recall-to-reject hypothesis in AD patients.

Table 1
Demographic data (mean ± SD) for the AD patients and the healthy controls.

	AD patients ($n = 18$)	Controls ($n = 18$)	p-Value
Age	74.5 (4.6)	74.8 (4.2)	$p > 0.1$
Sex (female/male)	14/4	11/7	$p > 0.1$
Education	10.7 (2.1)	10.9 (1.8)	$p > 0.1$
MMSE	24.4 (2.1)	28.0 (1.7)	$p < 0.001$

The chi-squared test was used for the gender ratio, and the t-test was used for the remaining variables. Standard deviations are in parentheses. MMSE, Mini-Mental State Examination.

2. Materials and methods

2.1. Participants

Eighteen patients with a clinical diagnosis of probable AD (National Institute of Neurological and Communicative Disorders and Stroke-Alzheimer's Disease and Related Disorders Association criteria; McKhann et al., 1984) and 18 healthy elderly adults participated in the experiment. AD patients were recruited from the clinical population at Tohoku University Hospital. Each of these patients was assessed by one or more board-certified neurologists with expertise in diagnosing dementia. Elderly adults who had no history of neurological or psychiatric diseases were recruited from the local community via an advertisement. The exclusion criteria for both groups were a medical history of neurological disease (e.g., stroke, head injury, and epilepsy) or psychiatric illness (e.g., schizophrenia and manic depression) and a documented or suspected history of alcohol or drug abuse. In addition, because we intended to study patients with mild AD, patients who scored less than 20 on the Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) were excluded. Healthy participants who scored less than 24 (a cutoff level for a diagnosis of dementia) on the MMSE were also excluded. All participants had normal or corrected-to-normal vision. At the time of the study, none of the patients was being or had been treated with specific medication, such as anti-acetylcholinesterase agents. The elderly adults were matched to the patients for gender (4 male and 14 female patients vs. 7 male and 11 female elderly adults), age (patient mean = 74.5 years, range = 67–87 years; elderly adult mean = 74.8 years, range = 67–82 years), and education (patient mean = 10.7 years, range = 8–14 years; elderly adult mean = 10.9 years, range = 8–14 years). The study was approved by the Ethical Committee of Tohoku University and was performed in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants or their caregivers when appropriate. The demographic data of each group are summarized in Table 1.

2.2. Stimuli

We prepared color photographs of 120 common living things and 120 common inanimate objects, which were used in our previous study (Hashimoto et al., in press). These photographs consisted of 60 pairs of different photographs of the same living things and 60 pairs of different photographs of the same inanimate objects. These pairs were divided into three sets (i.e., 40 pairs each) of an equal number of animate and inanimate stimuli. The first members of two sets (80 stimuli) were used as study items in the study phase, and the first members of the other set (40 stimuli) were used as distracters in the test phase. The assignment of these three stimuli sets to either study or to the test phase was counterbalanced across subjects. Of the two sets used in the study phase, the first members of one set (40 stimuli)