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Note

The picture superiority effect in patients with Alzheimer's disease and mild cognitive impairment

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ABSTRACT

The fact that pictures are better remembered than words has been reported in the literature for over 30 years. While this picture superiority effect has been consistently found in healthy young and older adults, no study has directly evaluated the presence of the effect in patients with Alzheimer's disease (AD) or mild cognitive impairment (MCI). Clinical observations have indicated that pictures enhance memory in these patients, suggesting that the picture superiority effect may be intact. However, several studies have reported visual processing impairments in AD and MCI patients which might diminish the picture superiority effect. Using a recognition memory paradigm, we tested memory for pictures versus words in these patients. The results showed that the picture superiority effect is intact, and that these patients showed a similar benefit to healthy controls from studying pictures compared to words. The findings are discussed in terms of visual processing and possible clinical importance.

1. Introduction

Impaired episodic memory is a central feature of mild Alzheimer's disease (AD) and amnestic-type mild cognitive impairment (MCI), a condition thought to represent a transition state between normal aging and AD (Gauthier et al., 2006; Petersen, 2004; Whitwell et al., 2007). Clinical observation suggests that pictures may improve memory in AD and MCI patients. For example, it is commonly observed that a patient with AD will appear to not remember a loved one upon hearing or reading the person's name, but will subsequently recognize him or her when presented with a photograph. Indeed, many nursing facilities encourage family members of patients with AD to create photo albums of important people and places to facilitate memory.

This clinical evidence is consistent with the picture superiority effect, a well-documented finding that stimuli presented as pictures are markedly better remembered on tests of recall or recognition than stimuli presented as words (Shepard, 1967). The picture superiority effect has been consistently found in young adults (for review see Mintzer & Snodgrass, 1999) and healthy older adults (Ally et al., 2008; Park, Puglisi, & Sovacool, 1983; Winograd, Smith, & Simon, 1982). Surprisingly, no study has directly assessed the presence of the picture superiority effect in AD or MCI patients.

In accordance with the clinical observation of memory enhancement by pictures, one might hypothesize that the picture superiority effect would be intact in patients with AD and MCI. On the other hand, AD and MCI patients are known to display visual processing deficits that might result in a diminished picture superiority effect compared to healthy older adults. For example, AD patients show deficient contrast sensitivity, impaired face discrimination, decreased speed in pointing to visual targets, and difficulty in locating targets in complex visual scenes (Cronin-Golomb et al., 2000; Neargarder & Cronin-Golomb, 2005; Tippett & Sergio, 2006). Enhanced stimulus contrast has been shown to yield normalized identification of rapidly presented items by AD patients, suggesting damage to visual processing pathways (Cronin-Golomb, Gilmore, Neargarder, Morrison, & Laudate, 2007; Gilmore, Cronin-Golomb, Neargarder, & Morrison, 2005). Imaging and electrophysiological studies indicate that visual impairments in AD are likely due to neuropathological changes in higher order association areas of cortex and not to neuroretinal dysfunction (Justino et al., 2001; Mielke, Kessler, Fink, Herholz, & Heiss, 1995). Fewer studies have evaluated visual processing in MCI. However, Lu, Neuse, Madigan, and Dosher (2005) reported that iconic memory, a form of visual sensory memory, decays more rapidly in MCI patients than in age-matched controls.

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In the current study, we sought to determine whether the picture superiority effect is intact or diminished in AD and MCI patients compared to healthy older adults. We hypothesized that although the patients with AD and MCI would show the picture superiority effect, the relative benefit of studying pictures compared to words would not be as robust as healthy older adults due to the visual processing deficits reported in these patient groups. The significance of these findings are twofold: First, it will help to determine whether visual processing deficits seen in patients with AD affect visual memory, and second, a finding of the picture superiority effect may lead directly to interventions that can improve the lives of these patients.

2. Methods

2.1. Participants

Eighteen healthy older adults, 17 patients with a diagnosis of amnestic-type MCI (multiple or single domain; Petersen, 2004), and 19 patients with a clinical diagnosis of mild AD were recruited for this study. Healthy older adults were screened in the same manner as patients with MCI and AD, and were defined as demonstrating no cognitive impairment on neuropsychological testing and having no blood relatives with Alzheimer's disease or notable memory problems. Patients with MCI reported a subjective memory complaint, showed abnormal memory performance for their age as evidenced by performing more than 1.5 standard deviations below the healthy control group on either the recall or the recognition portion of the CERAD Word List Memory Test (Morris, Heyman, & Mohs, 1989), and did not display functional impairment in activities of daily living according to caregiver report. Patients with probable mild AD met criteria described by the National Institute of Neurological and Communicative Disorders and Stroke-Alzheimer's Disease and Related Disorders Association (McKhann, Drachman, Folstein, Katzman, & Price, 1984), and were in the mild range of the disease based on MMSE scores ranging from 20 to 26 (Folstein, Folstein, & McHugh, 1975). The participants with mild AD and MCI were recruited from the Memory Disorders Unit at Brigham and Women's Hospital and the Boston University Alzheimer's Disease Center, both in Boston, Massachusetts. Healthy older adult controls were recruited from online and community postings in the Boston area, or were spouses and friends of the AD and MCI patients who participated in the study.

Participants were excluded if they were characterized by clinically significant depression, alcohol or drug use, cerebrovascular disease, traumatic brain damage, neurological or psychological disease that could affect cognitive function, or if English were not their primary language. Subjects were also required to have corrected 20/30 or better color vision. One AD patient was unable to complete the experiment. The study was approved by the human studies committees of the Bedford VA and Brigham and Women's Hospital. Written informed consents were obtained from all participants and from their caregivers where appropriate. Participants were paid $25/h for their participation.

Each participant completed a brief neuropsychological battery in a 45-min session either directly following the experimental session or on a separate date. Table 1 presents demographic and neuropsychological data for the three groups of participants. Neuropsychological scores were not obtained for one control and one AD patient. ANOVAs revealed no significant differences in age among the AD, MCI, and control groups, but significant differences among the three groups in years of education [$F(2, 50) = 4.79$, $p = .013$, $\eta^2 = .161$]. Independent-samples t-tests revealed that controls had more years of education than AD patients [$t(34) = 2.20$, $p = .035$]. MCI patients also had more years of education than AD patients [$t(33) = 2.92$, $p = .006$]. Years of education did not differ between healthy older adults and MCI patients [$t(33) = 1.02$, $p = .316$].

Table 1
Demographic and standard neuropsychological test data by group. Standard deviations are presented in italics. *Notes*: OC = healthy older adults; MMSE = Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975); CERAD = CERAD Word List Memory Test (Morris et al., 1989); Trails-B = Trail Making Test Part B (Adjutant General's Office, 1944); FAS and CAT = Verbal Fluency (Monsch et al., 1992); BNT-15 = 15-item Boston Naming Test (Mack, Freed, Williams, & Henderson, 1992).

	OC	MCI	AD
Age	74.5 (*3.7*)	73.5 (*8.3*)	73.2 (*9.9*)
Years of education	16.8 (*3.3*)	18.1 (*4.2*)	14.4 (*3.3*)
MMSE	29.4 (*.8*)	28.2 (*1.3*)	24.1 (*2.0*)
CERAD			
Immediate	22.1 (*3.0*)	14.2 (*4.3*)	10.8 (*3.6*)
Delayed	7.2 (*1.7*)	2.6 (*1.8*)	.8 (*1.1*)
Recognition	9.8 (*.4*)	8.2 (*1.8*)	5.7 (*3.3*)
Trails-B	90.4 (*31.4*)	188 (*170*)	237 (*109*)
FAS	47.6 (*7.6*)	38.2 (*11.6*)	28.7 (*16.4*)
CAT	50.1 (*11.1*)	33.8 (*13.9*)	36.7 (*11.9*)
BNT-15			
No cue	14.5 (*.9*)	13.3 (*1.5*)	11.7 (*3.5*)
Semantic cue	.1 (*.2*)	.1 (*.5*)	.4 (*.8*)
Phonetic cue	.4 (*.8*)	1.0 (*1.3*)	1.5 (*1.6*)

2.2. Stimuli and procedure

The stimuli used in the current study were derived from a previous stimulus set used by Ally and Budson (2007) and Ally et al. (2008). Two hundred high-resolution clip-art style color pictures of single items on white background and their verbal exemplars were counterbalanced for condition (pictures, words) and study status (old, new). Condition order was also counterbalanced across subjects. The picture and word study–test conditions presented 50 stimuli at study and 100 stimuli at test (50 old, 50 new). Participants completed the two study–test conditions in a single 90-min session.

During the study portion of each condition, participants were asked to make like/dislike judgments of the stimuli and to remember the stimuli for a subsequent memory test. Study stimuli were presented for 2 s each and were followed by the question, "Do you like this item?" Healthy older adult participants were then prompted to button press to signify their like/dislike judgment, while MCI and AD subjects reported their judgments aloud to an experimenter. There was a 1 s pause between each study trial. Test stimuli were each presented for 1.5 s, followed by the question, "Is this item old or new?" Healthy older adults were prompted to button press to signify their old/new judgment, while MCI and AD participants reported their judgments aloud and had responses input by the experimenter. Subjects were asked to hold their old/new response until the question appeared immediately following stimulus presentation.

3. Results

Analyses were performed to evaluate the difference in memory performance between the picture and word conditions. The analyses of interest involved the straightforward discrimination index Pr (percentage hits minus percentage false alarms; Snodgrass & Corwin, 1988), as the picture superiority effect is characterized by the difference between hit and false alarm rates for pictures versus words.

Table 2 displays hit and false alarm rates by group and condition. To compare true and false recognition, we performed a repeated measures ANOVA with the factors of Group (older adults, MCI, AD), Condition (pictures, words), and Item Type (hits, false alarms). Due to group differences in years of education, this analysis was performed with education as a covariate. The ANOVA revealed an effect of Condition [$F(1, 50) = 4.33$, $p = .043$, $\eta^2 = .083$] because recognition of pictures was better than words, and effect of Item Type [$F(1, 50) = 36.1$, $p < .001$, $\eta^2 = .651$] because hit rates exceeded false alarm rates. There was no overall effect of Education [$F(1, 50) < 1$]. However, the ANOVA also revealed interactions of Group and Item Type [$F(2, 50) = 44.3$, $p < .001$, $\eta^2 = .668$] and Condition and Item Type [$F(1, 50) = 18.6$, $p < .001$, $\eta^2 = .294$]. Follow-up t-tests revealed that the hit rate for words was greater for healthy older adults than for MCI patients [$t(33) = 2.73$, $p = .010$] and AD patients [$t(34) = 4.22$, $p < .001$], and was greater for patients with MCI compared to patients with AD [$t(33) = 2.12$, $p = .041$]. In contrast, the false alarm rate for words was lower for healthy older adults compared

Table 2
Mean hit and false alarm rates for word and picture conditions by group. Standard deviations are presented in italics.

	OC	MCI	AD
Hits			
Words	.88 (*.07*)	.78 (*.15*)	.67 (*.22*)
Pictures	.96 (*.05*)	.91 (*.07*)	.77 (*.23*)
False alarms			
Words	.08 (*.09*)	.22 (*.16*)	.39 (*.24*)
Pictures	.06 (*.10*)	.15 (*.12*)	.36 (*.24*)

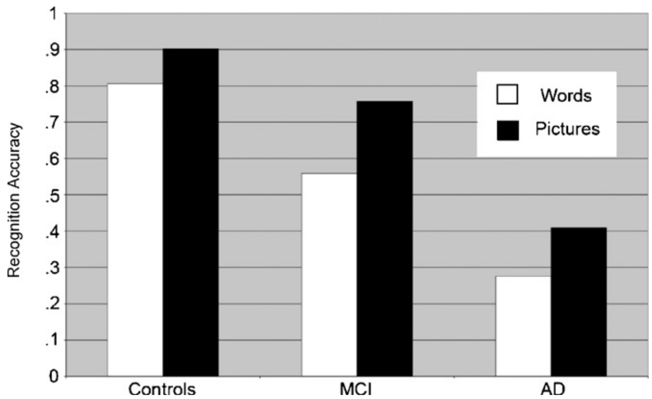

Fig. 1. Mean recognition accuracy (Pr; %hits – %false alarms) for the word and picture conditions.

to MCI patients [$t(33) = 3.60$, $p = .001$] and AD patients [$t(34) = 5.37$, $p < .001$], and lower for patients with MCI compared to patients with AD [$t(33) = 2.43$, $p = .021$]. A similar pattern emerged for pictures. The hit rate for pictures was greater for the healthy older adults than for patients with MCI [$t(33) = 3.06$, $p = .004$] and AD patients [$t(34) = 3.47$, $p = .001$], and was greater for patients with MCI compared to patients with AD [$t(33) = 2.27$, $p = .030$]. In contrast, the false alarm rate for pictures was lower for healthy older adults compared to MCI patients [$t(33) = 3.81$, $p = .001$] and AD patients [$t(34) = 5.66$, $p < .001$], and lower for patients with MCI compared to patients with AD [$t(33) = 3.38$, $p = .002$].

To measure discrimination we calculated Pr, the proportion of hits minus the proportion of false alarms. Fig. 1 displays Pr by group and Condition. To compare discrimination, we performed repeated measures ANOVA with the factors of Group (older adults, MCI, AD) and Condition (pictures, words) with Pr as the dependent variable. Due to group differences in years of education, this analysis was performed with education as a covariate. The ANOVA revealed effects of Group [$F(2, 50) = 48.2$, $p < .001$, $\eta^2 = .687$] and Condition [$F(1, 50) = 18.6$, $p < .001$, $\eta^2 = .294$], but no interaction of Group and Condition [$F(2, 50) = 1.94$, $p = .154$, $\eta^2 = .081$]. Again, there was no overall effect of Education [$F(1, 50) < 1$] in the ANOVA. The effect of Condition was present because Pr was greater for pictures than for words. To further investigate this effect, we performed within-group paired-samples *t*-tests. Pr values were greater for pictures than words for healthy older adults [$t(17) = 4.29$, $p < .001$], MCI patients [$t(16) = 5.05$, $p < .001$], and AD patients [$t(17) = 3.16$, $p = .006$].

4. Discussion

The main goal of the current experiment was to determine whether the picture superiority effect was present in patients with mild AD and MCI. We predicted that although these patients would demonstrate the picture superiority effect, the relative benefit of studying pictures over words compared to controls would be lost due to reported visual processing deficits in this population (Cronin-Golomb et al., 2000; Neargarder & Cronin-Golomb, 2005; Tippett & Sergio, 2006). The results confirmed that the picture superiority effect remains intact for patients with mild AD and MCI. However, in apparent conflict with our predictions, the relative benefit of studying pictures compared to words is similar across the three groups. These results suggest that perhaps visual processing deficits do not appear to interfere with memorial processing in these populations (or that visual processing deficits interfere equally with memory for words and pictures).

How pictures enhance memory in patients with known deficits in memory has yet to be thoroughly investigated. Earlier work suggests that patients with mild AD are able to use distinctive information provided by pictures to decrease false recognition, and use the 'distinctiveness heuristic' to correctly reject unstudied items in a picture–word study–test condition compared to a word–word condition (Budson, Dodson, Daffner, & Schacter, 2005). The distinctiveness heuristic, as proposed by Schacter, Israel, and Racine (1999), posits that subjects use metacognitive information about how vivid they expect their memories to be, and reject items that do not meet the requisite vividness. Perhaps the current study stimulus set of high-resolution color images may have helped patients overcome visual processing deficits, and use distinctive information to improve memory for pictures over words. Indeed, Cronin-Golomb et al. (2007) showed that enhanced visual stimuli could ameliorate visual cognition deficits in patients with mild AD. Future studies can perhaps examine whether increasing the amount of detail present in a picture enhances discrimination, or use techniques such as functional MRI and ERPs to determine whether the amount detail of pictures affects the amount of information retrieved at test.

From a clinical perspective, understanding memory for pictures versus words may be particularly salient. Outside of the laboratory, recognition of people, landmarks, and medications is often dependent on memories that involve images, scenes, and detailed visual stimuli. Memory impairment can drastically compromise an elder's ability to live independently and is one of the reasons most cited for nursing home placement (Andel, Hyer, & Slack, 2007). A recent study showed that a $4 billion savings could be realized by delaying nursing home placement by a single month (Clipp, 2005). New diagnostic tests and early behavioral interventions could potentially focus on the use of pictures, or even creating mental pictures or images of words, as a memorial aid. Understanding the underpinnings of the memory dysfunction associated with AD and MCI may therefore lead to interventions that can enhance the lives of these patients.

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References

Adjutant General's Office. (1944). *Army individual test battery: Manual of directions and scoring*. Washington, D.C.: War Department.

Ally, B. A., & Budson, A. E. (2007). The worth of pictures: Using high-density event-related potentials to understand the memorial power of pictures and the dynamics of recognition memory. *NeuroImage*, *35*, 378–395.

Ally, B. A., Waring, J. D., Beth, E. H., McKeever, J. D., Millberg, W. P., & Budson, A. E. (2008). Aging memory for pictures: Using high-density event-related potentials to understand the effect of aging on the picture superiority effect and the dynamics of recognition memory. *Neuropsychologia*, *46*, 679–689.

Andel, R., Hyer, K., & Slack, A. (2007). Risk factors for nursing home placement in older adults with and without dementia. *Journal of Aging Health*, *19*, 213–228.

Budson, A. E., Dodson, C. S., Daffner, K. R., & Schacter, D. L. (2005). Metacognition and false recognition in Alzheimer's disease: Further exploration of the distinctiveness heuristic. *Neuropsychology*, *19*, 253–258.

Clipp, E. (2005). US Department of Veterans Affairs HSR&D Study NRI 95-218, Informal Caregivers of Veterans with Dementia: Cost, QOL, and Service Use.

Cronin-Golomb, A., Cronin-Golomb, M., Dunne, T., Brown, A., Jain, K., Cipolloni, P. B., et al. (2000). Facial frequency manipulation normalizes face discrimination in Alzheimer's disease. *Neurology*, *54*, 2316–2318.

Cronin-Golomb, A., Gilmore, G. C., Neargarder, S. A., Morrison, S. R., & Laudate, T. M. (2007). Enhanced stimulus strength improves visual cognition in aging and Alzheimer's disease. *Cortex*, *43*, 952–966.

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

Gauthier, S., Reisberg, B., Zaudig, M., Petersen, R. C., Ritchie, K., Broich, K., et al. (2006). Mild cognitive impairment. *Lancet*, *367*, 1262–1270.

Gilmore, G. C., Cronin-Golomb, A., Neargarder, S. A., & Morrison, S. R. (2005). Enhanced stimulus contrast normalizes visual processing of rapidly presented letters in Alzheimer's disease. *Vision Research*, *45*, 1013–1020.

Justino, L., Kergoat, M., Bergman, H., Chertkow, H., Robillard, A., & Kergoat, H. (2001). Neuroretinal function is normal in early dementia of the Alzheimer type. *Neurobiology of Aging*, *22*, 691–695.

Lu, Z. L., Neuse, J., Madigan, S., & Dosher, B. A. (2005). Fast decay of iconic memory in observers with mild cognitive impairments. *Proceedings of the National Academy of Sciences of the United States of America*, *102*, 1797–1802.

Mack, W. J., Freed, D. M., Williams, B. W., & Henderson, V. W. (1992). Boston naming test: Shortened versions for use in Alzheimer's disease. *Journal of Gerontology*, *47*, 154–158.

McKhann, G., Drachman, D., Folstein, M., Katzman, R., & Price, D. (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.

Mielke, R., Kessler, J., Fink, G., Herholz, K., & Heiss, W. D. (1995). Dysfunction of visual cortex contributes to disturbed processing of visual information in Alzheimer's disease. *International Journal of Neuroscience*, *82*, 1–9.

Mintzer, M. Z., & Snodgrass, J. G. (1999). The picture superiority effect: Support for the distinctiveness model. *American Journal of Psychology*, *112*, 113–146.

Monsch, A. U., Bondi, M. W., Butters, N., Salmon, D. P., Katzman, R., & Thal, L. J. (1992). Comparisons of verbal fluency tasks in the detection of dementia of the Alzheimer type. *Archives of Neurology*, *49*, 1253–1258.

Morris, J. C., Heyman, A., Mohs, R. C., Hughes, J. P., van Belle, G., Fillenbaum, G., et al. (1989). The Consortium to Establish a Registry for Alzheimer's Disease (CERAD). Part I. Clinical and neuropsychological assessment of Alzheimer's disease. *Neurology*, *39*, 1159–1165.

Neargarder, S. A., & Cronin-Golomb, A. (2005). Characteristics of visual target influence detection of change in naturalistic scenes in Alzheimer's disease. *Cognitive and Behavioral Neurology*, *18*, 151–158.

Park, D. C., Puglisi, J. T., & Sovacool, M. (1983). Memory for pictures, words, and spatial location in older adults: Evidence for pictorial superiority. *Journal of Gerontology*, *38*, 582–588.

Petersen, R. C. (2004). Mild cognitive impairment as a diagnostic entity. *Journal of Internal Medicine*, *256*, 183–194.

Schacter, D. L., Israel, L., & Racine, C. (1999). Suppressing false recognition in younger and older adults: The distinctiveness heuristic. *Journal of Memory and Language*, *40*, 1–24.

Shepard, R. N. (1967). Recognition memory for words, sentences, and pictures. *Journal of Verbal Learning and Verbal Behavior*, *6*, 156–163.

Snodgrass, J. G., & Corwin, J. (1988). Pragmatics of measuring recognition memory: Applications to dementia and amnesia. *Journal of Experimental Psychology: General*, *117*, 34–50.

Tippett, W. J., & Sergio, L. E. (2006). Visuomotor integration is impaired in early stage Alzheimer's disease. *Brain Research*, *1102*, 92–102.

Whitwell, J. L., Petersen, R. C., Negash, S., Weigand, S. D., Kantarci, K., Ivnik, R. J., et al. (2007). Patterns of atrophy differ among specific subtypes of mild cognitive impairment. *Archives of Neurology*, *64*, 1130–1138.

Winograd, E., Smith, A. D., & Simon, E. W. (1982). Aging and the picture superiority effect in recall. *Journal of Gerontology*, *37*, 70–75.