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Wechsler Memory Scale–III Faces test performance in patients with mild cognitive impairment and mild Alzheimer's disease

Adriana M. Seelye[1,2], **Diane B. Howieson**[1], **Katherine V. Wild**[1], **Mindy Milar Moore**[1], and **Jeffrey A. Kaye**[1]

[1] Department of Neurology, Oregon Health & Science University, Portland, OR, USA

[2] Washington State University, Pullman, WA, USA

Abstract

Little is known about the sensitivity of the Wechsler Memory Scale–Third Edition (WMS-III) Faces subtest to memory impairment associated with mild cognitive impairment (MCI). In this study, Faces performance was examined in 24 MCI patients, 46 mild Alzheimer's disease (AD) patients, and 98 elderly controls. We hypothesized that participants with diagnoses of MCI or AD would be impaired relative to controls on Faces. Analyses showed that AD participants performed significantly worse than MCI and intact participants, although there were no significant differences between MCI and intact participants. Data suggest that brain areas specialized for face recognition memory may be less affected by MCI and mild AD than regions specialized for verbal memory.

Keywords

Wechsler Memory Scale–Third Edition; Face recognition; Face memory; Mild cognitive impairment; Alzheimer's disease

INTRODUCTION

The decline in episodic memory with amnestic forms of mild cognitive impairment (MCI) is well established for verbal material. A number of problems inherent in available test materials for nonverbal memory have made a comparison with verbal memory difficult. Most visual, nonverbal memory tests, such as the popular Complex Figure Test or the Wechsler Memory Scale–Third Edition (WMS-III) Visual Reproduction subtest, require visuographic reconstructions of stimuli, an ability that has known age-related decline. The WMS-III includes a visual, nonverbal memory test, Faces, that requires only a yes/no response and offers a test of nonverbal memory free from the requirement of visuographic reconstructions. We were interested in studying whether the memory impairment associated with amnestic MCI and mild Alzheimer's disease (AD) would include impairment on the WMS-III Faces recognition test. The study of face recognition memory is of value because of its importance as a social skill.

Address correspondence to Adriana M. Seelye, 282 Baker Street # 102, Moscow, ID 83843, USA (E-mail: adri_z@hotmail.com).

An advantage of the WMS-III Faces test over many visual memory tests is that Faces is difficult to mediate verbally, especially with such a short processing time. In contrast, many visual memory tests, such as WMS-III Family Pictures and Visual Reproduction, can be verbally mediated quite easily (Millis, Malina, Bowers, & Ricker, 1999; Price, Tulsky, Millis, & Weiss, 2002; Tulsky, 2004; Wilde et al., 2003). This may partially explain why several factor analytic studies have shown low correlations between Faces and the other WMS-III visual memory tests (Holdnack & Delis, 2004; Millis et al., 1999; Wilde et al., 2003). The exact construct that the Faces subtest measures remains unclear, and further exploration is warranted (Wilde et al., 2003).

Furthermore, there may be fundamental differences in the way faces and other objects are recognized and represented in the brain (Farah, Wilson, Drain, & Tanaka, 1998). In reviewing the literature on patients who had undergone surgery for treatment of intractable epilepsy, Barr (1997) concluded that right temporal lobe resections produce impairment in memory for information that is not easily verbalized, labeled, or coded into words. In his study, patients with right temporal lobe resections performed more poorly than those with left temporal lobe resections on a face memory recognition test but not on a spatial learning test. Similarly, Doss, Chelune, and Naugle (2004) found that right temporal lobe resections produced a worse score on WMS-III Faces I than did left temporal lobe resections. Not all studies have found this advantage for face memory tests. Wilde and colleagues (2001) found that the WMS-III Faces test did not contribute to differentiating laterality of disturbance in patients with temporal lobe epilepsy, further raising questions about the meaning of this subtest. It is unclear whether Faces may be a valuable test of visual memory with less potential for verbal encoding than many commonly used visual memory tests and perhaps one that taps an aspect of visual memory represented by cognitive processes or brain regions different from other visual recognition memory tests. Of note, studies suggest that multiple brain regions and neural pathways interact to mediate face encoding and face recognition memory, including the fusiform face area, temporal neocortex, medial temporal lobe, and prefrontal cortex (Hermann, Seidenberg, Wyler, & Haltiner, 1993; Kelley et al., 1998; Rapcsak, 2003). Both neuroimaging and neuropathology data suggest that the fusiform gyrus may undergo deterioration in MCI and AD (Guillozet, Weintraub, Mash, & Mesulam, 2003; Whitwell et al., 2007), suggesting that WMS-III Faces may be useful for assessing memory impairment associated with these disorders. Despite the advantages of the WMS-III Faces subtest, it has been the target of several criticisms in recent years. First, the recognition format without a recall component may make the test easier than other nonverbal memory tests (Tulsky et al., 2003). Some research suggests that recognition and recall memory rely on different cognitive processes and, therefore, may be dissociable (Aggleton & Shaw, 1996). In addition, since the test requires an individual to make a yes/no decision whether each face is either a target or a distractor, guessing may become a problem. Moreover, a purely random response pattern (24/48 correct) scores in the borderline to average range for a broad age span of older adults, which may make it difficult for the test to detect severe memory impairment in older adults (Levy, 2003). Nevertheless, guessing has been shown to occur more frequently with forced-choice recognition formats than with yes/no recognition formats in older adults (Bastin & Van der Linden, 2003), perhaps because a forced-choice format provides alternative faces to choose from, and a yes/no format offers no opportunity for comparison.

Deficits in a variety of cognitive processes may contribute to impaired performance on facial recognition memory tests in older adults and patients with dementia. Given the significant correlation between a face memory test and a test of visuospatial perception in patients with Alzheimer's disease (Diesfeldt, 1990), visuospatial factors likely play an important role in face recognition memory deficits. Other evidence suggests that executive functions, such as strategizing, planning, and control, may play a role in face recognition memory, particularly in older adults (Rapcsak, 2003; Rapcsak et al., 2001).

Face recognition memory tests have been used to examine nonverbal memory deficits in healthy older adults and patients with mild to moderate dementia, and several studies have found impaired recognition memory for faces in healthy older adults (Bastin & Van der Linden, 2003) and patients with mild and moderate Alzheimer's disease (Holdnack & Delis, 2004; Lee, Levi, Davies, Hodges, & Graham, 2007; Wilson, Kaszniak, Bacon, Fox, & Kelly, 1982). For example, Moss and colleagues (Moss, Albert, Butters, & Payne, 1986) found impaired recognition memory for faces in mild and moderate dementia patients relative to elderly controls. However, other studies have found intact recognition memory for faces in patients with mild and moderate Alzheimer's disease (Ferris, Crook, Clark, McCarthy, & Rae, 1980; Hart, Smith, & Swash, 1985). Ferris et al. (1980) found no differences between normal elderly and mild dementia patients on a face recognition memory test. In addition, Hart et al. (1985) found impaired memory for verbal and abstract visual stimuli in mild AD patients, while memory for faces was intact, suggesting that memory for faces may be uniquely preserved in this population. Although differences in the format and methodology of the face memory tests used in these studies may partially explain these conflicting findings, additional research in this area is needed to address the discrepancies in the literature.

Given that Alzheimer patients have been shown in some studies to have impaired memory for faces and because MCI often represents very early stage Alzheimer disease (Storandt, Grant, Miller, & Morris, 2006), it might be expected that memory for faces also would be impaired in patients with MCI. Only one study known to us has shown MCI patients to have impaired semantic memory for famous faces (Dudas, Clague, Thompson, Graham, & Hodges, 2005). No studies that we know of have examined WMS-III Faces test performance, or other tests of recognition memory for unfamiliar faces, in patients with MCI. Furthermore, no studies known to us have examined the ability of this test to discriminate between varying degrees of memory impairment severity associated with MCI and mild AD.

We hypothesized that both MCI and AD participants would be impaired on WMS-III Faces relative to controls. MCI patients usually have an intermediate level of impairment between mild Alzheimer's patients and controls on memory tests. We predicted a dementia dose-effect in that MCI participants would perform better than mild AD participants and worse than elderly controls.

METHOD

Sample

Participants in the present study were 168 community-dwelling older adults, including 24 participants with amnestic MCI, 46 participants with mild AD, and 98 elderly controls. They were enrolled in longitudinal studies of normal aging, and all participants were cognitively normal at entry. Procedures have been described elsewhere (Howieson et al., 2003, 2008). Participants converted to a cognitively impaired diagnosis based on at least one Clinical Dementia Rating (CDR) = 0.5 for MCI (Morris, 1993) or NINCDS-ADRDA (National Institute of Neurological and Communicative Disorders and Stroke–Alzheimer's Disease and Related Disorders Association) diagnostic criteria for Alzheimer's disease at evaluation. CDRs were based on interviews of collateral sources about the participants' memory and ability to carry out daily activities and patient interviews and examinations by a neurologist or other clinician. In assigning a CDR score, the clinician had access to the results of the Neurobehavioral Cognitive Status Examination (Kiernan, Mueller, Langston, & Van Dyke, 1987) and Mini-Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) scores of participants, but not to the neuropsychological battery test scores used in this paper's analyses. CDR ratings range from 0 (intact), 0.5 (questionable dementia), 1 (mild dementia), and above. Because all participants were rated 0 at entry, a new rating of CDR > 0 represented a mild cognitive decline in participants since their entry into the project. Groups differed in age ($p <$.

0001) and MMSE ($p < .0001$) but did not differ in gender or education. Of the total sample, 165 participants identified as Caucasian, 1 as Native American, 1 as Asian, and 1 as Hispanic.

Measures

From a larger battery of neuropsychological tests that were administered to all participants, the following tests were included in analyses: Wechsler Memory Scale–Third Edition (WMS–III) Faces and Logical Memory (Wechsler, 1997); Wechsler Adult Intelligence Scale–Revised (WAIS–R) Block Design and Digit Span (Wechsler, 1981); Animal Fluency (Rosen, 1980); and Consortium to Establish a Registry for Alzheimer's disease (CERAD) Word List task (Morris, Heyman, & Mohs, 1989). In Faces I, participants are shown 24 target faces, 1 at a time for 2 seconds. Then participants are shown 48 faces (24 targets and 24 distractors) and are asked to identify the target faces by responding either "yes" or "no" to each face. Participants are prompted to keep the target faces in mind. In Faces II, participants are shown 48 faces (24 targets and 24 distractors) after a 30-minute delay and are asked again to identify the target faces. The first evaluation of each participant with complete WMS-III Faces data was selected for analysis, and standard scoring procedures were used.

Statistical analyses

Skewed distributions on CERAD Delayed Recall, Recognition, WMS-III Faces II, and WMS-III Logical Memory II suggested violations of normality for these variables. To correct for these violations, we used a square root transformation (Tabachnick & Fidell, 2001). Skewness and kurtosis of the new variables were reexamined and indicated more normal distributions. One-way analysis of variance (ANOVA) was used to identify between-group differences in age, education, and MMSE scores. Chi-square analysis was used to identify between-group differences in gender. One-way analyses of covariance (ANCOVAs), with age as the covariate, were used to identify between-group differences on Faces I and II test scores, respectively, and on verbal memory tests. All analyses were conducted with a significance level of $p < .05$, despite multiple comparisons. Effect sizes for Faces I and Faces II were reported as partial eta squared (η_p^2) for ANCOVA. Effect sizes for MCI versus intact and AD versus intact groups' average scores on Faces I and II and verbal memory tests were reported as Cohen's *d*. Pearson's *r* correlations were used to describe the relationship between Faces I and II and a verbal memory recall test (Logical Memory), a verbal memory recognition test (CERAD), and a visuospatial task (Block Design).

RESULTS

Table 1 summarizes demographic data by group. Groups differed in age ($p < .0001$) and MMSE ($p < .0001$) but did not differ in gender or education. Of the total sample, 165 participants identified as Caucasian, 1 as Native American, 1 as Asian, and 1 as Hispanic. As seen in Table 2, after adjustment by the age covariate, group differences existed for Faces I, $F(2, 164) = 23.9$, $p < .001$, $\eta_p^2 = .224$, and Faces II, $F(2, 164) = 18.9$, $p < .001$, $\eta_p^2 = .188$. The covariate was significantly associated with Faces I, $F(1, 164) = 13.4$, $p < .001$, and Faces II, $F(1, 164) = 19.3$, $p < .001$, scores. Post hoc comparisons indicated that AD participants performed worse than MCI and intact participants on Faces I ($p < .05$) and Faces II ($p < .05$); there were no significant differences in performance between MCI and intact participants. After adjustment by the covariate, group differences existed for Logical Memory I, $F(2, 164) = 95.4$, $p < .0001$, Logical Memory II, $F(2, 164) = 174.10$, $p < .0001$, CERAD Word List Acquisition, $F(2, 164) = 90.0$, $p < .0001$, CERAD Word List Delayed Recall, $F(2, 164) = 112.09$, $p < .0001$, and CERAD Word List Recognition, $F(2, 164) = 59.7$, $p < .0001$. The covariate was significantly associated with Logical Memory I, $F(1, 164) = 13.4$, $p < .001$, Logical Memory II, $F(1, 164) = 12.7$, $p < .001$, CERAD Word List Acquisition, $F(1, 164) = 10.0$, $p < .01$, and CERAD Word List Delayed Recall, $F(1, 164) = 6.51$, $p < .001$. Post hoc comparisons indicated that AD participants

performed worse than MCI and intact participants on Word List and Logical Memory tests ($p < .05$); MCI participants performed worse than intact participants on Word List and Logical Memory tests ($p < .05$).

Effect size comparisons of average test scores of MCI versus intact and AD versus intact participants indicated that MCI and AD participants performed better on Faces I and II than on verbal memory tests. As seen in Table 3, effect sizes (d) for MCI patients ranged from 0.1 to 0.2 on Faces I and II, and from 1.1 to 1.3 on verbal memory tests. Effect sizes for AD patients ranged from 0.8 to 0.9 on Faces I and II, and from 2.2 to 3.1 on verbal memory tests. Correlations between Faces I and tests of verbal memory recall, recognition, and visuospatial perception and construction were significant ($p < .01$; WMS-III Logical Memory I, $r = .44$; WMS-III Logical Memory II, $r = .50$; CERAD Word List Delayed Recall, $r = .48$; CERAD Word List Recognition, $r = -.43$; WAIS–R Block Design, $r = .37$). Correlations between Faces II and tests of verbal memory recall, recognition, and visuospatial perception and construction were significant ($p < .01$; WMS-III Logical Memory I, $r = .45$; WMS-III Logical Memory II, $r = .46$; CERAD Word List Delayed Recall, $r = .45$; CERAD Word List Recognition, $r = -.36$; WAIS–R Block Design, $r = .34$).

DISCUSSION

Results from the present study suggest that patients with mild AD are impaired relative to controls on the WMS-III Faces. This result is consistent with previous research (Holdnack & Delis, 2004) and provide further evidence that mild AD patients have impaired recognition memory for faces. We did not find that amnestic MCI participants were impaired relative to controls on Faces. There are several possible interpretations for these results. First, Faces is a nonverbal memory test, and verbal memory tests may be more sensitive to detecting memory impairment characteristic of amnestic MCI. In our study, both MCI and mild AD patients showed greater impairments in verbal memory than in memory for faces, which is consistent with results from Wilson et al.'s study (1986). Second, brain areas specialized for face recognition memory may be less affected by MCI and mild AD than brain areas specialized for verbal memory. Imaging studies have suggested that the prefrontal and temporoparietal cortices may play a more important role in face recognition memory in older adults than brain regions that are typically affected early in MCI and mild AD, such as the hippocampus and medial temporal lobe (Grady, Bernstein, Beig, & Siegenthaler, 2002; Haxby et al., 1996). Furthermore, age related changes in the functional organization of brain regions underlying face memory might serve to compensate for reductions in medial temporal lobe mediated memory processing in older adults and those with memory impairments (Grady et al., 2002). For example, executive functions mediated by the prefrontal cortex that may be preserved in MCI may serve to enhance the efficiency and accuracy of the medial temporal lobe structures for face recognition memory (Grady et al., 2002). Finally, the interrater reliability of the CDR .5 diagnosis is less than that for diagnosing dementia, as would be expected because cognitive impairment associated with MCI is very mild (Tractenberg, Schafer, & Morris, 2001). Another possible interpretation is that the MCI group might have included some individuals who have very early MCI or a reversible cognitive decline and are not destined to develop dementia. This interpretation seems less likely because the verbal memory tests showed that the MCI group was impaired. Future studies should examine the relationship between WMS-III Faces and other tests of visual memory, face memory, and executive functioning to provide insight into the cognitive processes that mediate performance on Faces.

The relatively preserved memory for faces associated with MCI indicates an important social skill relatively retained in these patients because new faces are encountered often in daily life, and the recognition of faces combined with other biographic information contributes to the identification of individuals' unique identities (Rapcsak, 2003). In addition, given that memory

for faces is relatively preserved in MCI patients, it may be an appropriate type of episodic memory to target and strengthen in cognitive rehabilitation interventions with this population. In fact, in a study of individuals with MCI, Belleville and colleagues (2006) found improved memory for face–name associations after cognitive training.

In summary, results from the present study suggest that patients with mild AD are impaired relative to controls on the WMS-III Faces, although patients with MCI are not impaired relative to controls on WMS-III Faces. Future studies with larger samples of MCI and mild AD patients are needed to replicate these findings.

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TABLE 1

Participant characteristics

Characteristics	MCI	AD	Intact	p
Sample size	24	47	98	
Men/women	14/10	22/25	42/56	.393
Age (in years)	75.5 (11.6)[bc]	79.9 (10.1)[ac]	84.4 (7.0)[ab]	<.0001
Education (in years)	14.8 (3.0)	14.7 (2.8)	14.5 (2.5)	.8723
MMSE	26.9 (2.4)[bc]	22.4 (2.9)[ac]	28.3 (1.6)[ab]	<.0001

Note. MCI = mild cognitive impairment. AD = Alzheimer's disease. MMSE = Mini-Mental State Examination. Analyses compare differences between the three study groups. Variables with the same superscript yielded significant univariate effects ($p < .05$) using post hoc tests. Mean values are shown, with standard deviations in parentheses.

TABLE 2

Faces and verbal memory test scores by group after adjustment by the covariate

Variable	MCI	AD	Intact	p
Faces I	31.5 (4.3)[b]	26.9 (3.9)[ab]	32.3 (4.3)[a]	<.001
Faces II	31.9 (4.9)[b]	28.5 (4.9)[ab]	33.9 (4.7)[a]	<.001
Logical Memory I	10.5 (5.2)[a]	5.5 (3.7)[a]	14.7 (4.1)[a]	<.0001
Logical Memory II	6.7 (6.3)[a]	1.5 (2.5)[a]	12.8 (4.4)[a]	<.0001
Word List Acquisition	16.4 (4.3)[a]	10.6 (4.3)[a]	19.1 (3.3)[a]	<.0001
Word List Delay Recall	3.6 (2.9)[a]	0.70 (1.1)[a]	5.6 (2.2)[a]	<.0001
Word List Recognition	17.5 (2.8)[a]	15.4 (2.7)[a]	19.1 (1.2)[a]	<.0001

Note. MCI = mild cognitive impairment. AD = Alzheimer's disease. Variables with the same superscript yielded significant univariate effects ($p < .05$) using post hoc tests. Mean values are shown, with standard deviations in parentheses.

TABLE 3

Effect sizes (*d*) of memory test scores by group

Variable	MCI vs. intact	AD vs. intact
Faces I	0.1	0.9
Faces II	0.2	0.8
Logical Memory I	1.1	2.5
Logical Memory II	1.5	2.9
Word List Acquisition	0.8	2.6
Word List Recall	0.9	2.2
Word List Recognition	1.3	3.1

Note. MCI = mild cognitive impairment. AD = Alzheimer's disease. Faces II, Logical Memory II, Word List Recall, and Word List Recognition variables were transformed.