Is Knowledge of Famous People Compromised in Mild Cognitive Impairment?

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Objective: This study addressed the issue of whether person naming deficits in mild cognitive impairment (MCI) occurred with deficits in person semantic knowledge and whether person knowledge was more impaired than general semantics.

Background: Recent definitions of MCI are beginning to encompass cognitive impairments outside the domain of episodic memory. Increasing evidence suggests that semantic memory may also be compromised in this patient group, including tasks of person naming and identification.

Methods: Thirteen MCI patients and 14 control subjects matched for age and education performed parallel semantic batteries designed to probe person and general semantic knowledge.

Results: On the person battery, the MCI patients demonstrated impairment relative to controls, on tasks of category fluency, naming, identification, verbal and nonverbal associative and sorting tasks, as well as matching names to faces. By contrast, on the general semantic battery impairments, they were impaired only on category fluency and the nonverbal sorting and associative tasks. A composite measure of person knowledge tasks was also sensitive to disease severity as measured by Mini-Mental State Examination.

Conclusions: These results support the existence of deficits in MCI across various domains of person knowledge, and the suggestion that deterioration of unique semantic exemplars may be sensitive to incipient Alzheimer disease.

Key Words: person knowledge, mild cognitive impairment, proper names, Alzheimer disease, semantic memory

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Mild cognitive impairment (MCI) is a term commonly used to describe a condition intermediate between normal aging and early-stage Alzheimer disease (AD).[1] An accumulation of evidence indicates that semantic abilities may be compromised in this patient group[2–4] and, more specifically, that this impairment extends to the naming and identification of famous people.[5,6] This study addressed the issue of whether the naming deficit in MCI is representative of proper name anomia alone or if subtle deficits in person-related semantic knowledge might also be present. It also compared processing of person-related and general semantic information in this patient group.

An unresolved issue is whether subtle deficits in semantic knowledge are consistently present in MCI and predictive of the development of AD. The ability to name "famous" people, identify photographs, and/or recognize and identify their names, seems to be compromised from the earliest stages of AD.[7–9] Deficits have also been documented in other areas of famous person knowledge, including the ability to match names to faces and vice versa,[10] and to recall and recognize information about US presidential candidates.[11] Although some authors have argued that the primary deficit lies at the level of person semantics,[8,12] others have produced evidence for both semantic and postsemantic processing deficits.[13] Some research suggests that tests of person knowledge are sensitive to early AD and could even act as a useful diagnostic marker.[14]

Person knowledge in MCI patients has received relatively little attention, but initial findings indicate that subtle impairments might also be present in this group. Impaired performance on a Graded Faces Test of person naming and identification has been found in questionable dementia patients of the Alzheimer type who would mostly overlap with MCI criteria.[15] Graded Faces Test deficits were present in the majority of patients (6/7) who were given a diagnosis of AD within 2 years, suggesting that person knowledge could be sensitive to subsequent deterioration. Another study was able to differentiate between MCI patients who converted or did not convert to dementia over a 2-year follow-up period, on the basis of person naming deficits, adding further support to this suggestion.[5]

Dudas et al[16] found impaired performance in MCI patients on their so-called Face Place Test, which combined famous face identification, naming, and item recognition with the recall of spatial locations. Semenza and colleagues[17] additionally reported that tests requiring participants to name famous faces and famous people from a definition, effectively discriminated very mild AD patients from controls, unlike matched tests of common name retrieval and other screening tools.

By contrast, another study found that their MCI group did not differ significantly from controls on tasks of person naming and identification.[13] It is possible that this discrepancy relates to differences in disease severity between patient groups or, alternatively, the sensitivity of the tasks used to explore person-based knowledge.

Drawing together MCI studies to date, it seems possible that person knowledge impairments, where present, may provide some marker of disease severity and possibly predict conversion to AD.

It has been argued that anomia for famous people in MCI reflects an underlying *semantic* deficit, but evidence for this is limited.[15] Names of famous people are "proper nouns" with arbitrarily linked attributes, as opposed to "common nouns" that denote a general class of items (eg, George W. Bush vs. a leopard or wheelbarrow). It is, therefore, possible that impairment in naming famous people reflects a breakdown of proper noun retrieval, consistent with findings that proper noun retrieval deficits seem to become more pronounced with advancing age and are accelerated by AD.[18] Alternatively, person naming deficits might be indicative of a deterioration of person semantic knowledge, consistent with the recent findings of Joubert et al,[6] who found that patients with MCI were impaired both on naming and identification of famous people. Importantly, the same study found that patients were relatively more impaired on producing names and identifying information about unique exemplars (famous people and events) than objects, supporting the notion that semantic knowledge about specific conceptual entities may be sensitive to incipient dementia. This conclusion is also consistent with the findings of Ahmed et al,[19] who report greater deterioration of the naming of famous faces and buildings than everyday objects among patients with MCI.

A more recent study carried out by Joubert and colleagues[20] explored the ability to name both object and famous person stimuli in individuals with MCI and AD who were asked to answer yes/no questions about verbal and nonverbal semantic information related to the target items. Both the naming and semantic knowledge of famous person items were relatively more impaired in AD and MCI participants than naming and knowledge of objects, even when controlling for stimulus difficulty. Furthermore, consistency analyses indicated that the naming deficits could not be sufficiently explained in terms of an access deficit alone, but were also related to central semantic knowledge. Performance on person knowledge items was correlated with the integrity of both anterior temporal and inferior prefrontal regions (as measured by voxel-based morphometry), leading the authors to conclude that person semantic deficits were indicative not only of a breakdown in semantic knowledge but additional deficits in the "selection, manipulation, and retrieval" of this knowledge.

The main aim of the study was, therefore, to confirm whether patients with MCI exhibit person naming deficits and to see if: (i) the deficits appear to reflect breakdown across multiple indices of person knowledge and (ii) there is greater impairment of person-based than more general semantic knowledge. To achieve these aims, MCI patients were assessed using a newly devised battery of tasks. Task performance was also appraised with respect to disease severity.

MATERIALS AND METHODS

Participants

Two subject groups participated in the study: 13 patients with MCI (6 males and 7 females) and 14 neurologically normal controls (NC) (7 males and 7 females), who were matched on age (MCI: 66.7 ± 6.4, NC: 64.3 ± 5.7) and years of education (MCI: 13.1 ± 3.5, NC: 13.3 ± 2.1). The controls were recruited from the MRC-Cognition and Brain Sciences Volunteer Panel. MCI patients were selected from individuals undergoing prospective evaluation at the Memory Disorders Clinic at Addenbrooke's Hospital. The diagnosis of MCI was based on clinical consensus grounds after evaluation in the clinic by a senior neurologist (J.R.H.), psychiatrist, and clinical neuropsychologist. Patients met the following criteria: (1) Memory complaint, corroborated by an informant; (2) Objective memory impairment (> 1.5 SDs) for age and education; (3) Largely intact general cognitive function; (4) Preserved activities of daily living (assessed via clinical interview) and (5) Not demented, in accordance with proposed criteria.[21]

Background neuropsychological measures are illustrated in Table 1. The MCI patients had significant memory deficits (> 1.5 SD) on standard tests of memory (for example, Logical Memory,[24] delayed recall of the Rey Figure[25]), but performed within the normal range on visuoperceptive tasks from the Visual Object and Space Perception Battery.[23] They showed no evidence of a general decline in everyday skills except those related to memory. Individual Mini-Mental State Examination (MMSE)[26] scores varied in range from 23 to 30 (mean = 26.6 ± 2.4).

Experimental Tasks

Subjects underwent a battery of person and general semantic tests that have recently been used to investigate object and person knowledge.[27] Naming and category fluency tasks for each battery were given on separate testing occasions and equivalent tasks in different modalities, tapping the same knowledge domain (eg, Pyramids and Palm Trees [PPT] words and pictures) were also given on different occasions to avoid semantic interference and practice effects between tasks. Testing took between 4 and 6 hours.

TABLE 1. Means, Standard Deviations, and Independent *t* Tests Comparing Performance of the MCI and Control Groups on Tests From the Supporting Neuropsychological Battery

	MCI		NC			
	Mean	SD	Mean	SD	Independent *t*	*P*
Executive function						
Digit span (forwards)	6.5	1.1	7.5	0.8	$t = -2.7$	ns
Digit span (backwards)	5.0	1.2	6.0	1.1	$t = -2.2$	ns
Perceptual tests						
Rey copy	32.8	3.3	35	1.5	$t = -2.2$	ns
VOSP (object decision)	18.5	1.7	18.6	1.2	$t = -0.3$	ns
VOSP (dot counting)	9.9	0.3	10.0	0.0	$t = -1.2$	ns
VOSP (number location)	9.2	1.3	8.9	3.4	$t = 0.26$	ns
VOSP (cube analysis)	9.4	1.2	10.2	2.6	$t = -1.1$	ns
Episodic memory						
Logical memory (immediate)	6.7	3.4	40.6	12.1	$t = -9.7$	$P < 0.001$*
Logical memory (delayed)	1.3	1.7	25.7	5.3	$t = -15.8$	$P < 0.001$*
Rey delayed recall	8.4	8.7	20.5	5.9	$t = -4.1$	$P < 0.001$*
RMT faces	35.5	6.9	43.7	5.3	$t = -3.2$	ns
RMT words	33.2	7.5	47.0	2.9	$t = -5.7$	$P < 0.001$*

N.B. For some of the VOSP comparisons, a different group of control subjects with similar levels of age and education to patients was used.
*Indicates which results remain significant after Bonferroni correction.
RMT indicates Recognition Memory Test;[22] VOSP, The Visual Object and Space Perception Battery.[23]

General Semantic Battery

The general semantic battery was devised to assess conceptual knowledge across different input and output modalities.[28,29] The original 48 items have been updated to include 64 items, selected from the set of line drawings[30] representing 3 categories of living items (animals, birds, fruit) and 3 categories of artifact (household items, tools, vehicles). Matching of living and nonliving items was based on age of acquisition and familiarity.[31] The following subtests were given to patients and controls:

Category Fluency

Subjects were asked to produce as many exemplars as possible over a 1-minute period from the 6 specified categories (see above) and 2 further categories—breeds of dog and types of boat.

Object Naming

Subjects were asked to name the 64 black and white line drawings.

Category Sorting Test

This task examines conceptual knowledge at 3 levels—sorting the targets into living and nonliving domains (level 1, chance level 50%); appropriate semantic categories, for example, bird, animal, or fruit (level 2, chance level 33%); and by specific attributes, for example, native versus foreign animal (level 3, chance level 50%). The stimuli were tested as either words or pictures on 2 separate testing occasions, and the order of verbal and nonverbal stimulus presentation was approximately counterbalanced between participants (total score out of 272).

PPT Test

Both word and picture formats of the PPT test[32] were given. This task requires subjects to match conceptually related words or pictures (eg, which of palm tree or fir tree goes best with pyramid), scoring 1 point for each correct item (total = 52) with a 50% chance performance level (26/52).

Word-to-Picture Matching

Subjects were asked to match a spoken word (eg, zebra) to a picture of the target, embedded among 9 within category foils (see Fig. 1A, SDC 1a Supplemental Digital Content 1, http://links.lww.com/CBN/A8). This task uses the same items as the naming test.

Person-specific Semantic Battery

Semantic knowledge of people was tested using a recently designed battery[30] comprising tasks of a similar format to the ones described above. Forty-eight stimulus items or a subset of these were used throughout the tasks in different sensory domains, for example, faces versus names. The stimulus items consisted of 48 people falling into 4 broad categories: actors and television presenters, politicians and statesmen, singers and musicians, and sportsmen. The 48 stimuli were drawn from a large array of famous people on the basis of recognition, naming, and knowledge in a pilot control group. The following subtests from the battery were given:

Category Fluency

Subjects were asked to give as many exemplars of famous people as possible from each of the 4 occupational categories over a 1-minute period. Full names or surnames were considered adequate for a score of 1.

Person Naming

Subjects were asked to give the full name or surname of the 48 famous people depicted in a randomized set of black and white photographs. One point was given per item for the full name or surname of each famous face.

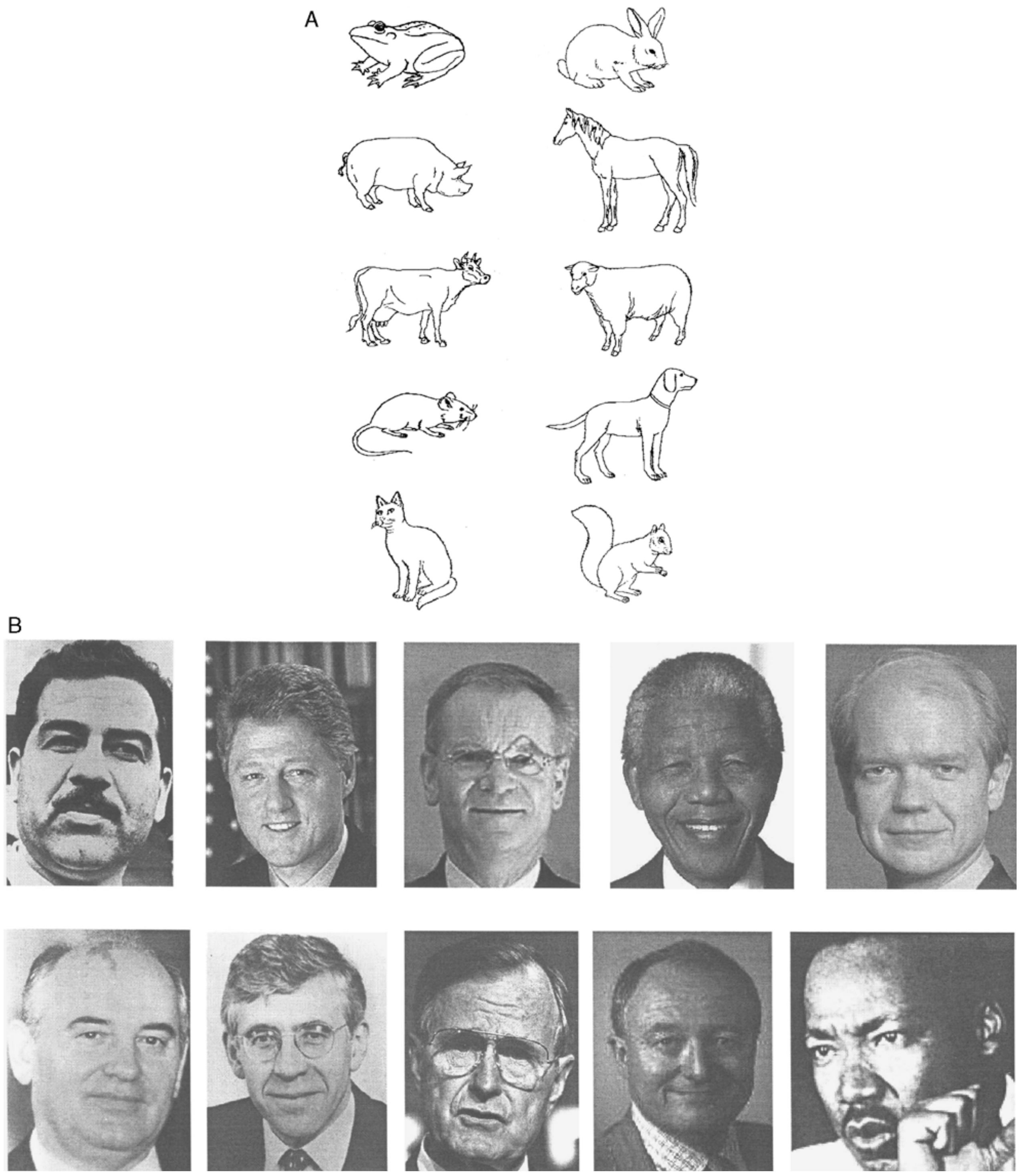

FIGURE 1. A, Sample stimulus from the word to picture matching test. B, Sample stimuli from the name to face matching test.

Person Information

To specifically address the relationship between naming and knowledge of famous people, a person identification task was additionally administered as part of the naming task. Subjects were asked to provide identifying information about each of the 48 famous people shown in the photographs. Subjects were given nonspecific prompts for each item (eg, Can you tell me anything else about this person?) to encourage them to give as much specific information as possible. A score of 1 was awarded for a uniquely identifying definition, whereas 0.5 was given for a correct response that provided less identifying details, such as occupational category.

Person Sorting Task

Thirty-two black and white photographs of famous faces were selected from the original 48-item set of famous faces plus a set of 32 unknown faces (64 items in total). These were presented individually for sorting at 3 different levels: level 1 where participants were asked to say whether each item was famous or nonfamous (chance level 50%), level 2 that involved assigning famous person items to 1 of 4 occupational categories (chance level 25%), and level 3 that asked for subordinate knowledge about the famous people (eg, dead or alive, British vs. foreign—chance level 50%). On a separate occasion, the sorting was repeated using name stimuli in place of face stimuli (total score out of 128).

Semantic Association Test

In this test, both targets and foils were drawn from the same occupational category and subjects were asked to match the stimulus item with the more closely associated item from 2 alternatives, in a similar format to the PPT task. The target and associate were linked by specific attributes (eg, Sean Connery and Roger Moore were linked by not only being actors, but having played James Bond). The test was given using a picture format with black and white photographs and a name format. Associates and foils were matched for familiarity (determined in a previous study using a separate group of control subjects). There were 48 items in each test format, with 1 point awarded per correct answer.

Name-to-Face Matching

In this task (Fig. 1B, SDC 1b Supplemental Digital Content 2, http://links.lww.com/CBN/A9), subjects were required to match spoken names to the appropriate face from an array of 10 famous people from the same occupational category. The position of the target item was randomized throughout the task and 1 point was awarded per correct item (total = 48).

RESULTS

Analysis

Analyses of variance (ANOVAs) were carried out on these data to ascertain whether performance differed across groups on percentage scores for person and general semantic knowledge tests (Table 2). Individual post-hoc comparisons were then performed on items where a significant task by group interaction was found.

Overall Task and Group Effects

Category fluency

As illustrated in Figure 2A–C, SDC 2a,b,c Supplemental Digital Content 3, http://links.lww.com/CBN/A10, MCI patients performed less well than controls on both the person (MCI mean = 16.15, SD = 10.79; NC mean = 47.36, SD = 7.58) and general semantic (MCI mean = 89.07, SD = 20.19; NC mean = 136.93, SD = 23.90) category fluency tasks. A 2(group) $\times$ 2(task) ANOVA revealed significant effects of task ($P < 0.001$) and group ($P < 0.001$), but no significant interaction was found between these variables, suggesting equivalent deficits on the 2 tasks (Table 2).

Object naming and person naming

Both groups performed better on the general (MCI mean = 61.31, SD = 3.09; NC mean = 62.43, SD = 0.94) than on the person naming task (MCI mean = 22.35, SD = 12.42; NC mean = 34.23, SD = 10.18) (Fig. 2B). A 2×2 ANOVA revealed significant effects of task ($P < 0.001$) and group ($P < 0.05$) as well as a significant task by group interaction ($P < 0.05$). Post-hoc comparisons confirmed a significant difference between the MCI and control group for person naming ($P < 0.05$) but not for object naming.

Person identification

Figure 2C illustrates performance on the person naming and identification tasks. Both groups' performance was better in the identification condition (MCI mean = 31.19, SD = 10.27; NC mean = 44.50, SD = 4.52). Controls improved from 70% (naming) to 93% (identification), whereas the MCI group improved from 47% to 63%. Independent *t*-testing confirmed a significant difference between NC and MCI groups on the identification task (t (16.2) = 4.3, P = 0.001). Paired *t*-tests revealed that both the control and MCI groups were significantly more impaired on the naming than the identification component of the task (MCI: t (12) = 7.0, $P < 0.001$, NC: t (12) = 5.5, $P < 0.001$).

Category sorting and person sorting

Initial analyses were performed for the total scores collapsed across levels on both the general semantic sorting tasks for pictures (MCI mean = 256.62, SD = 5.11; NC mean = 264.00, SD = 5.43) and words (MCI mean = 255.62, SD = 6.54; NC mean = 264.77, SD = 3.35) as well as person sorting tasks for faces (MCI mean = 123.23, SD = 11.65) and names (MCI mean = 130.62, SD = 9.64; NC mean = 138.07, SD = 4.87). For the nonverbal tasks, an ANOVA revealed significant effects of group ($F(1,24) = 19.8$, $P < 0.001$) and task ($F(1,24) = 69.5$, $P < 0.05$) as well as a group by task interaction ($F(1,24) = 4.5$, $P < 0.05$) (Table 2). Post-hoc independent *t*-tests revealed that the MCI group was impaired relative to controls on both face ($P < 0.05$) and picture sorting ($P < 0.05$). For the word-based sorting test, an ANOVA revealed an effect of group ($F(1,24) = 16.8$, $P < 0.001$), but no significant effects of task or group by task interaction (Table 2).

Figure 3A and B, SDC 3a,b Supplemental Digital Content 4, http://links.lww.com/CBN/A11 illustrate that differences between the patient and control groups become more apparent as the subjects are asked to sort at more specific levels on both the general and person sorting tasks.

For the person-based tasks, a 2 (modality) $\times$ 2(group) $\times$ 3 (level) ANOVA revealed significant effects

TABLE 2. 2 × 2 Analysis of Variance Table Comparing Percentage Scores for Person and General Semantic Tasks in the Mild Cognitive Impairment (MCI) and Normal Control (NC) Groups

Task	Task Effect	Group	Task×Group Interaction	Post Hoc (Independent *t*)
Category fluency	$F(1,25) = 115.6$ $P < 0.001$	$F(1,25) = 40.8$ $P < 0.001$	$F(1,25) = 0.2$ ns	
Naming	$F(1,24) = 69.5$ $P < 0.001$	$F(1,24) = 7.6$ $P < 0.05$	$F(1,24) = 6.3$ $P < 0.05$	MCI vs. NC (person): $t(24) = 2.67$, $P < 0.05$, $r = 0.48$ MCI vs. NC (general): $t(25) = 1.30$, $P = 0.21$ ns, $r = 0.25$
Sorting (nonverbal)	$F(1,24) = 7.6$ $P < 0.05$	$F(1,24) = 19.8$ $P < 0.001$	$F(1,24) = 4.5$ $P < 0.05$	MCI vs. NC (person): $t(25) = 3.45$, $P < 0.01$, $r = 0.57$ MCI vs. NC (general): $t(24) = 3.57$ $P < 0.01$, $r = 0.58$
Sorting (verbal)	$F(1,24) = 0.9$ ns	$F(1,24) = 16.8$ $P < 0.001$	$F(1,24) = 3.7$ ns	
Associative (nonverbal)	$F(1,25) = 48.5$ $P < 0.001$	$F(1,25) = 29.9$ $P < 0.001$	$F(1,25) = 16.1$ $P < 0.001$	MCI vs. NC (person): $t(17.6) = 4.68$ $P < 0.001$, $r = 0.74$ MCI vs. NC (general): $t(25) = 4.53$, $P < 0.001$, $r = 0.73$
Associative (verbal)	$F(1,24) = 40.5$ $P < 0.001$	$F(1,24) = 13.2$ $P < 0.001$	$F(1,24) = 19.1$ $P < 0.001$	MCI vs. NC (person): $t(24) = 4.10$ $P < 0.001$, $r = 0.63$ MCI vs. NC (general): $t(23) = 0.672$ $P = 0.509$ ns, $r = 0.14$
Category comprehension	$F(1,24) = 11.1$ $P < 0.05$	$F(1,24) = 8.8$ $P < 0.01$	$F(1,24) = 8.7$ $P < 0.01$	MCI vs. NC (person): $t(12.6) = 2.75$, $P < 0.05$, $r = 0.61$ MCI vs. NC (general): $t(24) = 1.72$ $P = 0.098$ ns, $r = 0.33$

of task ($F(1,23) = 8.42$, $P < 0.01$), difficulty ($F(2,46) = 214.40$, $P < 0.001$), and group ($F(1,23) = 16.0$, $P < 0.001$) but no significant interactions between any of these variables, suggesting that task difficulty was affecting the groups in a similar way. Post-hoc paired *t*-testing for the sorting of faces and names indicated significant differences between levels 1 and 2 ($P < 0.001$) and levels 2 and 3 ($P < 0.001$) for both groups.

In contrast, a mixed ANOVA of performance on the general semantic sorting tasks found no modality (word = picture) effect, but a significant effect of difficulty ($F(2,46) = 22.4$, $P < 0.001$), an interaction between difficulty and group ($F(2,46) = 7.6$, $P < 0.001$), and a further group × task × difficulty interaction ($F(2,46) = 5.4$, $P < 0.01$). Post-hoc paired *t*-testing revealed significant differences on both word and picture sorting between levels 1 and 2 ($P < 0.001$) and levels 1 and 3 ($P < 0.001$), but only between levels 2 and 3 for picture sorting ($P < 0.001$). A significant difference between groups was found only at level 3 of picture sorting ($P < 0.001$) and levels 2 ($P < 0.05$) and 3 ($P < 0.05$) of word sorting. These findings provide partial support for the hypothesis that subtle deficits in the MCI group are more likely to emerge at fine-grained levels of semantic processing Figures 4A and B, SDC 4a,b Supplemental Digital Content 5, http://links.lww.com/CBN/A12.

Association tasks: PPT and semantic association (person battery)

As shown in Figure 4A, control performance was well matched on the 2-choice association tasks. The control means were similar on both the picture (MCI mean = 50.08, SD = 1.04; NC mean = 51.57, SD = 0.646) and word versions (MCI mean = 50.91, SD = 0.831; NC mean = 51.21, SD = 1.31) of the PPT. A similar pattern is also evident in the mean scores of the face (MCI mean = 35.23, SD = 6.51; NC mean = 44.64, SD = 3.32) and name (MCI mean = 36.92, SD = 5.88; NC mean = 44.46, SD = 3.07) versions of the person associative test. Considering first the nonverbal tests, a 2 × 2 ANOVA revealed significant effects of task

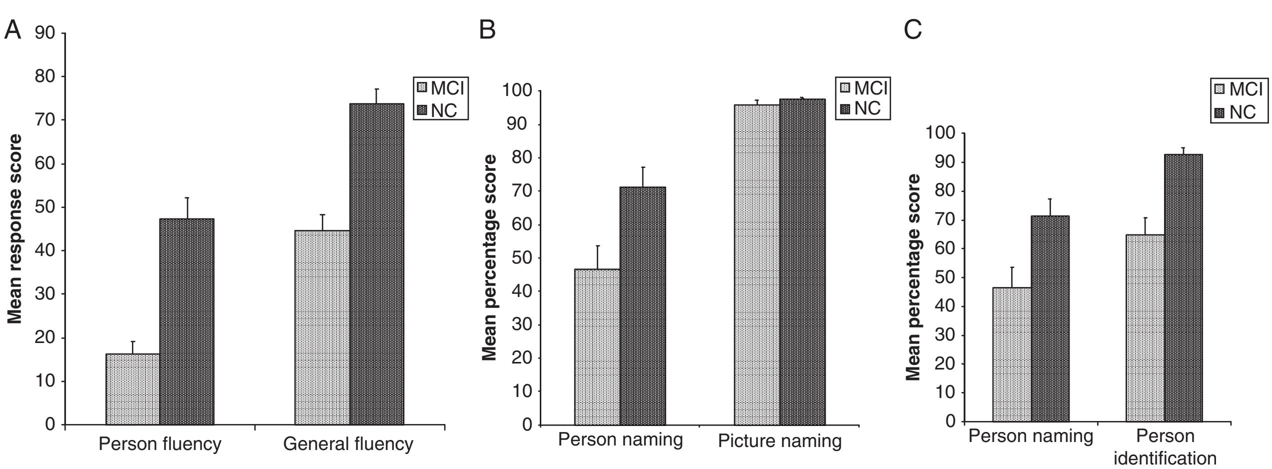

FIGURE 2. A, Mean response scores with standard error bars shown for the person and general semantic category fluency tasks in the control and MCI groups. B, Mean percentage scores with standard error bars shown for the person and general semantic naming tests in the control and MCI groups. C, Mean percentage scores with standard error bars shown for the person naming and person identification tasks in the control and MCI groups. MCI indicates mild cognitive impairment.

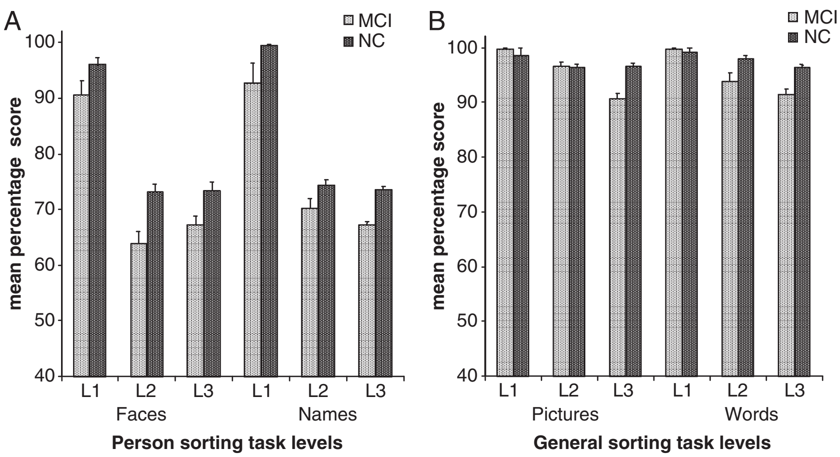

FIGURE 3. A, Mean percentage scores for the control and MCI groups at each level of the person semantic sorting tasks, with standard error bars shown. B, Mean percentage scores for control and MCI groups at each level of the general semantic sorting tasks, with standard error bars shown. MCI indicates mild cognitive impairment.

($P < 0.001$) and group ($P < 0.001$) and a task × group interaction ($P < 0.001$). The MCI groups were impaired relative to controls on both nonverbal associative tasks (face associative $P < 0.001$, PPT pictures $P < 0.001$).

For the verbal tasks, a 2 × 2 ANOVA (Table 2) revealed significant effects of group ($P < 0.001$) and task ($P < 0.001$) as well as a significant task × group interaction ($P < 0.001$). The MCI group only showed impairment on the 2-choice person name associative test ($P < 0.001$), but not on the word version of the PPT.

Word to picture matching and name to face matching

As shown in Figure 4B, percentage control performance was equivalent on both the name to face matching (MCI mean = 43.15, SD = 5.73; NC mean = 47.57) and word to picture matching (MCI mean = 63.17, SD = 1.19; NC mean = 63.78, SD = 0.58). A 2 (group) × 2 (task) ANOVA revealed significant task ($P < 0.05$) and group ($P < 0.01$) and interaction effects ($P < 0.01$) between these variables. The MCI group was impaired relative to controls on name to face matching ($P < 0.05$) but not on word to picture matching.

Effect of Participant Sex on Performance of Person Knowledge Tests

Descriptive analyses (Table 3) revealed a possible effect of participant sex on the performance of person naming and identification within the MCI group, though the participant numbers were too small to conduct meaningful inferential statistics. As indicated in Table 3, the mean performance of female patients appears to be lower than male MCI patients on items of person naming and identification, though performance of both males and females appeared to be similar among control participants. Further data collection would be required to establish whether this pattern in the MCI group might be an artifact of the sample size or reflect a potential sex bias within the test stimuli, given the relatively larger number of high familiarity male target items. The later

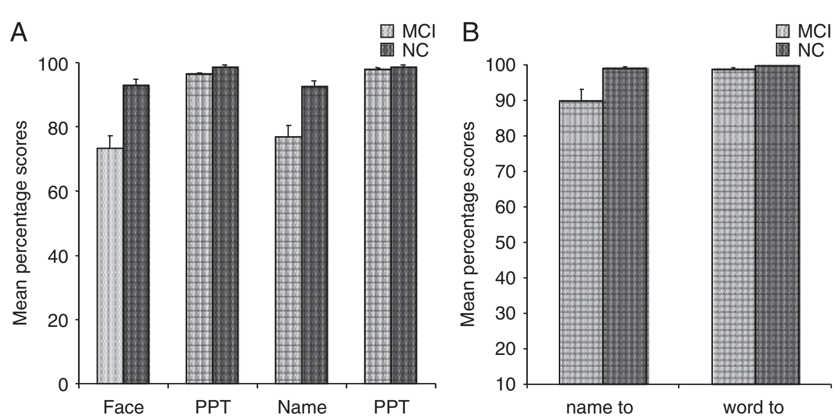

FIGURE 4. A, Mean percentage scores for the person associative and PPT tasks in the MCI and control groups with standard error bars shown. B, Mean name to face and word to picture matching scores in the MCI and control groups with standard error bars shown. MCI indicates mild cognitive impairment; PPT, Pyramids and Palm Trees.

TABLE 3. Mean Performance of Male and Female Participants in the Normal Control and Mild Cognitive Impairment Groups on Items From the Person Knowledge Battery

		MCI		NC	
Person Knowledge Test	**Participant Sex**	**Mean**	**SD**	**Mean**	**SD**
Category fluency (famous people)	Male	20.00	13.16	55.14	17.63
	Female	12.86	7.81	39.57	14.75
Person naming	Male	29.83	9.72	34.71	10.44
	Female	15.93	11.20	33.67	10.83
Person information	Male	37.50	7.18	44.21	5.87
	Female	25.79	9.70	44.79	3.11
Total face sorting	Male	127.00	8.12	137.71	3.40
	Female	120.00	13.78	138.43	6.29
Total name sorting	Male	134.50	5.99	141.57	1.27
	Female	127.29	11.31	141.57	2.07
Two choice associative (faces)	Male	38.83	6.21	44.86	2.73
	Female	32.14	5.34	44.43	4.04
Two choice associative (names)	Male	39.50	5.47	44.50	2.74
	Female	34.71	5.65	44.43	3.55
Name to face matching	Male	46.33	2.66	47.71	0.76
	Female	40.42	6.40	47.43	1.13

possibility seems relatively unlikely given the apparent matching of performance in male and female control participants.

Effect of Severity on Performance

To quantify how disease severity might affect performance on the person battery, composite scores were calculated for three of the most sensitive measures (naming, nonverbal associative, total nonverbal sort). The scatter plot in Figure 5A, SDC 5a Supplemental Digital Content 6, http://links.lww.com/CBN/A13 directly compares the distribution of percentage composite scores from each battery according to severity, as measured by MMSE. The person semantic composite appears to be more noticeably compromised toward the lower MMSE range, though these scores are hard to interpret in a sample of this size. Figures 5B and C, SDC 5b,c Supplemental Digital Content 6, http://links.lww.com/CBN/A13, depict individual z-scores for this composite measure and equivalent components for the general semantic battery, ordered according to MMSE, thus facilitating comparison to the matched control data. Considering the mildest subjects with an MMSE > 26 (taken as the half point of the range 30 to 23), it is notable that the person composite score is less often impaired in individuals within this upper range (3/7) than in individuals with scores of 26 and below (5/6). In contrast, on the general semantic composite score only 3 subjects out of 13 deviated more than 2 SD from the mean (compared with 8/13 for the people tasks).

Summary

The MCI group was significantly impaired, relative to controls, on all tasks of person knowledge as well as picture sorting and PPT (pictures). More detailed analysis of the sorting task collapsed across levels suggested that

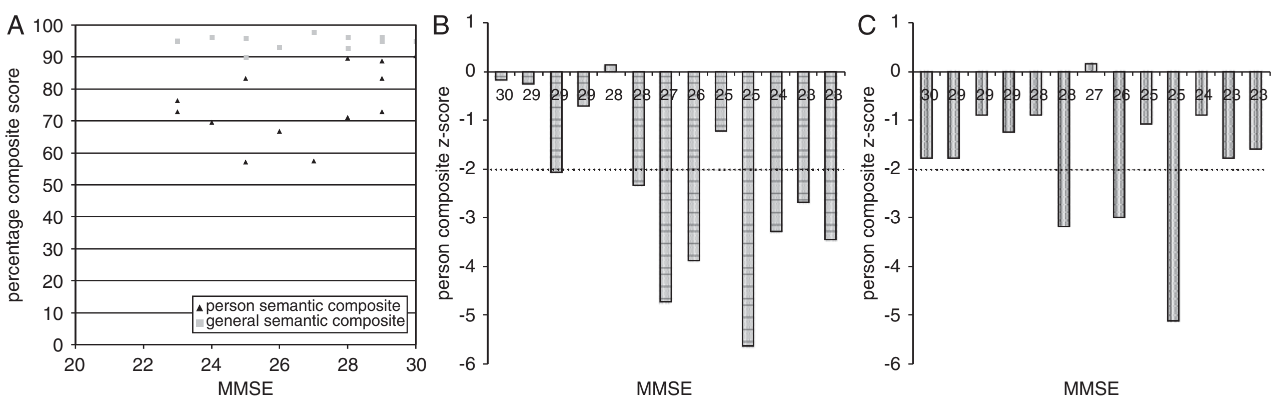

FIGURE 5. A, Scatter plot comparing distribution of percentage person semantic and general semantic composite scores within the MCI patient group according to MMSE score. B, Person semantic composite z-scores in the MCI patients. C, General semantic composite z-scores in the MCI patients. MCI indicates mild cognitive impairment; MMSE, Mini-Mental State Examination.

the MCI group was impaired relative to controls on the later, more difficult components of general semantic sorting. Finally, composites of scores from the person knowledge and general semantic battery indicated that combined tasks of person knowledge demonstrated some sensitivity to severity as measured by MMSE.

DISCUSSION

The finding of person semantic impairment in MCI extends previous studies in MCI and mild AD,[6,14–17] suggesting that multiple domains of person semantic knowledge are impaired in this patient group. Both person naming and semantic knowledge were impaired in the MCI group, and these findings are more easily reconciled with an underlying semantic deficit than an isolated proper name anomia. Furthermore, a composite of the 3 most discriminating person knowledge tasks appears to be particularly sensitive to increased disease severity, consistent with suggestions that deterioration in person knowledge may be more sensitive to disease progression in this group.[20] These findings also support earlier evidence that impairments in person naming and identification may be early markers of later conversion to AD.[5,15]

Another aim of this investigation was to see if person knowledge is more impaired early in MCI than more general semantic knowledge.[15] This is a complex issue, as person-based tasks are generally more difficult. Although we attempted to match tasks across domain, thus controlling for item difficulty, ANOVA revealed significant overall task effects for naming, fluency, and picture association tasks, leaving open the possibility that patients performed less well owing to the nature of the task.

An interesting outcome of this experiment was the differing sensitivity of sorting tests within the 2 batteries. Rather surprisingly, the later stages of the person sorting tasks seemed less sensitive to deficits in the MCI group than nonverbal general semantic sorting, probably as a result of the greater number of sorting categories at the later level of the task. The person-sorting test consisted of separating names or pictures of famous from nonfamous people, then subsequently sorting the famous people into 3 occupations and 2 final subcategories of that occupation. In contrast, the general semantic sorting task involved sorting stimuli into living and nonliving, then sorting into 3 categories at level 2 (eg, animals, birds, and fruit), and finally sorting subsets of living and nonliving items according to fine-grained categories at level 3 (eg, presence or absence of wooden parts). It seems, therefore, that the general semantic task may have been more taxing to perform overall and more likely to reveal deficits between the groups.

The most compelling evidence that tests of person knowledge might be more sensitive to semantic deficits in incipient dementia comes from the finding of significant group by task interactions on the majority of person tests, with post-hoc analyses indicating significantly worse performance in the MCI group. Well-matched control performance on semantic and person knowledge tasks such as verbal association and verbal to nonverbal matching appeared to indicate increased sensitivity of the person knowledge tests to impairment in MCI participants. This pattern was not, however, universal across the battery, and difficulty effects are also likely to have influenced comparisons between the batteries. Ceiling effects were also present in much of the control data on equivalent tasks from the 2 semantic batteries, making it difficult to conclusively infer differential levels of semantic impairment within the patient group.

The associative tasks appear most sensitive to deficits in the MCI group, though these measures could be difficult to apply clinically owing to cultural differences. In conjunction with tasks such as person naming or name to face matching, person associative tests might serve as a quick screen for mild semantic deficits in addition to any impairment revealed by standard episodic memory tests.

Person semantic deficits seem to be associated with disease severity and might, therefore, be an indicator of rapid conversion to dementia. In keeping with this, 1 study found that MCI patients who converted to AD within 2 years performed significantly less well on a task of person identification than matched controls and MCI patients who did not develop AD over the same time interval.[5] Semenza and colleagues[17] also reported person name retrieval deficits in patients who did not meet MCI criteria at the time of testing, but subsequently converted to dementia after 6 months of follow-up. Taken together with the findings of the current study, there is, therefore, a growing body of evidence to suggest that tasks of person knowledge could be usefully applied to screening for and monitoring the progression of MCI and early dementia symptoms.

Potential explanations for the apparent sensitivity of person knowledge to deterioration in MCI include the possibility that the representation of knowledge related to unique exemplars is "less robust" than more generic general semantic information.[20] Some structures thought to be compromised in MCI and AD have also been implicated in famous person naming, including the anterior temporal lobe[33] and hippocampus.[34,35] More recently, Joubert and colleagues[20] noted an apparent correspondence between knowledge and the integrity of both anterior temporal and prefrontal cortex in patients with MCI, suggesting that some additional executive functions may be recruited during tasks related to famous person knowledge.

Nonverbal stimuli seemed to be more sensitive to impairment, consistent with some of the findings of Joubert et al.[20] It is also possible that the perceptual properties of target stimuli may also have had some bearing on task performance.

The findings of this study are clearly consistent with evidence that semantic deficits are predictive of progression to dementia.[36–39] The current National Institute of Neurological and Communicative Disorders and Stroke and Alzheimer's Disease and Related Disorders Association criteria for probable AD[40] stipulate that deficits must be present in at least 2 areas of cognition to confer this diagnosis with a significant impact on everyday life. Findings indicating impairment across multiple domains in MCI give some justification to reverting to the earlier designations of minimal or early stage AD.[7,14] There are also reports, however, of individuals with MCI who do not convert to dementia[41] and MCI classification is somewhat dependent on the choice of measures applied and the cut-offs used to define actual impairment.[42]

Adding a semantic information component to the general semantic stimuli may have given a more detailed indication of participants' ability to define items according to category and more fine-grained areas of knowledge. The use of foils drawn from the original target items in the word to picture matching task is a further potential weakness in test design that may have resulted in some task facilitation, thus contributing to a lack of effect among the MCI patients on this task. Other limitations of the current dataset include the size of subject group (although testing of each subject was very time consuming) and the possible influence of media exposure on task performance and the lack of follow-up data as a result of relocation of the authors. Nonetheless, the stimuli employed in this study had high familiarity and provide informative insights into the status of person knowledge of a group of MCI patients.

Given the interesting pattern of deficits across multidimensional areas of semantic knowledge revealed by the current study, a worthwhile question for further investigation might be to explore and compare fine-grained semantic functioning across other unique semantic entities. Initial work exploring naming and identification across other domains in patients with MCI (eg, the findings of Ahmed and colleagues[19]) indicates that other areas of semantic knowledge, for example, famous buildings, may also be germane to the identification of early dementia symptoms.

In summary, individuals with MCI exhibited impaired famous person naming, which also appeared to be associated with deficits in person semantic knowledge.[15] The marked impairment of person knowledge, particularly in subjects with lower MMSE scores, suggests that person knowledge may be sensitive to pathology. Tasks of person knowledge in conjunction with other areas of cognitive function might, therefore, provide informative insights into the progression of MCI.

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APPENDIX

Appendix A

Target items included in the general semantic battery:

1. Apple	17. Duck	33. Mouse	49. Scissors
2. Axe	18. Dustbin	34. Orange	50. Screwdriver
3. Banana	19. Eagle	35. Ostrich	51. Sledge
4. Barrel	20. Elephant	36. Owl	52. Spanner
5. Basket	21. Envelope	37. Paintbrush	53. Squirrel
6. Bike	22. Frog	38. Peacock	54. Stool
7. Bus	23. Glass	39. Pear	55. Strawberry
8. Camel	24. Hairbrush	40. Penguin	56. Suitcase
9. Candle	25. Hammer	41. Piano	57. Swan
10. Cat	26. Helicopter	42. Pineapple	58. Tiger
11. Cherry	27. Horse	43. Plane	59. Toaster
12. Chicken	28. Kangaroo	44. Pliers	60. Tomato
13. Comb	29. Key	45. Plug	61. Toothbrush
14. Cow	30. Lorry	46. Rabbit	62. Tortoise
15. Crocodile	31. Monkey	47. Rhino	63. Train
16. Dog	32. Motorbike	48. Saw	64. Watering can

Appendix B

Target items included in the person-specific semantic battery (ordered by familiarity):

1. Princess Diana	25. Harold Wilson
2. Adolf Hitler	26. Andre Agassi
3. Tony Blair	27. John Thaw
4. Paul McCartney	28. John F Kennedy
5. John Cleese	29. David Beckham
6. Barbara Windsor	30. Mo Mowlam
7. Nelson Mandela	31. Ken Livingstone
8. Cliff Richard	32. Alfred Hitchcock
9. Margaret Thatcher	33. Terry Waite
10. Bill Clinton	34. Bob Geldof
11. Dawn French	35. Hugh Grant
12. Eric Morcambe	36. Mahatma Gandhi
13. Sean Connery	37. George Best
14. David Attenborough	38. Ronald Reagan
15. Gary Lineker	39. Humphrey Bogart
16. Tom Jones	40. Camilla Parker Bowles
17. Terry Wogan	41. Angus Deayton
18. Mick Jagger	42. David Blunkett
19. John Lennon	43. Sebastian Coe
20. Peter Sellers	44. Lester Piggott
21. Saddam Hussein	45. Buddy Holly
22. Elizabeth Taylor	46. Delia Smith
23. Stephen Fry	47. Luciano Pavarotti
24. Tim Henman	48. Steve Redgrave