Note

Naming of objects, faces and buildings in mild cognitive impairment

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ABSTRACT

Accruing evidence suggests that the cognitive deficits in very early Alzheimer’s Disease (AD) are not confined to episodic memory, with a number of studies documenting semantic memory deficits, especially for knowledge of people. To investigate whether this difficulty in naming famous people extends to other proper names based information, three naming tasks – the Graded Naming Test (GNT), which uses objects and animals, the Graded Faces Test (GFT) and the newly designed Graded Buildings Test (GBT) – were administered to 69 participants (32 patients in the early prodromal stage of AD, so-called Mild Cognitive Impairment (MCI), and 37 normal control participants). Patients were found to be impaired on all three tests compared to controls, although naming of objects was significantly better than naming of faces and buildings. Discriminant analysis successfully predicted group membership for 100% controls and 78.1% of patients. The results suggest that even in cases that do not yet fulfill criteria for AD naming of famous people and buildings is impaired, and that both these semantic domains show greater vulnerability than general semantic knowledge. A semantic deficit together with the hallmark episodic deficit may be common in MCI, and that the use of graded tasks tapping semantic memory may be useful for the early identification of patients with MCI.

1. Introduction

Impairment of episodic memory is the hallmark of Alzheimer’s Disease (AD), at least in the vast majority of cases (Welsh et al., 1992). It is now well established, however, that semantic memory breakdown is also a consistent finding in patients, even in the early stages of the disease (Chertkow and Bub, 1990; Hodges and Patterson, 1995; Dudas et al., 2005), with studies indicating that knowledge for famous people appears to be particularly vulnerable (Greene and Hodges, 1996). Before reaching full-blown dementia, patients with AD pass through a stage of more subtle cognitive impairment that can last for several years. A number of terms have been used to describe this pre-dementia phase. The most popular term is Mild Cognitive Impairment (MCI). Patients with MCI present with complaints of memory problems and perform poorly on neuropsychological tests of memory, but do not meet diagnostic criteria for AD as judged by performance on global screening.
instruments such as the Mini Mental State Examination (MMSE), and preservation of activities of daily living. Conversion rates from MCI to frank dementia of 15–25% over 2 years have been reported (Petersen et al., 2001; Bozoki et al., 2001; Albert et al., 2001; De Jager et al., 2003).

Although MCI was originally conceptualised as a purely episodic disorder, more recent studies have documented additional deficits in semantic memory (De Jager et al., 2003; Bozoki et al., 2001; Dudash et al., 2005; Clague et al., 2005). For example, Thompson et al. (2002) reported disproportionate deficits across semantic categories in a comparison of a novel Graded Faces Naming Test (GFT) and the more commonly used Graded Naming Test (GNT; McKenna and Warrington, 1980). Patients with questionable dementia – equivalent to cases now given a diagnosis of MCI – showed significantly greater impairment at baseline on the GFT compared to controls. Of the participants with questionable dementia who performed within the normal range on the GFT, only 6% progressed to AD properly compared to 86% of those who initially showed deficits on the GFT. Similarly, Estevez-Gonzalez et al. (2004) used a task of famous face identification and reported that MCI patients performed significantly worse than a control group. The current study addresses the question of whether the semantic impairment in MCI is specific to people or whether it extends to other proper name based information.

To explore this issue we investigated the knowledge of famous buildings. Unlike faces, buildings are not perceptually homogenous but share the feature of being semantically unique with associated proper names. Studies on testing knowledge and/or naming for buildings are few. Milders (2000) tested normal controls and patients with closed head injury on two tests of retrieval: retrieval of people names and retrieval of buildings’ names. Milders reported no significant difference in retrieval of famous buildings or famous names. Similarly, Brennen et al. (1990) showed that in normal participants the mean percentage error for naming of faces and buildings was similar, reporting 20% and 15% error, respectively.

Our study used the established GNT and GFT and the newly designed matched Graded Buildings Test (GBT), which incorporates famous buildings, to investigate naming in a large group of individuals with MCI. We predicted that performance on the GFT and GBT would be similar, with scores on both being consistently worse than those obtained on the GNT. At a theoretical level we wished to address the issue of whether patients with amnestic MCI also have deficits in semantic memory extending to person and building knowledge, and clinically whether test performance might discriminate MCI and controls. Our aim was to look into nature of impairment in the memory domain. Hence this paper accepts that episodic memory is the most salient impairment in aMCI, above other domains, but also suggests semantic memory is similarly a salient impairment in aMCI. A battery which includes tests of semantic and episodic memories may be valuable for diagnosis.

1.1. Method

1.1.1. Participants

A total of 69 participants took part in the study, 32 MCI patients (14 males, 18 females, mean age 69.5 ± 8.2) and 37 normal controls (19 males, 18 females, mean age 66.8 ± 5.5). Equal group sizes were initially recruited (n = 40) but 8 MCI patients were subsequently excluded because of changes in diagnosis. Three controls were excluded because of doubts about their cognitive status on the basis of screening questions about memory. Control participants were recruited from the Medical Research Council Cognition and Brain Sciences Unit Volunteer Panel in Cambridge, UK deemed cognitively normal by MMSE score >24 and no complaints of memory problems with no history of neurological or psychiatric illness. MCI patients were recruited from the Memory Disorders Clinic at Addenbrooke’s Hospital in Cambridge. Diagnosis of MCI was made by a senior neurologist based on the criteria outlined by Grundman and Petersen (2004) and Petersen et al. (2001), namely: (1) memory complaints corroborated by an informant; (2) evidence of memory impairment (>1.5 standard deviations (SDs) below control mean for delayed recall) based on the Rey Auditory Verbal Learning Test (RAVLT); (3) preserved activities of daily living (ADL); and (4) no evidence of dementia as judged by an MMSE score >24 and clinical judgement. MCI patients did not present with any significant psychiatric disorder or concomitant neurological disease (such as epilepsy, alcoholism or head injury). Patients taking medication to maintain cognitive function were excluded. t-Tests showed no significant difference between the two groups on age (t = 1.7, df = 67, p = .102) and education (t = 1.6, df = 67, p = .120). There was a significant difference in MMSE scores (t = 3.8, df = 66, p = .000).

1.1.2. Neuropsychological tests

All MCI patients were administered a general neuropsychological battery assessing global cognition, memory and fluency (Table 1). MCI patients were impaired on all components of the RAVLT, recall of the Rey-Osterrieth figure and on the ACE. Stein et al. (2001) reported 20% and 15% error, respectively.

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### Table 1 – Means and SDs of demographics and general neuropsychological testing and graded tasks

<table>
<thead>
<tr>
<th></th>
<th>Control (n = 37)</th>
<th>MCI (n = 32)</th>
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<tbody>
<tr>
<td>Age (years)</td>
<td>66.8 (5.5)</td>
<td>69.5 (8.2)</td>
</tr>
<tr>
<td>Education (years)</td>
<td>13.8 (2.2)</td>
<td>12.8 (2.9)</td>
</tr>
<tr>
<td>Gender (male:female)</td>
<td>19:18</td>
<td>14:18</td>
</tr>
<tr>
<td>Global cognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MMSE</td>
<td>28.8 (1.3)</td>
<td>27.2 (2.0)</td>
</tr>
<tr>
<td>ACE</td>
<td>94.5 (2.8)</td>
<td>82.9 (6.9)*</td>
</tr>
<tr>
<td>Memory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rey figure copy</td>
<td>–</td>
<td>33.1 (3.2)*</td>
</tr>
<tr>
<td>Rey figure delayed recall</td>
<td></td>
<td>7.8 (6.7)*</td>
</tr>
<tr>
<td>RAVLT total</td>
<td>–</td>
<td>30.3 (6.5)*</td>
</tr>
<tr>
<td>RAVLT recall after interference</td>
<td>–</td>
<td>3.3 (2.2)*</td>
</tr>
<tr>
<td>RAVLT 30 min delayed recall</td>
<td></td>
<td>2.8 (2.2)*</td>
</tr>
<tr>
<td>RAVLT recognition</td>
<td>–</td>
<td>10.8 (2.7)*</td>
</tr>
<tr>
<td>Graded tasks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GNT</td>
<td>26.1 (1.8)</td>
<td>19.7 (4.9)</td>
</tr>
<tr>
<td>GBT</td>
<td>24.7 (2.6)</td>
<td>15.9 (5.0)</td>
</tr>
<tr>
<td>GFT</td>
<td>22.2 (3.1)</td>
<td>14.0 (5.1)</td>
</tr>
</tbody>
</table>

*a* Scores suggest impairment (1.5 SD below mean) relative to internally established mean scores obtained form matched controls.
et al., 2000). Controls could not be tested with additional neuropsychological testing in this particular case due to limited time and manpower.

When developing the GFT and GBT, 60 faces and 60 buildings were administered to 28 controls (a different group from that reported in the experimental section of this study, mean age 66.9 ± 7.5; mean education 14.7 ± 2.5) for naming and identification. These results were used to select 30 items of graded difficulty, with naming for the items ranging from 100% to 20% of participants (the same range used in the GNT). Items were then matched on a three-way basis across all three tests, in order that each task contained a similar number of items that were similarly named by controls. Overall, this matching process resulted in the following mean naming accuracy (SDs in parentheses): GFT (21.5 ± 4.2) and GBT (22.4 ± 3.8), with the published figures given for the GNT being 20.4 ± 4.1 (Warrington, 1997). More specific details for each test are provided below (stimuli lists are provided in Appendix) (Fig. 1).

GNT (McKenna and Warrington, 1980): participants named 30 black and white line drawings of objects, starting with highly familiar objects (e.g., a kangaroo and scarecrow) and ending with more difficult and unusual exemplars (e.g., a cowl and retort). One mark was awarded for each correct name provided.

GFT: participants were asked to provide the full name for 30 famous faces presented using black and white greyscale images. The stimuli covered the last 50 years (1950–2000) with six items presented per decade. As for the GNT, as the test progressed, the famous faces become more difficult to name, as measured by the pilot naming data. One mark was awarded for each correct name provided.

GBT: participants were shown colour pictures of 30 famous buildings from across the world, for example, Buckingham Palace and Taj Mahal, and asked to provide the name of the building. A mark was given for each correct full name.

2. Results

The mean number of correct responses on each of the three tests can be seen in Fig. 2. In both groups the pattern of naming accuracy was the same: GNT > GBT > GFT. MCI patients made significantly fewer correct responses to faces, buildings and objects in comparison to controls. A 2 × 3 ANOVA (group × test) revealed a significant main effect of group ($F(1,67) = 107.68$, $p < .001$), significant main effect of test ($F(2,134) = 49.22$, $p < .001$) and a significant interaction between group and test ($F(2,134) = 3.40$, $p < .05$). Pairwise post hoc comparisons between groups confirmed a significant difference between MCI and controls on all three tests (GNT: $t = 7.0$, $df = 67$, $p < .001$; GFT: $t = 7.9$, $df = 67$, $p < .001$; GBT: $t = 8.9$, $df = 67$, $p < .001$).

A components of interaction test showed that differential impairment was significantly greater for GFT and GBT than GNT ($F(1,67) = 7.661$, $p < .01$), suggesting that unique exemplars were significantly more difficult to retrieve than

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**Fig. 1** – Examples from the (a) GNT; (b) GFT; (c) GBT.

**Fig. 2** – Comparison of the total correctly named items on the GNT, GFT and GBT (maximum score = 30). All differences between the control group and MCI patients were significant. Error bars represent the standard error of the mean; s – significant group difference, * – significant task difference in control group, † – significant task difference in MCI group.
common exemplars. There was no significant group effect for GFT versus GBT (F(1,67) = 0.468, p > .05), suggesting that differential impairment was the same for unique exemplars of different categories.

Pairwise post hoc comparisons confirmed the pattern evident in Fig. 2 that performance in the control participants was significantly different across all tests (GNT vs GBT (t = 2.7, df = 36, p < .01), GNT vs GFT (t = 6.6, df = 36, p < .001) and GBT vs GFT (t = 5.0, df = 36, p < .001)). While the MCI participants showed a significance difference between the GNT vs GBT (t = 5.9, df = 31, p < .001) and GNT vs GFT (t = 6.7, df = 31, p < .001) tests, their performance on the GBT and GFT was similar (t = 1.9, df = 31, p = .067). This pattern suggests equivalent impairment on the GBT and GFT in the MCI group.

2.1 Individual scores

Impairment was defined as 1.5 SDs below the control mean. Looking at the overlap of impairment across the tests 13% of controls were impaired on only one test (3% GNT, 5% GFT, 5% GBT) with the remaining 87% showing no impairment. Of the MCI cases, 13% showed no impairment, 31% were impaired on one test only (12% GNT, 12% GFT, 7% GBT), 28% were impaired on two tests (19% GNT and GFT, 3% GFT and GBT, 6% GNT and GBT) and 28% were impaired on all three tests.

2.1.1 Discriminant analysis

A combined discriminant analysis was performed with diagnosis as the dependent variable and GNT, GFT and GBT scores as predictor variables (Table 2). All 69 cases were entered. The correlations between predictor variables and the discriminant function suggested that GBT (r = .597), then GFT (r = .468), and then GNT (r = .157) were the best predictors of diagnosis. Overall the discriminant function using all three variables successfully predicted group membership for 100% of controls and 78.1% of patients suggesting that false positives were unlikely but false negatives (21.9%) were more common.

### Table 2 – Classification results of discriminant analysis

<table>
<thead>
<tr>
<th>Diagnosis on entry</th>
<th>Predicated group membership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MCI</td>
</tr>
<tr>
<td>Count</td>
<td>25</td>
</tr>
<tr>
<td>Normal</td>
<td>0</td>
</tr>
<tr>
<td>%</td>
<td>78.1</td>
</tr>
<tr>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

3 Discussion

The findings reported here replicate earlier studies documenting deficits in MCI patients that extend beyond episodic memory. Of particular note was that 87% of the individuals considered at high risk of developing dementia were impaired, compared to controls, on at least one of the naming tasks. The difficulties exhibited by the patients were particularly severe for the more unique semantic exemplars (buildings and faces). This study, therefore, confirms Thompson et al.’s (2002) reported finding of greater vulnerability for person’s knowledge over general semantic knowledge and extends this by adding new evidence suggesting that famous buildings are a similarly vulnerable category (see also Blackwell et al., 2004; De Jager and Budge, 2005; Van Lancker and Klin, 1990). Furthermore, the graded tests have good discriminant capabilities. The tests are able to distinguish between normal control performance and those with early stage dementia although some false negatives are possible (21.9% of cases). A combination of the graded semantic tasks may aid in earlier and more specific diagnosis, with implications for therapeutic intervention to delay the onset of frank dementia.

We have not addressed the question of whether the impairment in naming reflects problems with lexical access or a breakdown in the structure of semantic knowledge concerning famous people and buildings. Earlier studies of naming and knowledge of people in patients with very mild AD, some of whom would now be classified as MCI, points strongly towards a semantic disorder (Greene and Hodges, 1996; Binetti et al., 1995; Hodges et al., 1992).

In addition there are fundamental differences in the structure of semantic knowledge about things and people. Proper names are special because of their unique mapping and are thought to be more difficult to retrieve than common nouns due to the weak and arbitrary links between a proper noun and its reference. Detailed discussion on theories of proper name production can be found in Valentine et al. (1996). This is consistent with the widespread notion that proper names are essentially more difficult to retrieve, even in the healthy aged with intact recognition and knowledge for the famous people they are asked to name (Semenza et al., 1996, 2003; Bredart, 1993). The significant advantage in controls for naming of buildings over faces has been reported. Hanley and Kay (1998) noted that naming problems extended to other types of proper names in patients with quantitatively more severe face naming impairment (see also Fery et al., 1995). Brennen et al. (1990) and Milders (2000) also reported numerically (albeit not significantly) higher percentage naming for buildings over faces in normal participants.

Furthermore, there is evidence for anatomically distinct regions in the brain for processing of objects, people and buildings. The results of this study are in keeping with the idea that closely related brain regions are involved with the processing of famous people and famous building knowledge. Gorno-Tempini and Price (2001) found that the left anterior medial temporal cortex responded to famous faces and famous buildings. Similarly, Grabowski et al. (2001) asked normal participants to name pictures of famous faces and famous landmarks, including buildings and natural landscapes. Both categories produced increased activation in the left temporal pole relative to baseline activity at rest. There was no main effect of category suggesting that the left temporal pole is associated with retrieval of unique items rather than specific retrieval of categories of proper names. This emphasises that semantically unique items place demands on the same area of semantic processing as each other, and this is at least partially separate from common name processing, although not an absolute dichotomy (Hodges and Graham, 1998).
There is a common assumption of early and specific MTL damage in MCI but the results of this study support the literature showing that pathology, even very early on, must extend beyond the hippocampus. A number of studies have shown early temporal neocortex involvement (Convit et al., 2000; De Santi et al., 2001; Chetelat and Baron, 2003). This early temporal involvement may be relevant to the differential impairment in naming unique and non-unique entities. Moore and Price (1999) suggested that naming faces stimulates more activation in the semantic areas in comparison to naming objects because the semantic features associated with famous faces are unique and not applicable to other members of the category. It should be noted that not all aMCI showed semantic impairment. This variability in impairment might be accounted for by differences in severity of the disease process, differences in progression of disease, or educational and autobiographical experiences. This is an important focus for future research as it has been reported that MCI patients who convert to AD at follow up show greater atrophy in temporal areas than those who do not progress (Convit et al., 2000; Bell-McGinty et al., 2005; Hirao et al., 2005). It is important to note here that we are not attempting to dispute the notion of early episodic amnesia in aMCI. Our aim in this study was to highlight, in conjunction with this consistent episodic amnesia, other points of focus for optimal diagnostic efficacy in early stage disease. We agree that if MCI is considered to be incipient AD, as it is generally regarded, then the neuropathological features of AD will be present (Morris et al., 2001; Price et al., 2001). Hence in addition to the hallmark initial episodic memory deficit one might also expect sensitive neuropsychological instruments to detect impairment in other cognitive domains.

In retrospect there are a number of potential limitations, which must be acknowledged. The stimuli used were prototypical examples of objects, buildings and famous faces as far as they could be named by normal age and education matched controls. We matched items from the GNT, GBT and GFT according to the percentage of controls that could correctly name each item, with the GNT items being presented as line drawings and the GBT and GFT as photos. We accept that line drawings and photos may be visually processed differently. This may have added perceptual difficulty although such difficulties are not usually reported in MCI. This study could be replicated using photos of objects instead of drawings, where we would hypothesise the same result.

The notion that a semantic deficit together with the hallmark episodic deficit may categorise MCI merits to further study. However, we do not mean to suggest that semantic difficulties are specific. Instead, we confirm early semantic impairment and suggest semantic impairment as a point of emphasis in clinical testing, where the majority of clinical tests emphasize episodic memory. There is growing evidence that semantic memory is also a salient impairment in aMCI (Clague et al., 2005; Dudas et al., 2005; Thompson et al., 2002). It would be interesting to follow up performance on the graded tasks to map the progression of MCI patients who convert to AD and those who remain stable or revert to normal functioning. Retrospective data could provide valuable diagnostic information. Further study might look into using the graded tests in conjunction with imaging to help consolidate research into the structure and processes of semantic memory and also to delineate if the naming problem is due to semantic degradation or lexical access.

4. Conclusion

In conclusion, the results suggest that naming is impaired in MCI patients relative to controls, and can be used as an early diagnostic tool. The characteristics of proper names make them particularly sensitive to this naming deficit. The results confirm that impairments in generating semantic information can be seen very early on, in the pre-clinical stages of AD. Used together as a mini battery, the graded tests could prove useful as a sensitive indicator of the status of semantic memory in MCI.

Acknowledgements

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Appendix

Famous buildings utilised in the Graded Buildings Test (in ascending order of difficulty):

1. Taj Mahal
2. Leaning Tower of Pisa
3. Stonehenge
4. Statue of Liberty
5. Great Wall of China
6. Eiffel Tower
7. Big Ben/St. Stephen’s Tower
8. BT/British Telecom/Post Office Tower
9. Tower Bridge
10. Windsor Castle
11. Stansted Airport
12. Buckingham Palace
13. Sphinx
14. St. Paul’s Cathedral
15. Millennium Dome
16. Cenotaph
17. King’s College Chapel
18. Nelson’s Column
19. Arc de Triomph
20. (British Airways) London Eye
21. Notre Dame (Cathedral)
22. Golden Gate Bridge
23. Brandenburg Gate
24. Parthenon
25. Louvre
26. St. Pancras Station
27. Mount Rushmores
28. Capitol Building
REFERENCES


