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Personal memory function in mild cognitive impairment and subjective memory complaints: Results from the Australian Imaging, Biomarkers, and Lifestyle (AIBL) Study of Ageing

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Running title: Personal memory function in the elderly

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Abstract

Background: Autobiographical memory (ABM) refers to the recollection of individual experiences, while personal semantic memory (PSM) refers to personally relevant, but shared, facts. Mild cognitive impairment (MCI) is routinely diagnosed with the aid of neuropsychological tests, which do not tap the ABM and PSM domains. **Objective:** We aimed to characterise the nature of ABM and PSM retrieval in HC memory complainers, non-memory complainers and MCI participants, and to investigate the relationship between neuropsychological tests and personal memory. **Methods:** Sex and education-matched participants (HC = 80 and MCI = 43) completed the Episodic ABM Interview (EAMI) and a battery of neuropsychological tests. **Results:** ABM and PSM did not differ between complainers and non-complainers, but were poorer in MCI participants, after accounting for age and depressive symptomatology. There were significant associations between personal memory and objective memory measures were found in MCI participants, but standard cognitive measures were more sensitive to MCI. **Conclusion:** Personal memory was compromised in MCI, reflected by lower scores on the EAMI. Memory complaining, assessed by current approaches, did not have an impact on personal memory. Standard subjective questionnaires might not reflect the sorts of concerns that bring individuals to clinical attention. Understanding personal memory function in the elderly may aid in the development of a more sensitive measure of subjective memory concerns.

Key terms: Mild cognitive impairment, cognitive function, autobiographical memory, aging, episodic memory, Alzheimer dementia, subjective memory complaint, subjective cognitive decline

Introduction

Autobiographical memory (ABM) and personal semantic memory (PSM) are forms of everyday personal memory. ABM refers to the recollection of highly contextualised individual experiences [1]. Essential elements of ABM involve remembering the details of the event as they took place within a temporal, spatial, and emotional context, with rich accompanying visual imagery [2]. Personal semantic memory (PSM), on the other hand, refers to personally relevant knowledge or facts about the individual [3]. At its core, general semantic memory implies abstracted knowledge that is shared by many [4]. PSM, by contrast, is shared at a community level by individuals with overlapping autobiographical experiences [5, 6].

ABM and PSM are commonly treated as distinct sub-systems of personal memory in studies of clinical populations [1, 3, 7], perhaps mimicking the episodic/semantic distinction in declarative memory. Studies of patients with amnesia resulting from predominantly diencephalic/limbic lesions suggest that ABM is selectively impaired with relative sparing of PSM (for a commentary see, [8]). Healthy older adults show a similar but non-pathological pattern, relative to younger individuals, producing fewer autobiographical details in personal narratives [9, 10]. As a result, non-autobiographical details predominate, and appear to be imbued with greater subjective salience. A neural correlate of the ABM/PSM distinction has been developed from differential patterns of activation in response to autobiographical and personal semantic content (for a meta-analysis see, [11]). Specifically, autobiographical memory recruits hippocampal and posterior cingulate [12, 13] activity, while personal semantic memory recruits activity in regions associated with general semantic processing such as the middle temporal gyrus (for a review see, [11]).

The literature examining the effects of mild cognitive impairment (MCI) and dementia of the Alzheimer's type (DAT) on personal memory function is relatively small but all studies support the notion that ABM is impaired [2, 14-19]. The level of impairment in PSM, as well as the rationale for its dysfunction early in AD, remains unclear. Some studies have reported a relatively spared PSM compared with ABM [15, 19]. Greene, Hodges and Baddeley [15] reported an impaired recall of details surrounding a personal event but relatively preserved recall of personal semantic detail in patients with mild DAT. Additionally, a study of individuals with MCI reported a reduction of contextual (internal) details and elevation of incidentally-associated semantic (external) details within a personal narrative, revealing a dissociation similar to that observed in normal elderly individuals [19]. Other studies, however, report that individuals with MCI and DAT are impaired in both ABM and PSM, particularly for recent memories [2, 18]. Taking the literature as a whole, the following question emerges: how do deficits in personal forms of memory align with current concepts of memory impairment in MCI, and its subsequent progression?

Mainstream approaches to diagnosis of MCI generally do not formally investigate autobiographical and/or personal semantic memory dysfunction. It is concerns of personal memory loss, however, that represent the principal driver of presentation to a clinician. This may be due to the fact that autobiographical narratives are inherently subjective and are difficult to verify against normative standards, and diagnosis of MCI is supported chiefly by performance on standard neuropsychological testing. Tests of new learning and retention, such as the learning of word lists and short stories, have been found to be early markers of conversion to DAT, with varying levels of sensitivity, but are poorly correlated with conventional measures of subjective memory complaints [20-22]. Indeed, memory complaints, either elicited via a single question or a longer questionnaire, have been primarily associated with affective symptomatology [20] thus raising the question of their prognostic

value. While psychometric assessment samples the abilities on which the formation of personal memories is mounted, it does not reflect the broad and richly articulated landscape of personal memory.

The clinical symptomatology of MCI might align more closely with a subjective awareness of discrepancies in personal memory function. Given the current discrepancies in the literature, a study of patterns of personal memory loss in MCI is essential to deepen our understanding of, and clinical access to, early memory symptomatology in this population. Our objective was to ascertain how the MCI symptom complex, which is principally defined by performance on standard memory tasks, and subjective cognitive decline (SCD) impact personal memory function. Our secondary aim was to determine the sensitivity of personal memory measures in differentiating between diagnostic categories relative to standard cognitive measures. Lastly, we aimed to study the relationship between standard neuropsychological tests commonly used in the diagnosis of MCI, and personal memory dysfunction. We hypothesized that both ABM and PSM would be compromised in individuals with MCI but given their poor relationship with objective memory measures, that SCD would be an unlikely contributor to personal memory dysfunction. And finally we predicted that personal memory function would relate to measures of new learning and retention.

Materials and Methods

Participants

The Australian Imaging, Biomarkers and Lifestyle (AIBL) study of ageing is a longitudinal study with follow-up assessments at 18-month intervals. At the third time-point (36-months post baseline), the cohort comprised participants diagnosed with dementia due to DAT (154), participants classified as MCI (58), or classified as cognitively healthy (HC: 611). A smaller

sub-section of one hundred and twenty-four participants (HC = 80; MCI = 48) were recruited for this study. This study was treated as a cross-sectional study, focusing exclusively on data collected at the 36-month time-point. Human Research Ethics approval for the current study was obtained in Victoria from St Vincent's Hospital and the University of Melbourne, and Hollywood Private Hospital in Western Australia. All participants were recruited via telephone and asked to participate in a one hour semi-structured interview in their homes. There were 70 HCs and 25 individuals with MCI in Victoria and 10 HCs and 19 MCI participants in Western Australia. The recruitment procedures and exclusion criteria for the AIBL study have been published [23]. In brief, elderly volunteers responded to a media appeal or a referral by their medical practitioner and were screened via telephone for basic demographic information, and the following exclusion criteria: a history of dementia other than DAT, psychiatric illness (such as significant current (but not past) depression, which was determined by a Geriatric Depression Scale (GDS; [24]) score of greater than five), Parkinson's disease, cancers within the last few years, symptomatic stroke, uncontrolled diabetes, and alcohol consumption greater than recommended levels. Only HC and MCI participants were eligible to participate in the study reported here. In this sub-study, five participants with MCI were excluded as four MCI individuals had progressed to DAT by the time they were invited to participate in this study, and one had an elevated GDS score of eight at the 36-month time point. This gave a final sample size of 80 HCs and 43 individuals with MCI. Memory complaining was determined by a single question, "Do you have difficulties with your memory, yes or no?". This question split the HC group further, with 43 healthy controls with no subjective cognitive decline (HC-NSD) and 37 healthy controls with subjective cognitive decline (HC-SCD).

Thirty-six month follow-up cognitive assessments were carried out prior to the commencement of the present study. The mean administration time for the standard

neuropsychological protocol was two hours (for details see [23]). A diagnostic review panel of neurologists, geriatricians, psychiatrists and neuropsychologists, chaired by the fourth author (DA), oversaw the classification into HC, MCI and DAT groups according to well-established criteria [23, 25, 26]. MCI classification was made based on performance falling 1.5SD below age-adjusted levels in formal memory assessment, expressed memory complaint/subjective memory concern, and current preservation of activities of daily living.

Cognitive measures

The following tests were administered by AIBL neuropsychologists at the 36 month time-point. To measure verbal learning, the California Verbal Learning Test-Second edition (CVLT-II) new learning, post-interference recall, delayed recall, and recognition measures [27], and the Wechsler Memory Scale-Third edition (WMS-III) Logical Memory (LM) immediate and delayed recall measures [28] were administered. To measure non-verbal memory, the Rey Complex Figure Test (RCFT) 30 minute delayed recall and recognition [29] was administered. The Fruit and Furniture Switching (FFS) task from the D-KFES [30] and the Stroop test [31] were used to measure fundamental components of executive functioning. Language difficult in the form of naming was assessed using the US version of the 30-item Boston Naming Test (BNT; [32]). The GDS was included as the affective covariate.

Measure of personal memory

This measure was administered in the participant's home by the first author (RB). The duration of this assessment was approximately forty minutes. Both forms of personal memory were measured using the Episodic Autobiographical Memory Interview (EAMI; [2, 33]). The EAMI is a semi-structured interview that involves two parts; the first assesses PSM recall by probing personal factual information that can be shared by family and friends, and the second assesses ABM event recall by probing subjective experiences that are unique to the individual

and can be recalled within a specific spatiotemporal context. For the current study, a shortened version of the EAMI was used in which recall was constrained to the Recent Period (within the last 5 years).

The PSM part involved three items. The first asked the participant to recall the names of three people that they had only met in the last five years (one point for the full name and one point for their relationship to the individual). The second involved recalling the location and route to a frequented establishment in the last five years (one point each for the name of the establishment, location, what they did there and how they travelled there). The third item related to the ability to recall the exact date, month, year and location of a personally significant event within the last five years (one point for each of the four specifics remembered). This totaled to a maximum score of 14 for the PSM component. In an effort to avoid any compensatory effects that ABM may play on PSM, this section was administered first.

The ABM component involved recalling in as much detail as possible a personally significant event that occurred within the last five years. Once participants stopped spontaneously producing information pertaining to the event, the interviewer probed for further details using seven phenomenological categories taken from the Event Details Checklist of Moscovitch and colleagues [34]. These probes included event detail, temporal, spatial, sensory, implication of the event, emotion, and thought recall. Each detail was awarded a maximum score of one point, which would be summed to a maximum score of seven points. These interviews were recorded with the approval of the participant, transcribed, and scored by the interviewer and a blinded clinical neuropsychologist. Interrater reliability, as measured by intraclass correlation coefficient, was high for both sections ($r_{ABM} = 0.92$; $r_{PSM} = 0.94$).

Statistical analyses

Analyses were conducted using SPSS Version 21.0. We performed a multivariate analysis of covariance (MANCOVA) to determine whether ABM or PSM would differ according to diagnostic category, HC non-memory complainer (HC-NMC), HC subjective memory complainer (HC-SMC) or MCI, while including age and depression as covariates. To determine the sensitivity and specificity of personal memory to classify diagnostic categories (HC and MCI), we conducted a discriminant function analysis (DFA). The grouping of HC and MCI was based on performance on standard cognitive tasks in conjunction with a clinical assessment. We used another DFA to determine how the neuropsychological measures would classify the groups as they were not the sole grouping determinant. Finally, we attempted a linear regression model to determine which cognitive measures best predicted personal memory performance but we found very high multicollinearity amongst the predictor variables. To counteract this problem, we correlated personal memory and neurocognitive measures of memory, language and executive functioning. Missing data existed for both cognitive and affective measures but totaled less than 10% of the entire data set (refer to Table 1).

Results

Differences between healthy controls and individuals with MCI

The demographic and cognitive information for the HC-NMC, HC-SMC and MCI groups is presented in Table 1. Individuals with MCI ($M_{\text{Age}} = 79.6$ years, $SD = 6.9$, range = 67-94 years) and healthy memory complainers were significantly older ($M_{\text{Age}} = 77.8$ years, $SD = 7.3$, range = 67-95 years) than the healthy non-complainers ($M_{\text{Age}} = 73.8$ years, $SD = 6.1$, range = 66-93 years), $F(2, 120) = 8.48$, $p < .001$, $\eta^2 = .12$. The MCI and healthy memory complaining group demonstrated more depressive symptomatology compared to the healthy

non-complainers, $F(2, 117) = 13.09, p < .001, \eta^2 = .18$. There was no difference between the groups in level of education, $\chi^2 = 3.03, df = 2, p = ns, \phi = .16$, or gender, $\chi^2 = 4.98, df = 2, p = 0.08, \phi = 0.20$. Individuals with MCI were significantly impaired across all cognitive measures compared to both healthy control groups (all p values < 0.001).

Effect of classification, age and depression on ABM and PSM

Classification (HC-NMC/HC-SMC/MCI) was related to both forms of personal memory, Pillai's Trace = 0.15, $F(4, 228) = 4.70, p = 0.01$, partial eta squared (η^2) = 0.08. Both ABM performance, $F(2, 114) = 7.79, p = 0.001, \eta^2 = 0.12$, and PSM performance were affected, $F(2, 114) = 6.02, p = 0.003, \eta^2 = 0.10$, indicating a medium effect sizes (see Figure 1). There was no significant influence of age or depression on personal forms of memory. Post-hoc comparisons using Tukey's HSD revealed that MCI participants were significantly impaired in ABM and PSM comparison to both HC groups (see Figure 1) but there was no difference between healthy memory complainers or non-complainers. For this analysis, homogeneity of covariance was violated, Box's $M = 61.05, p < 0.001$, suggesting a poor fit of the model but the similarity of the logarithms of determinants of the different covariance matrices were within acceptable limits. Homogeneity of variance was violated for ABM and PSM recall but there was no violation of linearity or multicollinearity.

Discriminant function analyses

Two discriminant function analyses were performed to determine whether personal memory measures were as sensitive and specific as standard cognitive measures to differentiating between HC and MCI. The first model used PSM and ABM variables as predictors of membership in each group. Of the original 123 cases, one was dropped from the analysis due to missing data. Box's test of equality of covariances was violated, Box's $M = 36.42, p < 0.001$, but the logarithms of determinants were within acceptable limits. The function

accounted for 22.2% of the total relationship between predictors and groups. The structure matrix of correlations between predictors and discriminant functions suggested both ABM and PSM were good predictors. The model correctly classified 70.5% of original grouped cases (see Table 2). The cross-validation procedure indicated 67.2% of cases were classified correctly suggesting a high degree of consistency in the classification scheme. The sensitivity and specificity of this model was 56% and 79%, respectively, suggesting that true negatives were easier to classify. The model had a positive predictive power of 59% and negative predictive power of 77%, suggesting the model was better at predicting cases as HC which turned out to be observed as HC.

The second model included all neuropsychological variables as predictors of membership in each group. Of the original 123 cases, 14 were dropped from the analysis due to missing data. Box's test of equality of covariances was violated, Box's $M = 164.86$, $p < 0.001$, but the logarithms of determinants were within acceptable limits. The function accounted for 74.0% of the total relationship between predictors and groups. The structure matrix of correlations between predictors and discriminant functions suggested that the best predictors were BNT score, RCFT recognition and CVLT post-interference recall. It is important to note that all variables had a loading of less than .50, indicating a low level of contribution to the model overall. The model correctly classified 94.5% of original grouped cases (see Table 2), and the cross-validation procedure indicated 91.7% of cases were classified correctly. The sensitivity and specificity for the model was 97% and 89%, respectively, with a positive predictive power of 87% and negative predictive power of 99%.

Relationship between personal memory and standard cognitive tests

In all healthy controls, ABM and PSM were weakly correlated, $r(79) = 0.23$, $p = 0.04$, with healthy non-complainers showing a significant positive correlation and healthy memory

complainers showing no correlation (see Figure 2). ABM was found to correlate significantly with Logical Memory immediate recall, $r(79) = 0.27, p = 0.05$, and Logical Memory delayed recall, $r(78) = 0.22, p = 0.05$. No other correlations were found in the healthy control group.

In MCI participants, Pearson correlation analyses revealed a significant relationship between both forms of personal memory, $r(43) = 0.50, p = 0.001$. A scatterplot summarizes the correlation in both diagnostic categories (Figure 2). The correlations between personal memory and cognitive variables in MCI participants are presented in Table 3. There were significant correlations between ABM and the new learning measure, $r(43) = 0.41, p = 0.01$, and delayed recall measure of the CVLT, $r(43) = 0.34, p = 0.04$, and between ABM retrieval and the recognition measure of the RCFT, $r(43) = 0.32, p = 0.04$. There were significant correlations between PSM and all sub-scales of the CVLT, (with correlations ranging from 0.38 to 0.46, $p < 0.05$), except the recognition of list words, and also PSM and the delayed recall variables of Logical Memory, $r(43) = 0.45, p = 0.002$, and the RCFT, $r(43) = 0.47, p = 0.002$. No significant associations were found between personal memory and executive function or language.

Discussion

In support of our hypothesis, our findings suggest that personal forms of memory, whether semantic or episodic in nature, are compromised in individuals with MCI. This observation is consistent with previous studies of personal memory in MCI and DAT [2, 14-18]. Consideration of the relative effect sizes suggests that both ABM and PSM are affected to comparable extents. Healthy elderly individuals with memory complaints did not display poorer personal memory performance compared to non-complainers, raising the question as to whether current complaint measures are sensitive to the subjective experience of memory decline. We found a larger magnitude of effect of MCI on measures of new learning and

retention that formed the basis of the diagnosis (see Table 1), and this was an unsurprising finding. Personal memory measures possessed an acceptable level of specificity, or the ability to correctly identify healthy controls. Our aim, however, was to describe personal memory impairment in individuals with subjective memory complaints and MCI and not to define novel diagnostic markers.

PSM bridges the gap between autobiographical and non-personal semantic memory, deriving its ‘semantic-like’ quality as a result of repetition over time, and across multiple contexts [8, 35], by members of the individual’s social network. Functional neuroimaging ([11], for a review) and lesion studies [36, 37] suggest that semanticised personal memories are maintained by lateral temporal neocortex. Autobiographical memories are impaired in individuals with stable amnesic disorders in which the lesion involves limbic and diencephalic structures, and are generally non-responsive to cueing [7]. While personal semantic memory is also affected, it is responsive to priming [7, 38, 39], consistent with its dependence on neocortical systems [6]. By contrast, MCI has been related to incipient medial temporal and posterior cingulate pathology [40, 41], as well as temporal neocortical involvement [40, 42, 43]. The involvement of lateral temporal regions in MCI is in line with our finding of compromised PSM retrieval in this group. One could also hypothesize that personal semantic memory in MCI is becoming increasingly unresponsive to cueing, an avenue that we suggest is worthy of further investigation. One limitation of the current study was the omission of a general semantic memory measure to address this issue.

Unlike the well-documented impairment of ABM in MCI, PSM impairment is unclear. Murphy and colleagues’ [19] finding of an increase in semantic detail in an autobiographical narrative reflects the greater salience and accessibility of semantic details in the face of ABM impairment, and replicates a complimentary relationship between PSM and ABM previously demonstrated in other populations [7, 9, 10]. Differing methodological

approaches could account for the disparity between our findings. While these studies elicited a narrative in which both ABM and PSM elements were counted, the EAMI directly prompted participants for personal factual information. The critical question at this juncture, is how PSM differs from ABM. One perspective is that ABM is characterised by one-time ‘autonoetic’ experiences of events that are entirely unique to the individual, while PSM involves ‘noetic’ personal information that is repeated over time and across multiple contexts [1, 4]. The EAMI attempts to highlight these differences by probing highly contextualised ‘one-off’ details, such as sensory/emotion/thought details, in the ABM section and personal factual information, such as the name and location of a frequented establishment, in the PSM section. Within a free-flowing narrative, personal semantic information will likely increase in the face of ABM impairment as a compensatory mechanism but when directly challenged, a paucity of PSM detail exists. While the current study focused on recent memories, previous evidence using the EAMI showed a negative temporal gradient in PSM recall in MCI participants [16], and personal semantic memories across all epochs impaired compared to healthy elderly controls. This finding supports the notion that PSM function, even when learning was relatively normal, is impacted and not just the initial consolidation of the recent memory.

At a conceptual level, one could postulate an overlap between autobiographical and personal semantic memory [3, 35, 44]. Conway & Pleydell-Pearce [44] unite both forms of memory within a single self-referential memory system. The personal memory domain is comprised of interrelated autobiographical and personal semantic memory systems, the former dealing with retention and recall of uniquely personal and contextualised events, while the latter deals with semanticised memories shared by a community that has participated in the same events. Both of these memory systems link to a third system, which injects sensory-perceptual detail into the memory. Conway [45] argued that this system, what

he termed event-specific knowledge, lends richness to autobiographical narratives. The three systems interact dynamically to construct a personal memory [44]. In terms of this model, ABM impairment will inevitably be associated with some degree of PSM dysfunction, but from a neurocognitive perspective, retrievability will be contingent on the extent to which temporal neocortex is preserved.

Although the EAMI was not originally used to sort the HC and MCI groups, performance on this measure correctly classified a good majority of cases, with HCs having a greater chance of being correctly classified. Healthy elderly controls completed the task without difficulty, supporting the notion that personal memory is not an ‘ability-driven’ phenomenon and has the potential to be a clinical marker of abnormality. The advantage of a personal memory measure is that it involves a degree of ecological validity, that is, it can give an indication of real-world memory performance which is not captured by standard neuropsychological tests [46]. The best neuropsychological classifiers of the diagnostic groups were two measures of new learning and retention and a marker of language difficulty, which aligns with previous research [48]. Individuals with MCI were diagnosed using these cognitive tests, which may have accounted for the high specificity and sensitivity in the model, although relatively similar numbers are reported for clinical diagnosis using NINCDS-ADRDA criteria [49], or similar tests of new learning and retention [50].

Personal memory dysfunction in MCI was found to correlate with objective measures of new learning routinely used in diagnosis of this syndrome. Personal memory showed no association with measures of language and executive functioning, although a definitive conclusion cannot be drawn until a more comprehensive assessment of these cognitive domains is conducted. No convincing relationship was found in healthy elderly individuals; perhaps in the healthy elderly these memory systems are semi-autonomous, and with the probability of disease, multiple levels of memory systems will be driven down. Given the

relationship personal memory has with objective memory measures, it was unsurprising that no relationship existed between personal memories and memory complaints. Measuring the presence or severity of a complaint is not a substitute for probing individuals' subjective recollection of personal events. From a clinical perspective, it is difficult to ascertain from a questionnaire whether or not an individual is expressing a *memory* concern. The experience of memory loss is a form of ABM, and like other personal memories, has a semanticised component, reflected in the descriptions given by significant others in clinical settings. Given our finding of a relationship between personal memory, canvassed via a semi-structured interview [2], and standard neuropsychological measures of new learning and retention, a focus on subjectively appreciated content is an important step towards a clinically relevant understanding of subjective memory complaints. An interview approach differs from questionnaire measures of memory complaints, which typically do not relate to standard diagnostic procedures [20-22]. We therefore argue for the importance of incorporating assessments of subjective and personally experienced memories as an integral part of characterising the MCI symptom complex.

In conclusion, personal memory impairment is detectable in individuals with MCI but not in healthy elderly individuals with subjective cognitive decline. Both forms of personal memory, autobiographical events and personal semantic facts, are related to standard neuropsychological measures of new learning and retention, which are commonly used in the diagnosis of MCI. Personal memory, as measured by the EAMI, has an acceptable level of specificity indicating an ability to correctly classify healthy controls. Further investigation of personal memory breakdown in MCI is likely to lead to a more profound understanding of the clinical syndrome, particularly its subjectively experienced aspects. We suggest that an enhanced knowledge of personal memory impairment in MCI is crucial to develop a more

sensitive measure of subjective changes early in the disease process, and look to characterising the *content* of a complaint, not just its mere presence or severity.

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Conflict of Interest

None.

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Table 1

Demographic and cognitive differences between groups

	HC-NMC (n = 43) M (SD)	HC-MC (n = 37) M (SD)	MCI (n = 43) M (SD)	η_p^2	<i>sig</i>
<i>Demographics</i>					
Age	73.77 (6.1) ^a	77.76 (7.3) ^b	79.6 (6.9) ^b	0.12	0.002
Gender (% F)	56	35	58		<i>ns</i>
Education (% > 12 yrs)	65	65	49		<i>ns</i>
<i>Personal Memory (n)</i>					
ABM performance	5.16 (1.2) ^a	4.88 (1.5) ^a	3.53 (2.0) ^b	0.18	<0.001
PSM performance	12.91 (1.3) ^a	11.74 (2.5) ^a	9.70 (4.2) ^b	0.19	<0.001
<i>Cognition</i>					
LM (n)	43	37	43		
Immediate recall [#]	14.00 (3.7) ^a	12.35 (3.2) ^a	6.93 (3.5) ^b	0.44	<0.001
Delayed recall [#]	13.21 (3.6) ^a	11.22 (3.5) ^a	4.26 (4.0) ^b	0.53	<0.001
CVLT (n)	42	36	38		
New Learning [^]	64.55 (8.6) ^a	65.17 (10.4) ^a	41.58 (10.9) ^b	0.55	<0.001
Post-interference recall	1.20 (1.1) ^a	1.44 (1.1) ^a	-1.26 (1.2) ^b	0.55	<0.001
Delayed recall	1.10 (0.9) ^a	1.36 (0.9) ^a	-1.22 (1.3) ^b	0.54	<0.001
Recognition	0.30 (0.6) ^a	0.37 (0.7) ^a	-0.74 (1.1) ^b	0.23	<0.001
RCFT (n)	39	35	41		
30min delay	1.27 (1.6) ^a	1.48 (1.7) ^a	-0.46 (1.4) ^b	0.24	<0.001
Recognition	0.91 (1.1) ^a	0.75 (1.1) ^a	-0.87 (1.5) ^b	0.30	<0.001
BNT (n)	39	36	41		
No Cue	0.88 (0.5) ^a	0.99 (0.7) ^a	0.15 (0.9) ^b	0.20	<0.001
D-KFES FFS (n)	39	35	40		
FFS [#]	11.64 (3.0) ^a	11.06 (3.1) ^a	8.13 (3.2) ^b	0.19	<0.001
Stroop (n)	40	33	40		
Stroop	-0.71 (0.6)	-0.51 (0.6)	-0.36 (0.7)	0.04	<i>ns</i>
<i>Affect</i>					
GDS score (n)	41	36	40		
	0.51 (0.9) ^a	1.78 (2.0) ^b	2.35 (2.0) ^b	0.18	0.001

Note: ^a = variables are not significantly different, ^b = variable is significantly different, [^] = t-scores, [#] = age-scaled score. Differences in groups were determined using independent-sample t-tests and chi-square (χ^2) tests of independence. LM = Logical Memory, CVLT = California Verbal Learning Test, RCFT = Rey Complex Figure Test, BNT = Boston Naming Test, FFS = Fruit and Furniture Switching, GDS = Geriatric Depression Scale

Figure 1. The estimated marginal mean performances (error bars are CI: 95%) for (A) ABM and (B) PSM for healthy non-memory complainers (HC-NMC) and memory complainers (HC-SMC) and MCI participants, adjusting for covariates age (mean = 76.97 years) and GDS score (mean = 1.51). * = p value < 0.01

Table 2

Discriminant analyses of cognitive variables

Predictor variable	Canonical correlations	Univariate				
<hr/>						
<i>Model 1</i>		<i>F</i> (1, 120)				
ABM	0.60	23.74				
PSM	0.60	23.84				
			Classification Table			
			Predicted			
			HC	MCI	Total	
Observed			HC	62 (79%)	17 (22%)	79
			MCI	19 (44%)	24 (56%)	43
 <i>Model 2</i>			 <i>F</i> (1, 107)			
BNT	0.37	28.20				
CVLT PIR	0.31	132.46				
RCFT recog	0.31	59.02				
LM DR	0.27	102.39				
CVLT DR	0.23	126.59				
CVLT NL	0.19	157.21				
FFS	0.17	24.11				
LM IR	0.16	77.41				
RCFT delay	-0.15	32.03				
CVLT recog	0.09	32.26				
Stroop	0.06	2.07				
			Classification Table			
			Predicted			
			HC	MCI	Total	
Observed			HC	66 (93%)	5 (7%)	74
			MCI	1 (3%)	34 (97%)	35
<hr/>						
Note: ABM = autobiographical memory, PSM = personal semantic memory, BNT = Boston Naming Test, CVLT = California Verbal Learning Test, PIR = post-interference recall, LM = Logical Memory, DR = delayed recall, NL = new learning, RCFT = Rey Complex Figure Test

Figure 2. Scatterplot of ABM and PSM performance by group, with regression lines and correlations

Table 3

Inter-correlation matrix of memory variables and personal forms of memory in individuals with MCI

	Autobiographical memory	Personal semantic memory
<i>Verbal memory</i>		
LM immediate recall	0.11	0.19
LM delayed recall	0.17	0.45**
CVLT new learning	0.41**	0.46**
CVLT post-interference recall	0.31	0.38*
CVLT delayed recall	0.34*	0.46**
CVLT recognition	0.31	0.22
<i>Non-verbal memory</i>		
RCFT 30 min delay	0.21	0.47**
RCFT recognition	0.32*	0.13
<i>Language</i>		
BNT no cue	-0.07	0.14
<i>Executive function</i>		
D-KFES FFS	0.01	0.05
Stroop	0.16	0.11
Note: * $p < 0.05$, ** $p < 0.01$, $p < 0.001$. LM = Logical Memory, CVLT = California Verbal Learning Test, RCFT = Rey Complex Figure Test, BNT = Boston Naming Test, FFS = Fruit and Furniture Switching		