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Subjective Report of Word-Finding and Memory Deficits in Normal Aging and Dementia

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Abstract

Objective—Compare subjective reports of both memory and word-finding deficits to clinical diagnosis and objective neuropsychological testing.

Background—With the increasing number of aging individuals with cognitive impairments, effective screening measures would improve the likelihood of detection. Subjective reports of symptoms are typically obtained in clinical settings, yet the validity of these reports is relatively unknown.

Methods—Clinical screening for dementia was carried out at an Alzheimer's disease center. Dichotomous ratings for memory and word-finding/language problems were given by subjects and neurologists. These ratings were compared with 13 neuropsychological measures of word finding/language and episodic memory.

Results—Ratings of memory by both subjects and neurologists correlated well with standard neuropsychological measures of memory. However, both the patients' and physicians' ratings of word finding/language impairments had notably less of a correlation with the relevant neuropsychological measures of word finding/language.

Conclusion—Compared to ratings of memory, similar assessments of word-finding/language difficulties were relatively inaccurate and thus poor predictors of impairment. It is imperative to develop effective screening methods that will help reveal cognitive impairments, as this issue will almost certainly become more pressing given the projected increase in the number of aging individuals and those with dementia.

Keywords

Alzheimer's disease; language; semantic; memory; dementia; subjective report

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INTRODUCTION

There are approximately 18 million people worldwide suffering from Alzheimer's disease with projections to 34 million by 2025 (World Health Organization). The most common cognitive deficit initially observed in patients with AD is delayed recall of verbal material (Hodges et al., 1990). This impairment is also most commonly reported in patients developing dementia and Mild Cognitive Impairment (Petersen et al., 1999; Grundman et al., 2004; Winblad et al., 2004). The neuropsychological tests that are most commonly used to assess this symptom are new learning tasks of word lists or a paragraph in which memory for that newly learned material is tested after a standardized time delay (Wechsler, 1987). While these are the deficits noted objectively with MCI and AD, the subjective complaint with which patients most frequently use to describe delayed recall of verbal material is "memory problems."

The necessity of using subjective patient/caregiver symptom complaints and their report on these symptoms significantly disrupting activities of daily living (ADLs)/occupational performance has a potentially deleterious impact on diagnostic accuracy (DSM IV; McKhann et al., 1984; see also Roberts *et al.*, 2009). With the absence of other clear, dichotomous neural markers of dementia, the ability to accurately diagnose and treat these illnesses remains compromised and requires a clinical interview, mental status testing, imaging and laboratory studies, and clinical decision making.

Perhaps more importantly, the reliance on subjective criteria will impede studies aimed at surveying at-risk populations and the general public. Epidemiological studies of cognitive impairments, or studies accessing populations in general that do not present for clinical evaluation are therefore particularly vulnerable.

A second issue involves the ambiguity of the term "memory", as both patients and caregivers attribute this term to a wide array of cognitive symptoms. Examples of perceived "memory" difficulties range from issues with new learning, word finding, semantic memory, name recollection, attention, and/or true working memory problems. These ambiguities extend from both the patient/caregiver's perceptions of the meaning of these terms, as well as from the varying descriptions of these terms in the scientific literature.

While the symptoms encompassed by the term "memory" are ambiguous in the general population, other descriptors prevalent in degenerative diseases are more ambiguous in terms of their definition and degree of disruption in ADL, especially "word-finding." Difficulties in word finding, such as fluency and naming, have often been confused with memory problems by both patients and clinicians. This distinction is supported by the neuroanatomic correlates and underlying cognitive mechanisms which identify word finding as largely distinct from those associated with new learning/episodic memory. A clearer understanding of symptom report accuracy by the patient/caregiver for word-finding difficulty in normal aging and degenerative diseases would be useful, as would a better understanding of the correspondence between subjective reports of impairments and objective neuropsychological measures.

METHODS

Subjects

We studied 90 subjects who enrolled in the Alzheimer's Disease Center (ADC) between November 2001 and October 2004, and who were classified for research purposes. Data were collected on 48 AD and MCI patients and 42 normal aging controls. Patients were

between 49 and 91 years of age, in good health, with no evidence of focal neurological findings or a recent imaging study demonstrating cerebral infarction.

Dementia patients were identified using the DSM-IV criteria; AD patients met criteria for dementia and AD using the McKhann et al. criteria (1984) {McKhann et al., 1984} and amnesic MCI patients met criteria for this classification (Petersen et al., 1999; 2001}. No patients were diagnosed with Multidomain Amnesic MCI, Multidomain MCI, or Single Nonmemory MCI (Grundman et al., 2004).

Procedures

Neurological Evaluation—Patients were examined by a behavioral neurologist and underwent a neurological and brief neurobehavioral evaluation. The participants (and in the case of patients, also the caregivers) were asked if they had an impairment in memory. Participants/caregivers responded with either yes or no; this was recorded as a dichotomous variable of 0 for no deficit and 1 for presence of a deficit). In addition, they were asked whether they had an impairment in word finding and/or language, with the same scoring system as for memory. Following a brief neurobehavioral evaluation, each neurologist provided a similar yes/no dichotomous rating based on their history and examination as to whether the participant had a memory and/or word-finding/language deficit.

Neuropsychological Tests—The subjects subsequently underwent extensive neuropsychological testing. The patients were also seen by a nurse and social worker for evaluation. Each patient was then discussed amongst the providers who had evaluated them in a clinical consensus conference to reach a diagnosis. The neuropsychological tests consisted of an extensive battery of the following:

General: MiniMental State Exam (MMSE).

Intelligence: North American Adult Reading Test (NAART); WAIS-III subtests (Digit Span, Vocabulary, Similarities, Block Design, Matrix Reasoning & Letter Number Sequencing).

Language: Phrase Repetition Subtest of the Boston Diagnostic Aphasia Examination; Category Fluency for Animals and Fruit & Vegetables; Controlled Oral Word Association; Boston Naming Test; MAE Token Test – Modified (Multilingual Aphasia Examination); Semantic Object Retrieval Test (SORT) (Kraut et al., 2002a; 2002b; 2006; 2007); Cookie Theft Written Description.

Memory: Wechsler Memory Scale III; East Boston Memory Test.

Visuospatial: RBANS Figure Copy; Judgment of Line Orientation; Clock Design Test – spontaneous and copy; Necker Cube – Copy.

Praxis: Praxis Battery (Boston Diagnostic Aphasia Examination)

Frontal Lobe Functions: Trailmaking Test B; Stroop Interference Test.

Psychomotor Speed: Trailmaking Test A; Symbol Digit Modalities Test.

Mood: Geriatric Depression Scale.

Global level of functioning was assessed by the Clinical Dementia Rating (CDR).¹⁴

From the battery of neuropsychological tests, 13 tests that are most widely used and considered most relevant in assessing cognitive issues salient to Alzheimer's disease were used in the analyses. The test data used in the analyses were measures of memory (Logical Memory 2 – Recall, Logical Memory 2 – Recognition, WMS Word List 1 Trial 4, WMS

Word List 1 – Recall, WMS Word List 2 – Recall, WMS Word List 1 – Recognition) and language (SORT – semantic memory score [SORT – M], SORT – name production score [SORT – N], Category fluency for animals, Category fluency for fruit & vegetables, Boston Naming Test, Token Test, Controlled Oral Word Association Test [FAS]). The SORT task consists of pairs of words that are features of common objects (e.g., “desert” and “humps”). The participants were to determine whether the two words combined to result in retrieving the memory of a specific object (e.g., “desert” and “humps” ► “camel”) or a nonretrieval (e.g., “sleeve” and “jungle”). The same feature words used in the object retrieval pairs were used in the nonretrieval pairs, but were re-paired with a semantically unrelated word (e.g., “humps” and “alarm”). There are 16 retrieval pairs and 16 nonretrieval pairs. The total number correct that the patients report do or do not result in retrieval of an object memory is the SORT-M score. If the subject says that the stimulus pairs do result in an object memory, the subject’s are then asked to provide the name of the object retrieved. There are 16 correct names and the number correct is the SORT-N score.

RESULTS

A correlation matrix was computed using the 13 test scores, the dichotomous subjective ratings by participants/caregivers for memory and word-finding/language impairment, the behavioral neurologists’ evaluation of those parameters from their neurological and brief neurobehavioral evaluations, and the patients’ CDR.

This matrix revealed higher correlations for memory assessments than for language assessments in both patient and physician ratings (Table 1). Within the language assessments, the physician’s assessment correlates more highly with neuropsychological testing measures than do the assessments of the participants/caregivers.

Correcting for age and education showed no significant effect. Ratings on the Geriatric Depression Scale correlated to the subjective memory reports of participants ($r=.340$; $p<.001$) but not to their reports of language/word finding.

From this correlation matrix, a principal components analysis (PCA) was computed with varimax rotation, which extracted three factors accounting for 75.6% of the variance. All the factor loadings for the first component, which accounted for 58.7% of the variance, were high and positive, reflecting a general performance ability given one’s normal aging status or stage of decline. The second component, accounting for 10.6% of the variance, showed moderate positive loadings to assessments of memory (*Logical Memory 2 recognition and recall*) and moderate negative loadings to assessments of word finding (*SORT*). The third component, accounting for 6.3% of the variance, showed weak negative correlations to the word-finding scores and moderate positive loadings on category fluency task scores.

Logistic regressions of factor scores on patient and physician report of memory or language problems showed that only the first component reliably predicted whether the patient or the physician reported a memory problem ($\chi^2(1, N=90)>42$, $p<.0001$) or whether the patient or the physician reported a language or word-finding problem ($\chi^2(1, N=90)>7$, $p<.009$). As shown in Table 3 (see All Inclusive PCA), factor scores from the first component correctly predicted over 75% of whether a patient would report having a memory problem and correctly predicted almost 83% of reports of no memory problem. These factor scores correctly predicted over 83% of the behavioral neurologists’ indicating a memory problem and over 90% of their indicating no memory problem. The factor scores from the first component were less impressive at predicting the report of a language or word-finding problem, especially the patient reports. While 89% of patient reports indicating a language problem were correctly predicted by the factor scores from the first component, less than

12% of reports indicating no language or word-finding problems were correctly predicted. The factor scores from the first component correctly predicted over 62% of the behavioral neurologists' reports of a patient having a language problem and correctly predicted over 89% of the reports of no language problem. Neither the second nor third component's factor scores reliably predicted the patients' reporting of memory or word-finding problems ($\chi^2(1, N=90) < 3, p > .10$). This second factor was of particular interest because it revealed, after subtracting the variance of the first component, which reflected an overall performance level, opposite polarities for the language-specific and memory-specific tests.

The opposing weights of the two cognitive domains were explored subsequently by computing separate PCAs, one using only memory measures and one using only language measures (See Table 2).

The principal components analysis of memory test scores extracted two components, accounting for 87.2% of the variance, for varimax rotation (Table 3). The first component accounted for 73.7% of the variance, and was most highly correlated with list learning scores. The second component accounted for 13.5% of the variance and was most highly correlated with Logical Memory scores. Neither component was negatively correlated with any of the test scores.

Logistic regressions showed that factor scores from the first component reliably distinguished between those patients who did and did not report a memory problem ($\chi^2(1, N=90)=15.096, p=.0001$), correctly predicting over 71% of those who did report memory problem and over 56% of those who reported no memory problem (Table 3). Factor scores from this component also reliably distinguished between those whom the behavioral neurologist noted a memory problem and those they did not ($\chi^2(1, N=90)=18.947, p<.0001$). Over 79% of those denoted to have a memory problem by the behavioral neurologist and over 69% of those assessed not to have a problem were correctly predicted. Factor scores from the second component also reliably distinguished between patients who did and those who did not report a memory problem ($\chi^2(1, N=90)=24.954, p<.0001$), correctly predicting over 67% of those who did report a memory problem and almost 61% of those who reported no memory problem. The behavioral neurologists' assessment of a memory problem were reliably predicted by the factor scores from the second component ($\chi^2(1, N=90)=26.011, p<.0001$), predicting almost 69% of those for whom the behavioral neurologist indicated a memory problem and two-thirds of those for whom they did not.

The PCA using only language test scores extracted three components, which accounted for 82.8% of the variance (Table 2). The first component accounted for 61.9% of the variance and was most highly loaded with SORT scores. The second component, accounting for 11.9% of the variance, was most highly correlated with Category Fluency tasks. The third component was highly correlated with the scores on the Token Test but only accounted for 9% of the variance. None of the three components were negatively correlated with any of the test scores.

Logistic regression showed that the factor scores from the first and second components were not reliable predictors of the patient's report of a language or word-finding problem ($\chi^2(1, N=90) < 3, p > .09$). Although factor scores from the third component were statistically reliable predictors of the patient's report of a language or word-finding problem, this statistical significance was due to a strong degree to the model's success in predicting the report of no language or word-finding problem (96.88%) rather than its success in predicting an indication of having a language or word-finding problem (15.38%). This same pattern was seen in the trend toward reliable predictive power of the factor scores from the first component; only the report of no language or word-finding problem was predicted.

Logistic regression showed that the factor scores from all three components reliably predicted the behavioral neurologists' assessments of word-finding or language problems. Similar to the pattern seen in these scores reliably predicting patient reports, the predictive success was much greater for the reports of no language problem than for the reports of the presence of a language problem. Factor scores from the first component, most reflective of word finding, reliably predicted the behavioral neurologists' indication of a language or word-finding problem ($\chi^2(1, N=90)=13.906, p=.0002$), successfully predicting over 89% of the indications of no language problem but only 37.5% of indications of there being a language or word-finding problem (Table 3). Although the factor scores from the second component, reflecting Category Fluency, were statistically reliable predictors of the behavioral neurologists' assessments ($\chi^2(1, N=90)=4.739, p=.0295$), they reliably predicted only those patients for whom the behavioral neurologists indicated no language problem (95.45% success rate) and successfully predicted none of the patients for whom the neurologist indicated a word-finding or language deficit. Logistic regression using the factor scores from the third component showed a similar pattern. The neurologists' indications of language or word-finding problems for the patients were reliably predicted ($\chi^2(1, N=90)=16.327, p<.0001$), successfully predicting over 98% of the behavioral neurologists' assessments of no language or word-finding problem, but less than 30% of the assessments of a language or word-finding deficit.

DISCUSSION

Diagnostic criteria for dementia require the establishment of cognitive deficits affecting more than one domain that result in a significant decline in day to day function, while criteria for MCI require the endorsement of a memory deficit by the patient and/or caregiver, evidence of the deficit in relative isolation by mental status testing and the lack of a functional decline. Prior to the point of administration of a mental status assessment, a patient and/or their family must decide a) that a cognitive deficit is present beyond the typical decline in performance expected with aging, b) in what cognitive domain the deficit resides, and c) whether this cognitive deficit significantly impairs ADLs and/or occupational performance. The challenge is even greater when one considers that the relevant cognitive domains and degrees of impairment in these domains are poorly defined.

Once a patient presents for evaluation, another barrier to the diagnosis of dementia or MCI in the aging population is the ability to administer a mental status assessment, particularly since the normative scores for most measures change with the patient's age. In response to this problem, compounded by the increasing numbers of patient diagnosed with dementia or MCI (Grundman et al., 2004), more emphasis has been placed on subjective reports of cognitive functioning. These self reports usually address memory and word-finding performance as well as other cognitive domains that impact ADL. Thus, key aspects of these diagnoses are based on nonobjective measures of both the nature and severity of symptoms.

The present study demonstrates that while patients/caregivers and physicians both have reasonable facility in detecting the presence of a memory impairment, which is relatively consistent with previous findings (Schmand et al., 1996; Gron et al., 2002; Lautenschlager et al., 2005; Barnes et al., 2006; Cook et al., 2006; Mol et al., 2006; Glodzik-Sobanska et al., 2007; Clement et al., 2008; Minett et al., 2008; Snitz et al., 2008; Tsai et al., 2008), they do not have the same facility with word-finding/language deficits. This difficulty with word-finding/language assessments likely extends from a variety of reasons, including the lack of a clear definition of a word-finding/language impairment, a metric of these functions, and transparent criteria of significant impairments to this domain. We speculate that these challenges extend to the other cognitive domains listed in the DSM criteria for dementia that are not in the domain of memory.

We acknowledge the bias of this study as it focuses on normal aging controls and on patients with Mild Cognitive Impairment and Alzheimer's disease who enroll at an Alzheimer's Disease Center. Given that the study populations are self-selected and thus well motivated, it is likely that in the general population there would be even greater discrepancies between reported cognitive complaints and objective neuropsychological measures, because members of the general population possibly have less clarity on the criteria of subjective complaints, and are less likely to acknowledge a problem as they have not sought an evaluation.

Also, given the significant correlation between the GDS and participants' memory reports in our study, we acknowledge the possible impact of depression on subjective assessment of memory as described in other studies (Dux et al., 2008). While this correlation was significant, it is worth noting that ten of the thirteen neuropsychological tests used in this analysis showed a greater correlation with the participants' memory reports than with the GDS, and were therefore better predictors of memory assessment (See Table 1). Furthermore, there was no significant correlation between the GDS and the participants' report of language/word finding.

As demonstrated in this and in multiple other studies (Schmidt et al., 2001; Wong et al., 2006; Mitchell, 2008), there are variable degrees of accuracy in subjective reports of memory status as compared to standardized neuropsychological objective measures. The subjective report of memory difficulties in the subjects, including the controls and the patients with MCI and AD, shows reasonable correlations to the physician's clinical judgment and to performance on neuropsychological tests. Both the assessments of the subjects and the physicians as to whether there was a memory impairment correlated most highly with the neuropsychological tests of Logical Memory 2 recall and recognition, Word List 2 recall, and Category Fluency for fruit and vegetables (Table 1). Of these neuropsychological tests, the first three typically measure episodic memory and are commonly used in the diagnosis of episodic memory deficits, one of the early symptoms in degenerative dementias such as AD (Hodges et al., 1990). The PCA for memory (Table 2) showed that the first component accounted for approximately 74% of the variance, with both Word List Learning Recall measures and Trial 4 scores being the key neuropsychological tests contributing to this component. These tests again represent those typically used in dementia studies to detect episodic memory deficits. Overall, while there was less than optimal correlation between subjective judgment and objective neuropsychological measures, it was relatively robust. The specificity of the memory complaints was unknown in terms of subjective report, but based on inspection of the correlation matrix, there were other neuropsychological measures (e.g., Category Fluency) that correlate with memory reports of subjects and physicians.

To our knowledge there are no studies focusing on the correlation between subjective reports of word-finding or language difficulties in normal aging and dementia with corresponding neuropsychological performance. The correlation matrix demonstrated that the subjects' subjective impressions of whether they are having word-finding or language difficulties correlates poorly with all of the neuropsychological measures of word finding, language, or memory. The physicians' reports were notably superior to the subjects', but notably less accurate than their assessment of memory deficits. Additionally, this superiority was largely due to their ability to assess no word-finding or language problem. The word-finding PCA showed the first component accounted for 62% of the variance with the Semantic Object Retrieval Test (SORT; Kraut et al., 2006) scores having the highest factor loadings. The SORT task requires a subject to retrieve the memory of an object from two features presented (e.g., 'desert' + 'humps' → 'camel'). The task (Kraut et al., 2006; Kraut et al., 2007) provides a direct measure of semantic memory retrieval in its memory component and of lexical access and name production in the naming component. The test

engages fewer nonsemantic cognitive processes in its performance than do other putative tests of semantic memory commonly used in the assessment of patients with dementia. By separating the name production and memory components into two separate scores (e.g., SORT-M – correct answer for whether two features combine to make a specific item; SORT-N – the name of the item is ‘camel’), the task can distinguish between a semantic memory and a name production deficit. From the present study, the SORT appears to be a useful measure of word finding ability as well as providing one measure of semantic memory and another of name production.

No clear definition exists for what constitutes a word-finding deficit, the frequency of occurrence, or at what point this becomes pathological. Mounting evidence suggests that word-finding difficulty is a common symptom in aging and dementia and therefore needs to be effectively captured (Shafto et al., 2007). The SORT task appears to be the neuropsychological test that best assesses word-finding deficits – either in terms of a semantic memory or lexical access/name production problem. However, there is a clear need for well-defined screening questions to capture those with a possible impairment. It is imperative to develop effective screening questions that will help reveal cognitive impairments, allowing for accurate detection of those with a symptom and also assessing whether the presence of that symptom significantly impairs their functioning. This issue will almost certainly become more pressing given the projected increase in the number of aging individuals and those with dementia, coupled with the inadequate number of clinicians specializing in the care of these patients.

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Table 1

Correlation Matrix

	WFPt	WFPhy	MemPt	MemPhy
SORT M	−0.19	−0.45	−0.28	−0.46
SORT N	−0.16	−0.46	−0.28	−0.46
CatFlu A	−0.08	−0.31	−0.33	−0.44
CatFlu F&V	−0.24	−0.37	−0.54	−0.60
BNT	−0.13	−0.50	−0.44	−0.52
Token	−0.26	−0.48	−0.41	−0.41
COWAT	−0.18	−0.49	−0.38	−0.43
LM2 Recall	−0.24	−0.37	−0.66	−0.72
LM2 Rcgn	−0.21	−0.47	−0.64	−0.71
Wrd1 Tr4	−0.15	−0.53	−0.40	−0.59
Wrd1 Recall	−0.13	−0.49	−0.39	−0.55
Wrd2 Recall	−0.22	−0.37	−0.48	−0.63
Wrd2 Rcgn	−0.11	−0.36	−0.35	−0.51

SORT-M – Semantic Object Recall Test for Memory,
 SORT-N – Semantic Object Recall Test for Naming,
 CatFlu A – category fluency for animals,
 CatFlu F&V – category fluency for fruits and vegetables,
 BNT – Boston Naming Test, Token – MAE Token Test,
 COWAT – Controlled Oral Word Association Test,
 LM2 Recall – Logical Memory 2 Recall,
 LM2 Rcgn – Logical Memory 2 Recognition,
 Wrd1 Tr4 – Word List 1 Trial 4,
 Wrd1 Recall – Word List 1 Recall,
 Wrd2 Recall – Word List 2 Recall,
 Wrd2 Rcgn – Word List 2 Recognition.

Table 2

PCA of Correlation Matrix

All Inclusive PCA				
1st Component:	58.7%	2nd Component:	10.6%	3rd Component:
Wrd1 Tr4	0.90	LM2 Recall	0.56	CatFlu-A
Wrd1 Recall	0.90	LM2 Regn	0.52	CatFlu-F&V
Wrd2 Recall	0.84	Wrd2 Recall	0.27	MAE
BNT	0.81	Wrd2 Regn	0.26	BNT
SORT-N	0.79	Wrd1 Tr4	0.09	LM2 Regn
Wrd2 Regn	0.78	MAE	0.09	LM2 Recall
SORT-M	0.76	Wrd1 Recall	0.08	Wrd2 Recall
CatFlu-F&V	0.73	CatFlu-A	-0.19	Wrd2 Regn
COWAT	0.72	BNT	-0.20	Wrd1 Recall
LM2 Regn	0.69	COWAT	-0.23	COWAT
LM2 Recall	0.68	CatFlu-F&V	-0.27	Wrd1 Tr4
MAE	0.67	SORT-N	-0.45	SORT-N
CatFlu-A	0.64	SORT-M	-0.48	SORT-M
Memory PCA				
1st Component:	73.7%	2nd Component:	13.5%	3rd Component:
Wrd1 Recall	0.90	LM2 Regn	0.90	Wrd2 Regn
Wrd1 Tr4	0.88	LM2 Recall	0.88	Wrd2 Recall
Wrd2 Recall	0.75	Wrd2 Recall	0.37	Wrd1 Recall
Wrd2 Regn	0.47	Wrd1 Tr4	0.32	Wrd1 Tr4
LM2 Recall	0.29	Wrd2 Regn	0.29	LM2 Recall
LM2 Regn	0.29	Wrd1 Recall	0.26	LM2 Regn
WF/Lang PCA				
1st Component:	61.9%	2nd Component:	11.9%	3rd Component:
SORT-M	0.94	CatFlu-A	0.88	MAE
SORT-N	0.92	CatFlu-F&V	0.67	COWAT

All Inclusive PCA				
1st Component:	58.7%	2nd Component:	10.6%	3rd Component:
				6.3%
COWAT	0.67	BNT	0.57	BNT
BNT	0.56	MAE	0.26	CatFlu-F&V
CatFlu-F&V	0.49	SORT-N	0.21	SORT-N
CatFlu-A	0.23	SORT-M	0.19	CatFlu-A
MAE	0.19	COWAT	0.13	SORT-M

Table 3

Logistic Regression

All Inclusive PCA			
LangPt 1st Component			
	Predicted no	Predicted yes	% Correct
Observed no	57	7	89.1%
Observed yes	23	3	11.5%
Overall			66.7%
Chi-Sq 7.256 p < .007			
LangPhy 1st Component			
	Predicted no	Predicted yes	% Correct
Observed no	59	7	89.4%
Observed yes	9	15	62.5%
Overall			82.2%
Chi-Sq 35.667 p < .0001			
MemPt 1st Component			
	Predicted no	Predicted yes	% Correct
Observed no	34	7	82.9%
Observed yes	12	37	75.5%
Overall			78.9%
Chi-Sq 42.645 p < .0001			
MemPhy 1st Component			
	Predicted no	Predicted yes	% Correct
Observed no	38	4	90.5%
Observed yes	8	40	83.3%
Overall			86.7%
Chi-Sq 61.632 p < .0001			
Memory PCA			
MemPt 1st Component			
	Predicted no	Predicted yes	% Correct
Observed no	23	18	56.1%
Observed yes	14	35	71.4%
Overall			64.4%
Chi-Sq 15.096 p < .0001			
MemPhy 1st Component			
	Predicted no	Predicted yes	% Correct
Observed no	29	13	69.1%
Observed yes	10	38	79.2%
Overall			74.4%
Chi-Sq 18.947 p < .0001			
MemPt 2nd Component			
	Predicted no	Predicted yes	% Correct
Observed no	25	16	61.0%
Observed yes	16	33	67.4%
Overall			64.4%
Chi-Sq 15.096 p < .0001			
MemPhy 2nd Component			
	Predicted no	Predicted yes	% Correct
Observed no	28	14	66.7%
Observed yes	15	33	68.8%
Overall			67.8%
Chi-Sq 26.011 p < .0001			
WF/Lang PCA			
LangPt 1st Component			
	Predicted no	Predicted yes	% Correct
Observed no	64	0	100.0%
Observed yes	26	0	0.0%
Overall			71.1%
Chi-Sq 2.715 p < .0994			
LangPhy 1st Component			
	Predicted no	Predicted yes	% Correct
Observed no	59	7	89.4%
Observed yes	15	9	37.5%
Overall			75.6%
Chi-Sq 13.906 p < .0002			
LangPt 2nd Component			
	Predicted no	Predicted yes	% Correct
Observed no	64	0	100.0%
Observed yes	26	0	0.0%
Overall			71.1%
Chi-Sq 0.409 p < .5225			
LangPhy 2nd Component			
	Predicted no	Predicted yes	% Correct
Observed no	63	3	95.5%
Observed yes	24	0	0.0%
Overall			70.0%
Chi-Sq 4.739 p < .0295			
LangPt 3rd Component			
	Predicted no	Predicted yes	% Correct
Observed no	62	2	96.9%
Observed yes	22	4	15.4%
Overall			73.3%
Chi-Sq 4.364 p < .0367			
LangPhy 3rd Component			
	Predicted no	Predicted yes	% Correct
Observed no	65	1	98.5%
Observed yes	17	7	29.2%
Overall			80.0%
Chi-Sq 16.327 p < .0001			