The Utility and Sensitivity of Traditional and Novel Cognitive Screening Tools for MCI

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2009 ABSTRACT (UNPUBLISHED)

Background & Aims: Evaluation of cognitive complaints forms a significant component of geriatric services (Petersen and O Brien 2006). Sensitive cognitive screening tools are needed to identify patients with mild cognitive impairment (MCI) for treatment and accurate patient enrolment into studies and trials. The aim of our study was to investigate the utility of traditional and novel screening tools for use in MCI.

Methods: The Mini Mental State Examination (MMSE), Addenbrooke's Cognitive Examination-Revised (ACE-R), Montreal Cognitive Assessment (MoCA) and the novel Computer-Administered Neuropsychological Screen for Mild Cognitive Impairment (CANS-MCI) were administered to 20 normal elderly controls and 15 MCI patients.

Results: Non-parametric Mann-Whitney U tests showed a significant difference between controls and MCI on all four screening tasks. The CANS-MCI and MoCA revealed highly significant differences between controls and MCI ($p<.0001$), while the MMSE was least significant ($p<.05$). Specificity and sensitivity of the tests was assessed using ROC curve analysis. The ACE-R and MoCA total scores showed similar and very high sensitivity (90%) but lower specificity (67%). The CANS-MCI also revealed similarly high sensitivity (89%), and good specificity (73%) overall. The MMSE showed the lowest sensitivity (80%) and specificity (60%) in discrimination of the groups. Of the subscales, memory was the only domain for which the area under the curve was consistently significant across all four screening tests, although to differing degrees ($p<.05$-$p<.01$). Analysis of the profile of cognitive impairment on tests showed that MCI patients score consistently lower than controls on memory tasks, but also show comparatively low performance in domains of language, executive function and attention.

Conclusion: It is possible to obtain a useful profile of quantitative and qualitative information pertaining to cognitive functioning in MCI and normal elderly using the MoCA and ACE-R, and the CANS-MCI as an automated battery.

	Domains of Cognition (maximum scores)				
	Memory	***Language***	***Visuospatial/ perceptual processing/ praxis***	***Attention/Orientation***	***Executive function/fluency***
MMSE (30)	Delayed word recall (3)	Item naming (2) Sentence repeating (1) Sentence reading (1)	Pentagon copying (1) Command following (3) Sentence writing (1)	Backward spelling/serial subtraction (5) Temporal orientation (5) Topographic orientation (5) Word registration (3)	-

ACE-R (100)	Delayed word recall (3) Name and address registration, recall & recognition (19) Semantic probe questions (4)	Sentence reading (1) Command following (3) Sentence writing (1) Word & sentence repetition (4) Item naming (12) Item comprehension (4) Word reading (1)	Pentagon copying (1) Necker cube copy (2) Clock drawing (5) Dot counting (4) Letter identification (4)	Backward spelling/serial subtraction (5) Temporal orientation (5) Topographic orientation (5) Word registration (3)	Letter fluency (7) Animal fluency (7)
MoCA (30)	Word registration (no points) Delayed word recall (5)	Item naming (3) Sentence repeating (2) Letter fluency (1)	Necker cube copy (1) Clock drawing (3)	Digit span forward & backward (2) Tapping task (1) Serial subtraction (3) Temporal orientation (4) Topographic orientation (2)	Trail-making (1) Word pair similarities (2)
CANS-MCI	Free & guided immediate recognition Free & guided delayed recognition	Picture naming		-	Word-picture matching Design matching Stroop test Clock

MMSE = Mini Mental State Examination; ACE-R = Addenbrooke's Cognitive Examination-Revised; MoCA = Montreal Cognitive Assessment; CANS-MCI = Computerized Administered Neuropsychological Screen for Mild Cognitive Impairment

Table 1 *Cognitive domains tested and items included on each screening tools reviewed*

	Normal Controls (n = 20)		MCI (n = 15)		Mann-Whitney	
	M	StD	M	StD	U	p
Demographics						
Gender (male:female)	11:9	-	5:10	-	-	-
Age (yrs)	77.4	4.0	80.9	7.2	102.000	n.s.
Education (yrs)	14.7	2.9	13.1	3.0	100.000	n.s.
Screening Tests (maximum scores)						
Mini Mental State Examination (30)	*28.3*	*1.3*	*26.4*	*2.8*	*91.500*	*
Attention and Orientation (18)	17.7	0.5	16.9	1.7	113.000	n.s.
Memory (3)	1.9	1.1	0.9	1.1	85.000	*
Language (4)	3.8	0.4	3.7	0.5	140.000	n.s.
Visuospatial (5)	5.0	0	4.9	0.3	140.000	n.s.

Addenbrooke's Cognitive Examination (100)	*94.4*	*4.1*	*84.3*	*9.5*	*53.500*	***
Attention & orientation (18)	17.7	0.5	16.8	1.7	103.000	n.s.
Memory (26)	22.9	2.6	18.1	5.0	58.500	**
Executive function & fluency (14)	12.5	1.6	10.5	2.3	76.000	**
Language (26)	25.5	0.5	23.7	2.4	85.000	*
Visuospatial (16)	15.9	0.4	15.3	1.0	96.500	n.s.
Montreal Cognitive Examination (30)	*27.1*	*2.8*	*21.7*	*3.3*	*33.000*	****
Attention and Orientation (12)	11.7	0.7	9.9	1.4	39.000	****
Memory (5)	2.4	1.9	0.7	1.2	65.500	***
Language (6)	5.9	0.3	5.0	1.2	89.000	*
Visuospatial (4)	3.9	0.4	3.4	0.7	99.500	n.s.
Executive function & fluency (3)	3.0	0.2	2.3	0.7	76.500	**
CANS-MCI composite z-score†	3.02	2.11	-0.34	2.44	36.000	****
Memory composite z-score	0.80	0.55	-0.19	1.55	66.500	**
Executive function composite z-score	1.17	1.05	-0.28	1.34	42.500	****
Language fluency composite z-score	1.05	0.85	0.14	0.83	50.000	**

*n.s. not significant, *p<0.05, **p<0.01, ***p<0.001, ****p<0.0001*
† N=18 for Normal controls with regards to CANS-MCI data only. Data lost for two controls due to computer program error

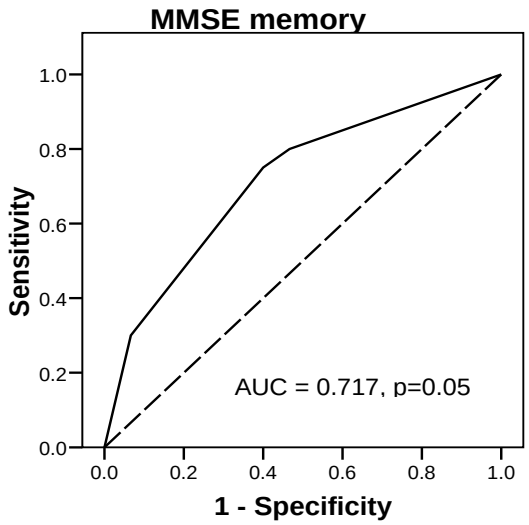
Table 2 *Means (M) and standard deviations (StD) of demographic characteristics and screening test scores, subdivided by the cognitive domains tested. Significant differences between groups explored using Mann-Whitney U tests.*

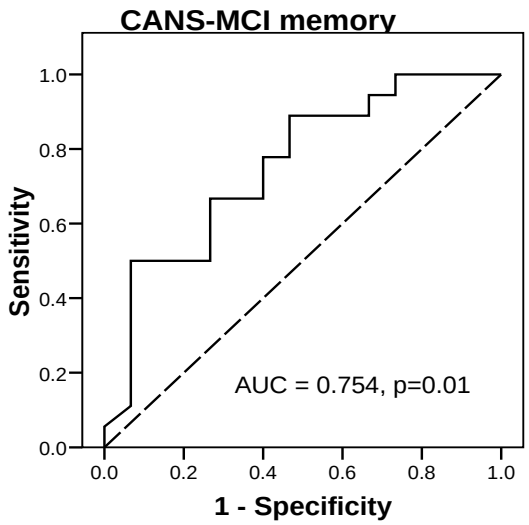
Neuropsychological t (maximum score	Area under curve (standard error)	P	95% Confidence intervals	Cut off	Sensitivity %	Specificity %	PPV %	NPV %
Mini Mental State Examination (30)	0.695 (0.09)	*	0.510 - 0.880	27.5	80	60	60	80
Memory (3)	0.717 (0.09)	*	0.544 – 0.889	1.5	75	60		
Addenbrooke's Cognitive Examination (100)	0.822 (0.08)	***	0.668 - 0.976	88.5	90	67	67	90
Memory (26)	0.805 (0.09)	**	0.638 - 0.972	20.5	90	73		
Executive function & fluency (14)	0.747 (0.09)	**	0.578 - 0.915	11.5	70	60		
Language (26)	0.717 (1.0)	*	0.526 - 0.908	24.5	100	53		
Montreal Cognitive Examination (30)	0.890 (0.05)	****	0.784 – 0.996	23.5	90	67		
Attention and Orientation (12)	0.870 (0.07)	****	0.742 – 0.998	11.5	80	87		
Memory (5)	0.782 (0.08)	**	0.628 – 0.936	0.5	80	67		
Language (6)	0.703 (0.10)	*	0.517 – 0.889	5.5	90	47		
Executive function & fluency (3)	0.745 (0.09)	**	0.568 – 0.922	2.5	95	53		
CANS-MCI composite z-score†	0.867 (0.06)	****	0.743-0.990	0.50	89	73		
Memory composite z-score	0.754 (0.09)	**	0.585-0.923	0.02	89	53		
Executive function composite z-score	0.843 (0.07)	***	0.703-0.983	0.26	83	67		
Language fluency composite z-score	0.815 (0.08)	**	0.667-0.962	0.48	83	60		

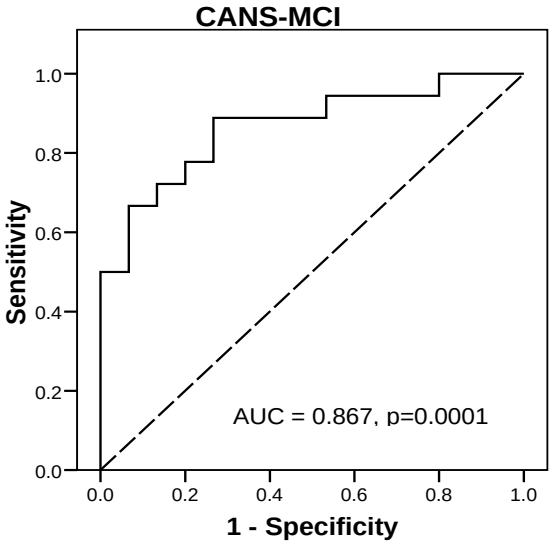
**p<0.05, **p<0.01, ***p<0.001, ****p<0.0001* *PPV Positive Predictive Value; NPV Negative Predictive Value*

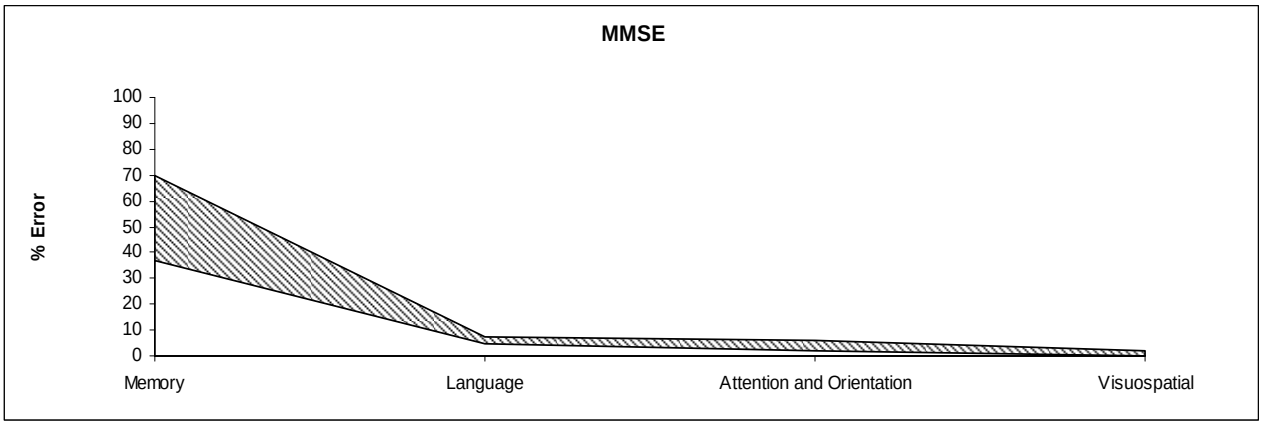
Table3 *Summary of ROC analyses for screening tests, subdivided by the cognitive domains tested.*

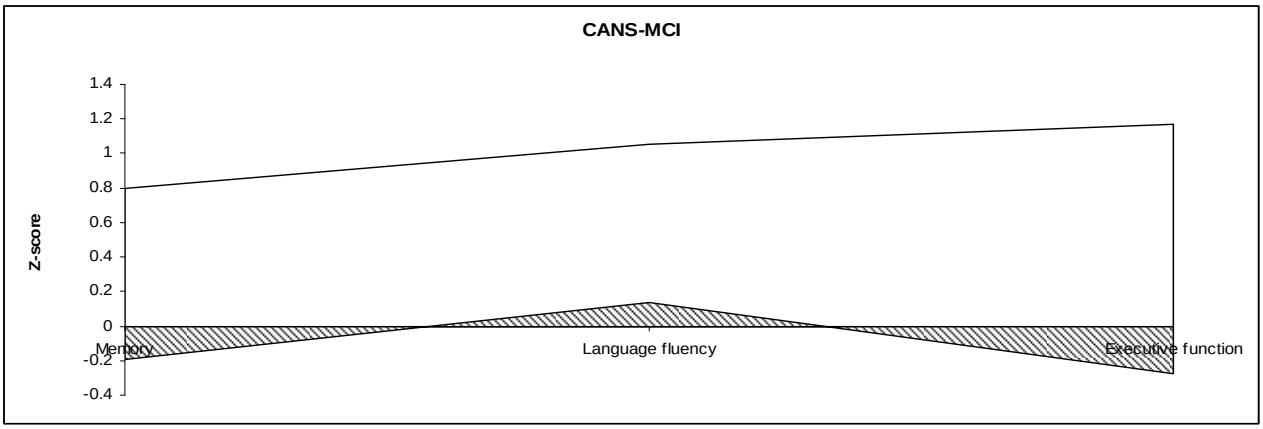
Figure 1(b) *Comparison of discriminative validity of memory domain in each screening test. AUC = Area under curve.*











Normal Controls

MCI patients

METHOD

Participants

A total of 35 participants took part in the study, 15 amnestic MCI cases (5 males, 10 females, mean age 80.9 ± 7.2; education 13.1 ± 3.0) and 20 normal elderly controls (11 males, 9 females, mean age 77.4 ± 4.0; education 14.7 ± 2.9). Participants were recruited from the Oxford Project to Investigate Memory and Ageing (OPTIMA) cohort, a cohort of community dwelling elderly persons with and without dementia. All participants had undergone extensive medical screening at enrolment. Informed consent for all participants and ethical approval had been obtained from the Central Oxford Research Ethics Committee, prior to the study.

Normal elderly controls were defined with an MMSE score of 28 or greater, with no significant complaints of memory problems, defined as either a negative response to the question "Are you experiencing difficulties with your memory?" or a score of <2 on the Everyday Memory Questionnaire (EMQ; (Sunderland et al., 1983). MCI patients were defined according to Petersen's criteria for MCI (Petersen et al., 2001) and an MMSE of 23 or greater. Subjective memory complaints were defined as either a positive response to the question "Are you experiencing difficulties with your memory?" or a score of >2 on the Everyday Memory Questionnaire (EMQ).

Objective memory impairment was defined by >12 errors on the 6-pattern stage of the Paired Associate Learning Task (De Jager et al., 2003), or a score of <13 on The Placing Test (Anderson et al., 2006). All participants were 60 years of age or older.

Exclusion criteria were: a history of any disease, which in the investigator's opinion, might confound the results of the study or pose an additional risk to the patient; a history of psychiatric or endocrine disease, or any other medical condition that may be expected to cause transient or continuous alteration of consciousness or attention; a history (within 2 years) or current evidence of major stroke, epilepsy, Parkinson's disease, progressive supranuclear palsy, Huntington's disease, amyotrophic lateral sclerosis, multiple sclerosis or other central neurological disorder and significant head trauma with loss of consciousness; a history (within 2 years) or current evidence of major untreated depressive disorder or psychotic disorder; significant problems with eyesight; dementia treatment medication being taken to maintain cognitive function. Consumption of vitamins and gingko biloba was not an exclusion criterion.

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test with percentage error in both groups.