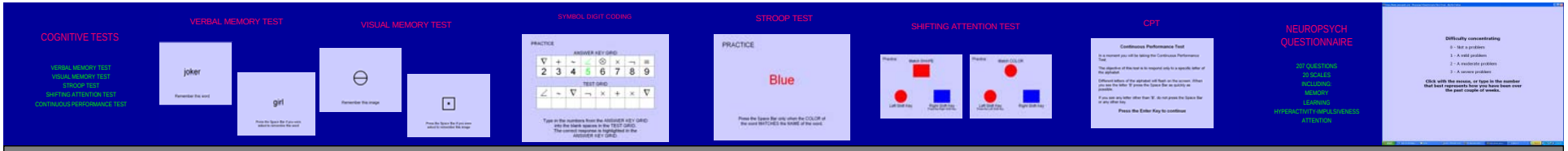


SENSITIVITY & SPECIFICITY OF COMPUTERIZED TESTING FOR MCI

C THOMAS GUALTIERI ALAN M BOYD NORTH CAROLINA NEUROPSYCHIATRY CHAPEL HILL

ABSTRACT

Computerized tests are an efficient way to screen large numbers of people who may have mild cognitive disorders, including MCI and early dementia. The CNS Vital Signs battery was administered to 322 patients age 55-94 at the NC Neuropsychiatry Clinics in Chapel Hill & Charlotte; to102 elderly people at the New England Cogntiive Center in Hartford, CT; and to 92 elderly subjects at the University of Colorado in Denver. The patients were clinically diagnosed as normal, MCI or early dementia. The different components of the Vital Signs battery were evaluated for receiver operating characteristics. Memory tests were the most sensitive and specific for the purpose of differentiating between normals and patients with MCI, followed by the composite Neurocognition Index, and then measures of executive function , processing speed and attention. A short screening battery, therefore, would appropriately consist of tests of verbal and visual memory, executive function , processing speed and complex attention.

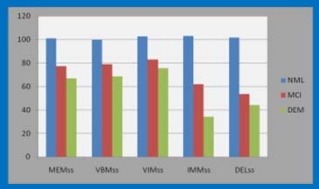
We compared the sensitivity & specificity of all the relevant domains generated by the CNS Vital Signs battery. The area under the ROC curve is the best single representation of the sensitivity & specificity of a mental test. The various memory domains were the best indicators of MCI. All of the memory domains were significantly different when normals were compared to patients with MCI and early dementia, but the composite memory domain was the best of all the memory scores.

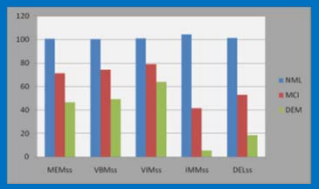
COGNITIVE DOMAIN	TEST	AUC
COMPOSITE MEMORY	VBM VIM	0.90
IMMEDIATE MEMORY	VBM VIM	0.88
VERBAL MEMORY	VBM	0.85
DELAYED MEMORY	VBM VIM	0.85
VISUAL MEMORY	VIM	0.85
NEUROCOGNITION INDEX	VBM VIM FTT SDC ST SAT CPT	0.85
COGNITIVE FLEXIBILITY	ST SAT	0.80
COMPLEX ATTENTION	ST SAT CPT	0.80
PSYCHOMOTOR SPEED	FTT SDC	0.79
EXECUTIVE FUNCTION	SAT	0.78
WORKING MEMORY	WMT	0.77
SUSTAINED ATTENTION	WMT	0.76
PROCESSING SPEED	SDC	0.73
REACTION TIME	ST	0.71
REASONING	NVRT	0.65

					COMPUTER USE			
	N	AGE	WHITE	NONWHITE	FREQ	SOME	NEVER	EDUC
	322	67.26	280	16	97	61	43	15.6
NML	211	65.1	178	7	74	36	19	15.9
MCI	80	70.7	76	4	19	21	16	15.4
DEM	31	72.9	25	5	4	4	8	14.1

Analysis of data from the CNS Vital Signs battery addresses the following co-variates: age, race, gender and self-reported computer familiarity

Tables, below: The optimal cutoff scores for tests of memory, with respect to sensitivity and specificity, is 85. The scores are standardized, with a mean of 100 and a standard deviation of 15. A score of 85, therefore, is one SD below the age-adjusted mean. The same cutoff score was generated by both the NC and the NECC samples.

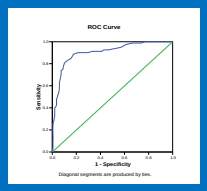




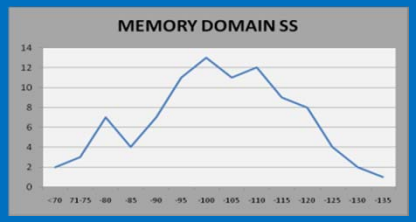
NC	MEMss		VBMss		VIMss		IMMss		DELss	
CUT	SENS	SPEC	SENS	SPEC	SENS	SPEC	SENS	SPEC	SENS	SPEC
75	0.54	0.95	0.48	0.92	0.39	0.96	0.78	0.83	0.73	0.83
80	0.71	0.93	0.60	0.90	0.56	0.93	0.78	0.80	0.76	0.77
85	0.83	0.88	0.71	0.84	0.63	0.88	0.85	0.76	0.78	0.72
90	0.90	0.75	0.85	0.74	0.76	0.79	0.87	0.73	0.84	0.68
AUC	0.904		0.854		0.848		0.88		0.852	

NECC	MEMs		VBMss		VIMss		IMMss		DELSS	
CUTOFF	SENS	SPEC	SENS	SPEC	SENS	SPEC	SENS	SPEC	SENS	SPEC
75	0.63	1.00	0.31	0.97	0.25	0.98	0.69	0.86	0.81	0.79
80	0.81	0.97	0.69	0.91	0.56	0.97	0.88	0.81	0.81	0.74
85	0.81	0.86	0.81	0.88	0.69	0.90	0.88	0.79	0.88	0.71
90	0.81	0.72	0.81	0.72	0.81	0.72	0.88	0.71	0.88	0.69
AUC	0.922		0.897		0.848		0.859		0.898	

	NECC	NC
MEMss	0.922	0.904
DELSS	0.898	
IMMss		0.880
VBMss	0.897	0.854
IMMss	0.859	
DELSS		0.852
VIMss	0.848	0.848



Figure, right: In the Colorado sample, of normal, older men, the composite memory scores were normally distributed, but there was an excess of subjects who scored lower than 85. These were inidentified cases of MCI.



THE CNS VITAL SIGNS BATTERY

The CNS Vital Signs Battery contains seven tests that are widely used by neuropsychologists, and known to be reliable and valid.

Verbal memory (VBM) and visual memory (VIM) are adaptations of the Rey Auditory Verbal Learning Test and the Rey Visual Design Learning Test (Rey, 1964; Taylor, 1959).

The finger tapping test (FTT) is one of the core tests of the Halstead-Reitan Battery. Symbol digit coding (SDC) is based on the symbol digit modalities test (Smith et al., 1982), itself a variant of the Wechsler digit symbol substitution test. The total of right and left taps from the FTT and total correct responses on the SDC generates a composite score for "psychomotor speed."

The Stroop Test (ST) (Stroop, 1935) in CNSVS has three parts that generate simple and complex reaction times. Averaging the two complex reaction time scores from the Stroop test generates a domain score for "reaction time."

The Shifting Attention Test (SAT) measures the subject's ability to shift from one instruction set to another quickly and accurately. Color-shape tests like the SAT have been used in cognitive imaging studies (Le, Pardo, & Hu, 1998; Nagahama et al., 1998). A domain score for cognitive flexibility is generated by taking the number of correct responses on the SAT and subtracting the number of errors on the SAT and the Stroop test.

The Continuous Performance Test is a measure of vigilance or sustained attention (Rosvold & Delgado, 1956). A domain score for "complex attention" is generated by adding the number of errors committed in the CPT, the SAT and the Stroop.

The CNS VS battery has been normed in >1600 normal volunteers ranging in age from 6 to 96. Peak performance on the tests is achieved during the third decade of life, and declines gradually thereafter.

Test-retest reliability coefficients ranged from 0.65 (Attention) to 0.87 (Psychomotor Speed). The TRT of the CNS VS battery is comparable to those reported for similar, traditional tests and to similar tests in other computerized test batteries (Gualtieri & Johnson, in press).

The concurrent validity of the CNS VS battery was established in a series of studies comparing the performance of subjects on CNSVS to their performance on conventional neuropsychological tests and on another computerized neurocognitive test, the NES2 (Baker et al, 1985). CNSVS tests were moderately well correlated with tests of psychomotor speed (finger tapping [0.41-0.52] and coding [0.6-.79]) and executive function on the NES2 [0.51-0.55]. Correlations between the CPT in CNSVS and the NES2 were low [0.26-0.47]. The concurrent validity of the CNS VS battery is comparable to similar, conventional neuropsychological tests.

The discriminant validity of the CNS VS battery has been established in studies of patients with mild cognitive impairment (MCI) and early dementia (Gualtieri & Johnson, 2006); post-concussion syndrome (PCS) and severe traumatic brain injury (Gualtieri & Johnson, 2005; Gualtieri & Johnson, 2007); ADHD (Gualtieri & Johnson, 2006b); depression (Gualtieri & Johnson, 2006c); schizophrenia and bipolar disorder (Gualtieri & Johnson, 2006d); and malingering (Gualtieri & Johnson, 2006).

The test battery also includes tests of nonverbal reasoning, social acuity and working memory, which were also evaluated as part of this investigation. The test battery is available in 58 languages and is widely used in research facilities around the world.

Acknowledgements: Dr Gualtieri & Mr Boyd are two of the developers of the CNS Vital Signs test battery. This research was supported by CNS Vital Signs LLC and North Carolina Neuropsychiatry, PA. No external funding was sought or received for this presentation.

Dr Gualtieri 919 933 2000 x 106 tg@ncneuropsych.com