ISCTM09 **Neurocognitive Evaluation of Patients with Traumatic Brain Injuries**

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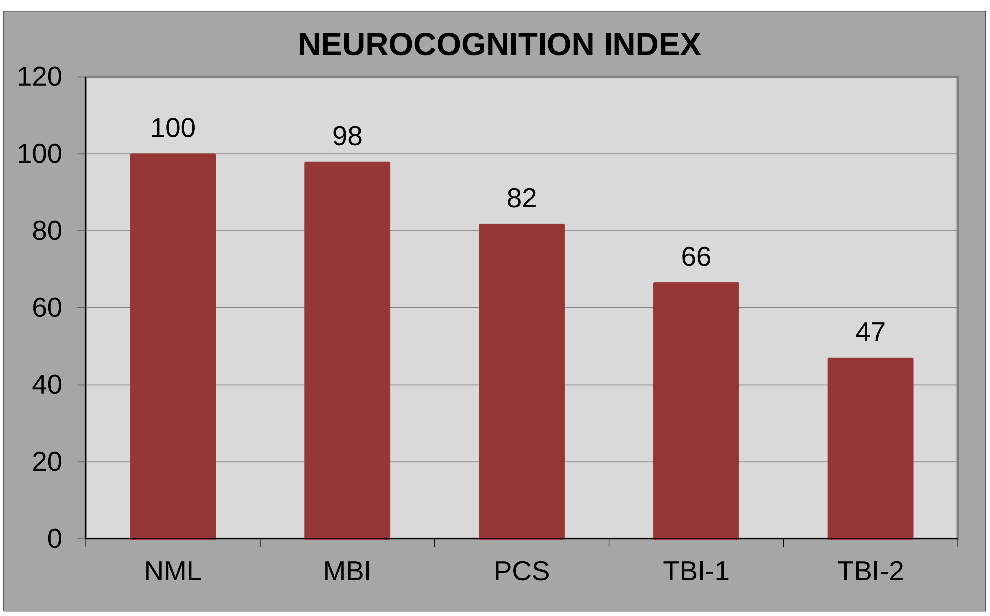
Introduction: Every year, more than 2M Americans sustain brain injuries and at least 10% are moderate to severe, with lasting motor or sensory deficits, cognitive impairment and emotional instability. The judicious application of psychotropic drugs and other somatic treatments has the potential to improve cognition and neurobehavioral symptoms. Monitoring treatment response usually entails serial cognitive testing.

Method: A computerized neurocognitive test battery was administered to 777 patients age 15-70 who had sustained moderate or severe TBI, and compared to results from normal control subjects, matched for age, race, gender, education and computer familiarity. Comparison groups were patients with post-concussion syndrome (N=97), mild brain injury (recovered)(25) and post-traumatic stress disorder (203).

Results: Although severe TBI patients were impaired in all cognitive domains, relative to normals, the most sensitive and specific differentiators were measures of psychomotor speed, processing speed, executive function and reaction time variability. The same measures were also successful in distinguishing mild TBI patients from patients with PTSD, and in tracking recovery from concussion.

Conclusion: Neurocognitive assessment of TBI patients requires a comprehensive battery, with tests of memory, psychomotor speed, reaction time and RT variability, executive function and attention. Specific tests in a comprehensive battery are expected to be particularly impaired, and may be useful for distiguishing patients with PTSD.

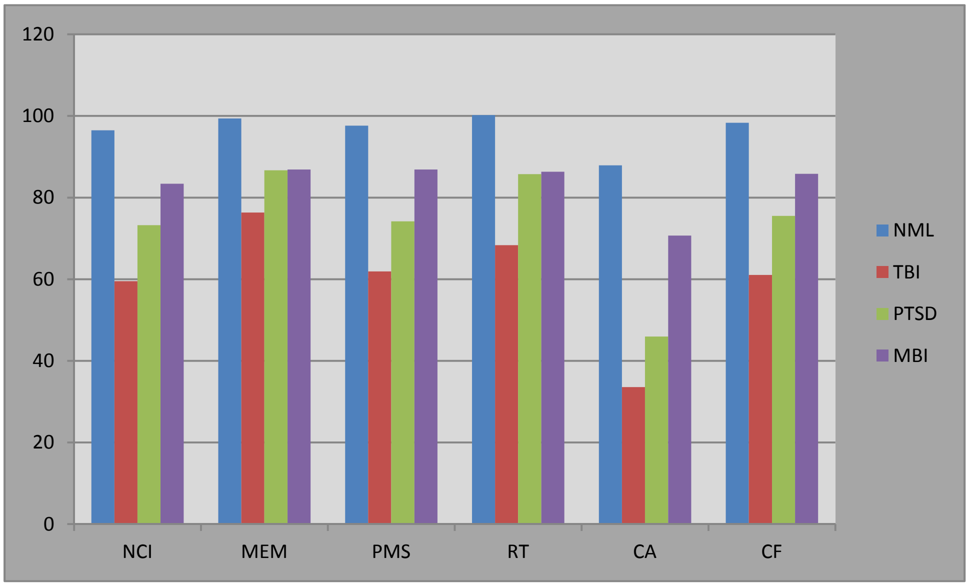
In 2008, we demonstrated the reliability and validity of a computerized neurocognitive test battery for the evaluation of patients who had the post concussion syndrome (PCS, N=13); who had recovered from mild brain injuries (MBI, N=15); who had had moderate-to-severe traumatic brain injuries (TBI1, N=85); and who had had severe and disabling TBI (TBI2, N=28) (Gualtieri & Johnson, A computerized test battery sensitive to mild and severe brain injury. The Medscape Journal of Medicine, 2008. Posted 04/15/08.) The Neurocognition Index, a summary scored based on tests of verbal and visual memory, finger tapping, coding, shifting attention, continuous performance and the Stroop test, demonstrated a graded level of cognitive performance relative to injury severity.



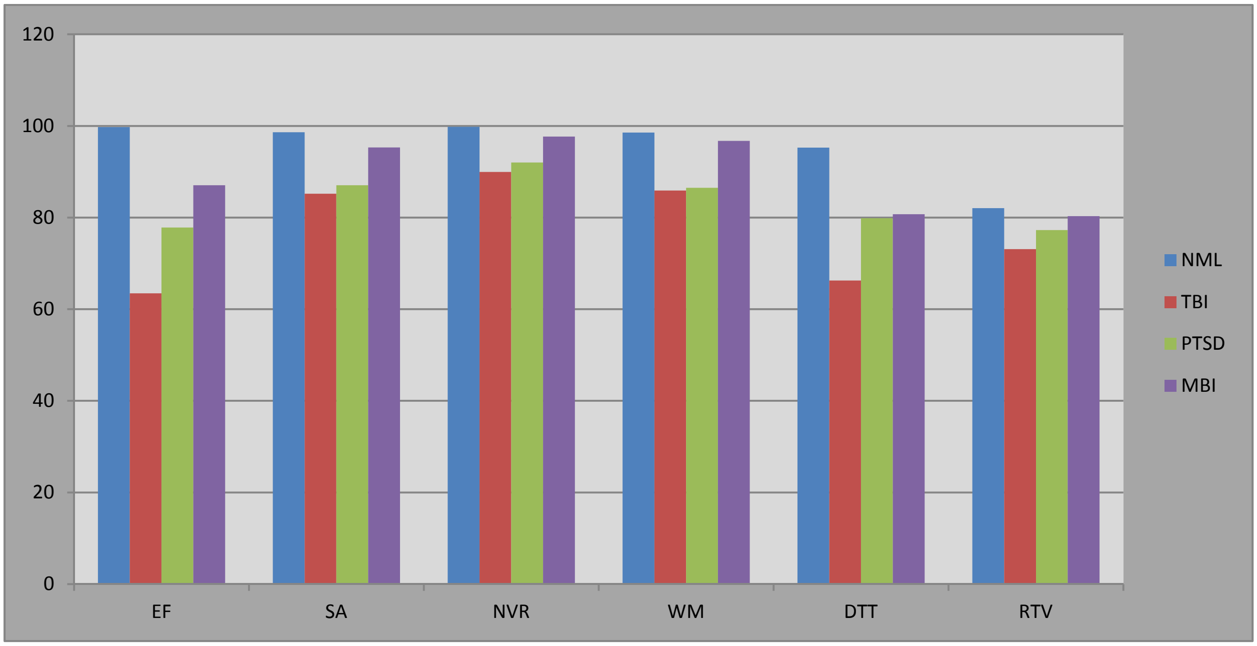
Measures of psychomotor speed (FTT & SDC) and cognitive flexibility (SAT & ST), and the NCI, were the best discriminators between normals and people who had had concussions.

	AUC	Asymptotic Sig
PSYCHOMOTOR SPEED ss	0.752	0.0170
NEUROCOGNITION INDEX ss	0.747	0.0192
COGNITIVE FLEXIBILITY ss	0.708	0.0485
COMPLEX ATTENTION ss	0.643	0.1761
MEMORY ss	0.620	0.2567
REACTION TIME ss	0.618	0.2644

This study involves 219 patients who had moderate to severe brain injuries but who were ambulatory and verbal, and independent in most of their activities of daily living; 121 patients with post-traumatic stress disorder; 98 patients who had the post-concussion syndrome; and 219 normal controls. The age of the Ss was 15 to 69. The four groups were successfully matched for age, race, gender and computer familiarity, but not for education (F=12.5, Sig < 0.001), which was accordingly entered as a covariate in the subsequent analyses.



In this study, an expanded test battery was used in a larger subject sample. This allows us to assess a wider range of variables as candidates for an optimal TBI battery. The conventional seven tests of the VS7 battery have been augmented with measures of reaction time variability for every test, and these, together, generate an RTV index. The conventional battery also generates new domains of executive function and processing speed. In addition, four new tests have been added to the battery: the perception of emotions test, which measures social acuity; tests of nonverbal reasoning and working memory; and a test of multitasking, the dual task test. When our four groups are compared with these various measures, the same pattern emerges: **NORMALS > MBI > PTSD > TBI**



NMLvTBI	Area	Asymptotic Sig	Effect Size
PSYCHOMOTOR SPEED	0.846	1.86657E-09	1.18
REACTION TIME	0.820	2.75162E-08	1.03
DUAL TASK TEST	0.811	6.43318E-08	0.99
DUAL TASK %	0.796	2.64678E-07	0.82
EXECUTIVE FUNCTION	0.782	9.57359E-07	1.06
COGNITIVE FLEXIBILITY	0.775	1.71874E-06	1.02
DUAL TASK CORRECT	0.757	7.78578E-06	0.59
MEMORY	0.747	1.7412E-05	0.91
COMPLEX ATTENTION	0.707	0.00032257	0.60
WORKING MEMORY	0.700	0.000504357	0.64
SOCIAL ACUITY	0.700	0.00051113	0.56
REACTION TIME VARIABILITY	0.689	0.00102528	0.64
NONVERBAL REASONING	0.654	0.007503006	0.55

It is a moot point that severe TBI patients score lower than normals on neurocognitive tests, and that computerized tests are perfectly capable of demonstrating those differences. The issue that is of concern in recent days, especially in military medicine, is whether one can use cognitive testing to distinguish between MBI patients and patients with PTSD. Theoretically, brain injury patients should score lower than patients with an anxiety disorder like PTSD. In fact, the opposite is the case. In almost every domain, PTSD patients score lower than MBI patients, and almost as badly as patients do who have had severe TBIs.

Logistic regression indicates that a model including measures of reaction time, executive function, psychomotor speed, memory and multitasking (dual task test) correctly classify 93% of the subjects (compared to normals). An appropriate MBI battery, therefore, might include tests of verbal and visual memory, finger tapping and coding, shifting attention and the Stroop test, and the dual task test. All of these tests are appropriate, as well, for the evaluation of patients with severe TBI.

NORMALS v MBI	Area	Asymptotic Sig	Effect Size
REACTION TIME	0.699	0.0169	0.48
PSYCHOMOTOR SPEED	0.676	0.0345	0.36
DUAL TASK TEST	0.673	0.0378	0.49
MEMORY	0.665	0.0480	0.50
WORKING MEMORY	0.664	0.0500	0.09
REACTION TIME VARIABILITY	0.655	0.0628	0.13
DUAL TASK %	0.653	0.0661	0.01
EXECUTIVE FUNCTION	0.646	0.0802	0.38
COGNITIVE FLEXIBILITY	0.642	0.0900	0.29
COMPLEX ATTENTION	0.610	0.1878	0.20
DUAL TASK CORRECT	0.595	0.2539	0.28
SOCIAL ACUITY	0.547	0.5732	0.12
NONVERBAL REASONING	0.495	0.9501	0.12

The cognitive differences between normal Ss and patients with PTSD were more dramatic, and involved a wider number of tests and variables, suggesting a broader, non-specific effect on cognitive function.

NMLS v PTSD	Area	Asymptotic Sig	Effect Size
PSYCHOMOTOR SPEED	0.787	0.0000	0.78
COGNITIVE FLEXIBILITY	0.730	0.0001	0.64
COMPLEX ATTENTION	0.729	0.0001	0.50
EXECUTIVE FUNCTION	0.729	0.0001	0.65
WORKING MEMORY	0.683	0.0017	0.62
DUAL TASK %	0.665	0.0047	0.56
DUAL TASK TEST	0.663	0.0052	0.52
MEMORY	0.646	0.0125	0.50
SOCIAL ACUITY	0.636	0.0196	0.46
REACTION TIME	0.626	0.0313	0.47
NONVERBAL REASONING	0.626	0.0313	0.45
DUAL TASK CORRECT	0.592	0.1164	0.35
REACTION TIME VARIABILITY	0.514	0.8154	0.35

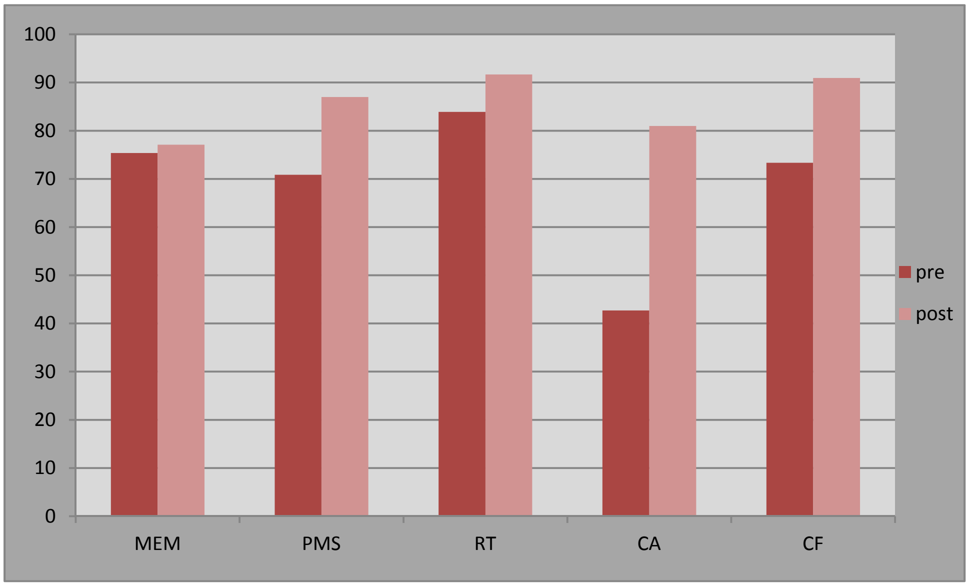
When MBI patients are compared to PTSD patients, there are significant differences, for example in working memory, multitasking and social acuity, but the effect sizes are small.

MBI v PTSD	F	Sig.	Effect Size
WORKING MEMORY	6.93	0.0033	0.53
DUAL TASK TEST	5.16	0.0069	0.03
SOCIAL ACUITY	5.13	0.0119	0.35
NONVERBAL REASONING	4.13	0.0256	0.35
DUAL TASK %	3.08	0.0603	0.55
EXECUTIVE FUNCTION	2.48	0.1000	0.27
COGNITIVE FLEXIBILITY	1.77	0.1878	0.29
REACTION TIME	1.57	0.2247	0.03
PSYCHOMOTOR SPEED	1.40	0.2620	0.42
REACTION TIME VARIABILITY	1.23	0.3061	0.22
DUAL TASK CORRECT	0.79	0.4635	0.15
COMPLEX ATTENTION	0.64	0.5338	0.29
MEMORY	0.31	0.7385	0.02

It was notable that social acuity was depressed in the PTSD patients, but not in the MBI patients. Could this be a point of differentiation? Logistic regression, however, does not generate a satisfactory model with social acuity as a covariate. Nor does a finer-grained analysis of the POET indicate salient differences, beyond what we might expect. The POET generates scores for errors of omission and commission, and correct responses and reaction times for negative and positive emotions. The deficits of PTSD patients are simply consistent with their generalized cognitive deficits.

	PTSD	MBI	F	Sig.
POETc	10.9	11.0	1.25	0.2917
POETrt	1108.0	1116.4	8.98	0.0000
POETq	1.6	1.3	0.74	0.5954
POETom	1.1	1.0	1.25	0.2917
POETcomm	3.7	2.7	3.19	0.0102
PORTposC	5.5	5.7	0.96	0.4459
POETposRT	1052.7	1081.2	7.71	0.0000
POETnegC	5.4	5.3	1.69	0.1439
POETnegRT	1149.5	1154.4	5.27	0.0002
RTd	96.7	73.2	0.71	0.6188

DRUG SENSITIVITY: TBI patients are often treated with psychostimulant drugs for cognitive problems including inattention and cognitive slowing. A subset of 32 TBI patients who had sustained moderate or severe TBI were administered a test dose of psychostimulant, methylphenidate 0.3 mgm/kgm (max, 20 mgm). The "test dose" paradigm has been described (Psychiatry2005, 2, 44-53, 2005). Improvement tends to be seen in most domains.



The areas where improvement was likeliest to seen are measures of impulsive responding, executive function, complex attention, psychomotor speed and reaction time variability.

	d	F	
SATerr	0.62	4.29	impulsive responding
CF	0.58	5.69	executive function
PMS	0.56	5.19	psychomotor speed
STstERR	0.53	2.83	impulsive responding
STcRTsd	0.52	1.77	RT variability
CPTc	0.52	2.86	impulsive responding
STcERR	0.51	2.69	impulsive responding
CPTcomm	0.51	2.80	impulsive responding
CA	0.49	3.86	complex attention
SATc	0.48	2.47	executive function
FTT rRTsd	0.46	2.12	RT variability
SATrtSD	0.42	1.84	RT variability
FTT LrtSD	0.41	1.69	RT variability

CONCLUSIONS

1. The same broad-spectrum neurocognitive battery can be used to assess patients with mild and severe TBI or PTSD.
2. An appropriate battery, therefore, might include tests of verbal and visual memory, finger tapping and coding, shifting attention and the Stroop test, and the dual task test. Tests of attention and working memory might also be included in a long battery. An abbreviated battery should include the finger tapping and shifting attention tests.
3. Patients with PTSD score lower than MBI patients on virtually all cognitive tests (save memory) and almost as poorly as patients who have had moderate-to-severe TIBs.
4. It is not possible to reliably distinguish between MBI and PTSD patients simply on the basis of neurocognitive testing at a point in time. One would expect the former to improve over time, however, while the latter may not.