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Validation of the Meyers Short Battery on mild TBI patients

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Abstract

This manuscript reports the results of two studies focusing on patients with mild Traumatic Brain Injury (TBI). The first assesses the validity of the Meyers Short Battery (MSB) of neuropsychological tests. The second study reports on the reliability of the MSB. The groups consisted of normal controls, depressed, chronic pain patients, and patients with mild TBI. Validity was assessed using a discriminant function analysis comparing the non-TBI participants with the TBI participants, which showed a 96.1% correct classification rate. When patients were assessed at least 6 months post-injury and re-assessment 12–14 months later, an overall reliability of $r = .86$ was obtained. This indicates that the MSB has adequate psychometric properties for clinical use. The results are consistent with previous published research indicating that the MSB is sensitive not only to the presence of mild TBI but also to the degree of cognitive impairment based on loss of consciousness.

Keywords: Neuropsychology; Validity; Reliability; Short Battery

The Meyers Short Battery (MSB) of neuropsychological test was published in an initial validation study by Volbrecht, Meyers, and Kaster-Bundgaard (2000). This initial validation was done on a sample of 150 patients with identified loss of consciousness (LOC), which was defined as time until able to follow a command. The results of this study showed that the MSB was sensitive to the presence of brain injury and to the degree of injury as defined by LOC. In that study, the MSB was compared to the Halstead–Reitan Battery (HRB) as utilized by Dikmen, Machamer, Winn, and Temkin (1995). The MSB was found to be as sensitive as the

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HRB to cognitive impairment. However, sensitivity and specificity data was not presented. Another comparison of the HRB and MSB was made by Rohling et al. (2003). The results of this study demonstrated that in a clinical sample, both the MSB and HRB exhibit similar sensitivity to the presence of brain injury.

The MSB consists of many commonly used tests that are presented in a standard order. These tests were selected to provide a wide range of cognitive functions, including speed of processing, working memory and attention, visual and verbal processing, and visual and verbal memory, motor and sensory, and reasoning and problems solving. This order is selected subtests from the WAIS-III (i.e., Picture Completion, Digit Symbol, Similarities, Block Design, Arithmetic, Digit Span, Information; Pilgrim, Meyers, Bayless, & Whetstone, 1999; Ward, 1990); Forced Choice (FC; Brandt, Rubinsky, & Larson, 1985); Rey Complex Figure Test (RCFT) Copy (Meyers & Meyers, 1995); Animal Naming (Spreen & Strauss, 1998); 3-min recall of RCFT (Meyers & Meyers, 1995); Controlled Oral Word Association Test (COWA; Spreen & Strauss, 1998); Dichotic Listening (Meyers, Roberts, Bayless, Volkert, & Evitts, 2002; Roberts et al., 1994); North American Adult Reading Test (NAART; Spreen & Strauss, 1998); Sentence Repetition (Meyers, Volkert, & Diep, 2000; Spreen & Strauss, 1998); 30-min Recall of RCFT and Recognition Trial of RCFT (Meyers & Meyers, 1995); Rey Auditory Verbal Learning Test (Spreen & Strauss, 1998); Judgment of Line Orientation (JLO) (Benton, Hamsher, Varney, & Spreen, 1983); Boston Naming Test (Spreen & Strauss, 1998); Finger Tapping (Reitan & Wolfson, 1985); Finger Localization (Benton et al., 1983); Trail Making Test (Reitan & Wolfson, 1985); Token Test (Spreen & Strauss, 1998); AVLT 30-min Recall and Recognition (Spreen & Strauss, 1998); Booklet Category Test (Victoria Revision; Kozel & Meyers, 1998; Spreen & Strauss, 1991).

One of the necessary components of assessing reliability and validity is to assess for adequate motivation. Within the MSB are nine different validity checks/methods. These are explained in detail in Meyers and Volbrecht (2003). In short, several different methods were used, these were: Memory Error Patterns (Attention, Encoding or Storage, Reliable Digits ≤ 6; Greiffenstein, Baker, & Gola, 1994), Forced Choice ≤ 10, Judgment of Line Orientation ≤ 12, Token Test Orientation ≤ 150, Sentence Repetition ≤ 9, Rey Auditory Verbal Learning Test Recognition ≤ 9 (see also Meyers, Galinsky, & Volbrecht, 1999; Meyers, Morrison, & Miller, 2001; Meyers & Volbrecht, 1998a, 1998b).

The ninth method used was an estimated Finger Tapping speed based on performance of Block Design, Digit Symbol, and Copying the Rey Complex Figure that is more than 10 points below the actual mean Finger Tapping trials raw score. Using the scores from a large database of 650 varied neuropsychological patients, a formula was generated for estimating scores based on linear regression. The resulting formula was (RCFT raw score $\times$ .185) + (Digit Symbol scale score $\times$ .491) + (Block Design scale score $\times$ .361) + 31.34. This formula was used to calculate the Estimated Finger Tapping score (EFT) which was then subtracted from the actual Finger Tapping (FT) and the difference (FT-EFT) was used as a band of error. It was found that persons with mild TBI or chronic pain were not expected to score less than a -10 difference in expected performance on FT (Meyers & Volbrecht, 2003).

Using these nine methods, failure on any two methods was taken to mean failure on the validity checks. As indicated in the individual articles, the cutoff scores are at such a low level, that failure on any one individual validity check would be improbable; therefore, failure on any

two validity checks would be considered not valid and result in the patient's data being excluded from further analysis from the two studies presented in this paper. Meyers and Volbrecht (2003) demonstrated in a sample of non-litigating individuals with LOC varying from brief to more than 8 days of LOC with no one failing more than one of the nine validity checks.

1. Methods

1.1. Participants

No persons in the study were involved in any related lawsuits or worker's compensation claims. If, at any time, a request was made for the records of a patient to go to workers compensation board, disability bureau or a lawyer they were removed from this study. As was noted above, each participant was administered nine separate validity checks as part of the battery. Participants were allowed to fail only one of the nine validity checks and still remain in the study sample. Failure on two or more validity checks resulted in a participant's data not being included in this study (Meyers & Volbrecht, 2003). Using failure on two or more of the validity checks, seven participants were excluded from the study. A higher failure rate (failure on two or more of these validity check) has been found in litigating subjects (Meyers & Volbrecht, 2003).

The Normal Control group (Group 1) consisted of 30 hospital patients who were seen for services within the hospital for problems not related to their central nervous system (i.e., ingrown toe nails) or were community dwelling individuals. None had a history of learning disability, mental health problems, substance abuse, brain injury, or any other medical condition that is known to affect cognition. All were currently living independently. The mean age for this group was 38.60 years (S.D. = 18.89) years with 13.43 years of education (S.D. = 3.19). Fifteen participants were male and 15 were female, 29 were right handed and 1 was left handed; 29 were Caucasian and 1 was Native American.

The Depressed group (Group 2) was comprised of 41 patients with history of depression, and all were taking an SSRI. The mean age for this group was 45.95 years (S.D. = 15.02), with 13.54 years of education (S.D. = 2.66). Twenty of these individuals were female and 21 were male; 38 were right handed and 3 were left handed; 1 was of mixed racial background and 40 were Caucasian. Twenty-nine of these individuals had completed an MMPI-2 with mean scores as follows: $L = 52.14$ (S.D. = 11.43), $F = 60.52$ (S.D. = 11.67), $K = 50.17$ (S.D. = 10.19), $1 = 63.79$ (S.D. = 12.75), $2 = 70.76$ (S.D. = 14.50), $3 = 66.65$ (S.D. = 15.98).

The Chronic Pain group (Group 3) was comprised of 32 individuals who were being treated on an outpatient basis for chronic pain. None of these individuals was not involved in litigation and had not previously had litigation proceedings. These individuals were injured in non-work-related injuries or were injured on their own farms, or had chosen not to pursue Workman's compensation and were being treated at an outpatient pain clinic. The mean age for this group was 40.72 years (S.D. = 14.17) with 13.41 years of education (S.D. = 2.06). This group was comprised of 20 females and 12 males; 29 were right handed and 3 were left handed; 31 were Caucasian and 1 was Native American.

The fourth group (Group 4) consisted of 57 individuals with history of Traumatic Brain Injury (TBI). All of these individuals had been seen at the local hospital and rehabilitation unit and followed by the senior author. These individuals all had identified loss of consciousness (LOC) that was 20 min or less, other data such as GCS and Post-Traumatic Amnesia were not always available; however, LOC data were available for all participants. Loss of consciousness was defined as the time to follow commands (e.g., Dikmen et al., 1995; Volbrecht et al., 2000). The mean years of age were 36.93 (S.D. = 15.10), with 12.63 years of education (S.D. = 2.08). This group of individuals was seen an average of 7.59 months post-injury (S.D. = 10.99). Fourteen of these individuals were female and 43 were male; 51 were right handed and 6 were left handed; 2 were of mixed racial background, 1 was Hispanic, and 54 were Caucasian.

1.2. Materials

The participants in this study were gathered over a several year period in a rehabilitation setting. All participants were administered a similar battery of tests in a standard format (as presented earlier), although some individuals may not have been able to complete all tests due to time constraints or health care insurance reimbursement limitations. The average time to complete this battery was approximately 3 h. In this sample, the mean number of neuropsychological variables collected for all participants was 34.52 (S.D. = 4.50), indicating that most participants were able to complete the entire MSB.

1.3. Results

The means and standard deviations for the individual tests in the MSB are presented in Table 1. An ANOVA was performed using the Barona, Reynolds, and Chastain (1984) demographic based FSIQ estimate of premorbid functioning. The results indicate that the four study groups did not differ on this variable, $F = 1.247$, $df = (3, 156)$, $P = 2.95$. The NART estimate did differ, $F = 11.262$, $df = (3, 147)$, $P \leq .001$; the Scheffe post hoc test (alpha set to .05) indicated only Group 4 differed on this measure ($P \leq .05$). Given that the demographics of the groups did not differ, the difference in NART performance was believed to be related to the severity of injury for the Group 4 participants. The NART may underestimate premorbid functioning in impaired participants (Spreen & Strauss, 1998). The groups are considered comparable based on the Barona et al. (1984) data. The Full Scale IQ data (based on seven subtests) from the WAIS-III was also significantly different among the groups, $F = 13.74$, $df = (3, 154)$, $P \leq .001$. A Scheffe post hoc analysis was also conducted and the only group that was significantly different was Group 4 (alpha set to .05). These results are assumed to be due to TBI of the participants in this group.

Next, the Overall Test Battery Mean (OTBM) was calculated (Miller & Rohling, 2001). This measure has been found to be a good usable measure of overall functioning as measured by a battery of neuropsychological tests (Miller & Rohling, 2001). The OTBM is simply a mean of the T scores for the tests given in the battery. An ANOVA was performed with the groups and the OTBM showed a significant difference among the groups, $F = 43.42$; $df = (3, 156)$; $P < .001$. A Scheffe post hoc analysis shows that Groups 1, 2, and 3 are not significantly

Table 1
Test scores obtained for each of the study groups

		Normal controls	Depressed	Chronic pain	Mild TBI
NART FSIQ	Mean	108.03	105.03	103.71	98.45
	n	29	40	31	51
	S.D.	8.34	8.57	8.03	6.02
FSIQ (Barona et al., 1984)	Mean	105.63	105.61	106.25	103.74
	n	30	41	32	57
	S.D.	7.07	7.12	6.57	6.21
WAIS VIQ	Mean	104.97	103.15	102.28	92.45
	n	30	41	32	56
	S.D.	9.36	12.86	11.17	9.87
WAIS PIQ	Mean	107.93	100.22	107.59	96.80
	n	30	41	32	55
	S.D.	11.55	13.24	13.04	10.50
WAIS FIQ	Mean	106.53	101.56	105.19	94.18
	n	30	41	32	55
	S.D.	8.43	11.04	10.78	9.15
Information	Mean	55.60	51.27	50.47	43.84
	n	30	41	32	55
	S.D.	8.05	7.68	9.64	7.89
Digit Span	Mean	51.10	50.80	51.22	47.27
	n	30	41	32	56
	S.D.	7.47	8.19	8.11	7.62
Arithmetic	Mean	53.00	52.71	51.53	49.57
	n	30	41	32	56
	S.D.	6.81	9.23	7.69	8.31
Trails A	Mean	49.00	48.65	50.06	46.87
	n	30	40	31	52
	S.D.	6.44	6.00	4.55	4.13
Trails B	Mean	49.60	49.70	49.19	47.87
	n	30	40	31	52
	S.D.	5.23	4.35	4.59	4.72
Judgment of Line Orientation	Mean	55.07	54.33	53.84	52.58
	n	30	40	31	48
	S.D.	5.14	6.24	7.43	6.77
Picture Completion	Mean	54.37	50.12	53.69	48.91
	n	30	41	32	55
	S.D.	8.37	10.70	11.53	8.25
Block Design	Mean	54.20	51.07	54.09	50.75
	n	30	41	32	56
	S.D.	6.93	8.45	9.76	7.87

Table 1 (*Continued*)

		Normal controls	Depressed	Chronic pain	Mild TBI
Digit Symbol	Mean	53.70	50.07	52.63	44.86
	n	30	41	32	56
	S.D.	8.47	8.06	8.30	8.84
Finger Tapping Dominant Hand	Mean	50.24	47.53	49.39	43.19
	n	29	40	31	52
	S.D.	7.16	8.05	6.50	8.56
Finger Tapping Non-Dominant Hand	Mean	51.31	50.03	49.94	44.31
	n	29	40	31	52
	S.D.	8.16	7.66	6.42	8.55
Finger Localization Dominant Hand	Mean	56.34	55.77	55.26	55.00
	n	29	39	31	45
	S.D.	2.55	3.04	4.11	3.77
Finger Localization Non-Dominant Hand	Mean	54.79	54.27	53.22	50.37
	n	29	41	32	52
	S.D.	4.97	6.44	7.35	9.63
Token	Mean	55.00	55.15	52.94	50.72
	n	30	41	32	57
	S.D.	3.27	3.55	5.02	9.15
Sentence Repetition	Mean	52.90	52.08	49.55	45.21
	n	29	39	31	48
	S.D.	14.93	11.57	9.81	12.14
Similarities	Mean	52.37	52.29	52.25	45.29
	n	30	41	32	56
	S.D.	5.86	9.31	8.53	7.15
Controlled Oral Word	Mean	49.90	46.18	46.19	40.58
	n	29	40	31	55
	S.D.	10.20	9.86	11.00	9.53
Animal	Mean	52.59	51.45	53.19	45.27
	n	29	40	31	48
	S.D.	8.57	9.79	10.84	6.80
Boston	Mean	52.21	50.90	46.13	37.45
	n	29	39	31	47
	S.D.	8.84	11.17	13.87	14.54
Dichotic Left	Mean	48.00	48.78	47.80	39.65
	n	27	37	30	49
	S.D.	6.98	7.58	7.32	10.91
Dichotic Right	Mean	56.78	55.86	54.63	45.61
	n	27	37	30	49
	S.D.	10.29	7.51	9.95	17.50
Dichotic Both	Mean	49.74	51.16	48.97	37.27
	n	27	37	30	49
	S.D.	10.09	8.49	9.05	13.31

Table 1 (*Continued*)

		Normal controls	Depressed	Chronic pain	Mild TBI
Forced Choice	Mean	49.17	47.63	48.03	41.94
	n	29	35	31	53
	S.D.	10.16	11.25	9.44	11.63
AVLT 1	Mean	50.30	53.65	49.65	43.06
	n	30	40	31	54
	S.D.	8.05	9.83	10.96	10.36
AVLT Total	Mean	53.10	54.40	49.39	38.04
	n	30	40	31	54
	S.D.	8.96	11.34	11.50	11.94
AVLT Distractor	Mean	51.73	49.37	48.81	45.59
	n	30	40	31	54
	S.D.	11.41	9.03	10.18	9.84
AVLT Immediate	Mean	53.47	53.00	46.68	36.83
	n	30	40	31	54
	S.D.	9.16	10.24	11.78	11.85
AVLT Delayed	Mean	52.60	52.83	45.97	36.30
	n	30	40	31	54
	S.D.	9.10	8.97	12.79	13.15
AVLT Recognition	Mean	51.87	54.10	52.61	46.48
	n	30	40	31	54
	S.D.	4.42	5.12	4.00	9.22
RCFT Time	Mean	49.40	53.30	54.77	50.45
	n	30	40	31	55
	S.D.	11.75	8.84	8.12	9.16
RCFT Copy	Mean	42.60	43.78	40.77	39.42
	n	30	40	31	55
	S.D.	4.39	6.52	4.32	7.23
RCFT Immediate	Mean	52.20	53.28	47.06	44.00
	n	30	40	31	54
	S.D.	8.19	11.86	11.28	11.77
RCFT Delayed	Mean	49.20	52.58	44.81	41.52
	n	30	40	31	54
	S.D.	8.21	10.35	10.42	12.01
RCFT False Positive	Mean	45.17	46.05	45.45	44.44
	n	30	40	31	55
	S.D.	5.76	7.06	6.08	6.96
RCFT False Negative	Mean	49.30	51.76	55.56	50.09
	n	30	41	32	56
	S.D.	13.37	11.18	6.97	8.11

Table 1 (*Continued*)

		Normal controls	Depressed	Chronic pain	Mild TBI
RCFT Recognition	Mean	46.80	49.40	51.94	47.15
	n	30	40	31	55
	S.D.	9.46	9.26	5.99	7.29
Victoria Version:	Mean	51.25	44.56	44.34	38.56
Booklet Category Test	*n*	28	41	32	54
	S.D.	10.74	11.36	9.42	10.99
Overall Test Battery Mean	Mean	51.76	51.21	49.92	44.54
	n	30	41	32	57
	S.D.	2.64	3.74	3.55	3.61

NART: North American Reading Test; WAIS: Wechsler Adult Intelligence Scale—III; AVLT: Rey Auditory Verbal Learning Test; CFT: Rey Complex Figure and Recognition Trial.

different based on the OTBM, but Group 4 is significantly different from Groups 1 to 3 with alpha = .05.

Groups 1, 2, and 3 were then combined and compared to Group 4 using a Discriminant Function Analysis with prior probabilities computed based on group size. The resulting function resulted in a 96.1% correct classification rate with 98.9% specificity and 90.0% sensitivity. Based on examination of the regression scores, the recommended cutoff of −.74218 for discriminating the groups was defined. Table 2 shows the variables entered into the discriminant function analysis and the analysis results.

1.4. Discussion

Consistent with the results reported by Volbrecht et al. (2000), the MSB appears to have adequate sensitivity and specificity to discriminate groups of patients with general medical conditions or depression, and those with brain injury, of even mild severity. The results of this first experiment indicate that the MSB does appear sensitive to the presence of mild cognitive impairment. Overall, the battery of tests shows a 96.1% correct classification rate for normal controls, depressed, chronic pain, and mild TBI patients. As Lezak (1995) points out, "the real test of differentiation is not whether these groups can be identified by examining a variety of neuropsychological functions, but whether participants with subtle damage can be identified" (p. 719). This was achieved in the current first study.

2. Study 2

Not only is it necessary to validate this battery against mild TBI patients, but it is also necessary to ensure that it is consistent in its results. A common method of doing this consists of performing a test-retest analysis.

2.1. Materials

Each participant was administered the MSB as in Study 1.

Table 2
Unstandardized canonical discriminant function coefficients

Test	Coefficient
Information	.038
Digit Span	.023
Arithmetic	−.006
Trails A	.075
Trails B	−.020
Judgment of Line Orientation	−.074
Picture Completion	−.005
Block Design	−.007
Digit Symbol	−.002
Finger Tapping Dominant Hand	.020
Finger Tapping Non-Dominant Hand	.042
Finger Localization Dominant Hand	−.119
Finger Localization Non-Dominant Hand	.083
Token Test	.065
Sentence Repetition	.010
Similarities	.003
Controlled Oral Word Association Test	−.014
Animal Naming	.033
Boston Naming	−.013
Dichotic Listening Left Ear	.013
Dichotic Listening Right Ear	.030
Dichotic Listening Both Ears	.004
Forced Choice	.023
Rey Auditory Verbal Learning Test Trial 1	.010
Rey Auditory Verbal Learning Test Trial Total	−.019
Rey Auditory Verbal Learning Test Trial Immediate Recall	.031
Rey Auditory Verbal Learning Test Trial Delayed Recall	.045
Rey Auditory Verbal Learning Test Trial Recognition A	.027
Rey Complex Figure Time	.022
Rey Complex Figure Copy	−.003
Rey Complex Figure Immediate Recall	−.041
Rey Complex Figure Delayed Recall	.008
Rey Complex Figure False Positives	−.021
Rey Complex Figure False Negatives	.003
Rey Complex Figure Recognition	.027
Victoria Version: Booklet Category Test	.031
Constant	−15.107

Eigenvalue = 2.333; canonical correlation = .83; Wilks' Lambda = .300; Chi-square = 128.82; df = 36; significance ≤ .001.

2.1.1. Participants

Reflecting a general clinical sample, 63 persons with mixed diagnoses were assessed more than once, with the first testing at least 6 months post-injury. Those who were involved in disability or workman's compensation petitions were not excluded, but all patients performances were deemed reliable because they passed all validity checks (as discussed in Study 1; see also

Meyers & Volbrecht, 2003). The mean age for this group was 38.38 years (S.D. = 22.83), with 12.22 years of education (S.D. = 2.88). The average months post-injury at the time of the first testing was 21.60 (S.D. = 22.83) and the second testing occurred at 40.69 months (S.D. = 33.17). The mean time difference was 19.14 months (S.D. = 16.60) between the two testings, with a range of 2–91 months, and a median months difference of 13 months.

The demographics of this group consisted of 33 female and 30 male participants, 50 were right handed and 13 left handed, 1 was of mixed racial background and 62 were Caucasian. The diagnostic make up of this group was 47 TBI, 7 vascular/CVA, 2 had hypoxic events, 2 had Hypoxia/Carbon monoxide poisoning, 1 had gunshot wounds to the head, 1 had Encephalitis, 2 had mental health diagnoses, 2 had right temporal lobectomy, and 1 had left temporal lobectomy.

2.1.2. Results

The data as indicated in Table 3 shows the range of correlations (r) for the test retest which ranged from .45 (AVLT Total) to .88 (Block Design), with an Overall Test Battery Mean (OTBM) test retest of .86. This suggests that this combination of tests, as a formal battery has good reliability, both for the individual tests and for the battery overall. Tabachnick and Fidell (1989) indicates that a correlation must be at least .30 or higher to be interpretable and individually the tests that comprise this battery more than meet this requirement. These results suggest that the battery of tests has adequate consistency for test-retest comparison at about 12–14 months, with recommended time between testing of at least 6 months for best consistency.

Table 3 shows the mean differences between the individual tests under the test-retest condition. Table 4 shows the correlations for each test and Table 5 shows the paired samples t test for each to the tests in the MSB and the OTBM as an overall measure. If the clinician wishes to correct for test retest the difference of the means as presented in Table 3 for each test may be subtracted from the second testing. It should be pointed out that the groups used in this study had cognitive impairment, there may be a larger test-retest finding in normal controls. However, rarely is the neuropsychological clinician in a position for test retest of normal participants. The authors believe that a patient sample provides better and more clinically usable information for the clinician.

3. General discussion

It is important for the reliability and validity of a battery of tests to be established. Not only do the individual tests making up a battery need to be valid and reliable, but also the "whole" of a battery needs to be established; as a test is not interpreted alone, but always in context with the other tests used in the battery. The initial validation of this battery of tests was presented by Volbrecht et al. (2000). That study compared the MSB with the HRB using mild, moderate, and severe brain injury patients. This previous study demonstrated that the MSB was sensitive to varying degrees of injury. The current study adds to this basic validity information by assessing very mild TBI. A discriminant function analysis was used to differentiate groups of individuals with no history of TBI from mild TBI patients. Many times individuals with depression or

Table 3
Paired samples statistics, *T* scores

	Testing	Mean	*N*	S.D.	S.E.M.
Information	1	43.03	59	6.98	0.91
	2	43.73	59	8.49	1.11
Digit Span	1	44.59	54	7.97	1.08
	2	43.33	54	6.73	0.92
Arithmetic	1	43.15	54	10.03	1.36
	2	44.20	54	9.43	1.28
Trails A	1	36.28	57	13.13	1.74
	2	36.91	57	13.77	1.82
Trails B	1	38.16	57	13.07	1.73
	2	40.12	57	11.67	1.55
Judgment of Line Orientation	1	48.02	50	11.72	1.66
	2	50.54	50	10.19	1.44
Picture Completion	1	42.37	54	10.24	1.39
	2	43.54	54	10.78	1.47
Block Design	1	44.46	54	10.74	1.46
	2	44.87	54	10.03	1.36
Digit Symbol	1	38.98	59	10.24	1.33
	2	37.93	59	9.52	1.24
Finger Tapping Dominant Hand	1	36.03	58	11.82	1.55
	2	37.90	58	11.41	1.50
Finger Tapping Non-Dominant Hand	1	37.81	57	14.21	1.88
	2	40.47	57	13.45	1.78
Finger Localization Dominant Hand	1	53.65	48	5.71	0.82
	2	52.54	48	5.93	0.86
Finger Localization Non-Dominant Hand	1	47.77	48	11.70	1.69
	2	48.08	48	9.89	1.43
Token Test	1	45.56	63	14.57	1.84
	2	48.30	63	13.42	1.69
Sentence	1	40.71	49	15.76	2.25
	2	40.51	49	13.16	1.88
Similarities	1	44.70	54	9.31	1.27
	2	45.80	54	9.90	1.35
Controlled Oral Word Association (FAS)	1	37.10	58	10.81	1.42
	2	38.31	58	11.52	1.51
Animal	1	39.92	49	12.61	1.80
	2	40.35	49	12.76	1.82
Boston	1	32.84	51	17.51	2.45
	2	31.80	51	18.21	2.55

Tabla 3 (*Continued*)

	Testing	Mean	*N*	S.D.	S.E.M.
Dichotic Listening Left	1	29.24	49	18.73	2.68
	2	30.51	49	19.07	2.72
Dichotic Listening Right	1	42.29	49	20.88	2.98
	2	45.53	49	17.06	2.44
Dichotic Listening Both	1	28.18	49	19.79	2.83
	2	30.86	49	19.25	2.75
Rey Auditory Verbal Learning 1	1	41.54	57	12.90	1.71
	2	39.14	57	13.14	1.74
Rey Auditory Verbal Learning Total	1	31.21	57	16.15	2.14
	2	31.63	57	16.22	2.15
Rey Auditory Verbal Learning Immediate	1	30.96	56	16.39	2.19
	2	30.57	56	16.09	2.15
Rey Auditory Verbal Learning Delayed	1	31.37	57	16.19	2.14
	2	30.51	57	15.87	2.10
Rey Auditory Verbal Learning Recognition	1	41.39	57	15.36	2.03
	2	43.18	57	12.77	1.69
Rey Complex Figure Test Time	1	46.73	62	13.69	1.74
	2	47.87	62	11.62	1.48
Rey Complex Figure Test Copy	1	33.57	63	13.25	1.67
	2	35.11	63	12.34	1.55
Rey Complex Figure Test Immediate	1	47.58	62	15.29	1.94
	2	40.24	62	14.64	1.86
Rey Complex Figure Test Delayed	1	34.63	63	15.31	1.93
	2	37.73	63	15.23	1.92
Rey Complex Figure Test Recognition	1	37.81	62	15.14	1.92
	2	40.42	62	12.95	1.65
Victoria Version: Booklet Category Test	1	36.74	53	14.41	1.98
	2	39.28	53	13.89	1.91
Overall Test Battery Mean	1	39.26	63	8.27	1.04
	2	40.33	63	7.77	0.98

1: first testing; 2: second testing.

chronic pain report cognitive deficits; however, the study finds that depressed individuals and individuals with chronic pain do not differ significantly from normal controls on this neuropsychological battery. These results suggest that this battery may be used to assess cognitive impairments even with individuals who are reporting chronic pain or depression if there is a question of reduced cognition. The MSB shows good sensitivity (90%) and specificity (98.9%). Results of this evaluation are the second validation of this battery. This battery misclassified four individuals from the TBI group. The fact that four individuals were misclassified suggests

Table 4
Paired samples correlations (r), T scores

	Correlation	Significance (P)
Information	.715	<.001
Digit Span	.546	<.001
Arithmetic	.718	<.001
Trails A	.788	<.001
Trails B	.670	<.001
Judgment of Line Orientation	.619	<.001
Picture Completion	.766	<.001
Block Design	.881	<.001
Digit Symbol	.814	<.001
Finger Tapping Dominant Hand	.694	<.001
Finger Tapping Non-Dominant Hand	.789	<.001
Finger Localization Dominant Hand	.511	<.001
Finger Localization Non-Dominant Hand	.503	<.001
Token Test	.677	<.001
Sentence	.714	<.001
Similarities	.731	<.001
Controlled Oral Word Association (FAS)	.775	<.001
Animal	.674	<.001
Boston	.792	<.001
Dichotic Listening Left	.799	<.001
Dichotic Listening Right	.521	<.001
Dichotic Listening Both	.814	<.001
Rey Auditory Verbal Learning 1	.459	<.001
Rey Auditory Verbal Learning Total	.768	<.001
Rey Auditory Verbal Learning Immediate	.744	<.001
Rey Auditory Verbal Learning Delayed	.746	<.001
Rey Auditory Verbal Learning Recognition	.559	<.001
Rey Complex Figure Test Time	.745	<.001
Rey Complex Figure Test Copy	.712	<.001
Rey Complex Figure Test Immediate	.747	<.001
Rey Complex Figure Test Delayed	.690	<.001
Rey Complex Figure Test: Recognition Trial	.574	<.001
Victoria Version: Booklet Category Test	.772	<.001
Overall Test Battery Mean	.863	<.001

that these four individuals had relatively mild cognitive impairments that probably did not have any significant effect on their functioning. Individuals who made up the TBI group had loss of consciousness of "seconds" up to less than 20 min. The four TBI patients misclassified as normals, had a loss of consciousness in "seconds" and so the "misclassification" is not considered significantly errant, it may have been that any cognitive impairment may have been so mild as to be non-significantly different from normal controls or there may not have been any cognitive impairment. This battery appears to be of adequate test construction for general use. The MSB is considered a short battery and of course a clinician may add other tests as desired.

Table 5
Paired samples test

	Mean difference	S.D.	S.E.M.	t	df	P (two tailed)
Information	−0.69	6.01	0.78	8.89	58	.378
Digit Span	1.26	7.09	0.96	1.305	53	.197
Arithmetic	−1.06	7.33	1.00	−1.058	53	.295
Trails A	−0.63	8.79	1.16	−0.543	56	.589
Trails B	−1.96	10.13	1.34	−1.464	56	.149
Judgment of Line Orientation	−2.52	9.66	1.37	−1.845	49	.071
Picture Completion	−1.17	7.21	0.98	−1.189	53	.240
Block Design	−0.41	5.10	0.69	−0.586	53	.560
Digit Symbol	1.05	6.06	0.79	1.333	58	.188
Finger Tapping Dominant Hand	−1.86	9.09	1.19	−1.561	57	.124
Finger Tapping Non-Dominant Hand	−2.56	9.01	1.19	−2.146	56	.036
Finger Localization Dominant Hand	1.10	5.76	0.83	1.328	47	.190
Finger Localization Non-Dominant Hand	−0.31	10.87	1.57	−0.199	47	.843
Token Test	−2.75	11.29	1.42	−1.930	62	.058
Sentence	0.20	11.21	1.60	0.127	48	.899
Similarities	−1.09	7.07	0.96	−1.135	53	.261
Controlled Oral Word Association (FAS)	−1.21	7.52	0.99	−1.222	57	.227
Animal	−0.43	10.25	1.46	−0.293	48	.771
Boston	1.04	11.53	1.61	0.644	50	.523
Dichotic Listening Left	−1.27	11.98	1.71	−0.739	48	.463
Dichotic Listening Right	−3.24	18.86	2.69	−1.205	48	.234
Dichotic Listening Both	−2.67	11.92	1.70	−1.571	48	.123
Rey Auditory Verbal Learning 1	2.40	13.56	1.80	1.339	56	.186
Rey Auditory Verbal Learning Total	−0.42	11.03	1.46	−0.288	56	.774
Rey Auditory Verbal Learning Immediate	0.39	11.61	1.55	0.253	55	.801
Rey Auditory Verbal Learning Delayed	0.86	11.43	1.51	0.568	56	.572
Rey Auditory Verbal Learning Recognition	−1.79	13.41	1.78	−1.007	56	.318
Rey Complex Figure Test Time	−1.15	9.25	1.17	−0.975	61	.333
Rey Complex Figure Test Copy	−1.54	9.75	1.23	−1.253	62	.215
Rey Complex Figure Test Immediate	−2.66	10.67	1.36	−1.964	61	.054
Rey Complex Figure Test Delayed	−3.10	12.03	1.52	−2.042	62	.045
Rey Complex Figure Test Recognition	−2.61	13.10	1.66	−1.570	61	.122
Victoria Version: Booklet Category Test	−2.55	9.57	1.31	−1.938	52	.058
Overall Test Battery Mean	−1.06	4.22	0.53	−1.996	62	.050

The reliability of this battery as a whole was good, showing an overall correlation of $r = .86$. The reliability of this battery also is sufficient to allow for comparison of performance over time. The results also demonstrate that the effects of depression and chronic pain on test performance are not significantly different from controls. This shows that this battery of tests would be useful when assessing persons with known or suspected depression or chronic pain who have known or suspected cognitive impairment. These same results were reported by Reitan and Wolfson (1997) in their examination of the effects of depression on the HRB. The current results are similar to their findings in that depression and chronic pain do not appear to significantly affect performance on neuropsychological tests, give adequate motivation. Overall, the MSB appears adequately reliable and valid for use by the clinician in a variety of settings.

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