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Detection of Symptom Exaggeration With the MMPI-2 in Litigants With Malingered Neurocognitive Dysfunction

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ABSTRACT

MMPI-2 scores of 26 persons identified as meeting criteria for definite malingered neurocognitive dysfunction (MND), were contrasted with the MMPI-2 scores of 29 persons who had suffered moderate or severe closed head injury. The Lees-Haley Fake Bad Scale (FBS) was the most sensitive MMPI-2 scale in discriminating the malingerers from the head-injured persons, with additional significant differences obtained on standard MMPI-2 clinical scales including Scales 1 (Hs), 2 (D), 3 (Hy), 7 (Pt), and 8 (Sc). Correlational analyses on a larger sample combining additional subjects with evidence of possible or probable MND, with the original sample and the head injured subjects, demonstrated the concurrent validity of the FBS, which correlated with the Portland Digit Recognition Test (PDRT), and with Scales 1 (Hs), 2 (D), 3 (Hy), and 7 (Pt) of the MMPI-2.

The MMPI and MMPI-2 have long played a role in the assessment of the symptom exaggeration characteristic of malingering (Berry, Baer, & Harris, 1991; Graham, 2000; Greene, 2000; Rogers, Sewell, & Salekin, 1994). Various scales and procedures have been devised since the development of the F scale, the prototypic measure of symptom exaggeration on the original MMPI that was originally derived by selecting items endorsed by 10% or less of the normal adult sample (Graham, 2000).

The MMPI-2 (Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989) includes the F scale as well as the Fb scale, developed for items occurring after the first 370 MMPI-2 questions, and VRIN a measure of response inconsistency. Fb was developed using the same methodology as F, selecting items endorsed by 10% or less of the normal adult sample. VRIN was developed to assist in interpretations of significant elevations on F ($T \geq 100$) and Fb ($T \geq 90$). VRIN scores $\geq$T80 indicate inconsistent random responding as the cause of elevations on F and Fb (Butcher & Williams, 1992). Graham (2000) recommends considering VRIN raw scores greater than 13 as consistent with random responding.

Subsequent to the publication of the MMPI-2, Arbisi and Ben-Porath (1995) developed the Infrequency-Psychopathology Scale, F(p). This scale was developed by selecting MMPI-2 items endorsed by 20% or fewer of hospitalized psychiatric patients, as well as infrequently endorsed by 20% or fewer MMPI-2 normal subjects. In a subsequent study, Arbisi and Ben-Porath (1998) found that F(p) out performed F in distinguishing between psychiatric patients performing honestly and those attempting to fake bad.

The F, Fb, and F(p) scales as well as other traditional MMPI-2 validity indicators such as the F−K raw score difference (Gough, 1950),

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Dissimulation (Ds) and Dissimulation – revised (DS–r; Gough, 1954, 1957), and obvious–subtle (O−S) difference scores (Wiener, 1948), were developed to assist in detection of exaggerated psychopathology. Indeed, F, Fb and F(p) correlate most strongly with elevations on MMPI-2 Scale 6 (Pa) and Scale 8 (Sc) (Arbisi & Ben-Porath, 1995). By contrast, these MMPI-2 validity scales may not be sensitive to exaggeration of symptoms in personal injury settings for litigants pursuing neuropsychological claims. In this vein, Greiffenstein, Gola, and Baker (1995) found that F, total sum of Obvious-Subtle difference, and F−K did *not* discriminate probable malingerers from subjects with traumatic brain injury (TBI), and persistent postconcussion syndrome, despite the presence of significant group differences on several measures of neuropsychological malingering including the Rey-15 Item Test, Recognition Word List, Auditory Verbal Learning Test Recognition score, Reliable Digit Span, and PDRT-27.

Lees-Haley and colleagues (Lees-Haley, English, & Glenn, 1991; Lees-Haley, 1992) recognized a different pattern of symptom-reporting in personal injury litigants, and developed a validity scale that would be sensitive to personal injury exaggeration, the Fake Bad Scale (FBS). The FBS was constructed on a rational content basis, considering unpublished frequency counts of malingerers' MMPI test data, and responses that fit a model of goal-directed behavior oriented towards: (1) appearing honest; (2) appearing psychologically normal except for the influence of the alleged cause of injury; (3) avoiding admitting preexisting psychopathology; (4) attempting to minimize the impact of previously disclosed preexisting complaints; (5) minimizing or hiding preinjury antisocial or illegal behavior; and (6) presenting a degree of injury or disability within perceived limits of plausibility. The FBS contains 18 items scored in the "True" direction, and 25 items scored in the "False" direction. The FBS does not correlate strongly with F(0.14), Fb (0.26) or F(p) (0.08) in normals, despite significant correlations between F, Fb, and F(p) that average 0.75 for normals and patients with mental disorders (Greene, 1997). The majority of FBS items occur on Scales 1 and 3, with six on Scale 1, seven on Scale 3, and seven appearing on Scales 1 and 3. One FBS item occurs on L, one on *K*, four on *F*, four on Scale 2, two on Scale 4, four on Scale 6, three on scale 7, six on Scale 8, and three on Scale 0 (note: there is some item overlap on more than one scale).

Lees-Haley et al. (1991) found that 24 of 25 (96%) personal injury claimants assessed as malingering emotional distress were correctly classified, with 18 of 20 (90%) claimants assessed as presenting genuine injuries correctly classified using an FBS cut-off of 20 or higher. In a subsequent investigation, Lees-Haley (1992) found sensitivity and specificity values of 75% and 96% using an FBS cut-off of 24 or higher for males, and 74% and 92% for a cut-off of 26 or higher for females, in discriminating Pseudo-PTSD claimants from claimants with legitimate emotional distress claims.

As might be expected, the sensitivity and specificity of the FBS decline when investigated in psychiatric settings. Rogers, Sewell, and Ustad (1995) found that F, Fb, F−K, and F(p) were superior to the FBS in correct identification of psychiatric outpatients taking the MMPI-2 under honest or simulated malingering conditions. In the honest condition, the FBS had a 21.1% false positive rate, with only a 48.5% sensitivity in the malingered condition. Rogers, Sewell, and Ustad (1995) commented that their results did not necessarily demonstrate the invalidity of the FBS, which they observed may be more sensitive in context-specific (e.g., personal injury) or diagnosis specific (e.g., PTSD) circumstances.

Consistent with this observation, other investigations of detection of malingering in neuropsychological settings have demonstrated superior sensitivity of the FBS in comparison to F and related scales (Larrabee, 1998; Larrabee, in press; Millis, Putnam, & Adams 1995; Putnam, Millis, & Adams, 1998; Tsushima & Tsushima, 2001). Millis et al. (1995) found that FBS was superior to F, F−K, and Fb and F(p) in discriminating Mild Head Injury (MHI) litigants performing below chance on the Recognition Memory Test from patients with moderate to severe Closed Head Injury (CHI). Larrabee (1998) found that the FBS was more sensitive than F, Fb, F−K and F(p) to identifying MMPI-2 symptom exaggeration in probable malingerers alleging acquired neuropsychological deficit. Putnam et al. (1998) found that FBS was superior to F in discriminating moderate/severe CHI from a group of MHI litigants failing forced choice testing. Tsushima and Tsushima (2001) found that the FBS alone discriminated litigating patients from nonlitigating clinical patients, with no discrimination provided by F, Fb, F(p) or Ds–r. Larrabee (in press) found that the FBS was more sensitive than F, Fb, or F(p) in detecting exaggeration in litigants meeting criteria for either definite or probable malingered neurocognitive dysfunction (MND; Slick, Sherman, & Iverson, 1999).

Recently, Meyers, Millis, and Volkert (2002) have developed a new scale to assess malingering in chronic pain patients, combining a variety of MMPI-2 validity indicators, including F, F−K, F(p) Ds–r, Ego Strength (Es), sum of obvious−subtle, and the FBS. Based on their review of the literature, they determined ranges of performance for the above validity indicators that were assigned weights of 0, 1, or 2 (e.g., F < T74 was weighted 0; F = T75-89 was weighted 1; F = T > 90 was weighted 2). They then evaluated the frequency distribution of these weighted totals in a group of nonlitigating pain patients. A weighted score of 5 or more yielded 100% specificity (no false positives). By contrast, 86% of noninjured knowledgeable actors scored 5 or higher, as did 36% of litigating chronic pain patients.

The purpose of the present study is to further evaluate the validity of the FBS in comparison to F, Fb, F(p) and the Meyers et al. Weighted Validity Index. The first part of the current investigation will evaluate the sensitivity and specificity of the MMPI-2 validity scales in discriminating litigating malingerers from subjects who have sustained moderate to severe CHI. In this study, malingering will be defined using the Slick et al. (1999) criteria for definite MND: (1) presence of a substantial external incentive, (2) definite negative response bias, demonstrated by significantly worse-than-chance performance on the PDRT, a well-validated measure of malingering (Bianchini, Mathias, & Greve, 2001; Bianchini, Mathias, Greve, Houston, & Crouch, 2001; Vickery, Berry, Inman, Harris, & Orey, 2001), and (3) the definite negative response bias is not fully accounted for by psychiatric, neurological or developmental factors.

The second part of the current study will evaluate the intercorrelation of the various validity scales with one another, with the PDRT, and with the standard MMPI-2 clinical scales in a group including the litigants with definite MND, combined with litigants who meet the Slick et al. criteria for probable MND (performance at PDRT levels exceeded by 98% of nonlitigants with bonafide brain dysfunction, Binder & Kelly, 1996; plus failure on at least one other measures of effort such as the Rey-15 Item Test; Test of Memory Malingering, Tombaugh, 1996; or Warrington Recognition Memory Test, Millis, 1992), possible MND (PDRT performance at levels exceeded by 98% of nonlitigants with bonafide brain dysfunction, with no failures on any other measures of effort), combined with patients suffering moderate and severe closed head injury.

METHODS

Subjects

Case files were reviewed to identify 26 litigants performing significantly worse-than-chance ($p < .05$) on either the Easy, Hard, or Total PDRT, or on any single 18-item PDRT trial block. Twenty-one had alleged mild CHI (none with documented loss of consciousness, posttraumatic amnesia, or abnormal neurologic, CT/MRI, or medical findings), one had alleged hypoxic brain dysfunction (normal acute and chronic medical and neurologic findings), and four had alleged neurotoxic injury (normal medical, neurologic, laboratory, CT/MRI, and EMG/NCV studies). All subjects were either in litigation or pursuing Workman's Compensation, meeting the Slick et al. (1999) Criterion A (presence of a substantial external incentive), and none showed any evidence that their poor PDRT performance could be accounted for by psychiatric, neurological or developmental factors (Criterion D of Slick et al., 1999). Fourteen litigants were from the Larrabee (in press) study, and five were from the Larrabee (1998) study. Mean PDRT Easy Total (out of 36) was 17.58 ($SD = 4.70$), mean PDRT Hard Total (out of 36) was 12.23 ($SD = 3.70$), and mean lowest score on any 18 item trial block was 4.69 ($SD = 1.74$).

Case files were reviewed to identify 12 subjects who had sustained moderate CHI (Glasgow Coma Scale, GCS, of 9–12 or GCS of 13–15 with positive CT/MRI scans) and 17 subjects who had sustained severe CHI (GCS of 8 or less). Of the 25 cases with available data on CT and/or MRI, 22 had positive radiologic findings of brain trauma. One case with negative MRI had an abnormal EEG. Twenty of the 29 moderate/severe CHI were in litigation. Eight of these had normal PDRT scores, and one had a normal Rey-15 Item score. Eleven did not have any symptom validity testing (SVT) as they were examined prior to 1995, when SVT examination became standard in this practice. Clinical review of the neuropsychological test data of the 11 litigating cases lacking SVT data showed test performance consistent with trauma severity (cf. Dikmen, Machamer, Winn, & Temkin, 1995). MANOVA comparing the MMPI-2 standard validity and clinical scales (L, F, K, and 1 through 0) of litigants and nonlitigants did not show any significant differences, $\wedge = .429$, $p < .211$. Consequently, the litigating and nonlitigating moderate/severe CHI were combined for a single group of 29 Ss considered to be representative of moderate/severe CHI.

The malingering subjects had a mean age of 40.11 ($SD = 11.67$), mean education of 12.35 years ($SD = 2.27$), and were examined a mean time-since-injury of 32.22 months ($SD = 12.72$). The head injured subjects had a mean age of 34.72 ($SD = 16.41$), mean education of 12.45 years ($SD = 2.51$), and were examined a mean time since injury of 43.95 months ($SD = 82.05$). The malingering and head-injured Ss did not differ significantly on age, $t = 1.393$, $p < .169$; education, $t(53) = 0.158$, $p < .875$, or time since injury, $t(53) = 0.760$, $p < .453$. There were 14 males and 12 females in the malingering group, and 16 males and 13 females in the head-injured group, chi-square $= 0.01$, $p < .921$.

For the correlational analyses evaluating the concurrent validity of MMPI-2 validity scales, the 26 Ss with definite MND were combined with the 29 moderate/severe CHI Ss, and with a new group of 36 subjects who failed the PDRT at a level worse than 98% of nonlitigating brain injured patients (cf. Binder & Kelly, 1996). Six of these new Ss were from Larrabee (1998), and 19 were from Larrabee (in press). Twenty-six of the 36 had alleged mild CHI (no documented loss of consciousness or posttraumatic amnesia; no objective medical or neurologic findings), 9 had alleged neurotoxic injury (no objective medical or neurologic findings), and 1 had alleged electrical injury (no objective medical or neurologic findings).

Twenty of the 36 met the Slick et al. (1999) criteria for possible MND, performing worse than 98% of nonlitigants with bonafide brain dysfunction on the PDRT, either in litigation or pursuing Workman's compensation, without any evidence that their poor PDRT performance could be accounted for by psychiatric, neurological or developmental factors. The possible MND subjects had a mean age of 43.20 ($SD = 9.06$), mean education of 12.70 ($SD = 3.18$), and mean total time since injury of 39.53 months ($SD = 31.30$). There were 7 males and 13 females. Mean PDRT Easy total (out of 36) was 22.30 ($SD = 4.34$), mean PDRT Hard total (out of 36) was 17.10 ($SD = 2.55$), and mean PDRT lowest score on any 18-item trial block was 7.80 ($SD = 1.28$).

Sixteen of the 36 met the Slick et al. (1999) criteria for probable MND, performing worse than 98% of nonlitigants with bonafide brain dysfunction on the PDRT *and* performing in a motivationally impaired manner on the 15-item test (score <10; Greiffenstein, Baker, & Gola, 1994), $n = 4$; Recognition Memory Test for Words (RMT; score <29; Millis, 1992), $n = 2$; Test of Memory Malingering (TOMM; score <45 on Trial 2 or Retention; Tombaugh, 1996), $n = 5$; Rey-15, RMT, and TOMM, $n = 3$; Rey-15 and TOMM, $n = 2$; either in litigation or pursuing Workman's Compensation, and without any evidence that their poor symptom validity test performance could be accounted for by psychiatric, neurological or developmental factors. The probable MND subjects had a mean age of 43.25 ($SD = 11.73$), mean education of 11.22 ($SD = 1.47$), and mean total time since injury of 44.05 months ($SD = 19.78$). There were 11 males and 5 females.

The definite MND, probable MND, possible MND, and CHI subjects did not differ on age $F(3, 87) = 2.35$, $p < .079$. These subjects also did not differ on education, $F(3, 87) = 1.28$, $p < .304$, or time since injury, $F(3, 87) = 0.305$, $p < .822$. The four subject groups did not differ in proportion of males and females, chi-square $(3) = 4.25$, $p < .235$.

MANOVA, comparing the definite, probable, and possible MNDs, on L, F, K, FBS, and the ten MMPI-2 primary scales, was nonsignificant, $\wedge = .609$, $p < .579$. Combining all three MND groups yielded 47 Ss with alleged mild head injury, 13 Ss with alleged neurotoxic injury, 1 with alleged electrical injury, and 1 with alleged hypoxic injury. As is typical for such a group (cf. Hartman, 1995; Lees-Haley & Brown, 1993; Uomoto & Esselman, 1993), all had complaints of cognitive and emotional changes, and all but 2 had chronic pain complaints (e.g., headache, neck and back pain; headache was the most common complaint, made by 54 of 62 Ss in the combined MND group). The similarity of shared cognitive, affective and physical complaints was supported by contrasting the MMPI profiles of the alleged mild CHI Ss ($n = 47$) with the alleged neurotoxic injury Ss ($n = 13$), on L, F, K, clinical scales 1 through 0, and the FBS, in a MANOVA, with $\wedge = 0.827$, $p < .787$.

Procedures

Each subject was examined in the following order: clinical interview, followed by PDRT, other symptom validity tests (e.g., Rey-15 item, TOMM, Warrington RMT) MMPI/MMPI-2, and a standard battery of neuropsychological procedures including measures of language, perceptual/spatial, sensorimotor, attention, verbal learning and memory, visual learning and memory, intelligence, and problem solving skills (see Table 3, Larrabee, 2000). This battery included procedures from the Benton Iowa Tests (Benton, Sivan, Hamsher, Varney, & Spreen, 1994), Halstead–Reitan Battery (Heaton, Grant, & Matthews, 1991), the Wechsler Adult Intelligence Scale – Revised (WAIS–R; Wechsler, 1981), Wisconsin Card Sorting Test (Heaton, Chelune, Talley, Kay, & Curtiss, 1993), measures of information processing such as the Paced Auditory Serial Addition Test (PASAT; Gronwall, 1977), and measures of memory such as Verbal Selective Reminding (Buschke, 1973), and the Continuous Visual Memory Test (CVMT; Trahan & Larrabee, 1988).

Two of 26 malingerers, and 20 of 29 moderate/severe CHI had taken the MMPI. For those subjects, MMPI scores were converted to the MMPI-2 (Table J-2, Butcher et al., 1989, pp. 153–154). Following the procedure used in an earlier investigation (Larrabee, 1998), MMPI FBS scores were prorated (1.125 multiplied by MMPI FBS "True" items, added to 1.19 multiplied by MMPI FBS "False" items), to equate for the reduced number of MMPI-2 FBS items appearing on the original MMPI. None of the subjects had elevations over T79 on VRIN or TRIN.

RESULTS

MANOVA was conducted on the various validity indicators including F, Fb, F(p), FBS, and the Meyers et al. (2002) Weighted Validity Index, as well as the validity indicators comprising this index, including F−K, Ds–r, sum of subtle−obvious difference scores, and Es, yielding Λ of 0.461, $p < .001$. The means, standard deviations, and effect sizes for these variables are displayed in Table 1. FBS, Meyers' Weighted Validity Index, and Es yielded the largest effect sizes.

MANOVA was also conducted on the standard MMPI-2 scales, including L, F, K, and Scales 1

Table 1. MMPI-2 Validity Scales for Malingering and Closed Head Injury Subjects.

MMPI-2 scale	Malingerers[a]	Closed Head Injury[b]	*p*	Effect size[c]
F				
M (*SD*)	64.81 (16.12)	57.10 (12.57)	.052	0.54
Fb				
M (*SD*)	66.19 (27.85)	55.28 (9.09)	.051	0.54
F(p)				
M (*SD*)	54.00 (13.94)	58.73 (9.98)	.151	−0.39
FBS				
M (*SD*)	26.15 (5.41)	15.67 (6.02)	.001	1.81
Meyers' Index				
M (*SD*)	3.31 (3.10)	0.79 (1.78)	.001	1.01
F−K				
M (*SD*)	−7.15 (8.59)	−8.48 (6.54)	.519	0.18
Ds–r				
M (*SD*)	57.52 (16.04)	53.96 (9.86)	.320	0.27
Subtle−obvious				
M (*SD*)	81.50 (76.22)	35.47 (63.67)	.018	0.66
Es				
M (*SD*)	28.05 (12.28)	41.77 (13.81)	.001	−1.05

Note. [a]$n = 26$.
[b]$n = 29$.
[c]Effect size as a function of the pooled standard deviation.

through 0, yielding ∧ of 0.417, $p < .001$. The means, standard deviations and effect sizes (based on the pooled standard deviation) are displayed in Table 2. The largest effect sizes associated with differences between the head injured and malingering Ss were obtained on Scale 1 (Hs), Scale 2 (D), Scale 3 (Hy), Scale 7 (Pt), and Scale 8 (Sc). The greatest effect size, 1.74, was associated with Scale 3 (Hy).

The sensitivity of the various MMPI-2 validity scales and clinical scales showing the largest effect sizes in discriminating the definite MND and CHI groups was further evaluated using logistic regression. These select scales included FBS, F, Fb, Meyers' Weighted Validity Index, sum of obvious minus subtle difference scores, Es, and clinical scales 1, 2, 3, 7, and 8. The FBS alone correctly identified 86.21% of CHI, and 80.77% of definite MND for a combined hit rate of 83.64%, Wald statistic (1 *df*) = 14.316, $p < .0002$. The next best discriminator was Scale 3, which alone correctly identified 79.31% of CHI, 80.77% of definite MND, with a combined hit rate of 80.00%. A series of logistic regressions was conducted, in which FBS was entered first, followed by each of the other

Table 2. MMPI-2 Basic Scales for Malingering and Closed Head Injury Subjects.

MMPI-2 scale	Malingerers[a]	Closed Head Injury[b]	*p*	Effect size[c]
L				
M (*SD*)	58.92 (10.40)	58.62 (10.46)	.915	0.03
F				
M (*SD*)	64.81 (16.12)	57.10 (12.67)	.052	0.54
K				
M (*SD*)	51.65 (11.30)	49.52 (9.86)	.457	0.20
1 (Hs)				
M (*SD*)	82.38 (9.42)	63.24 (16.52)	.001	1.40
2 (D)				
M (*SD*)	81.88 (23.04)	61.86 (12.88)	.001	1.60
3 (Hy)				
M (*SD*)	86.35 (13.54)	59.21 (17.15)	.001	1.74
4 (Pd)				
M (*SD*)	64.04 (11.71)	56.41 (13.39)	.030	0.60
5 (Mf)				
M (*SD*)	52.54 (9.75)	48.75 (11.59)	.198	0.35
6 (Pa)				
M (*SD*)	63.77 (16.27)	53.03 (12.95)	.009	0.74
7 (Pt)				
M (*SD*)	76.38 (13.22)	56.93 (14.66)	.001	1.39
8 (Sc)				
M (*SD*)	78.31 (14.04)	60.76 (14.78)	.001	1.22
9 (Ma)				
M (*SD*)	52.58 (8.84)	56.55 (11.87)	.169	−0.38
0 (Si)				
M (*SD*)	56.65 (12.98)	50.00 (8.06)	.025	0.62

Note. [a]$n = 26$.
[b]$n = 29$.
[c]Effect size as a function of the pooled standard deviation.

MMPI-2 validity and clinical scales, with evaluation of the change in −2(log likelihood) accounted for by each additional variable (note: this change is distributed as chi-square, see Pampel, 2000). Then, the process was reversed, predicting group membership first by each of the validity and clinical scales, exclusive of the FBS, tested against a model including the validity or clinical scale *and* the FBS. As can be seen in Table 3, only Scale 2 caused a significant change in chi-square compared to the logistic regression based on the FBS alone (note: despite this significant change, overall classification accuracy dropped from 83.64% based on FBS alone to 78.18% in the equation combining FBS and Scale 2). By contrast, in every comparison, FBS caused a significant change in predictive accuracy beyond that accounted for by the other MMPI-2 validity and clinical scales.

Table 4 contrasts the sensitivity (true positive), specificity (true negative) and combined hit rates for F, Fb, F(p), Meyers' Weighted Validity Index, Es, and FBS for various cutting scores that have been recommended in the literature. The FBS, at

Table 3. Incremental Validity for the FBS in Discriminating Malingerers from Closed Head Injury.

MMPI-2 scales tested against FBS	Change in chi-square accounted for beyond FBS	Change in chi-square FBS accounts for beyond other variable
F	0.027	28.661***
Fb	0.002	28.523***
Meyers' Index	1.124	20.234***
Es	1.625	20.643***
Subtle/obvious	0.819	27.615***
1 (Hs)	1.153	11.697***
2 (D)	4.273*,[a]	10.212**
3 (Hy)	3.753	5.024*
7 (Pt)	2.337	14.013***
8 (Sc)	1.424	16.113***

Note. [a]This significant change was associated with a decrease in classification accuracy from 83.64% based on FBS alone, to 78.18% based on FBS and Scale 2.
*$p < .05$.
**$p < .01$.
***$p < .001$, $df = 1$.

Table 4. Sensitivity, Specificity, and Combined Hit Rates for Various MMPI-2 Validity Scales.

MMPI-2 scale	Sensitivity to malingering ($n = 26$)	Specificity for CHI ($n = 29$)	Combined hit rate ($n = 55$)
F > 100	3.8%	100%	54.5%
F > 90	7.7%	100%	56.4%
F > 65	34.6%	79.3%	58.2%
Fb > 100	19.2%	100%	61.8%
Fb > 90	26.9%	100%	65.5%
Fb > 65	26.9%	89.7%	60.0%
F(p) > 100	0%	100%	52.7%
F(p) > 90	3.8%	100%	54.5%
F(p) > 65	11.5%	65.5%	40.0%
Meyers' Index > 4	26.9%	89.7%	60.0%
Es < 30	57.7%	86.2%	72.7%
FBS > 19	92.3%	79.3%	85.5%
FBS > 22	69%	86.2%	78%
FBS > 23 male/25 female	53.8%	96.6%	76.4%

three different cut-offs for abnormality, is superior to all other scales, with the highest combined hit rates. Table 5 displays sensitivity and specificity for various cut-off scores (equal to or greater than) based on the current sample of 26 definite MND and 29 CHI subjects. As per Table 5, the optimal cutting score in the present data is either 21 or 22.

For the correlational analyses evaluating the concurrent validity of the various validity scales, the definite MND and CHI Ss were combined in one group, with an additional 20 Ss meeting the Slick et al. (1999) criteria for possible MND, and 16 Ss meeting the criteria for probable MND. Eighteen of 20 possible MND (90%) had an FBS of 21 or higher, with 17 of 20 (85%) scoring 22 or higher, compared to 21 of 26 definite MND (80.8%) scoring 21 or 22 or higher (Table 5). Fifteen of 16 probable MND (93.8%) scored 21 or 22 or higher on the FBS, compared to 21 of 26 definite MND (80.8%, Table 5).

Table 5. Diagnostic Classification Rates for the FBS Predicting Definite Malingered Neurocognitive Dysfunction.

Cut-off score	Sensitivity	Specificity
4	1.000	0.000
5	1.000	0.034
6	1.000	0.034
7	1.000	0.034
8	1.000	0.138
9	1.000	0.138
10	1.000	0.172
11	1.000	0.207
12	1.000	0.207
13	1.000	0.276
14	1.000	0.310
15	1.000	0.448
16	1.000	0.517
17	0.962	0.552
18	0.923	0.552
19	0.923	0.690
20	0.923	0.793
21	0.808	0.862
22	0.808	0.862
23	0.692	0.862
24	0.615	0.862
25	0.615	0.931
26	0.538	0.966
27	0.500	0.966
28	0.500	0.966
29	0.423	0.966
30	0.385	0.966
31	0.308	1.000
32	0.192	1.000
33	0.115	1.000
34	0.115	1.000
35	0.038	1.000
36	0.000	1.000

Table 6 displays the intercorrelations of the various MMPI-2 validity scales. FBS correlates highest with the Meyers' Weighted Validity Index and Es, and lowest with F(p) and F−K. F and Fb correlate strongly with one another and with the Meyers' Weighted Validity Index, F−K and subtle−obvious total. The Meyers' Weighted Validity Index correlates most strongly with F, Fb, F−K, Ds–R, subtle–obvious total, and Es. F(p) correlates most strongly with F and Fb.

The PDRT total correct was also correlated with various validity scales. Based on $n = 70$, PDRT Total Correct correlated −0.038 with F, −0.043 with Fb, 0.050 with F(p), −0.440 with FBS, −0.122 with Meyers' Weighted Validity Index, and 0.080 with Es. Only the correlation with FBS was significant, $p < .001$.

Table 7 shows the correlations of the PDRT Total Correct with the 10 standard MMPI-2 scales (Hs through Si), as well as the correlations of select MMPI-22 validity scales with the standard scales. The PDRT Total Correct correlated significantly with Scales 1 (Hs), 2 (D), 3 (Hy), and 7 (Pt). The F and Fb scales correlated most strongly with Scale 8 (0.752 and 0.754, respectively), with the FBS correlating most strongly with Scale 1 (Hs), 2 (D) and 3 (Hy) (0.757, 0.753 and 0.785, respectively).

Multiple regression, predicting FBS from *L*, *F*, *K* and the 10 standard MMPI-2 scales yielded an R of .888, R^2 of .788, and a standard error of estimate of 3.667. The regression equation for predicting FBS requires use of T scores, and the following weights: −0.028(L) + 0.051(F) −0.032(*K*) + 0.127(Hs) + 0.106(D) + 0.169(Hy) −0.176(Pd) + 0.017(MF) + 0.083(Pa) + 0.049(Pt) −0.002(Sc) −0.004(Ma) −0.015(Si) −4.886.

Table 6. Intercorrelations of MMPI-2 Validity Scales.

	Fb	F(p)	FBS	Meyers' Index	F−K	Ds−r	Subtle−obvious	Es
F	.71**	.53**	.35**	.83**	.82**	.62**	.81**	−.60**
Fb		.45**	.45**	.77**	.61**	.59**	.73**	−.56**
F(p)			−.07	.37**	.44**	.30**	.42**	−.16
FBS				.54**	.17	.33*	.41**	−.54**
Meyers' Index					.75**	.75**	.84**	−.75**
F−K						.69**	.88**	−.64**
Ds−r							.72*	−.60**
Subtle−obvious								−.72**

Note. $n = 91$, including 26 Ss with definite malingered neurocognitive dysfunction (MND), 29 Ss with moderate/severe Closed Head Injury, 20 with possible MND, and 16 with probable MND.
*$p < .01$.
**$p < .001$.

Table 7. Correlations of MMPI-2 Validity Scales and the PDRT with Standard MMPI-2 Scales.

Standard scales	F[a]	Fb	F(p)	FBS	Meyers' Index	PDRT[b]
1 (Hs)	.262*	.267**	.018	.757**	.380**	−.442**
2 (D)	.469**	.514**	.054	.753**	.585**	−.362**
3 (Hy)	.118	.216*	−.142	.785**	.259*	−.583**
4 (Pd)	.532**	.273**	.155	.190	.397**	−.099
5 (Mf)	.199	.110	.013	.120	.152	−.126
6 (Pa)	.631**	.649**	.263*	.460**	.634**	−.050
7 (Pt)	.566**	.603**	.136	.663**	.633**	−.356**
8 (Sc)	.752**	.704**	.293*	.586**	.699**	−.169
9 (Ma)	.404**	.201	.446**	−.109	.266*	.203
0 (Si)	.461**	.546**	.175	.378**	.568**	−.013

Note. [a]n for MMPI-2 Validity scales = 91, including 26 Ss with definite malingered neurocognitive deficit (MND), 29 Ss with moderate/severe Closed Head Injury, 20 with possible MND, and 16 with probable MND.
[b]n for PDRT = 70.
*$p < .05$.
**$p < .01$.

DISCUSSION

The current results demonstrate two major findings: (1) the sensitivity of the FBS to malingering in neuropsychological settings is superior to any other MMPI-2 validity or standard clinical scale and (2) F, Fb, and F(p) are generally insensitive to malingering of neuropsychological symptoms. Although Es and the newer Meyers' Weighted Validity Index also yielded large effect sizes between malingering and CHI Ss, logistic regression analysis demonstrated that these two scales did not add any significant increase in group discrimination beyond that provided by the FBS alone. These findings are congruent with past research using similar neuropsychological samples (Millis et al., 1995; Putnam et al., 1998; Tsushima & Tsushima, 2001), and replicate and extend previous findings of the current author (Larrabee, 1998, in press). The MANOVA and regression results demonstrating the superiority of the FBS to all other validity scales was further supported by the sensitivity, specificity and combined hit rates for the FBS, which showed superior differential diagnostic classification compared to F, Fb, F(p), Es and the Meyers' Weighted Validity Index.

Comparisons of the malingering and CHI Ss on the standard MMPI-2 profile (L, F, K, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0) demonstrated significant group differences on five scales: 1 (Hs), 2 (D), 3 (Hy), 7 (Pt) and 8 (Sc). These results are consistent with previous research (Boone & Lu, 1999; Millis et al., 1995; Putnam et al., 1998). As shown in Table 2, the effect sizes for these five MMPI-2 clinical scales all exceeded 1.0, with the largest effect size of 1.74 for Scale 3 (Hy), a value approaching the effect size of 1.81 for the FBS (see Table 1). As demonstrated in the logistic regression analyses (see Table 3), only Scale 2 caused a significant change in chi-square, but actually lowered the combined hit rate when included with the FBS, compared to the group discrimination based on the FBS alone. Moreover, in each of the five analyses, FBS did add significant predictive variance above and beyond that accounted for by Scale 1 (Hs) or Scales 3 (Hy), 7 (Pt) or 8 (Sc).

The concurrent validity of the FBS was further supported by the finding that it alone was significantly correlated with performance on the PDRT ($r = -.440$). By contrast, F, Fb, F(p), Meyers' Weighted Validity Index, and Es did not correlate significantly with PDRT scores.

As per Table 6, the FBS was most strongly associated with the Meyers' Weighted Validity Index, subtle−obvious total, and Es, whereas F and F(b) were more strongly associated with one another, the Meyers' Weighted Validity Index, F−K and subtle−obvious total. F(p) was generally weakly related to the other validity scales. These findings are further explained by the correlations in Table 7, which suggest that F and Fb are associated with malingered psychopathology (Scales 6, Pa, and 8, Sc), whereas FBS is most strongly associated with exaggerated health, affective and cognitive concerns (Scales 1, Hs; 2, D; 3, Hy; and 7, Pt). Moreover, Scales 1–3, and 7 were the only MMPI-2 clinical scales that correlated significantly with the PDRT.

These data demonstrating different dimensions of exaggeration on the MMPI-2 are consistent with Lanyon's (2001) recent investigation of dimensions of self-serving misrepresentation in forensic assessment. Lanyon argued that sucessful assessment of misrepresentation in a particular content area requires instruments tailored to that content area. Lanyon terms this the "accuracy of knowledge" model, because assessment of deception relies on the respondent's lack of complete knowledge of the particular characteristic being assessed. In his investigation, he factor analyzed scores selected from the MMPI-2, Psychological Screening Inventory (Lanyon, 1993), and Balanced Inventory of Desirable Responding (Paulhus, 1991), obtained on a mixed forensic sample, including child custody evaluees, personal injury litigants, sex offenders, and other criminal offenders. Lanyon obtained three distinct factors, representing exaggeration of psychiatric symptoms (highest positive loadings from MMPI-2 F and Ds–r), exaggeration of virtue (highest positive loadings from MMPI-2 *L* Scale), and exaggeration of health concerns (highest positive loadings from MMPI-2 Scales 1 (Hs) and 3 (Hy); note that Lanyon did not analyze the FBS).

Lanyon's (2001) data, the current investigation (see Table 7), an extensive MMPI-2 research literature (Graham, 2000), and the Rogers et al. (1995) investigation indicate that F, and other F-scale derivatives (Fb, F−K) are sensitive to exaggeration of psychiatric symptoms. The current investigation and other recent research (Millis et al., 1995; Putnam et al., 1998; Tsushima & Tsushima, 2001) indicate that the FBS is best suited to detect exaggeration of health and injury concerns, which is also evident on Scales 1 (Hs) and 3 (Hy) (Boone & Lu, 1999; Lanyon, 2001; current study).

The current demonstration of limited validity for F(p), which showed much lower correlations with Scales 6 (Pa) and 8 (Sc), than were found for the correlation of 6 and 8 with F and Fb, can be understood in light of a recent investigation by Gass and Luis (2001). As discussed earlier, the F(p) was derived by selecting those items endorsed by 20% or fewer of (a) psychiatric patients and (b) the MMPI-2 normative sample. As Gass and Luis noted, this process of item identification resulted in four items from the L scale being included on F(p). Gass and Luis demonstrated that these L scale items were not correlated with

F(p) or with other measures of exaggerated psychopathology but rather were correlated with measures of defensiveness. Moreover, Gass and Luis demonstrated that the correlation of F(p) with Scales 6 and 8 increased, when the L scale items were removed (note: a prior argument advanced for using F(p) as a validity index was the finding of lower correlations of F(p) with Scales 6 and 8 than observed for correlations of F and Fb with these two scales; Arbisi & Ben-Porath, 1995). Gass and Luis' data demonstrated a lowering of the sensitivity of F(p) by including the L scale items, and they recommended dropping these items and rescaling the norms for F(p).

The reduced sensitivity of the Meyers' Weighted Validity Index to malingering in the present investigation is not likely due to chronic pain. Meyers et al. (2002) developed the Weighted Validity Index on samples of litigating and nonlitigating chronic pain patients who were undergoing neuropsychological assessment because of cognitive complaints. Nearly one-half of each group reported loss of consciousness when injured, with one fourth to one third having history of closed head injury. In the current investigation, all but two of the definite, probable and possible MND subjects had complaints of chronic pain typically involving multiple complaints (e.g., headache and neck pain; headache and low back pain). Nine of 29 moderate and severe CHI Ss had chronic pain complaints. Hence, posttraumatic chronic pain does not explain the difference between the current results and Meyers et al. (2002).

The poorer sensitivity of the Meyers' Weighted Validity Index in the present investigation does appear to be a function of the composition of the scale. As seen in Table 6, the Meyers' Weighted Validity Index shares more in common with F, Fb and F−K than with the FBS. This is the consequence of a heavier weighting on this Index of items sensitive to exaggerated psychopathology; F, F−K, F(p). Actually, Meyers et al. (2002) found that the Index scores most likely to be elevated in their litigants were FBS (42 out of 100 subjects), Es (51 out of 100 subjects), and obvious−subtle total (48 out of 100 subjects). These data, Lanyon's (2001) findings, and the results of the current investigation support the feasibility of constructing sub-scales for the Meyers' Weighted Validity Index for (a) exaggerated psychopathology (F, F−K, F(p) without the L items, Ds–r, and obvious−subtle totals for Scale 6 (Pa) and Scale 9 (Ma)), and for (b) exaggerated injury/illness (FBS, Es, Ds–r, and obvious−subtle totals for MMPI-2 Scale 2 (D) and 3 (Hy).

The regression formula for predicting FBS on the basis of basic MMPI-2 *T* scores (L, F, K, and the 10 primary scales) should be useful in two manners. First, if a clinician is reviewing an MMPI-2 profile, and there is no computed FBS or True-False answer sheet, the FBS can be estimated with the regression equation. Second, the regression equation can be employed to estimate the FBS in published data sets that do not report FBS scores, such as the Keller and Butcher (1991) chronic pain sample. Pending independent replication of this equation, a conservative confidence interval employing the standard error of estimate (3.667) is recommended, as well as additional confirmation of malingering with measures independent of the MMPI-2.

The data in Tables 4 and 5 show that FBS cut-offs *lower* than Lees-Haley's (1992) revised scores of 24 or more for males and 26 or more for females are more appropriate for neuropsychological settings. In the present investigation, FBS cut-offs of either 21 or higher or 22 or higher yielded a combined hit rate of 83.6%. These data are consistent with a recent investigation by Ross, Millis, Krukowski, Putnam, and Adams (in press), who found that scores of 21 or higher or 22 or higher had identical combined hit rates of 90%, and nearly identical sensitivity and specificity, in discriminating 59 probable malingerers alleging mild CHI, from 59 nonlitigating patients with moderate or severe CHI. Ross et al. found an optimal combined hit rate of 91.5%, at a cut score of 23 or higher (sensitivity = 0.881, specificity = 0.949), with no nonlitigating moderate/severe CHI subject producing an FBS greater than 26.

The slightly lower diagnostic accuracy in the current investigation compared to the results of Ross et al.(in press) may be due to including litigants in the current moderate/severe CHI sample, although there were no MMPI-2 differences when litigating and nonlitigating moderate/severe CHI were compared. Moreover, although three of the four moderate/severe CHI with elevated FBS were litigating, there was no evidence of motivational impairment. One had normal performance on the PDRT, Rey-15 item and Warrington RMT, and the other two had normal Reliable Digit Span (RDS) and normal recognition hits on the CVLT (13) or AVLT (14). The one nonlitigant had a normal RDS, and 14 recognition hits on the CVLT. All four false positives had CT scan abnormalities.

A potential contributing factor resulting in lower specificity compared to Ross et al. was that three of the four false positive moderate/severe CHI Ss had MMPIs that were converted to MMPI-2s (their converted FBS scores were 24, 25 and 30). The procedure used to convert MMPI to MMPI-2 FBS in the present study included use of Table J-2 (Butcher et al., 1989), and prorating to equate for the reduced number of MMPI-2 FBS items appearing in the original MMPI. Since prorating assumes a perfect correlation, which is unlikely, there should actually be some regression to the mean. Consequently, the current data most likely represent a lower bound on the specificity of the FBS. MMPI to MMPI-2 conversion had no apparent effect on sensitivity in the definite MND group, as all of the MND scores bracketing the optimal cutting scores were from MMPI-2 administrations. Indeed, combining the definite and probable MND samples yielded a sensitivity of 0.857 (36/42) at an FBS of 22 or higher, a value close to the sensitivity of 0.881 reported by Ross et al. (in press) for their probable malingering sample.

The data in Table 5 can be used to determine positive and negative predictive power for different base rates of malingering. Larrabee (2002) reviewed 11 studies, covering 1,363 consecutive mild CHI litigants, and found that 40% were identified with motivated performance deficit suggestive of malingering. The minimum base rate was 15% (Trueblood & Schmidt, 1993), with a maximum base rate of 64% (Heaton, Smith, Lehman, & Vogt, 1978). Mittenberg, Patton, Canyock, and Condit (2002) surveyed members of the American Board of Clinical Neuropsychology who did forensic work, and determined a 0.385 base rate of malingering in mild head injury litigants (0.412 base rate when adjusted for referral source). Using an FBS cut-off score of 22 or higher (Table 5) yields a sensitivity of 0.808, and specificity of 0.862. At a 40% base rate of malingering, positive predictive power (PPP) is 0.669, with negative predictive power (NPP) of 0.764.

The combined error rate of 0.16 associated with an FBS cut-off score of 22 or higher in the present study indicates this cut-off score will be effective (i.e., superior to base rate prediction alone) with base rates of malingering >16% and <84% (Gouvier, 1999). As per Ross et al., who obtained a lower combined error rate of 0.10, an FBS cut-off score of 22 or more will be effective when the base rate of malingering is >10% and < 90% (Gouvier, 1999).

At high levels of endorsement, FBS scores are associated with 100% positive predictive value (i.e., only malingerers score in this range). In the present investigation, no moderate/severe CHI subject had an FBS score over 30, whereas in Ross et al. (in press), no CHI subject scored over 26. Meyers et al. (2002) found that no nonlitigating chronic pain patient obtained an FBS score greater than 29. Hence, FBS scores in the 30+ range are unlikely to be associated with false positive diagnoses. For scores less than 30, it is advisable to obtain other evidence of malingering independent of the MMPI-2, such as failure on symptom validity testing, or exaggeration of report on chronic pain scales. Requiring multiple indicators of poor effort and symptom exaggeration reduces the likelihood of false positive diagnosis of malingering (Larrabee, 1998; Slick et al., 1999).

The present findings, showing greater sensitivity of the FBS than F to the presence of malingered neuropsychological symptoms, are consistent with other independent investigations (Millis et al., 1995; Putnam et al., 1998; Ross et al., in press; Tsushima & Tsushima, 2001), and should generalize to other personal injury settings. By contrast, the current findings would not be expected to generalize to a criminal forensic population, where one would expect to see superiority of F, F−K, and Fb relative to the FBS, in detection of persons feigning insanity (Lanyon, 2001; also see Rogers et al., 1995). Indeed, the pattern of validity scale correlation with symptom validity tests such as the PDRT may actually reverse in a criminal forensic population, such that the PDRT correlates with F and Fb, and Scales 6 (Pa) and 8 (Sc), but does not correlate with the FBS, or with Scales 1 (Hs), 2 (D), 3 (Hy) or 7 (Pt).

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