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Detecting Symptom Exaggeration in Combat Veterans Using the MMPI–2 Symptom Validity Scales: A Mixed Group Validation

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Although validity scales of the Minnesota Multiphasic Personality Inventory–2 (MMPI–2; J. N. Butcher, W. G. Dahlstrom, J. R. Graham, A. Tellegen, & B. Kaemmer, 1989) have proven useful in the detection of symptom exaggeration in criterion-group validation (CGV) studies, usually comparing instructed feigners with known patient groups, the application of these scales has been problematic when assessing combat veterans undergoing posttraumatic stress disorder (PTSD) examinations. Mixed group validation (MGV) was employed to determine the efficacy of MMPI–2 exaggeration scales in compensation-seeking (CS) and noncompensation-seeking (NCS) veterans. Unlike CGV, MGV allows for a mix of exaggerating and nonexaggerating individuals in each group, does not require that the exaggeration versus nonexaggerating status of any individual be known, and can be adjusted for different base-rate estimates. MMPI–2 responses of 377 male veterans were examined according to CS versus NCS status. MGV was calculated using 4 sets of base-rate estimates drawn from the literature. The validity scales generally performed well (adequate sensitivity, specificity, and efficiency) under most base-rate estimations, and most produced cutoff scores that showed adequate detection of symptom exaggeration, regardless of base-rate assumptions. These results support the use of MMPI–2 validity scales for PTSD evaluations in veteran populations, even under varying base rates of symptom exaggeration.

Keywords: MMPI–2, posttraumatic stress disorder, veterans, validity, symptom exaggeration

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The detection of potential symptom exaggeration among combat veterans evaluated for posttraumatic stress disorder (PTSD) has been an increasing source of concern. Between 1999 and 2004, PTSD-related disability compensation from the Department of Veteran's Affairs (VA) increased 148%, from $1.7 billion to $4.3 billion, and veterans diagnosed with PTSD, although representing only 8.7% of all VA disability claims, received 20.5% of all VA disability compensation (Institute of Medicine, 2007). Thus, clinicians and researchers should be concerned with obtaining an accurate diagnosis of PTSD in combat Veterans and should employ the necessary methods to do so.

The most widely used measures of symptom exaggeration are the Minnesota Multiphasic Personality Inventory (MMPI; Hathaway & McKinley, 1967) and the MMPI–2 (Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989), which contain numerous embedded symptom-validity scales. In small-scale studies, estimates of symptom exaggeration using these scales range from 21% to 43% of compensation-seeking veterans (DeViva & Bloem, 2003; Frueh, Gold, & de Arellano, 1997; Gold & Frueh, 1999; Smith & Frueh, 1996). The MMPI and MMPI–2 validity scales generally perform well in criterion-group validation (CGV) studies, usually comparing instructed feigners with known patient groups (Nicholson et al., 1997; Rogers, Sewell, Martin, & Vitacco, 2003). An example of such a study is that of Storm and Graham (2000), who instructed 400 college students to feign mental illness on the MMPI–2. Students' responses were compared with those of 352 psychiatric inpatients instructed to respond honestly; results indicated that the feigning students scored higher than did the patients on several validity scales. A variation on the CGV design can be found in the development of measures such as the Response Bias Scale (RBS; Gervais, Ben-Porath, Wygant, & Green, 2007), in which MMPI–2 items that differed between disability claimants (N = 1212) who passed versus failed other tests of symptom exaggeration, such as the Word Memory Test (WMT; Green, 2003), Computerized Assessment of Response Bias (CARB; Allen, Conder, Green, & Cox, 1997), or Test of Memory Malingering (TOMM; Tombaugh, 1996), were retained for scale inclusion. Here, the validity of RBS score interpretations is dependent on the validity of interpretations of WMT, CARB, and TOMM scores, assuming that all normative sample participants scoring

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beyond the cutoffs on those measures were exaggerating and that no normative sample participants scoring within the normal range were exaggerating. In general, the extant knowledge of the validity of MMPI/MMPI–2 symptom exaggeration scales is derived from studies in which scores are compared between two or more groups whose exaggeration status is presumably known.

In clinical samples of combat veterans, however, the base rates of exaggeration are not well understood. For example, Frueh et al. (2005) accessed military records from the U.S. National Military Personnel Records Center for a convenience sample of 100 self-described Vietnam veterans, the majority (62%) of whom were applying for VA disability. These records indicated that 2% had never served in the military, 3% had served in the military but had not served in Vietnam, and 32% had served in Vietnam but had no distinct record of exposure to combat. In a similar vein, Freeman, Powell, and Kimbrell (2008) examined 74 veterans undergoing evaluations for PTSD (59% of whom were seeking disability compensation) using the Structured Interview of Reported Symptoms (SIRS; Rogers, Bagby, & Dickens, 1992); 53% of veterans met criteria for symptom exaggeration according to the SIRS. Conversely, in a very well-designed reanalysis of the military records of participants from the National Vietnam Veterans Readjustment Survey, Dohrenwend et al. (2006) found that of the 182 veterans whose military records showed low war-zone exposure, only 3.5% self-reported high war-zone exposure. Similarly, an internal review of 2,100 VA disability cases resulted in only 13 (0.6%) considered potentially fraudulent (Department of Veterans Affairs Office of Inspector General, 2005). Unfortunately, no high-accuracy, "gold standard" method for distinguishing exaggerating versus nonexaggerating veterans has been developed.

In cases such as these, mixed group validation (MGV; Dawes & Meehl, 1966; Frederick, 2000) may provide a useful adjunct to the more traditional CGV designs. Unlike CGV, in which each participant's classification (e.g., exaggerating or not exaggerating) is presumably known, MGV allows test scores to be compared between two groups that are thought to contain both exaggerating and nonexaggerating individuals, albeit at different base rates. It is not necessary, from a test evaluation perspective, to know the classification of any given individual; rather, MGV allows the researcher to determine the TPR and FPR of a test on the basis of estimates of base rates of symptom exaggeration in two groups of individuals. This design is particularly appealing in the complicated VA PTSD population: CS and NCS groups both likely include some exaggerating and nonexaggerating individuals, the classification of any given individual is usually not known, and estimates of the base rates of symptom exaggeration in each group vary widely. Thus, MGV can be used to examine the performance of MMPI–2 validity scales under different sets of base-rate assumptions. Recently, Crawford et al. (2006) used MGV to compare depressed patients with students instructed to feign illness. The performance of MMPI–2 validity scales was tested under different base-rate estimates (90%, 97% and 100% of students were estimated to be feigning vs. 7%, 5%, and 0% of patients). As base-rate estimates approached 100% and 0% (which would replicate CGV), the performance of most validity tests diminished. Therefore, MGV may be more sensitive than CGV to the detection accuracy of symptom validity scales, particularly in settings where the difference in base rates between two groups are less pronounced than in traditional CGV research.

The present study examined the ability of various MMPI–2 validity scales to detect symptom exaggeration in CS versus NCS veterans, using MGV with different base-rate estimates drawn from the available literature. It was predicted that at least some of the scales would demonstrate robustness against varying base-rate estimates; that is, they would show acceptable true and false positive rates under multiple base-rate assumptions. Such scales would likely be much more useful to clinicians and researchers than would scales whose adequacy was highly dependent on the underlying assumptions.

Method

Participants

Four hundred ninety-five adult male veterans, seen for clinical services at the Behavioral Science Division of the National Center for PTSD, completed the MMPI–2. Of those, nine (1.8%) were eliminated from analysis because of variable response inconsistency (VRIN) or true response inconsistency (TRIN) scores of 80 or above (no participants skipped more than 30 items). Of the remaining 486 participants, information about whether or not veterans were applying for service-connected disability or an upgrade of existing service-connected disability was available for 377 (77.6%) veterans, whose data were analyzed in the present study. Consistent with previous studies (e.g., Frueh et al., 1997), participants were classified as CS if they had already filed or were planning to file for a new or an increased service-connected disability for PTSD ($n = 290$) or as NCS if no service-connected disability or upgrade was being sought ($n = 87$).

Materials

Participants completed the MMPI–2 (Butcher et al., 1989), from which were derived common indices of symptom exaggeration: Infrequency (*F*), Back-Page Infrequency (*Fb*), and the *F-K* Dissimulation Index (Gough, 1950). To these were added the more recently developed Infrequency-Psychopathology (F_p; Arbisi & Ben-Porath, 1995), Symptom Validity Scale (*FBS*; Lees-Haley, English, & Glenn, 1991), Infrequency-PTSD (F_{PTSD}; Elhai, Ruggiero, Frueh, Beckham, & Gold, 2002), and Response Bias Scale (*RBS*; Gervais et al., 2007).

Two composite indices of symptom exaggeration were also computed. The first of these, developed by Meyers, Millis, and Volkert (2002; and hereinafter labeled the Meyers index), assigns weights from 0 to 2 for each of the *F-K*, *F*, *FBS*, F_p, Revised Dissimulation Scale (*Ds-R*; Gough, 1947), Ego Strength (*Es*; Barron, 1955), and Obvious-Subtle (*O-S*; Weiner & Harmon, 1946) scales, depending on scale scores. The Meyers index is calculated as the sum of the weights, with scores ≥ 5 showing good sensitivity and specificity in distinguishing instructed feigners from chronic pain patients (Meyers et al., 2002). The second, the Malingering Discriminant Function Index (*M-DFI*; Bacchiochi & Bagby, 2006) is calculated by weighting scores on Hypochondriasis (*Hs*), Depression (*D*), Psychasthenia (*Pt*), Hypomania (*Ma*), Anxiety (*ANX*), Work Interference (*WRK*), Generalized Fearfulness (*FRS1*), Multiple Fears (*FRS2*), Self-Deprecation (*DEP3*), Neurological Symptoms (*HEA2*), Schizotypal Characteristics (*BIZ2*), Antisocial Attitudes (*ASP1*), Antisocial Behavior (*ASP2*),

Competitive Drive (*TPA2*), Self-Doubt (*LSE1*), Introverson (*SOD1*), and Family Discord (*FAM1*) scales by standardized canonical discriminant function coefficients derived from a discriminant function analysis of instructed feigners versus psychiatric patients. *M-DFI* scores show good sensitivity and specificity in distinguishing uninstructed and instructed feigners versus psychiatric patients and are relatively robust against coaching (Bacchiochi & Bagby, 2006), although less favorable results were obtained in a more recent examination of instructed inmate feigners versus psychiatric inmates (Steffan & Morgan, 2008).

In addition to the MMPI–2, participants completed the Combat Exposure Scale (CES; Keane et al., 1989), a self-report measure of exposure to combat-related trauma; the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), a self-report measure of depression; the Mississippi Scale for Combat-Related PTSD (M–PTSD; Keane, Caddell, & Taylor, 1988), a self-report measure of PTSD symptoms, and the Clinician-Administered PTSD Scale (CAPS; Blake et al., 1995), a semistructured interview of PTSD symptoms. PTSD diagnoses were made using Diagnostic and Statistical Manual of Mental Disorders (4th ed.; American Psychiatric Association, 1994) criteria by a clinical team consisting of doctoral-level psychologists with expertise in PTSD and extensive experience conducting diagnostic interviews and by predoctoral psychology interns who were trained and supervised by the psychologists. PTSD diagnoses were based on chart review, clinical interview, and the CAPS.

Procedure

Estimated base rates of symptom exaggeration. As described previously, MGV is based not on the known characteristics (e.g., exaggerating vs. not exaggerating) of any given participant but, rather, on the known (or estimated) base rates within each group. The base rates of symptom exaggeration in CS and NCS veterans have not been well established and are a source of some controversy. Therefore, four different sets of base rates from the literature were used. The first of these (Mittenberg, Patton, Canyock, & Condit, 2002) was a survey of clinical neuropsychologists, who estimated that 30.43% of individuals seeking disability, versus 8.11% of medical or psychiatric cases not involving litigation or compensation, were malingering. In the second (Smith & Frueh, 1996), 41.03% of CS veterans and 18.60% of NCS veterans were estimated to be exaggerating on the basis of *F-K* scores > 13. The same criterion was used to determine symptom exaggeration in the third study (DeViva & Bloem, 2003), in which 33.33% of CS veterans and 17.95% of NCS veterans were determined to be exaggerating. The fourth and final set of estimated base rates was derived from a recent study by Freeman et al. (2008), in which 53% of veterans undergoing evaluations for PTSD met criteria for clear symptom exaggeration on the SIRS (Pollock, Quigley, Worley, & Bashford, 1997). Although Freeman et al. (2008) did not report SIRS responses according to CS versus NCS status (59% were CS), subsequent analyses indicated that 61.22% of CS veterans versus 37.50% of NCS veterans met criteria for definite symptom exaggeration on the SIRS (T. Freeman, personal communication, February 17, 2009). The estimated base rates of symptom exaggeration for CS versus NCS veterans used in the present study, therefore, were .3043/.0811, .4103/.1860, .3333/.1795, and .6122/.3750. The present study provides no opinion about the accuracy of any of these hypothesized base rates; rather, its aim is to determine the performance of MMPI–2 validity scales if each of the base rate pairs is accurate.

Data Analyses

MMPI–2 scores of CS versus NCS veterans were examined using MGV, which produces true positive rates (TPR) and false positive rates (FPR) using the following formulas (Frederick, 2000):

$$TPR = \frac{[S2^{+}XP1^{-}] - [S1^{+}XP2^{-}]}{(P2^{+}) - (P1^{+})}$$

$$FPR = \frac{[S1^{+}XP2^{+}] - [S2^{+}XP1^{+}]}{(P2^{+}) - (P1^{+})}$$

where $S1^{+}$ = proportion of individuals in Group 1 (in this case, CS) with a positive test result for exaggeration, $S2^{+}$ = the proportion of individuals in Group 2 (in this case, NCS) with a positive test result, $P1^{+}$ = the estimated base rate of exaggeration in Group 1, and $P2^{+}$ = the estimated base rate of exaggeration in Group 2. $P1^{-}$ and $P2^{-}$ refer to $1 - P1^{+}$ and $1 - P2^{+}$, respectively. TPR or FPR rates outside the bounds of 0.00–1.00 were truncated to 0.00 and 1.00, respectively, as is commonly accepted (Frederick, 2000; Goodman, 1959).

Kraemer (1992) has recommended that test statistics be presented as quality indices (kappa coefficients), which adjust for agreement due to chance. Quality indices can be calibrated to adjust for optimal sensitivity (e.g., for screening), optimal specificity (e.g., for differential diagnosis), or optimal efficiency (overall agreement). From TPR and FPR, we therefore derived Kraemer's quality index of sensitivity, $\kappa(1, 0)$; quality index of specificity, $\kappa(0, 0)$; and quality index of efficiency, $\kappa(.5, 0)$ using DAG_Stat software (Mackinnon, 2000).

Results

Sample Characteristics

As shown in Table 1, CS and NCS veterans did not differ significantly in terms of race (White vs. non-White) or self-reported combat exposure (moderate in both groups). CS veterans were significantly older, received higher depression and PTSD symptom severity scores, and were more likely to be diagnosed with PTSD according to the CAPS than were NCS veterans. NCS veterans were significantly more likely than were CS veterans to have served during the Vietnam era.

Differences Between Compensation-Seeking and Noncompensation-Seeking Veterans

Table 2 shows mean MMPI–2 validity and clinical scales for CS versus NCS veterans. Compared with NCS veterans, CS veterans scored significantly higher on Clinical Scales 1, 2, 3, 4, 6, 7, 8, 9, and 0. On the validity scales, CS veterans scored significantly lower than did NCS veterans on *K* and significantly higher on *F*, *Fb*, *Fp*, *FBS*, *F-K*, F_{PTSD}, *RBS*, and the Meyers Index. Of note, CS and NCS veterans did not differ significantly on *M-DFI*, and CS veterans scored significantly *lower* than did NCS veterans on *Ds-R*.

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Table 1
Sample Characteristics (N = 377)

Variable	CS (*N* = 290)	NCS (*N* = 87)	*t*(375)	$\chi^2(1)$
Age (*M*, *SD*)	47.94 (9.62)	45.37 (7.04)	2.31*	
Nonwhite (*N*, %)	55 (19.0%)	11 (12.6%)		1.85
Vietnam era (*N*, %)	216 (74.5%)	75 (86.2%)		5.22*
CES (*M*, *SD*)	25.24 (9.68)	25.76 (9.40)	0.41	
BDI (*M*, *SD*)	28.22 (11.59)	21.31 (11.48)	4.81**	
MISS (*M*, *SD*)	123.99 (19.26)	110.86 (21.88)	5.33**	
PTSD diagnosis (*N*, %)	214 (73.8%)	52 (59.8%)		6.34*

Note. CS = compensation seeking; NCS = noncompensation seeking; CES = Combat Exposure Scale (Keane et al., 1989); BDI = Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961); MISS = Mississippi Scale for Combat-Related PTSD (Keane, Caddell, & Taylor, 1988); PTSD = posttraumatic stress disorder.
* $p < .05$. ** $p < .01$.

Mixed Group Validation of MMPI–2 Scores

Table 3 shows results of the MGV, comparing CS and NCS veterans, for each of the MMPI–2 indices of symptom exaggeration (other than Ds-R, as described above). From Table 3, we can determine which validity scales and cut scores show acceptable sensitivity, specificity, and efficiency, regardless of base-rate estimates. It is presumable that these scales and scores would be the most useful for clinicians and researchers. Kappa coefficients can be interpreted using conventional cutoffs of 0.61–0.80 as showing substantial agreement and 0.81–1.00 as showing almost perfect agreement (Landis & Koch, 1977). As depicted in Table 3, several indices showed adequate (0.61 or greater) quality indices of sensitivity, specificity, and efficiency under widely varying estimates of exaggeration base rates. These include *F* (>90), *Fb* (>90), *F-K* (>7), *FBS* (>22), F_{PTSD} (>60), *Fp* (>60), and the Meyers Index (>5). *RBS* and *M-DFI* showed adequate quality indices under certain base-rate assumptions but not under others. A cutoff of 16

Table 2
Mean (SD) Scores on MMPI–2 Validity and Clinical Scales for Compensation-Seeking (CS) and Noncompensation-Seeking (NCS) Veterans

Variable	CS (*N* = 290)		NCS (*N* = 87)		*t*	*p*	*d*
VRIN	52.42	10.00	52.89	10.77	0.37	.709	.05
TRIN	57.23	6.92	58.76	7.60	1.76	.078	.21
F	87.99	22.44	75.06	21.47	4.76	<.001	.59
Fb	90.51	26.65	76.32	24.94	4.70	<.001	.55
F_p	65.83	20.07	57.29	15.41	3.66	<.001	.48
FBS	23.46	5.95	19.63	6.04	3.21	.001	.64
L	51.89	9.20	51.77	8.23	0.11	.913	.01
K	37.84	7.39	42.01	9.01	4.37	<.001	.51
1 (*Hs*)	77.63	14.71	66.97	15.30	5.88	<.001	.71
2 (*D*)	80.95	12.57	71.87	15.61	5.57	<.001	.64
3 (*Hy*)	75.04	15.23	65.22	14.98	5.30	<.001	.65
4 (*Pd*)	71.62	13.64	68.18	12.43	2.10	.036	.26
5 (*MF*)	51.91	8.10	51.59	8.60	0.30	.762	.04
6 (*Pa*)	79.63	19.78	70.82	18.48	3.10	<.001	.46
7 (*Pt*)	81.40	15.47	71.68	16.90	5.03	<.001	.60
8 (*Sc*)	88.65	19.55	76.36	18.32	5.22	<.001	.65
9 (*Ma*)	61.19	13.53	57.28	11.74	2.44	.015	.31
0 (*Si*)	69.41	11.44	64.64	12.50	3.33	.001	.40
F-K	8.28	10.95	1.43	10.54	5.16	.001	.64
Ds-R	59.77	11.25	66.40	10.53	4.89	<.001	.61
F_{PTSD}	60.15	14.59	54.63	12.12	3.21	.001	.41
RBS	13.73	4.61	10.02	4.32	6.68	<.001	.83
M-DFI	0.09	1.10	0.12	1.05	1.56	.119	.20
Meyers Index	5.59	3.13	3.63	2.97	5.16	<.001	.64

Note. MMPI–2 = Minnesota Multiphasic Personality Inventory–2 (Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989); VRIN = variable response inconsistency; TRIN = true response inconsistency; *F* = Infrequency; *Fb* = Back-Page Infrequency; F_p = Infrequency-Psychopathology (Arbisi & Ben-Porath, 1995); *FBS* = Symptom Validity Scale (Lees-Haley, English, & Glenn, 1991); *L* = Lie; *K* = Defensiveness; *Hs* = Hypochondriasis; *D* = Depression; *Hy* = Hysteria; *Pd* = Psychopathic Deviate; *MF* = Masculinity/Femininity; *Pa* = Paranoia; *Pt* = Psychasthenia; *Sc* = Schizophrenia; *Ma* = Hypomania; *Si* = Social Introversion; *F-K* = Dissimulation Index (Gough, 1950); *Ds-R* = Revised Dissimulation Scale (Gough, 1947); F_{PTSD} = Infrequency-Posttraumatic Stress Disorder (Elhai, Ruggiero, Frueh, Beckham, & Gold, 2002); RBS = Response Bias Scale (Gervais et al., 2007); *M-DFI* = Malingering Discriminant Function Index (Bacchiochi & Bagby, 2006); Meyers Index (Meyers, Millis, & Volkert, 2002).

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Table 3
Quality Indices of Symptom Exaggeration Using Varying Base-Rate Estimations

		.304, .081 (Mittenberg et al., 2002)			.333, .179 (DeViva & Bloem, 2003)			.410, .186 (Smith & Frueh, 1996)			.612, .375 (Freeman et al., 2008)		
Scale	Cut score	κ(1,0)	κ(0,0)	κ(.5,0)	κ(1,0)	κ(0,0)	κ(.5,0)	κ(1,0)	κ(0,0)	κ(.5,0)	κ(1,0)	κ(0,0)	κ(.5,0)
F	>85	1.00	.60	.75	1.00	.82	.90	.91	.71	.80	.63	.92	.75
	>90	1.00	.65	.79	1.00	.89	.94	.89	.76	.83	.62	1.00	.77
	>95	1.00	.85	.92	1.00	1.00	1.00	.96	1.00	.98	.60	1.00	.75
	>100	.96	.88	.92	1.00	1.00	1.00	.79	1.00	.88	.50	1.00	.67
	>105	.70	.91	.79	1.00	1.00	1.00	.58	1.00	.74	.40	1.00	.57
	>110	.51	.94	.66	.75	1.00	.86	.44	1.00	.61	.30	1.00	.46
	>115	.46	.97	.62	.67	1.00	.80	.38	1.00	.56	.26	1.00	.42
Fb	>85	1.00	.57	.73	1.00	.82	.90	1.00	.70	.83	.83	.98	.90
	>90	1.00	.64	.78	1.00	.88	.94	1.00	.76	.87	.74	1.00	.85
	>95	1.00	.74	.85	1.00	1.00	1.00	1.00	.92	.96	.76	1.00	.87
	>100	.95	.73	.83	1.00	1.00	1.00	.79	.87	.83	.55	1.00	.71
	>105	.86	.82	.84	1.00	1.00	1.00	.72	.98	.83	.48	1.00	.65
	>110	.72	.80	.76	1.00	1.00	1.00	.62	.98	.76	.42	1.00	.60
	>115	.48	.76	.59	.72	1.00	.84	.42	.90	.58	.32	1.00	.48
	120	.44	.78	.56	.65	1.00	.79	.40	.93	.56	.30	1.00	.46
F-K	>2	1.00	.46	.63	1.00	.70	.82	1.00	.58	.74	1.00	.85	.92
	>3	1.00	.50	.67	1.00	.74	.85	1.00	.62	.77	1.00	.90	.95
	>4	1.00	.54	.70	1.00	.80	.89	1.00	.68	.81	.98	.98	.98
	>5	1.00	.55	.71	1.00	.81	.90	1.00	.70	.82	.92	.98	.95
	>6	1.00	.60	.75	1.00	.88	.94	1.00	.75	.86	.90	1.00	.95
	>7	1.00	.66	.80	1.00	.96	.98	1.00	.83	.91	.81	1.00	.90
	>8	1.00	.68	.81	1.00	.94	.97	1.00	.83	.91	.66	1.00	.80
	>9	1.00	.70	.83	1.00	.96	.98	.88	.84	.86	.60	1.00	.75
	>10	1.00	.75	.86	1.00	1.00	1.00	.84	.92	.88	.56	1.00	.72
	>11	1.00	.85	.92	1.00	1.00	1.00	.90	1.00	.95	.58	1.00	.74
	>12	.96	.84	.90	1.00	1.00	1.00	.78	1.00	.88	.51	1.00	.68
	>13	.94	.90	.92	1.00	1.00	1.00	.76	1.00	.87	.50	1.00	.67
	>14	.70	.88	.78	1.00	1.00	1.00	.60	1.00	.75	.40	1.00	.58
	>15	.68	.95	.79	1.00	1.00	1.00	.57	1.00	.73	.38	1.00	.55
	>16	.62	1.00	.77	.96	1.00	.98	.52	1.00	.68	.34	1.00	.51
	>17	.52	1.00	.69	.80	1.00	.89	.45	1.00	.62	.30	1.00	.46
	>18	.47	1.00	.64	.68	1.00	.81	.40	1.00	.57	.26	1.00	.42
FBS	>20	1.00	.50	.67	1.00	.80	.89	1.00	.66	.80	1.00	1.00	1.00
	>21	1.00	.58	.74	1.00	.92	.96	1.00	.76	.87	1.00	1.00	1.00
	>22	1.00	.68	.81	1.00	1.00	1.00	1.00	.88	.94	1.00	1.00	1.00
	>23	1.00	.69	.82	1.00	.96	.98	.98	.83	.90	.65	1.00	.79
	>24	.76	.68	.72	1.00	.92	.96	.65	.78	.71	.48	1.00	.65
	>25	.78	.76	.77	1.00	1.00	1.00	.66	.90	.77	.47	1.00	.64
	>26	.64	.80	.71	.98	1.00	.99	.56	.94	.70	.38	1.00	.56
	>27	.52	.86	.65	.78	1.00	.88	.46	1.00	.63	.32	1.00	.49
F_{PTSD}	>50	1.00	.32	.49	1.00	.47	.64	1.00	.40	.58	1.00	.56	.72
	>60	1.00	.68	.81	1.00	.94	.97	.98	.82	.89	.65	1.00	.79
	>70	.28	.69	.40	.41	.93	.57	.26	.80	.39	.22	1.00	.36
RBS	>16	.96	1.00	.98	1.00	1.00	1.00	.79	1.00	.88	.48	1.00	.65
	>17	.68	1.00	.81	1.00	1.00	1.00	.56	1.00	.72	.36	1.00	.53
	>18	.39	1.00	.56	.56	1.00	.72	.33	1.00	.50	.23	1.00	.37
F_p	>60	1.00	.63	.77	1.00	.92	.96	1.00	.79	.88	.92	1.00	.96
	>70	.61	.81	.70	.94	1.00	.97	.53	.97	.69	.38	1.00	.55
	>80	.44	.90	.59	.62	1.00	.77	.38	1.00	.55	.26	1.00	.42
M-DFI	>0.5	.49	.55	.52	.74	.76	.75	.44	.61	.51	.36	.78	.49
	>0.6	.50	.58	.54	.76	.81	.79	.45	.68	.54	.36	.86	.51
	>0.7	.46	.62	.53	.69	.84	.76	.41	.70	.52	.43	.92	.50
	>0.8	.30	.51	.38	.46	.72	.56	.28	.58	.38	.24	.72	.36
Meyers Index	>4	1.00	.57	.73	1.00	.85	.92	1.00	.72	.84	.94	1.00	.97
	>5	1.00	.65	.79	1.00	.90	.95	1.00	.79	.88	.70	1.00	.83
	>6	1.00	.75	.86	1.00	1.00	1.00	1.00	.94	.97	.68	1.00	.81
	>7	1.00	.90	.95	1.00	1.00	1.00	.86	1.00	.93	.55	1.00	.71
	>8	.45	.88	.60	.66	1.00	.80	.40	1.00	.57	.28	1.00	.44

Note. *F* = Infrequency; *Fb* = Back-Page Infrequency; κ (1,0) = quality index of sensitivity; *F-K* = Dissimulation Index (Gough, 1950); *FBS* = Symptom Validity Scale (Lees-Haley, English, & Glenn, 1991); F_{PTSD} = Infrequency-Posttraumatic Stress Disorder (Elhai, Ruggiero, Frueh, Beckham, & Gold, 2002); *RBS* = Response Bias Scale (Gervais et al., 2007); F_p = Infrequency-Psychopathology (Arbisi & Ben-Porath, 1995); *M-DFI* = Malingering Discriminant Function Index (Bacchiochi & Bagby, 2006); Meyers Index (Meyers, Millis, & Volkert, 2002). κ(0,0) = quality index of specificity; κ(.5,0) = quality index of efficiency (Kraemer, 1992; Mackinnon, 2000).
[a] Considered adequate (κ > 0.61).

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on *RBS* performed well in all cases except under the high base-rate assumptions of Freeman et al. (2008), in which case sensitivity was unacceptably low. *M-DFI* showed more pervasive problems, performing adequately only under moderate assumptions of exaggeration base rates (DeViva & Bloem, 2003).

Discussion

We were deliberate in making no assumptions about the base rates of symptom exaggeration. The aim of the present study was to test the capacity of the MMPI–2 validity scales to perform under varying base rates, not to determine the prevalence of symptom exaggeration in veterans. As noted previously, base-rate assumptions range from low (Mittenberg et al., 2002) to high (Freeman et al., 2008), and each set of estimates has its own limitations. Mittenberg et al. (2002) did not assess patients; rather, they surveyed neuropsychologists in clinical practice and asked them to estimate rates of symptom exaggeration. Smith and Frueh (1996) and DeViva and Bloem (2003) both used MMPI–2 (*F-K*) scores to identify exaggerating versus nonexaggerating veterans, which rests on the (likely inaccurate) assumption that all veterans with *F-K* scores > 13 are exaggerating and that no veterans with *F-K* scores ≤ 13 are exaggerating. Freeman et al. (2008), whose research yielded the highest base-rate estimates (indeed, this is the only study suggesting that the majority of CS veterans are exaggerating), inferred the presence of symptom exaggeration using the SIRS, a measure that has not been well validated for detecting feigned PTSD in veterans. The accuracy of each set of base-rate estimates is a critical issue that is beyond the scope of the present study.

Caution is indicated in any interpretation of findings of symptom exaggeration, and the MMPI–2 should always be considered in the context of additional sources of information about a patient. We note as well that the presence of symptom exaggeration does not in itself imply that true illness and impairment are not present; evaluating clinicians should use validity scales, such as those embedded within the MMPI–2, to test the limits of symptom reporting and combine these findings with a careful clinical interview and other sources of information (Steenkamp, McLean, Arditte, & Litz, 2010).

Although numerous CGV studies have indicated that the MMPI–2 validity scales show acceptable detection of symptom exaggeration when the base rates are known and markedly different between two groups (e.g., a group of patients are compared to a group of instructed feigners), less is known about the performance of these scales under more clinically representative circumstances. In the VA system, the population base rates of symptom exaggeration in CS and NCS veterans are not well established (as evidenced by widely varying base-rate estimates), and it is quite likely that even the NCS population is characterized by at least moderate rates of symptom exaggeration (Hyer et al., 1988; Hyer, Fallon, Harrison, & Boudewyns, 1987; Jordan, Nunley, & Cook, 1992). Thus, CGV results from known patient and feigning groups may not apply well to veterans seeking evaluations for PTSD, and some authors have recommended caution when using these scales with combat veterans (Perconte & Goreczny, 1990).

The use of MGV allows an examination of the performance of the MMPI–2 validity scales to detect symptom exaggeration under various base-rate estimates, even when the status (exaggerating vs. not exaggerating) of any given patient is not known. In this sense, MGV provides an ideal means by which to determine whether the results from previous CGV studies apply to these more complex CS and NCS groups, each of which is characterized by a mix of exaggerating and nonexaggerating individuals. The present results suggest that the MMPI–2 validity scales can accurately detect symptom exaggeration in veterans undergoing VA PTSD evaluations. *F, Fb, F-K, FBS,* F_{PTSD}, *Fp,* and the Meyers Index were able to demonstrate adequate sensitivity, specificity, and efficiency across estimates.

Ds-R performed poorly in this analysis, with NCS veterans scoring *higher* than CS veterans, a finding that fails to replicate previous research (Frueh et al., 1997). Because no studies have suggested that base rates of symptom exaggeration are higher in NCS veterans than in CS veterans, the higher *Ds-R* score in the present sample of NCS veterans raises significant questions about the utility of this scale with this population. *M-DFI,* which is calculated by weighting several symptom and validity scales, also showed relatively limited utility in the present MGV analyses. Post hoc examination of the scales comprising *M-DFI* suggests that this finding may be due to CS veterans' higher scores, compared with NCS veterans, on most of the symptom-related scales which are given negative weights in *M-DFI.*

Although the ability of MGV to adjust for base-rate estimates is generally a strength of the procedure, it is noted that the accuracy of those estimates creates an upper limit on the accuracy of the MGV results, particularly if CS estimates are erroneously high and NCS estimates are erroneously low (Frederick, 2000). As noted by Frederick and Bowden (2009), the closer $P1^+$ (in this case, estimated base rate of exaggeration in CS veterans) and $P2^+$ (estimated base rate of exaggeration in NCS veterans) are to each other, the more variability is introduced to the TPR and FPR estimates. The DeViva and Bloem (2003) study has the smallest distance between $P1^+$ and $P2^+$ ($0.333 \quad 0.179 = 0.154$); by contrast, the Mittenberg et al. (2002), Smith and Frueh (1996), and Freeman et al. (2008) studies have larger $P1^+ \quad P2^+$ differences (0.223, 0.224, and 0.237, respectively). The large number of truncated FPR results (estimates of FPR calculated at < 0) was high for the DeViva and Bloem study, suggesting instability of the underlying regression line.

As noted previously, estimates of the base rates of symptom exaggeration among CS and NCS veterans vary widely, and the present study makes no assertion of the accuracy of any of these estimates. It is reassuring to note, however, that at least some of the cutoff scores tested in the present study appear robust against varying base-rate estimates, suggesting that these scales can be used effectively in combat veterans seeking PTSD assessments.

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