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Psychometric Properties of the Minnesota Multiphasic Personality Inventory-2-Restructured Form (MMPI-2-RF) FBS-r, Fs, and RBS Scales in a Neuropsychological Setting

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ABSTRACT

PSYCHOMETRIC PROPERTIES OF THE MINNESOTA MULTIPHASIC PERSONALITY INVENTORY-2-RESTRUCTURED FORM (MMPI-2-RF) FBS-r, Fs, and RBS SCALES IN A NEUROPSYCHOLOGICAL SETTING

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The Minnesota Multiphasic Personality Inventory-2 (MMPI-2) is the most widely used self-report measure of personality and psychopathology in the United States. The recently released MMPI-2-RF (Restructured Form), meanwhile, was designed to be a shorter and more efficient version of the MMPI-2. All MMPI-2-RF items are fully contained within the larger MMPI-2 and all MMPI-2-RF scales may be scored from a standard MMPI-2 administration. This study sought to examine the relationship between the RBS, Fs, and FBS-r over-reporting validity scales of the MMPI-2-RF, a stand-alone measure of symptom validity/cognitive effort, and neuropsychological indicators commonly used in assessment batteries. Results of this study supported the clinical utility of the RBS, FBS-r, and Fs, though RBS demonstrated superior predictive utility by explaining performance above and beyond FBS-r and Fs. Since the assessment of symptom exaggeration should be a multifactorial approach, incorporating these embedded measures of validity may provide additional information for neuropsychological assessments.

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Introduction

The objectives of this study are two-fold. The first objective is to examine the relationship between specific over-reporting validity scales of the Minnesota Multiphasic Personality Inventory-2-Restructured Form (MMPI-2-RF), chosen measures of symptom validity, and neuropsychological performance indicators commonly used in assessment batteries. The second objective is to shed light on the utility of the MMPI-2-RF as additional assessment of symptom validity in an assessment battery.

Neuropsychological assessments are subject to intensive speculation of specificity and sensitivity in detecting dysfunction; however, these measures rely upon each patient's motivation and effort during the testing battery (Cullum, Heaton, & Grant, 1991). If motivation and effort are poor, then test scores falling below the average range may not be indicative of impaired brain functions (Cullum et al., 1991). Demakis, Sweet, Sawyer, Moulthrop, Nies, and Clingerman (2001) stated, "If effort is fully applied throughout testing, the resulting test data can be considered valid, but if incompletely or insufficiently applied (whether because of psychopathology, malingering, or some other cause), test data may be invalid (240)."

Invalid test data may result from, but is not limited to, symptom exaggeration, sometimes referred to as over-reporting. As noted by Ben-Porath and Tellegen (2008), over-reporting is not synonymous with malingering. Test-takers may over-report symptoms for a variety of reasons, which may include malingering, but there are other possible explanations (e.g., somatoform disorder). Ben-Porath and Tellegen (2008) stressed that extra-test data (e.g., clinical interview) are needed to rule-in or rule-out

malingering. Nevertheless, psychological test data can be a useful component in the overall assessment of malingering.

Malingering is a medical term referring to the fabrication of either physical or medical symptoms due to external incentives that may include financial compensation, avoiding school, work, or military service, obtaining drugs, reducing a criminal sentence, or to gain attention or sympathy (Rogers, 2008). Zillmer and Green (2006) stated that there are many reasons for invalid or biased performance and malingering may only be one of these reasons. Causes may range from definite malingering and volitional distortion of performance to more subtle nuances, including exaggeration or even neurologic symptoms (Zillmer & Green, 2006).

Resnick (1997) described three types of malingering, which he labeled "pure malingering," involving a complete fabrication of symptoms; "partial malingering," defined as the exaggeration of actual symptoms or by reporting the false continuation of past symptoms; and "false imputation," referring to the deliberate misattribution of actual symptoms to the event. It is important for neuropsychologists to move away from the dichotomous classification system where only pure malingering is considered, as effort falls on a continuum from very poor to outstanding (Iverson, 2006). Recent research indicates that general malingering constitutes a large portion of response bias; therefore, neuropsychologists must have expertise in the evaluation of one's test-taking approach and their exerted effort to make a determination regarding underlying effort and motivation to perform (Zillmer & Green, 2006; Iverson, 2006).

Failure to detect cases of malingering imposes a substantial economic burden on the health care system in the United States; conversely, false attribution of malingering

imposes a substantial burden of suffering on a significant portion of the patient population (Garriga, 2007). Survey data indicate that 20-40% of compensation-seeking adults are thought to be feigning some type of neuropsychological impairment (Mittenberg, Patton, Canyock, & Condit, 2001). The costs to the health care system and society in general are measurable in terms of dollars, safety, and availability of health care (Garriga, 2007). In 2006, the Texas Department of Insurance estimated that fraud, including malingering, costs the insurance industry an annual sum of $150 billion, which subsequently increases the cost of insurance by $1800 per family on average. Costs to public safety are inflicted when bottlenecking occurs in the criminal courts and when psychiatric inpatient beds are full and admission is deferred (Garriga, 2007). When malingering is not considered in clinical practice, those truly ill patients are frequently delayed or denied care (Garriga, 2007).

In neuropsychology, assessment of symptom validity is crucial to maximize confidence in the results obtained from neurocognitive and personality measures and in the diagnoses and recommendations based upon these results (Bush, Ruff, Troster, Barth, Koffler, Pliskin, Reynolds, & Silver, 2005). Clinicians must take caution when basing conclusions about response style and effort on one measure, as doing so requires the clinician to infer that similar response styles and effort were employed by the examinee when completing all measures (Otto, 2008). Therefore, a complete assessment should include tests of symptom validity, in addition to evaluating the consistency across test results and the patient's self-report, cultural factors, the pattern of test results, and demand characteristics of the testing situation (Zillmer & Green, 2006). It has been found

that unless specific measures of malingering are used, many malingerers go without detection (Rogers, 1998).

Individuals with and without brain dysfunction may complain of diminished abilities; subsequently, it is standard practice for neuropsychologists to assess for effort and symptom exaggeration. If a clinician is making inferences from performance instruments, it is especially crucial to evaluate effort, as sufficient output must be exerted by the examinee on all tests of ability to ensure valid results (Heilbronner, Sweet, Morgan, Larrabee, Millis, and Conference Participants, 2009). Therefore, effort should be evaluated repeatedly, if not continuously, throughout the course of an examination (Boone, 2009). These measures may take the form of stand-alone cognitive effort tests, embedded indicators within ability tests, and evaluation of response bias within disorder-specific and personality inventories. The recommendations of the American Academy of Clinical Neuropsychology (AACN, 2009) state, "Stand-alone effort measures and embedded validity indicators should both be employed" and "When a psychological disorder (e.g., depression) and ability deficits (e.g., memory) are claimed, clinicians should administer measures that can evaluate response bias related to both."

In choosing tests for any given battery, neuropsychologists select assessments with broad, empirical foundations to enhance the accuracy of the conclusions drawn and the usefulness of the information gleaned (Iverson, 2006). The same psychometric standards must be applied to the assessment of effort. Both traditional and specialized measures have been developed to identify poor effort in neuropsychology (Iverson, 2010). Traditional tests are those that have been developed to measure a specific ability and are also used to identify poor effort (Iverson, 2010). Examples include the California

Verbal Learning Test, the Category Test, Digit Span, Reliable Digit Span, Vocabulary-Digit Span Difference Scores, the Rey Auditory Verbal Learning Test, the Recognition Memory Test, and the Wechsler Memory Scale—Third Edition. Specialized tests are those that have been designed and validated specifically for the purpose of detecting poor effort (Iverson, 2010). Examples of these tests include the Amsterdam Short-Term Memory Test, b Test, the Computerized Assessment of Response Bias, the Dot Counting Test, the Portland Digit Recognition Test, the Rey 15-Item Test, the Test of Memory Malingering, the 21-Item Test, the Validity Indicator Profile, the Victoria Symptom Validity Test, and the Word Memory Test. This research will utilize three widely used and empirically supported measures, including Green's Memory Complaints Inventory (Green's MCI), and Green's Medical Symptom Validity Test (Green's MSVT). The reliability and validity of scores on these measures will be discussed in detail.

Other measures of symptom validity are embedded within measures assessing a variety of constructs. For the purpose of this research, we will remain within the domain of personality assessment, specifically the MMPI-2-RF. The original MMPI (MMPI; Hathaway & McKinley, 1943) and MMPI-2 (Butcher, Graham, Ben-Porath, Tellegen, Dahlstrom, & Kaemmer, 2001) are examples of well researched clinical measures of personality and psychopathology that also provide scales designed to measure over-reporting (Sellbom & Ben-Porath, 2006). Furthermore, the MMPI-2 is one of the five most widely used instruments in the determination of response bias (Sharland & Gfellar, 2007). The MMPI was once the most frequently used self-report inventory, while the MMPI-2 remains the most frequently investigated and utilized psychological test (Archer, Buffington-Vollum, Stredny, & Handel, 2006; Sellom & Ben-Porath, 2006;

Lubin, Larsen, & Matarazzo, 1984; Piotrowski & Keller, 1989; Camara, Nathan & Puente, 2000; Butcher & Rouse, 1996). In 2008, a revised version of the MMPI-2, the MMPI-2-Restructured Form (MMPI-2-RF; Ben-Porath & Tellegen, 2008), was published.

The main objective of the MMPI-2-RF project was to develop a set of psychometrically adequate scales that represent the clinically meaningful information presented in the MMPI-2 item pool (Tellegen & Ben-Porath, 2008). Although Tellegen and Ben-Porath (2008) provided substantial data on the psychometric properties of scores on the MMPI-2-RF in a number of samples, the measure is still relatively new. Therefore, additional empirical data would be useful in further establishing the psychometric properties of this measure in a wide variety of samples and applications. Toward this end, the current study aims to measure the relationship between embedded validity indicators, stand-alone symptom validity measures, and general performance on an ability test. This study will incorporate data from patients assessed at a neuropsychology private practice. Results of this research have aimed to expand the understanding of the use of the MMPI-2-RF as an additional tool measuring symptom validity in the practice of neuropsychology. Since invalid performance on the MMPI-2-RF or any other measure of personality and psychopathology does not permit conclusions to be drawn regarding effort on other neurocognitive testing or vice versa, it is important to explore the reliability and validity scores on any new measure (Bush et al., 2005).

Defining Malingering

The Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR) describes the essential feature of malingering as the intentional production of false or intentionally exaggerated symptoms (American Psychiatric Association [*DSM-IV-TR*], 2000). It should be particularly suspected if any of the following circumstances are present: the patient is referred by an attorney under a medico-legal context; a marked discrepancy exists between the patient's claimed stress or disability and the results of testing; the patient does not readily cooperate during the clinical interview and assessment as well as with the prescribed treatment regimen; and lastly, Antisocial Personality Disorder is suspected (*DSM-IV-TR*, 2000). Malingering can be distinguished from other psychiatric disorders, including Factitious Disorder, Conversion Disorder, and other Somatoform Disorders because of the intentional production of symptoms and the presence of external incentives (Cullum et al., 1991).

The neuropsychological literature has employed a variety of terms to describe invalid information or test data, based upon either the examinee's self-report or observed behavior [while others emphasize the reasoning behind the invalidity] (Bush et al., 2005). First, symptom validity refers to the accuracy of the patient's behavioral presentation, self-reported symptoms, or performance on neuropsychological measures (Bush et al., 2005). Second, response bias denotes a purposeful attempt to deceive or mislead the examiner through inaccurate or incomplete response patterns or effort (Bush et al., 2005). Third, effort is one's investment in their own performance and is indicative of their true capacity; in other words, the patient's effort to perform well on given measures (Bush et al., 2005). Fourth, dissimulation describes the attempt to appear dissimilar from one's

true condition through the over- or under-representation of true symptoms (Bush et al., 2005). For the purpose of this research, each of these terms will be utilized.

Prevalence of Malingering

Over reporting or feigning neurological symptoms may occur in a sizable minority of patients in a neuropsychological assessment setting, especially in contexts with obvious secondary gain from performance falling below normal limits (Bush et al., 2005). The symptoms most commonly claimed for disability are associated with disorders including mild head injury, fibromyalgia, chronic fatigue syndrome, chronic pain, and major depressive disorder (Rogers, 2008; Mittenberg, Patton, Canyock, & Condit, 2002). A review of the literature conducted by Larrabee (2003) found a rate of 40% in 1,363 patients seeking compensation for mild head injury claims in 11 published studies using objective diagnostic measures. These results replicate previous findings utilizing a variety of objective methods (Binder & Kelly, 1996; Green, Rohling, Lees-Haley, & Allen, 2001; Grote et al., 2000; Millis, 1994; Rohling, 2000; Youngjohn, Burrows, & Erdal, 1995).

Among those claiming disability due to fibromyalgia, chronic fatigue syndrome, or major depressive disorder, 25-30% performed in a range that may indicate symptom exaggeration on forced choice tests (Mittenberg et al., 2002; Gervais, Russell, Green, Allen, Ferrari, & Pieschl, 2001; Green et al., 2001; Van der Werf, Prins, Jongen, Van der Meer, & Bleigenberg, 2000). Furthermore, similar results have been found for approximately 40% of those disability claimants with chronic pain (Mittenberg et al., 2002; Gervais, Green, Allen, & Iverson, 2001). Regardless of diagnosis, approximately

25-30% of those presenting within the context of personal injury litigation, worker's compensation, and disability claims are believed to have exaggerated their symptom presentation (Green et al., 2001; Lees-Haley, 1997).

Symptom Validity Assessment Guidelines

The field of psychology has a long history of evaluating deception and psychologists have subsequently gained particular expertise in psychometrics and test theory (Zillmer & Green, 2006). Neuropsychologists, in particular, must consider the possibility of feigned or exaggerated performance as an integral part of their interpretation of tests results (Cullum et al., 1991). Those in clinical practice should engage in adequate assessment of symptom validity so that they may make appropriate diagnoses and recommendations, which are typically based upon patients' performance on neurocognitive and personality measures (Bush et al., 2005). Although neuropsychologists typically evaluate patients in multiple contexts, it is crucial that they utilize instruments that can effectively determine the veracity of symptom presentation, especially in a forensic setting (Sellbom, Toomey, Wygant, Kucharski, & Duncan, 2010). As a result, it has become standard practice to assess symptom validity, and neuropsychologists have created tests designed to measure these constructs (Bush et al., 2005; Heilbronner et al., 2009; Zillmer & Green, 2006).

With that said, it should not be implied that one should use a single test in isolation to identify the presence of over-reporting, or any other disorder (Millis, 2008; Zillmer & Green, 2006; Iverson, 2006). Neuropsychologists should determine whether an individual examinee's failure of one symptom validity domain also applies to a test in

another domain (Zillmer & Green, 2006). Preliminary research has demonstrated that symptom validity measures of cognition (e.g. memory malingering) and personality assessment (e.g., MMPI-2 and MCMI-III) are unique and do not represent a single domain of dissimulation (Greiffenstein, Baker, Gola, Donders, & Miller, 2002; Larrabee, 2003; McCaffrey, O'Bryant, Ashendorf, & Fisher, 2003; Ruocco, 2005). This implies the difficulty in predicting cognitive malingering from psychiatric malingering and vice versa; similar results have also been shown for performance tests, thus supporting the practice of utilizing different measures for assessing neuropsychological and psychiatric malingering (Zillmer & Green, 2006). However, there is an overlap among different types of symptom exaggeration.

The evaluation of malingering is complex and requires converging evidence from multiple sources. If an examinee is determined to have engaged in malingering, then the clinician has concluded that he or she is purposely exaggerating and underperforming on testing to increase the likelihood of obtaining an obvious external incentive (Iverson, 2006; Bianchini, Greve, & Glynn, 2005; Slick, Sherman, & Iverson, 1999; Millis, 2008). To make this determination, the AACN Consensus Conference statement (2009) confirms that clinicians can diagnose malingering in some patients, though this does not imply that malingering is a mental illness or disorder; rather, it is a designation and a term used to describe intentional exaggeration. Through scientific inquiry, clinicians can differentiate intentionally exaggerated presentations (e.g., malingering and factitious disorder) from unintentionally exaggerated presentations (e.g., somatoform pain disorder, cogniform disorder) (Heilbronner et al., 2009). To establish which diagnosis, the AACN recommends that clinicians "...consider the context of the evaluation and overall

presentation of the examinee, including background information, history information gathered during interview, observations, neuropsychological tests, and measures of response bias" (Heilbronner et al., 2009, 1097-1098).

Measuring Symptom Validity

There are many styles of symptom validity tests measuring negative response bias, motivation, and effort. A significant portion of these tests are described as "forced-choice," which presents two alternatives to the examinee. By providing a 50% probability of obtaining the correct answer by chance alone, statistics suggests that scores less than 50% are improbable and indicate deliberate choice of the wrong response (Gervais, Ben-Porath, Wygant, & Green, 2007).

While this sounds like a feasible basis for interpretation, sensitivity is compromised as this level of performance rarely occurs (Gervais et al., 2007). Empirically based, above-chance norms have been developed based on the performance of patients with severe traumatic brain injury, dementia, or other objective neurocognitive impairment (Rogers, 2008). This is known as a "floor approach," since scores that fall below the established cutoffs are associated with symptom exaggeration (Gervais et al., 2007). The floor approach provides increased sensitivity while maintaining a high level of specificity and allows clinicians to have more confidence in the data (Gervais et al., 2007).

While there are many steps in the process of determining symptom validity, it should be emphasized that data from symptom validity tests should be given substantially greater weight than subjective indicators of effort, including statements by the examinee

and examiner observations (Bush et al., 2005). This is largely due to the increasing amount of scientific evidence supporting the sensitivity and specificity of symptom validity tests above and beyond subjective assessment (Bush et al., 2005). When invalid performance occurs on symptom validity measures, doubt may be cast upon the validity of other measures. At this point, the examiner must consider performance on all assessments of symptom validity and neurocognitive performance in order to provide justification for interpretation (Bush et al., 2005). If an examinee scores slightly below the cut-off on one SVT, it may not justify a conclusion of biased responding and the examiner should then refer to the data from other indicators (Bust et al., 2005). However, if invalid performance is corroborated by other assessments, the examinee's performance on ability tests may be interpreted as a representation of his or her minimum level of ability (Bust et al., 2005). As stated previously, it is important to remember invalid performance on a personality assessment, such as the MMPI-2-RF, does not allow for generalizations to be made regarding the validity of neurocognitive tests, though it should certainly raise questions regarding the overall validity of the assessment batter (Bush et al., 2005). There is a need to establish the utility of both cognitive and psychiatric measures of symptom validity.

Development and Review of the MMPI-2-RF

The MMPI-2 has also dominated forensic psychological assessment and meets the criteria outlined in the U.S. Supreme Court decision in *Daubert v. Merrell Dow Pharmaceuticals Inc.* (1993), which ruled the following:

> Trial judges must determine the validity of inferences based on a scientific technique by considering whether (1) the technique can be and has been

tested empirically, (2) the technique has been subjected to peer review, (3), the error rates of the technique are known, (4) there are standards for applying the technique, and (5) the technique is generally accepted in the relevant scientific discipline.

While this ruling provides a basis for interpretation of data obtained from empirically supported psychological assessment measures, it does not provide much support for innovations in the way of change and improvement as a result of scientific scrutiny (Sellbom & Ben-Porath, 2006). For example, when the Restructured Clinical (RC) Scales were introduced in 2003, they did not possess the broad and extensive research base needed to guide interpretation as the original Clinical Scales (Sellbom & Ben-Porath, 2006). Even though revisions and enhancement of scales offered significant improvement, the recommendations at the time were to use the RC Scales to refine interpretation of the Clinical Scales until the research based broadened (Sellbom & Ben-Porath, 2006).

As the research supporting the RC Scales substantially increased, the next step was to create a restructured version of the MMPI-2. The goal of the MMPI-2-RF was to extend the work that began with the RC Scales, such that the development of substantive scales would capture the clinically relevant content of the MMPI-2 item pool (MMPI-2-RF; Ben-Porath & Tellegen, 2008). Furthermore, improvements in psychometric properties included reducing intercorrelations among scales and enhanced discriminant and convergent validity compared to the MMPI-2 (MMPI-2-RF; Ben-Porath & Tellegen, 2008). Research has established the comparability of scores of the 338 items comprising

the MMPI-2-RF scales with the 567 items that make up the scales of the MMPI-2 (Tellegen & Ben-Porath, 2008; Van Der Heijden, Eger, & Derksen, 2010).

The MMPI-2-RF is comprised of 338 of the original 567 items of the MMPI-2 for a total of 42 substantive scales (Ben-Porath & Tellegen, 2008). These include the Higher-Order Scales, RC Scales, Specific Problem Scales, Interest Scales, and revised versions of the Personality Psychopathology Five Scales (MMPI-2-RF; Ben-Porath & Tellegen, 2008). The MMPI-2-RF also includes revised versions of eight MMPI-2 Validity Scales: VRIN-r (Variable Response Inconsistency), TRIN-r (True Response Inconsistency), F-r (Infrequent Responses), Fp-r (Infrequent Psychopathology Responses), FBS-r (Symptom Validity), L-r (Uncommon Virtues), and K-r (Adjustment Validity) (MMPI-2-RF; Ben-Porath & Tellegen, 2008). In addition, the MMPI-2-RF contains two new validity scale, Fs (Infrequent Somatic Responses) and RBS (Response Bias Scale), that measure over-reporting of somatic and cognitive symptoms, respectively (MMPI-2-RF; Ben-Porath & Tellegen, 2008).

The MMPI-2-RF was also designed to be less time-consuming and burdensome for patients compared to the MMPI-2, as it consists of 338 items instead of the 567 featured on the MMPI-2 (Ben-Porath & Tellegen, 2008). No new items were added and the standardization sample remains the same (Ben-Porath & Tellegen, 2008). To date, the MMPI-2-RF scales have been validated with numerous populations (e.g., psychiatric inpatients, psychiatric outpatients, medical patients, disability patients, criminal defendants, and college students) using various criterion measures (e.g., intake variables, psychiatric diagnoses, patient description form variables, mental status variables, and discharge medications, in addition to a variety of self-report measures) (Ben-Porath &

Tellegen, 2008). For the purpose of this research, the RBS, FBS and FBS-r, and F-s will now be discussed.

The Response Bias Scale (RBS)

To aid in the detection of cognitive response bias, Gervais, Ben-Porath, Wygant, & Green (2007) developed the Response Bias Scale (RBS), which has been correlated with symptom validity test failure and exaggerated cognitive complaints. This scale is conceptually different from FBS, which identifies post-injury exaggeration of emotional distress and minimization of pre-injury emotional or personality problems (Gervais, Ben-Porath, Wygant, & Sellbom, 2010). The RBS is the only MMPI-2/MMPI-2-RF scale developed from an actual forensic disability sample (Gervais et al., 2010). RBS was developed through an empirical-keying method involving multiple regression analyses to identify a set of MMPI-2 items that were correlated with failure on the Word Memory Test (WMT; Green, 2003), the Computerized Assessment of Response Bias (Allen, Conder, Green, & Cox, 1997), and the Test of Memory Malingering (TOMM; Tombaugh, 1996) (Gervais, et al., 2007).

Gervais et al. (2007) reported Cronbach's Alpha coefficient of .76 for RBS scores in both their development and cross-validation samples. Furthermore, scores on RBS demonstrated statistically significant incremental validity when scores on F were entered in the first block of a regression equation. Scores on RBS also showed evidence of incremental validity when scores on FBS were entered in the first block of a second regression equation. In a third equation, the inclusion of RBS scores did not add

statistically significant incremental variance above and beyond Fp scores (Block 2 ΔR^2 = .02, p = .06).

A study examining the utility of the RBS and other MMPI-2 over-reporting scales in predicting TOMM performance indicated that the RBS exhibited the largest effect size (d = .98) when distinguishing between groups who passed and failed the TOMM (Whitney, Davis, Shepard, & Herman, 2008). Moreover, scores on the RBS were found to better predict score elevations on Green's Memory Complaints Inventory (Green, 2004) in comparison to scores on the other MMPI-2 over-reporting scales, whereas no correlation was found between scores on the RBS and the California Verbal Learning Test (CVLT, Delis, Kramer, Kaplan, & Ober, 1987), an objective assessment of verbal learning (Gervais, Ben-Porath, Wygant, & Green, 2008). These results indicated that RBS scores successfully detected exaggeration of subjective memory complaints (Gervais et al., 2008). Similar results were found in predicting symptom validity test performance with disability and criminal forensic samples, as scores on RBS outperformed scores on over-reporting scales of the MMPI-2 (Wygant, Sellbom, Gervais, Ben-Porath, Stafford, Freeman, & Heilbronner, 2010). Overall, the research supports the use of the RBS as an effective measure of general symptom exaggeration as well as in predicting failure on symptom validity tests in disability settings (Wygant et al., 2010).

The FBS and FBS-r

Though the MMPI-2 has been one of the most widely used instruments employed by neuropsychologists (Archer et al., 2006), it did not include validity scales specifically designed to assess cognitive symptom exaggeration until the addition of the Symptom

Validity Scale (FBS; Lees-Haley, English, & Glenn, 1991). The FBS, formerly known as the Fake Bad Scale, is standardly scored on the MMPI-2 and is generally accepted as a measure of symptom over-reporting in personal injury settings (Sharland & Gfeller, 2007; Greffenstein, 2010; Dionysus, Denney, & Halfaker, 2010). It has also demonstrated sensitivity to exaggerated disability in those seeking benefits for neurological trauma and has been supported by more than 45 research studies (Greiffenstein, Fox, & Lees-Haley, 2007).

There has been significant debate as to what FBS measures, though the research demonstrates its usefulness in detecting somatic and cognitive over-reporting (Graham, 2006). FBS has demonstrated sensitivity to illogical symptom histories (Greiffenstein, Baker, Gola, Donders, & Miller, 2002) and has accurately identified patients with mild head injuries exerting poor cognitive effort (Slick, Hopp, Strauss, & Spellacy, 1996; Ross, Millis, Krukowski, Putnam, & Adams, 2004).

Several studies have shown the positive relationship among elevated FBS scores, symptom exaggeration, and malingered neurocognitive dysfunction (Larrabee, 1998, 2003; Slick et al., 1999). Research has also demonstrated scores on FBS are sensitive to exaggerated emotional distress in personal injury settings (Crawford, Greene, Dupart, Bongar, & Childs, 2006; Lees-Haley et al., 1991), as well as among those exhibiting somatic malingering (Larrabee, 1998, 2003) and suboptimal effort on cognitive symptom validity tests (Greffeinstein et al., 2002; Larrabee, 2003, Ross et al., 2004; Bianchini, Love, Brennan, & Heinly, 2006). Lees-Haley, English, and Glenn (1991) found that FBS correctly classified 24 of 25 patients malingering emotional distress in the context of personal injury, while 18 of 20 patients assessed as presenting with genuine injuries were

correctly classified when a cut-off of 20 was utilized. FBS is twice as likely to be elevated among individuals with mild traumatic brain injury seeking compensation in comparison to those not seeking compensation (Miller & Donders, 2001).

Furthermore, FBS has demonstrated its superiority to other MMPI-2 validity scales in detecting malingering in neuropsychological settings (Larrabee, 1998; Larrabee, 2003; Millis, Putnam, & Adams, 1995; Putnam, Millis, & Adams, 1998; Tsushima & Tsushima, 2001). A recent meta-analysis documented the incremental validity of FBS scores in comparison to other scores on MMPI-2 validity scales in discriminating over-reporting and comparison groups, thus supporting the use of FBS within forensic settings (Nelson, Hoelzle Sweet, Arbisi & Demakis, 2010). This meta analysis updated the composite effect size of FBS ($d = 0.95$), thus demonstrating greater stability and ability to differentiate among individuals with traumatic brain injuries based on effort (Nelson et al., 2010).

However, some controversy exists regarding the interpretation of elevated FBS scores. Specifically, the likelihood of false positives increases in the presence of confounding variables, such as intensity of head injury or preinjury psychiatric history (Martens, Donders, & Millis, 2001). Elevations in psychiatric settings may not be indicative of malingered neurocognitive dysfunction, thereby reducing the sensitivity and specificity of FBS in this setting (Rogers, Sewell, & Ustad, 1995). In addition, data exists suggesting FBS has poor internal consistency, a high rate of false-positive identification, and over-identified malingering in a personal injury context (Butcher, Arbisi, Atlis, & McNulty, 2003). The methodology of this research has been questioned, including the sample distribution as well as failure to control for the effects of malingering (Lees-Haley

& Fox, 2004). The literature states "...raw scores above 28 on the FBS are associated with a very low false positive rate, which is consistent with the false positive rate of other standard MMPI-2 validity scales" (Ben-Porath & Tellegen, 2008_2, page 1). Overall, FBS has demonstrated clear validity in forensic settings (Nelson et al., 2010).

FBS was revised for the MMPI-2-RF (FBS-r), resulting in the FBS-r scale (Ben-Porath & Tellegen, 2008_2). Scores on FBS-r have produced large effect sizes in discriminating between medical control and medical simulation over-reporting samples (Wygant, Ben-Porath, Arbisi, Berry, Freeman, & Heilbronner, 2009). In order to provide a less inferential label in addition to better description of the scale, the FBS was renamed as the Symptom Validity scale (FBS-r) (Ben-Porath, Tellegen, & Graham, 2008). It is comprised of 30 of the 43 items originally on the FBS scale and has been used widely by neuropsychologists to aid in the identifying patients presenting with non-credible symptoms in the context of civil litigation (Ben-Porath & Tellegen, 2008). Research on the FBS-r will be discussed below.

The Infrequent Somatic Responses Scale (Fs)

Many of the MMPI-2 validity scales, including FBS, were revised for use with the MMPI-2-RF; however, the Infrequent Somatic Responses (Fs) was first introduced on the MMPI-2-RF. The Fs consists of 16 items that are somatic in content and were endorsed by 25% or less of medical and chronic pain patients (Wygant, Ben-Porath, & Arbisi, 2004). This scale was designed to detect individuals who are over-reporting somatic or cognitive complaints, as it consist of somatic items rarely endorsed by medical patients (Ben-Porath & Tellegen, 2008).

Wygant (2007) employed this scale in a variety of settings, including simulations, known-groups, and mental health samples. Significant elevations were found among those patients who failed cognitive symptom validity tests as well as those instructed to feign symptoms of head injury (Wygant, 2007). These results also showed less of a correlation with measures of genuine somatic complaints and mood psychopathology in comparison to other MMPI-2 validity scales, thus establishing its ability to detect symptom exaggeration (Wygant, 2007). In general, the addition of Fs on the MMPI-2-RF has shown a strong benefit in predicting response bias.

MMPI-2-RF Validity Scale Research

Since the MMPI-2-RF is a relatively new measure, relatively few studies outside of the data presented in Tellegen and Ben-Porath (2008) have been conducted. However, the findings of these additional studies provide empirical support for MMPI-2-RF over-reporting scales in both clinical and forensic settings (Gervais et al., 2010; Larrabee, 2008; Gervais, Sellbom, & Wygant, 2010; Burchett & Ben-Porath, 2010; Locke, Kirlin, Thomas, Osborne, Hurst, Drazkowski, Sirven, & Noe, 2010; Sellbom, Toomey, Wygant, Kucharski, & Duncan, 2010). A review of the available research to date on the MMPI-2-RF validity scales will now be discussed.

Gervais and colleagues (2010) explored the utility of the MMPI-2-RF over-reporting scales and the RBS in assessing the validity of subjective memory complaints. The scores on RBS were found to be more strongly correlated with scores on the Memory Complaints Inventory (r = .63) in comparison to scores on MMPI-2-RF validity scales (Gervais et al., 2010). With that said, however, the scores on MMPI-2-RF validity scales

were more strongly correlated with scores on measures of symptom validity in comparison to the scales of the MMPI-2 (Pearson's *r* for Fs and FBS-r = .51 and .50, respectively). These findings suggest that the over-reporting validity scales of the MMPI-2-RF are more sensitive to potentially exaggerated memory complaints than those of the MMPI-2 and support its use as a measure of psychopathology in a forensic context (Gervais et al., 2010). Furthermore, the RBS was found to provide an incremental contribution in predicting memory complaints above and beyond the scales of the MMPI-2-RF (Gervais et al., 2010). Similar results were found by Larrabee (2008) who compared the diagnostic validity of the MMPI-2 scales, MMPI-2-RF validity scales, and the RBS to distinguish between civil litigants and nonmalingering patients with true neurological disorders (e.g. moderate to severe brain injury) and psychiatric illness. The FBS, RBS, and FBS-r were found to have the strongest effect sizes when discriminating groups (*d* = 1.99, 1.91, and 1.85, respectively).

The MMPI-2-RF validity scales have also shown clinical utility in detecting over-reporting in a criminal forensic setting (Sellbom et al., 2010; Wygant et al., 2007; Burchett & Ben-Porath, 2010). Using a known-groups design, Sellbom et al. (2010) compared scores on the MMPI-2-RF validity scales and the Structured Interview of Reported Symptoms (SIRS; Rogers, 1992). Results demonstrated that F-r and Fp-r best discriminated between malingered and nonmalingered groups determined by the SIRS, which was expected given previous data with criminal populations (Sellbom et al., 2010). Notably, the FBS-r and Fs were still associated with large effect sizes when differentiating between groups, indicating the utility of these scales in the criminal setting (Sellbom et al., 2010). Burchett and Ben-Porath (2010) examined the substantive scale

score validity to determine the effect of over-reporting on the MMPI-2-RF among one simulated group instructed to feign somatic complaints, a second group instructed to feign psychopathology, and a third group as a control who received standard instructions. While a majority of the control group scored within the average range, somatic feigners and those feigning psychopathology elevated a significant number of scales. These studies support the notion that individuals in forensic evaluation settings who may profit from appearing mentally ill tend to over-report a wide variety of symptoms, including psychopathology, cognitive complaints, and somatic problems (Sellbom et al., 2010; Wygant et al., 2007; Burchett & Ben-Porath, 2010).

The MMPI-2-RF has also been compared to results of other personality instruments. Gervais, Sellbom, and Wygant (2010) compared the MMPI-2-RF validity scales and RBS to the Personality Assessment Inventory (PAI) in predicting performance on four different symptom validity tests, including the Word Memory Test (WMT), the Medical Symptom Validity Test (MSVT), the Test of Memory Malingering (TOMM) Trial 2, and the Non-Verbal Medical Symptom Validity Test (NV-MSVT). In general, higher scores on the MMPI-2-RF and PAI over-reporting validity scales were associated with failure on symptom validity tests. The RBS obtained larger effect sizes in comparison to the MMPI-2-RF and PAI validity scales, which replicated previous findings (Gervais et al., 2010).

The MMPI-2-RF validity scales have also demonstrated utility in detecting symptom exaggeration in medico-legal settings. Wygant and colleagues (2009) examined scores on the MMPI-2-RF and symptom validity test results in both simulation and known-groups samples. Data were gathered from control sample with actual head

injuries were compared to a group instructed to simulate symptoms of a head injury (Wygant et al., 2009). Results supported the use of Fs and and F-r to discriminate between true symptomatology and over-reporting of somatic and emotional complaints among those presenting with sequelae of head injury (Wygant et al., 2009). In a medical simulation sample, MMPI-2-RF validity scales were significantly elevated among those instructed to feign symptoms, though effect sizes were largest for FBS-r, F-r, and Fs (d = 2.31, 2.03, and 1.97, respectively) (Wygant et al., 2009). These results were corroborated in a personal injury/disability sample in which participants were grouped based on symptom validity test performance, which demonstrates the utility of these scales to identify cognitive bias when a patient fails multiple symptom validity tests (Larrabee, 2008). The results of this study speak to the ability of these MMPI-2-RF scales to detect exaggerated somatic, neurocognitive, and emotional complaints that may be seen in medico-legal settings (Wygant et al., 2009).

Locke and colleagues (2010) conducted research on the MMPI-2-RF on an epilepsy monitoring unit. This study compared the scores of four different groups: (1) those diagnosed with epilepsy only, (2) those with psychogenic nonepileptic seizures (NES), (3) those with both epileptiform activity and some events showing no EEG activity, and (4) an indeterminate group based on a nondiagnostic admission with no typical events recorded and no data indicative of epilepsy (Locke et al., 2010). Among the validity scales, those diagnosed with NES demonstrated the highest score elevations on Fs and FBS-r in comparison to those in the epilepsy group (Locke et al., 2010). Other elevations were noted on the RC Scales, the Somatic/Cognitive Scales, the Internalizing Scale, and the Externalizing Scale (Locke et al., 2010). Overall, these results indicate that

those with NES report an increased rate of somatic symptoms in comparison to those diagnosed with epilepsy (Locke et al., 2010).

To date, the research generally supports the use of the MMPI-2-RF over-reporting scales in both clinical and forensic settings, although relatively few studies have been conducted.

Statement of the Problem

It is standard practice in a thorough and competent assessment to assess the validity of claimed symptoms and obtained test data, especially in instances where secondary gain or incentives could influence the clinical presentation (Gervais et al., 2010). Systematic assessment of malingering requires that clinicians obtain data from the clinical interview, as well as from self-report measures with embedded indicators and symptom validity tests, stand-alone cognitive effort tests, embedded indicators within ability tests, and evaluation of response bias within disorder-specific and personality inventories (Slick et al., 1999; Bianchini et al., 2005). Because of the prevalence of symptom exaggeration in the field, the American Academy of Clinical Neuropsychology has called for ongoing research efforts that strive to improve the effectiveness of procedures used by neuropsychologists (Heilbronner et al., 2009). Formal assessment of cognitive effort and performance validity primarily takes place through the administration of cognitive symptom validity tests, though research has shown that these indicators may not provide evidence regarding other areas of potential malingering (Gervais et al., 2010).

The MMPI-2-RF is a relatively new measure of personality and psychopathology that was introduced with the objective to provide a more reliable and valid assessment

measure in a condensed, less burdensome format. Additional empirical data would be useful in further evaluating the psychometric properties of various MMPI-2-RF scales, particularly in the area of detecting over-reporting and symptom exaggeration. Specifically, few studies have been conducted on the new validity scales of this measure, especially in relation to symptom validity tests.

The proposed study will expand the knowledge base surrounding the efficacy and utility of the MMPI-2-RF in neuropsychological settings. By exploring the relationship among embedded validity indicators of the MMPI-2-RF, stand-alone symptom validity measures, and general performance on an ability test, new data will be gleaned regarding the use of the MMPI-2-RF in a clinical setting. The limitation of much past research on symptom exaggeration is the reliance on feigned symptom exaggeration; conversely, this study will incorporate the results from actual patients from a neuropsychology private practice.

Invalid performance on the MMPI-2-RF or any other measure of personality raises questions regarding the reliability of assessment data (Bush et al., 2005). Therefore, it is important to explore the reliability and validity of this new measure. Results will further understanding of the use of the MMPI-2-RF as an additional tool measuring symptom validity in the practice of neuropsychology. The present study was undertaken to examine whether elevated scores on the RBS, the FBS-r, and Fs are associated with increased self-reported memory complaints, failure of one or more cognitive symptom validity tests, and poor performance on a measure of cognitive ability in a sample of actual patients from a neuropsychology private practice.

METHOD

Participants

One hundred and fourteen patients were administered test batteries that included the MMPI-2, Green's Memory Complaints Inventory (MCI; Green, 2004), Green's Medical Symptom Validity Test (MSVT; Green, 2004), and the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS; Randolph, 1998) from 2005 to 2010. MMPI-2 data were then scored using MMPI-2-RF scales. Analyses excluded patients who omitted 15 or more MMPI-2-RF items or who obtained *TRIN-r* or *VRIN-r* *T*-scores greater than or equal to 80. After these exclusion criteria were applied, a total of 77 patients produced valid profiles and were thus included in the analyses. This total sample size of 77 was less than originally projected; subsequently, this should be taken into consideration when interpreting findings. It should be noted that most participants included in this study were referred for neuropsychological evaluation to assess the potential presence of cognitive dysfunction, not to assess for the presence of psychiatric disorder.

Archival data were collected from a private neuropsychology practice in Virginia Beach, VA. After cases were removed based on MMPI-2-RF criteria, the sample consisted of 77 English-speaking adults over the age of 18 ($M = 44.39$, $SD = 12.81$) who presented with cognitive complaints and were administered MMPI-2, MCI, MSVT, and RBANS as part of a larger clinical evaluation. Demographic information was gleaned from a record review and included age, gender, etiology of complaint, and highest education level attained. Across the sample, there were 36 males (41%) and 41 females included in the sample with a mean education level of 13.75 years ($SD = 2.18$). Of these

77 total participants, 53 (60%) were Caucasian, 15 (17%) were African American, and 9 participants (9%) did not have ethnicity demarcated in their records. Nineteen patients (22%) were diagnosed with cognitive deficits secondary to a traumatic brain injury (TBI), 22 (25%) were diagnosed with a mood disorder, eight (9%) were diagnosed with a pain-related disorder, and two with substance abuse issues. Twenty-three participants (32%) reported a work-related injury, 23 participants (32%) reported a motor vehicle accident, 15 participants (14%) complained of a significant history of mood-related disorder(s), 12 (17%) presented with cognitive complaints as a result of a peripheral medical condition, and four participants (5%) reported a history of a progressive or degenerative neurologic condition. Participants were also identified on the basis of whether or not they were involved in some type of litigation (e.g., workers' compensation, disability, or personal injury) at the time of the evaluation. Specifically, 31 participants (40%) reported ongoing litigation at the time of evaluation while 46 participants denied active legal involvement.

Instruments

All participants in this study were administered a neuropsychological assessment battery consisting of a variety of cognitive tests, the MMPI-2, a number of symptom validity or effort tests, and self-report symptom questionnaires. For the purposes of the present study, the analyses focused on the MMPI-2-RF FBS-r and Fs scales, the RBS, the MCI, the MSVT, and the RBANS.

The MMPI-2-RF

All participants were administered the MMPI-2; however, because all of the items of the MMPI-2-RF are included on the MMPI-2, it is possible to score MMPI-2-RF scales in archival MMPI-2 data sets. As previously stated, analyses have established the equivalence of scaled scores produced with the two versions of this instrument (Tellegen & Ben-Porath, 2008; Van Der Heijden, Eger, & Derksen, 2010). Extensive psychometric data on the MMPI-2-RF scales are available in Tellegen and Ben-Porath (2008).

The RBS

This 28 item MMPI-2 scale was developed to aid in the prediction of failed cognitive symptom validity tests. All items were retained in the MMPI-2-RF; the only changes were with respect to the numbering of the items (Gervais et al., 2010). Per Gervais et al. (2010), the scoring key and T-score conversion table for the RBS remains the same.

Green's MCI

The MCI is a computer-administered self-report inventory consisting of 58 items describing a variety of commonplace and implausible memory problems. The inventory has nine scales: General Memory Problems (GMP), Numeric Information Problems (NIP), Visuospatial Memory Problems (VSP), Verbal Memory Problems (VMP), Pain Interferes with Memory (PIM), Memory Interferes with Work (MIW), Impairment of Remote Memory (IRM), Amnesia for Complex Behavior (ACB), and Amnesia for Antisocial Behavior (AAB). Internal consistency was found to range from .79 to .93 in a

sample of 1550 consecutive non-head injury disability-related referrals. While the first six scales contain items describing the most plausible memory complaints, the last three scales describe the least credible memory problems that are rarely found in patients with organic memory impairment, but may be associated with psychological or psychiatric disorders (Gervais et al., 2008). In cases where secondary gain is involved, however, endorsement of these items may represent exaggerated or feigned memory complaints (Gervais et al., 2008). Individuals with moderate to severe traumatic brain injuries or neurological disorders who have passed the Word Memory Test report fewer memory complaints in comparison to patients diagnosed with mild brain injuries, chronic pain, anxiety, or depression that fail effort tests and complain about a greater number of memory impairments (Gervais et al., 2008).

Green's MSVT

The MSVT is a short, computerized, verbal memory screening test with various subtests that measure memory and response consistency (MSVT; Green, 2004). The test presents a list of 10 word pairs and then assesses recognition memory using a target-foil combination, which requires patients to identify the original word pairs amongst a list of novel words (Green, 2004). After a 10 minute delay, a similar recognition task is administered, followed by a paired associate trial, which is more difficult as the first word of each pair is presented and one's ability to recall the second word is assessed (Green, 2004). Lastly, there is a free recall subtest (Green, 2004).

Test takers receive 1 point, or 5%, for each correct word that is chosen from the original word list. Twenty words are presented in pairs and a test taker who chooses all

20 original words correctly would receive a score of 100%. A cutoff raw score of 85 indicates that a test taker answered 85% of the items correctly. This score is two to three standard deviations below the mean of various clinical groups (e.g., children with ADHD, Fetal Alcohol Syndrome, psychiatric disorders) and normal adult volunteers, is suggested for immediate, delayed, and consistency indices, as performance at or below this score indicates a failure of the symptom validity subtests. In addition, cutoff raw scores of 70 and 55 are suggested for the Paired Associate and Free Recall trials, respectively. The Consistency Index measures how consistent scores were from the Immediate Recall trial to the Delayed Recall trial (i.e., whether or not they were right or wrong on both trials).

Research using this cutoff with a German-language version of the MSVT with simulated malingerers demonstrated 100% sensitivity and specificity between those feigning symptoms and the control group (Merten, Green, Henry, Blaskewitze, & Brockhaus, 2005). Overall, those simulating impairment have been shown to have very different profiles in comparison to those with actual neurocognitive symptomatology (Green, 2004). Individuals with genuine severe cognitive impairment can be distinguished from simulators by the presence of the "dementia" or "genuine memory impairment profile" (GMIP) in contrast to the "simulator" or "poor effort" profile (Howe & Loring, 2009).

The RBANS

The RBANS is a brief, individually administered neuropsychological screening tool that measures attention, language, visuospatial/constructional abilities, and immediate and delayed memory (Randolph, 1998). It consists of 12 subtests that yield

five Index scores and a Total Scale score (Randolph, 1998). The Attention Index is made up of a digit span task as well as a timed graphomotor coding task (Randolph, 1998). The Language Index requires the patient to name items presented in pictures and complete a task of semantic fluency (Randolph, 1998). The Visuospatial/Construction Index involves copying a complex figure and judging the orientation of lines (Randolph, 1998). The Immediate Memory Index measures the patient's ability to recall elements of a novel story and a list of unrelated words (Randolph, 1998). The Delayed Memory Index is based on four subtests, including delayed recall of the word list, story, and complex figure, as well as forced-choice recognition of the word list (Randolph, 1998). Normative information is based on 540 healthy adults ranging in age from 20-89 years and is presented in the manual to calculate the Index and Total scores (Randolph, 1998).

Procedure

Data were extracted archivally from a private neuropsychology practice on the East Coast of the United States. Patients were administered the MMPI-2, symptom validity tests (MCI/MSVT), and the RBANS as part of their clinical evaluations. Demographic information gleaned from a record review included sex, age, ethnicity, and highest education level attained.

Participants were coded on categorical variables. The first variable was the reason for referral or the type of evaluation that was conducted (e.g., personal injury, medical disability, or general cognitive complaints). Participants were also coded regarding the potential for secondary gain at the time of the evaluation (e.g., personal injury lawsuit, workers' compensation claims, and private insurance disability claims) and were

compared with patients with general neuropsychological complaints who have no apparent secondary gain from the results of the evaluation. In addition, participants were grouped according to pass/fail performance on the MSVT and MMPI-2-RF over-reporting scales, as determined by cutoff scores on the respective test manuals. Specifically, the recommended cutoff percentages for the MSVT that were utilized in this study was 85% or less for the immediate, delayed, and consistency indices, a cutoff of 70% or less on the paired associates trial, and 55% for the free recall trial (Green, 2004). Individuals who failed the MSVT were assigned to the "fail SVT" group while those who passed were assigned to the "pass SVT" group where binary classification was required. Analyses that grouped participants based on pass/fail performance on the MMPI-2-RF implemented recommended cutoff scores found in the manual, including a *T* score of 99 for FBS-r and Fs and a *T* score of 100 for RBS. Continuous variables included raw and *T* score results from the MMPI-2-RF over-reporting scales, including the FBS-r and Fs, and the RBS, as well as percentage scores collected from the MCI and the MSVT, and standard scores from the RBANS index scores.

Questions to be answered by the Current Study

1. Do scores on the MMPI-2-RF over-reporting scales predict symptom validity test performance?
2. Do scores on the MMPI-2-RF over-reporting scales predict subjective memory complaints?
3. Does this performance translate to ability test performance, in this case, the RBANS?

4. What are the best cutoff scores on the MMPI-2-RF over-reporting scales to optimize sensitivity, specificity, positive predictive power, and negative predictive power?

Data Analyses

Statistical analyses were calculated using SPSS, Version 18.0 (SPSS, Chicago, IL). Alpha was set at .05 for all analyses. Two-tailed Pearson correlations were conducted with the MMPI-2-RF validity scales and continuous data obtained from each measure utilized in the study.

Hierarchical regression analyses were also utilized to assess the ability of the MMPI-2-RF over-reporting scales to predict performance on a symptom validity test (Green's MSVT), after accounting for age, sex, ethnicity, highest education level attained. To examine the unique contributions of the over-reporting scales and demographic variables with respect to both continuous scores on the MSVT and pass/fail group categorization, hierarchical multiple regression analyses and hierarchical binary logistic regression analyses were performed, respectively. Performance on each MSVT subscale was used as dependent variables (Immediate Recall, Delayed Recall, Paired Associates, Free Recall, and the Consistency index) and the order of independent variables were entered in four steps. The independent variables in each analysis were (1) demographic variables, (2) Fs, (3) FBS-r, (4), RBS. The order of entry was varied until each option was exhausted.

Hierarchical regression analyses were also employed to examine the ability of the MMPI-2-RF over-reporting scales to predict performance on a measure of subjective memory complaints (Green's MCI). Since an MCI manual supplying relative cut-off

scores has not been published on this measure to date, hierarchical linear regression analyses were utilized on continuous data only. Analyses examined relative performance on first six scales of the MCI (plausible memory complaints) and on the final three scales (implausible memory complaints) to determine the relationship with the MMPI-2-RF over-reporting scales. Performance on each MCI scale was explored by entering the following independent variables: (1) demographic variables, (2) Fs, (3) FBS-r, (4), RBS. The order of entry was varied until each option was exhausted.

To determine the relationship among MMPI-2-RF scales and ability test performance, hierarchical regression analyses were conducted using the subtest scores of the RBANS as at outcome measure. In this study, RBANS performance was hypothesized to decline as scores on over-reporting scales increased. Scores on RBANS substantive scales were compared by dividing the sample into participants identified as over-reporting on at least one MMPI-2-RF validity scale versus valid respondents using independent t-tests.

Finally, Hit Rate, Sensitivity, Positive Predictive Power, and Negative Predictive Power were calculated at cutting scores of $T \geq 80$, 90, 99, 105, and 110 for Fs and FBS while cut scores of $T \geq 80$, 90, 100, 105, and 110 for RBS were utilized to predict classification status based on the MSVT. However, these analyses were limited in practical utility due to the small sample size.

RESULTS

Prediction of symptom validity test performance by MMPI-2-RF Fs, FBS-r, and RBS, controlling for demographic characteristics

The RBS had the largest effect size difference between those who passed Green's MSVT (n = 55) and those who failed (n = 15) (Table 1). However, this analysis was limited by the small number of participants in the MSVT fail group (21%). As expected, those who failed Green's MSVT scored higher and subsequently demonstrated more negative response bias than those who passed the MSVT. Results of Pearson correlations showed that RBS was most strongly related to the trials of Green's MSVT while FBS-r showed some mild association (Table 2). Means and standard deviations of MSVT scale performance based on MMPI-2-RF valid/invalid classification status are presented in Table 3.

Table 1

Means and standard deviations of the MMPI-2-RF over-reporting scales based on Green's Medical Symptom Validity Test pass/fail classification status

MMPI-2-RF scales	MSVT pass *M (SD)*	MSVT fail *M (SD)*	Cohen's *d*
RBS	**75.34 (15.72)**	**87.87 (12.53)**	**0.88**
FBS-r	71.22 (13.99)	78.53 (9.14)	0.62
Fs	73.00 (19.67)	74.87 (15.98)	0.10

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.
*Significant at the .01 level

Table 2

Linear correlations between Green's MSVT scales and the MMPI-2-RF over-reporting scales

Green's MSVT Scales	RBS	FBS-r	Fs
Immediate Recall	-.26*	-.15	-.11
Delayed Recall	-.35**	-.27*	-.15
Paired Associates	-.41**	-.27*	-.15
Free Recall	-.37**	-.09	-.09
Consistency Index	-.31**	-.30	-.12

Note. Green's MSVT: Green's Medical Symptom Validity Test; RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.
* Significant at the .05 level
**Significant at the .01 level

Table 3

Means and standard deviations of performance on Green's MSVT scores based on MMPI-2-RF over-reporting scales pass/fail classification status

Green's MSVT	MMPI-2-RF valid *M (SD)*	MMPI-2-RF invalid *M (SD)*	Cohen's *d*
Immediate Recall	95.73 (10.99)	96.66 (5.56)	0.11
Delayed Recall	91.25 (18.14)	93.00 (10.65)	0.12
Paired Associates	88.36 (17.40)	87.00 (20.33)	0.07
Free Recall	59.16 (21.55)	56.66 (23.41)	0.11
Consistency Index	91.62 (17.36)	93.00 (9.78)	0.10

Note. Green's MSVT: Green's Medical Symptom Validity Test.

Hierarchical regression analyses were performed to examine the ability of the MMPI-2-RF over-reporting scales to predict performance on the MSVT Immediate Recall (IR), Delayed Recall (DR), Paired Associates (PA), Free Recall (FR), and Consistency Index (CNS), after accounting for age, gender, ethnicity, and highest level of education obtained. Specifically, MSVT IR, DR, PA, FR and CNS were used as the dependent variables, each in separate analyses, while Fs, FBS-r, and RBS were entered into sequential blocks of the regression. To determine the incremental validity of each respective scale after accounting for demographic variables, hierarchical multiple regression analyses were performed that varied the order of each independent variable until each potential option was exhausted.

RBS added incremental variance when entered in the second step, R^2 change = .124 (Table 4). The addition of FBS-r and Fs did not significantly improve prediction above and beyond the RBS in this sample, R^2 change = .017, $F = 2.54$, *ns* and R^2 change = .030. $F = 2.58$, *ns,* respectively. When FBS-r was entered before RBS, it also produced a significant R^2 change, although this value was lower than the value for RBS (Tables 5, 6, and 7). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 2.08. The assumption of homoscedasticity was met through inspection of a scatterplot while normality of residuals was demonstrated through a histogram and p-p plot.

Table 4

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Delayed Recall trial performance when RBS was entered in step two, FBS-r in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.232	.054	-.004	.054	.925	(4, 65)	.455
Step 2							
RBS	**.422**	**.178**	**.114**	**.124**	**9.65**	**(5, 64)**	**.003**
Step 3							
FBS-r	.442	.195	.118	.017	1.35	(6, 63)	.249
Step 4							
Fs	.475	.225	.138	.030	2.43	(7, 62)	.124

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 5

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Delayed Recall trial performance with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.232	.054	-.004	.054	.925	(4, 65)	.455
Step 2							
FBS-r	**.386**	**.149**	**.083**	**.095**	**7.17**	**(5, 64)**	**.009**
Step 3							
RBS	.442	.195	.118	.046	3.60	(6, 63)	.062
Step 4							
Fs	.475	.225	.138	.030	2.43	(7, 62)	.124

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 6

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Delayed Recall trial performance with Fs in step two, RBS in step three and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.232	.054	-.004	.054	.925	(4, 65)	.455
Step 2							
Fs	.248	.062	-.012	.008	.526	(5, 64)	.471
Step 3							
RBS	**.443**	**.196**	**.120**	**.135**	**10.57**	**(6, 63)**	**.002**
Step 4							
FBS-r	.475	.225	.138	.029	2.33	(7, 62)	.132

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 7

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Delayed Recall trial performance with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.232	.054	-.004	.054	.925	(4, 65)	.455
Step 2							
Fs	.248	.062	-.012	.008	.526	(5, 64)	.471
Step 3							
FBS-r	**.393**	**.154**	**.074**	**.093**	**6.92**	**(6, 63)**	**.011**
Step 4							
RBS	**.475**	**.225**	**.138**	**.030**	**5.68**	**(7, 62)**	**.020**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

With respect to performance on the MSVT Paired Associates trial, the final model had an R^2 value of .225. When RBS was entered in the final step, 3% additional variance was accounted for (Table 8). As in the DR trial, addition of FBS-r and Fs did not account for significantly more variance after RBS was entered first, R^2 change = .012, $F = 3.41$, *ns* and R^2 change = .023, $F = 3.25$, *ns*, respectively (Table 8). However, FBS-r significantly predicted performance on this trial when entered prior to RBS, thus demonstrating utility in predicting performance on the MSVT (Tables 9, 10, and 11). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 2.16. Review of a scatterplot demonstrated homogeneity of variance while normality of residuals was indicated through a histogram and p-p plot.

Table 8

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Paired Associates trial performance with RBS entered in step two, FBS-r in step three, and Fs in step four

Variable	*R*	R^2	*Adj*R^2	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.286	.082	.025	.082	1.45	(4, 65)	.228
Step 2							
RBS	**.483**	**.234**	**.174**	**.152**	**12.67**	**(5, 64)**	**.001**
Step 3							
FBS-r	.495	.245	.173	.012	.98	(6, 63)	.326
Step 4							
Fs	.518	.269	.186	.023	1.98	(7, 62)	.165

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 9

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Paired Associates trial performance with FBS-r entered in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.286	.082	.025	.082	1.45	(4, 65)	.228
Step 2							
FBS-r	**.423**	**.179**	**.114**	**.097**	**7.53**	**(5, 64)**	**.008**
Step 3							
RBS	**.495**	**.245**	**.173**	**.067**	**5.57**	**(6, 63)**	**.021**
Step 4							
Fs	.518	.269	.186	.023	1.98	(7, 62)	.165

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 10

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Paired Associates trial performance with Fs entered in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.286	.082	.025	.082	1.45	(4, 65)	.228
Step 2							
Fs	.311	.097	.026	.015	1.04	(5, 64)	.311
Step 3							
RBS	**.498**	**.248**	**.177**	**.152**	**12.71**	**(6, 63)**	**.001**
Step 4							
FBS-r	.518	.269	.186	.020	1.73	(7, 62)	.193

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 11

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Paired Associates trial performance with Fs entered in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	*Adj*R^2	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.286	.082	.025	.082	1.45	(4, 65)	.228
Step 2							
Fs	.311	.097	.026	.015	1.04	(5, 64)	.311
Step 3							
FBS-r	**.424**	**.180**	**.102**	**.083**	**6.39**	**(6, 63)**	**.014**
Step 4							
RBS	**.518**	**.269**	**.186**	**.089**	**7.53**	**(7, 62)**	**.008**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

RBS also accounted for a significant portion of the variance on the MSVT's Free Recall Trial, as it explained 12% of the variance, R^2 change = .119, *F* change (5, 64) = 9.55, $p < .01$ (Table 12). The FBS-r and Fs did not provide significant incremental validity to the model, R^2 change = .008, $F = 2.84$, *ns* and R^2 change = .65, $F = 1.22$, *ns,* respectively. Unlike other MSVT scales, FBS-r did not significantly predict performance, even when entered before RBS (Tables 13, 14, and 15). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 2.03. The assumptions of homoscedasticity and normality of residuals were also met through inspection of a scatterplot, histogram, and p-p plot.

Table 12

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Free Recall trial performance

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.294	.086	.030	.086	1.53	(4, 65)	.203
Step 2							
RBS	**.453**	**.205**	**.174**	**.119**	**9.55**	**(5, 64)**	**.003**
Step 3							
FBS-r	.461	.213	.138	.008	.65	(6, 63)	.423
Step 4							
Fs	.478	.228	.141	.015	1.22	(7, 62)	.274

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 13

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Free Recall trial performance with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.294	.086	.030	.086	1.53	(4, 65)	.203
Step 2							
FBS-r	.318	.101	.031	.015	1.06	(5, 64)	.306
Step 3							
RBS	**.461**	**.213**	**.138**	**.112**	**8.95**	**(6, 63)**	**.004**
Step 4							
Fs	.478	.228	.141	.015	1.22	(7, 62)	.274

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 14

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Free Recall trial performance with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.294	.086	.030	.086	1.53	(4, 65)	.203
Step 2							
Fs	.304	.092	.151	.006	.44	(5, 64)	.510
Step 3							
RBS	**.474**	**.225**	**.151**	**.132**	**10.77**	**(6, 63)**	**.002**
Step 4							
FBS-r	.478	.228	.141	.003	.26	(7, 62)	.612

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 15

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Free Recall trial performance with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.294	.086	.030	.086	1.53	(4, 65)	.203
Step 2							
Fs	.304	.092	.022	.006	.44	(5, 64)	.510
Step 3							
FBS-r	.319	.102	.016	.009	.64	(6, 63)	.426
Step 4							
RBS	**.478**	**.228**	**.141**	**.127**	**10.16**	**(7, 62)**	**.002**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

RBS accounted for significantly more variance than demographic variables on the MSVT's Immediate Recall trial, R^2 change = .081, $p < .05$ (Table 16). FBS-r and Fs did

not provide significant contributions to the incremental validity of this trial when entered both before and after RBS (Tables 17, 18, and 19). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 1.96. Homogeneity of variance was observed on a scatterplot while residuals appeared normally distributed on a histogram and p-p plot.

Table 16

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Immediate Recall trial performance

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.094	.009	-.052	.009	.146	(4, 65)	.964
Step 2 **RBS**	**.300**	**.090**	**.019**	**.081**	**5.73**	**(5, 64)**	**.020**
Step 3 FBS-r	.302	.091	.005	.001	.077	(6, 63)	.783
Step 4 Fs	.324	.105	.004	.014	.94	(7, 62)	.335

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 17

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Immediate Recall trial performance with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.094	.009	-.052	.009	.146	(4, 65)	.964
Step 2							
FBS-r	.212	.045	-.030	.036	2.42	(5, 64)	.125
Step 3							
RBS	.302	.091	.005	.046	3.22	(6, 63)	.078
Step 4							
Fs	.324	.105	.004	.014	.94	(7, 62)	.335

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 18

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Immediate Recall trial performance with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.094	.009	-.052	.009	.146	(4, 65)	.964
Step 2							
Fs	.121	.015	-.062	.006	.372	(5, 64)	.544
Step 3							
RBS	**.318**	**.101**	**.016**	**.087**	**6.07**	**(6, 63)**	**.016**
Step 4							
FBS-r	.324	.105	.004	.004	.259	(7, 62)	.613

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 19

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Immediate Recall trial performance with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.094	.009	-.052	.009	.146	(4, 65)	.964
Step 2							
Fs	.121	.015	-.062	.006	.372	(5, 64)	.544
Step 3							
FBS-r	.213	.045	-.046	.031	2.03	(6, 63)	.159
Step 4							
RBS	**.324**	**.105**	**.004**	**.060**	**4.13**	**(7, 62)**	**.046**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Both RBS and FBS-r significantly predicted performance on the MSVT Consistency index, though neither provided incremental validity when added after one another (Tables 21, 22, 23, and 24). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 2.07. The assumptions of homoscedasticity and normality of residuals were also met through inspection of a scatterplot, histogram, and p-p plot.

Table 20

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Consistency Index

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.204	.042	-.017	.042	.708	(4, 65)	.589
Step 2 **RBS**	**.368**	**.135**	**.068**	**.094**	**6.92**	**(5, 64)**	**.011**
Step 3 FBS-r	.414	.172	.093	.036	2.76	(6, 63)	.101
Step 4 Fs	.441	.194	.104	.023	1.76	(7, 62)	.189

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 21

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Consistency Index with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.204	.042	-.017	.042	.708	(4, 65)	.589
Step 2 **FBS-r**	**.389**	**.151**	**.085**	**.109**	**8.25**	**(5, 64)**	**.006**
Step 3 RBS	.414	.172	.093	.020	1.55	(6, 63)	.218
Step 4 Fs	.441	.194	.104	.023	1.76	(7, 62)	.189

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 22

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Consistency Index with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.204	.042	-.017	.042	.708	(4, 65)	.589
Step 2							
Fs	.224	.050	-.024	.008	.569	(5, 64)	.453
Step 3							
RBS	**.381**	**.145**	**.064**	**.095**	**7.00**	**(6, 63)**	**.010**
Step 4							
FBS-r	.441	.194	.104	.049	3.80	(7, 62)	.056

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 23

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MSVT Consistency Index with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.204	.042	-.017	.042	.708	(4, 65)	.589
Step 2							
Fs	.224	.050	-.024	.008	.569	(5, 64)	.453
Step 3							
FBS-r	**.397**	**.158**	**.078**	**.108**	**8.05**	**(6, 63)**	**.006**
Step 4							
RBS	.441	.194	.104	.037	.037	(7, 62)	.098

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

After conducting multiple analyses, RBS appeared to be the best predictor of performance on the MSVT when added in the second step, as neither FBS-r nor Fs provided incremental validity above and beyond what was explained by RBS. When FBS-r was entered before RBS, it significantly predicted performance as well. The RBS added incremental validity to FBS-r on the paired associates and free recall trials, though not on the immediate and delayed recall trials and consistency index. Multiple analyses were conducted and RBS was found to account for a significant amount of the variance on the MSVT DR, PA, and FR scales. Demographic variables did not significant account for performance on any MSVT measures.

To investigate the utility of the MMPI-2-RF over-reporting scales in predicting overall MSVT performance, binary logistic regressions were conducted utilizing MSVT Pass/Fail classification as a dependent variable. As in the previous analyses, demographic variables were entered in the first step of the model followed by MMPI-2-RF over-reporting scales. The order of these scales was subsequently varied until all possible options were exhausted to determine the best predictive model.

After controlling for age, gender, ethnicity, and highest education level attained, RBS predicted pass/fail classification status on the MSVT (Table 24). When only the constant was included, the model correctly classified 78.6% of patients. The addition of RBS as a predictor significantly increased the percentage of correctly classified patients to 81.4%. Results of this analyses indicated that Fs and FBS-r did not provide significant incremental validity above and beyond what was explained by RBS. Assumptions of the logistic regression were met, such that the linearity of the logit was proven through nonsignificant interaction terms based on the predictors and the natural log of itself.

However, the analyses were underpowered as a sample size of 77 is small for logistic regression. Furthermore, a linear regression analysis using the same outcome and predictors was run to determine the proportions and subsequent eigenvalues of the scaled, uncentered cross-products matrix. No multicollinearity was found as a result of this model.

Table 24

Binary logistic regression analysis of the MMPI-2-RF over-reporting scales and MSVT pass/fail classification

Variable	*B (SE)*	Cox and Snell R^2	*-2 Log Likelihood*	*Wald*	χ^2 *change*	*p-value*
Constant	-1.30 (0.29)					
Block 1		.05			3.68	.552
Age	0.03 (0.30)		69.08	1.95		.231
Gender	-0.30 (0.62)		69.08	.69		.627
Ethnicity	0.76 (0.49)		69.07	1.56		.112
Education	0.07 (0.07)		69.07	.19		.652
Block 2						
RBS	**.27 (0.10)**	**.16**	**60.71**	**6.79**	**8.36**	**.004**
Block 3						
Fs	-.37 (0.20)	.21	53.56	3.51	5.15	.061
Block 4						
FBS-r	.21 (0.13)	.24	53.76	2.77	3.06	.240

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Predicting subjective memory complaints on Green's Memory Complaints Inventory (MCI) by MMPI-2-RF Fs, FBS-r, and RBS, controlling for demographic characteristics

Means and standard deviations for MCI scores based on failure of one or more MMPI-2-RF over-reporting scale are presented in Table 25. Results of Pearson correlations showed significant, positive correlations among the MMPI-2-RF over-reporting scales and subjective memory complaints (Table 26). In general, these data suggest that as patients endorsed more subjective memory complaints on the MCI, they tended to endorse items from RBS, FBS-r, and Fs at a higher rate. With respect to probable memory complaints, RBS demonstrated moderate, positive associations with general memory problems, numeric information problems, visuospatial memory problems, verbal memory problems, and memory interferes with work. Small, positive correlations were observed between FBS-r and scales measuring probable memory complaints, as well. A small, positive correlation was demonstrated between Fs and memory interferes with work. On measures of improbable memory complaints, RBS was moderately associated with impairment of remote memory and amnesia for complex behavior while FBS-r was mildly associated with these same scales. A mild association was demonstrated between Fs and amnesia for complex behavior.

Table 25

Means and standard deviations of performance on Green's MSVT scores based on MMPI-2-RF over-reporting scales pass/fail classification status

Green's MCI	MMPI-2-RF valid *M (SD)*	MMPI-2-RF invalid *M (SD)*	Cohen's *d*
General Memory Problems	38.69 (22.63)	44.68 (25.95)	0.11
Numerical Information Problems	43308 (24.89)	47.31 (26.34)	0.12
Visuospatial Memory Problems	32.88 (24.62)	47.31 (26.34)	0.07
Verbal Memory Problems	53.85 (27.77)	60.63 (25.88)	0.11
Memory Interferes with Work	45.31 (28.35)	54.69 (29.91)	0.10
Impairment of Remote Memory	23.52 (18.79)	25.63 (18.41)	0.10
Amnesia for Complex Behavior	29.60 (21.64)	37.36 (24.06)	0.10
Amnesia for Antisocial Behavior	11.60 (14.21)	7.75 (6.44)	0.10

Note. Green's MSVT: Green's Medical Symptom Validity Test.

Table 26

Linear correlations between Green's MSVT scales and the MMPI-2-RF over-reporting scales

Green's MSVT Scales	RBS	FBS-r	Fs
Probable Memory Complaints			
General Memory Problems	.54**	.31*	.22
Numeric Information Problems	.49**	.26*	.12
Visuospatial Memory Problems	.42**	.26*	.16
Verbal Memory Problems	.55**	.32*	.23
Pain Interferes with Memory	.17	.32*	.18
Memory Interferes with Work	.53**	.38**	.27*
Improbable Memory Complaints			
Impairment of Remote Memory	.46**	.26*	.20
Amnesia for Complex Behavior	.50**	.29*	.36*
Amnesia for Antisocial Behavior	.24	.22	.20

Note. Green's MSVT: Green's Medical Symptom Validity Test; RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.
* Significant at the .05 level
**Significant at the .01 level

Hierarchical linear regression analyses were also used to predict the variability among probable and improbable subjective memory complaints reported on Green's MCI. As in the MSVT analyses, the independent variables were entered in four blocks. Demographic variables were entered in the model in the first block, followed by FBS-r, Fs, and RBS in the subsequent three blocks for each of the nine MCI scales. In this way, it was possible to examine the predictive utility of the MMPI-2-RF over-reporting variables, controlling for the potential effects of demographic variables.

Overall, RBS explained a significant amount of the variance in subjective memory complaints, based on performance on the MCI scales that assessed general memory problems, numeric information problems, visuospatial memory problems, verbal memory problems, memory interferes with work, impairment of remote memory, and amnesia for complex behavior. FBS-r also provided significant predictive validity on scales measuring pain interfering with memory and amnesia for antisocial behavior.

Specifically, RBS explained 28% of the variance on the General Memory Problems scale (Table 27). The addition of Fs and FBS-r did not add significant incremental validity to the model when added after RBS. When entered before RBS, FBS-r also predicted a significant amount of variance (Tables 28, 29, and 30). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 2.53. The assumptions of homoscedasticity and normality of residuals were also met through inspection of a scatterplot, histogram, and p-p plot, respectively.

Table 27

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI General Memory Complaints scale

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.154	.024	-.038	.024	.384	(4, 63)	.819
Step 2 **RBS**	**.548**	**.301**	**.244**	**.277**	**24.54**	**(5, 62)**	**.000**
Step 3 FBS-r	.556	.309	.241	.008	.73	(6, 61)	.395
Step 4 Fs	.556	.309	.229	.000	.018	(7, 60)	.895

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 28

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI General Memory Complaints scale with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.154	.024	-.038	.024	.384	(4, 63)	.819
Step 2 **FBS-r**	**.327**	**.107**	**.035**	**.083**	**5.78**	**(5, 62)**	**.019**
Step 3 **RBS**	**.548**	**.301**	**.232**	**.194**	**16.89**	**(6, 61)**	**.000**
Step 4 Fs	.556	.309	.229	.008	.732	(7, 60)	.396

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 29

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI General Memory Complaints scale with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.154	.024	-.038	.024	.384	(4, 63)	.819
Step 2							
Fs	.269	.072	-.003	.048	3.24	(5, 62)	.077
Step 3							
RBS	**.556**	**.309**	**.241**	**.237**	**20.89**	**(6, 61)**	**.000**
Step 4							
FBS-r	.556	.309	.229	.000	.018	(7, 60)	.895

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 30

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI General Memory Complaints scale with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.154	.024	-.038	.024	.384	(4, 63)	.819
Step 2							
Fs	.269	.072	-.003	.048	3.24	(5, 62)	.077
Step 3							
FBS-r	.340	.116	.029	.043	2.99	(6, 61)	.089
Step 4							
RBS	**.556**	**.309**	**.229**	**.194**	**16.81**	**(7, 60)**	**.000**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

RBS scores and demographic variables also explained 23% of the variance on the Numeric Information Problems of the MCI, R^2 change = .225, $F(5, 62) = 18.69$, $p < .001$ (Table 31). The addition of Fs and FBS-r did not lead to a substantial increase in the amount of variance explained in this scale above and beyond RBS, although FBS-r predicted a significant amount of variance when entered before RBS (Tables 32, 33, and 34). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 2.50. Homogeneity of variance was observed on a scatterplot while residuals appeared normally distributed on a histogram and p-p plot.

Table 31

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Numeric Information Problems scale

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.166	.028	-.034	.028	.448	(4, 63)	.773
Step 2							
RBS	**.503**	**.253**	**.215**	**.225**	**18.69**	**(5, 62)**	**.000**
Step 3							
FBS-r	.535	.286	.215	.033	2.81	(6, 61)	.099
Step 4							
Fs	.535	.286	.203	.000	.021	(7, 60)	.884

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 32

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Numeric Information Problems scale with FBS-r in step two, RBS in step three and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.166	.028	-.034	.028	.448	(4, 63)	.773
Step 2							
FBS-r	**.294**	**.087**	**.013**	**.059**	**4.00**	**(5, 62)**	**.050**
Step 3							
RBS	**.509**	**.254**	**.180**	**.167**	**13.66**	**(6, 61)**	**.000**
Step 4							
Fs	.535	.286	.203	.032	2.71	(7, 60)	.105

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 33

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Numeric Information Problems scale with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.166	.028	-.034	.028	.448	(4, 63)	.773
Step 2							
Fs	.203	.041	-.036	.014	.877	(5, 62)	.353
Step 3							
RBS	**.535**	**.286**	**.215**	**.245**	**20.88**	**(6, 61)**	**.000**
Step 4							
FBS-r	.535	.286	.203	.000	.021	(7, 60)	.884

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 34

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Numeric Information Problems scale with Fs in step two, FBS-r in step three, and RBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.166	.028	-.034	.028	.448	(4, 63)	.773
Step 2							
Fs	.203	.041	-.036	.014	.877	(5, 62)	.353
Step 3							
FBS-r	.294	.087	-.003	.045	3.03	(6, 61)	.087
Step 4							
RBS	**.535**	**.286**	**.203**	**.199**	**16.76**	**(7, 60)**	**.000**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

RBS added incremental variance above and beyond the demographic variables when predicted scores on the Visuospatial Memory Problems scale when entered in the second step, R^2 change = .139, F change (5, 62) = 10.89, $p < .01$ (Table 35). Addition of FBS-r and Fs did not significantly improve prediction above and beyond the RBS in this sample, although FBS-r significantly predicted performance on the visuospatial memory problems scale when entered before RBS (Tables 36, 37, and 38). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 2.43. The assumptions of homoscedasticity and normality of residuals were also met through inspection of a scatterplot, histogram, and p-p plot.

Table 35

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Visuospatial Memory Problems scale

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.258	.066	.007	.066	1.12	(4, 63)	.354
Step 2 **RBS**	**.454**	**.206**	**.142**	**.139**	**10.89**	**(5, 62)**	**.002**
Step 3 FBS-r	.461	.212	.135	.006	.48	(6, 61)	.490
Step 4 Fs	.468	.219	.128	.000	.51	(7, 60)	.477

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 36

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Visuospatial Memory Problems scale with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.258	.066	.007	.066	1.12	(4, 63)	.354
Step 2 **FBS-r**	**.366**	**.134**	**.064**	**.067**	**4.81**	**(5, 62)**	**.032**
Step 3 **RBS**	**.458**	**.210**	**.132**	**.076**	**5.85**	**(6, 61)**	**.019**
Step 4 Fs	.468	.219	.128	.009	.51	(7, 60)	.401

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 37

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Visuospatial Memory Problems scale with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.258	.066	.007	.066	1.12	(4, 63)	.354
Step 2 Fs	.296	.087	.014	.021	1.42	(5, 62)	.238
Step 3 **RBS**	**.461**	**.212**	**.135**	**.125**	**9.67**	**(6, 61)**	**.003**
Step 4 FBS-r	.468	.219	.128	.000	.51	(7, 60)	.477

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 38

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Visuospatial Memory Problems scale with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.258	.066	.007	.066	1.12	(4, 63)	.354
Step 2							
Fs	.296	.087	.014	.021	1.42	(5, 62)	.238
Step 3							
FBS-r	.366	.134	.049	.047	3.30	(6, 61)	.074
Step 4							
RBS	**.468**	**.219**	**.128**	**.085**	**6.50**	**(7, 60)**	**.013**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

With respect to performance on the Verbal Memory Problems scale, RBS also accounted for a significant portion of the variance, R^2 change = .283, *F* change (5, 62) = 25.60, $p < .001$ (Table 39). As with the other scales, the addition of FBS-r and Fs did not account for significantly more variance. However, FBS-r predicted a significant amount of variance when entered before RBS (Tables 40, 41, and 42). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 2.78. Homogeneity of variance was observed on a scatterplot while residuals appeared normally distributed on a histogram and p-p plot.

Table 39

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Verbal Memory Problems scale

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.180	.032	-.029	.032	.526	(4, 63)	.717
Step 2							
RBS	**.561**	**.315**	**.260**	**.283**	**25.60**	**(5, 62)**	**.000**
Step 3							
FBS-r	.570	.325	.259	.010	.92	(6, 61)	.341
Step 4							
Fs	.572	.327	.249	.002	.16	(7, 60)	.691

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 40

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Verbal Memory Problems scale with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.180	.032	-.029	.032	.526	(4, 63)	.717
Step 2							
FBS-r	**.360**	**.130**	**.060**	**.098**	**6.95**	**(5, 62)**	**.011**
Step 3							
RBS	**.562**	**.315**	**.248**	**.186**	**16.53**	**(6, 61)**	**.000**
Step 4							
Fs	.572	.327	.249	.012	1.04	(7, 60)	.691

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 41

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Verbal Memory Problems scale with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.180	.032	-.029	.032	.526	(4, 63)	.717
Step 2							
Fs	.280	.079	.004	.046	3.11	(5, 62)	.083
Step 3							
RBS	**.570**	**.325**	**.259**	**.247**	**22.30**	**(6, 61)**	**.000**
Step 4							
FBS-r	.572	.237	.249	.002	.16	(7, 60)	.691

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 42

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Verbal Memory Problems scale with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.180	.032	-.029	.032	.526	(4, 63)	.717
Step 2							
Fs	.280	.079	.004	.046	3.11	(5, 62)	.083
Step 3							
FBS-r	**.368**	**.135**	**.050**	**.057**	**3.99**	**(6, 61)**	**.050**
Step 4							
RBS	**.572**	**.327**	**.249**	**.192**	**17.12**	**(7, 60)**	**.000**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

RBS explained 25.7% of the variance in the Memory Interferes with Work scale, (Table 43). The addition of Fs and FBS-r did not add significant incremental validity to the model above and beyond what was explained by RBS. However, Fs predicted a significant amount of variance when entered prior to FBS-r and RBS while FBS-r significantly predicted performance when entered before RBS (Tables 44, 45, and 46). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 2.58. The assumptions of homoscedasticity and normality of residuals were also met through inspection of a scatterplot, histogram, and p-p plot, respectively.

Table 43

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Memory Interferes with Work scale

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.234	.055	-.055	.055	.916	(4, 63)	.460
Step 2 **RBS**	**.558**	**.311**	**.256**	**.257**	**23.09**	**(5, 62)**	**.000**
Step 3 FBS-r	.559	.313	.245	.002	.138	(6, 61)	.712
Step 4 Fs	.575	.330	.252	.017	1.54	(7, 60)	.220

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 44

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Memory Interferes with Work scale with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.234	.055	-.055	.055	.916	(4, 63)	.460
Step 2							
FBS-r	**.448**	**.201**	**.136**	**.146**	**11.29**	**(5, 62)**	**.001**
Step 3							
RBS	**.570**	**.325**	**.259**	**.125**	**11.27**	**(6, 61)**	**.001**
Step 4							
Fs	.575	.330	.252	.005	.44	(7, 60)	.509

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 45

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Memory Interferes with Work scale with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.234	.055	-.055	.055	.916	(4, 63)	.460
Step 2							
Fs	**.344**	**.118**	**.047**	**.063**	**4.46**	**(5, 62)**	**.039**
Step 3							
RBS	**.559**	**.313**	**.245**	**.195**	**17.28**	**(6, 61)**	**.000**
Step 4							
FBS-r	.575	.330	.252	.017	1.54	(7, 60)	.220

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 46

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Memory Interferes with Work scale with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.234	.055	-.055	.055	.916	(4, 63)	.460
Step 2							
Fs	**.344**	**.118**	**.047**	**.063**	**4.46**	**(5, 62)**	**.039**
Step 3							
FBS-r	**.454**	**.207**	**.128**	**.088**	**6.78**	**(6, 61)**	**.012**
Step 4							
RBS	**.575**	**.330**	**.252**	**.124**	**11.07**	**(7, 60)**	**.001**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

With respect to performance on the improbable complaints scales, RBS accounted for 18% of the variance on the Impairment of Remote Memory scale (Table 47). Fs and FBS-r did not produce a significant increase in the amount of variance explained, though FBS-r predicted significant variance when entered in step two following demographics (Tables 48, 49, 50). Variance inflation factors raised no significant concerns about multicollinearity. Independence of residuals was also found, Durbin Watson Test = 2.12. Homogeneity of variance was observed on a scatterplot while residuals appeared normally distributed on a histogram and p-p plot.

Table 47

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Impairment of Remote Memory scale

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.291	.085	.026	.085	1.45	(4, 63)	.227
Step 2							
RBS	**.512**	**.262**	**.202**	**.177**	**14.90**	**(5, 62)**	**.000**
Step 3							
FBS-r	.516	.266	.194	.004	.36	(6, 61)	.552
Step 4							
Fs	.517	.267	.181	.001	.05	(7, 60)	.824

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 48

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Impairment of Remote Memory scale with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.291	.085	.026	.085	1.45	(4, 63)	.227
Step 2							
FBS-r	**.379**	**.144**	**.075**	**.059**	**4.28**	**(5, 62)**	**.043**
Step 3							
RBS	**.512**	**.262**	**.189**	**.118**	**9.78**	**(6, 61)**	**.003**
Step 4							
Fs	.517	.267	.181	.005	.40	(7, 60)	.531

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 49

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Impairment of Remote Memory scale with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.291	.085	.026	.085	1.45	(4, 63)	.227
Step 2 Fs	.343	.118	.047	.033	2.33	(5, 62)	.132
Step 3 **RBS**	**.516**	**.266**	**.194**	**.149**	**12.35**	**(6, 61)**	**.001**
Step 4 FBS-r	.517	.267	.181	.001	.05	(7, 60)	.824

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 50

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Impairment of Remote Memory scale with Fs in step two, FBS-r in step three, and RBS in step four

Variable sig	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change
Step 1 Demographics	.291	.085	.026	.085	1.45	(4, 63)	.227
Step 2 Fs	.343	.118	.047	.033	2.33	(5, 62)	.132
Step 3 FBS-r	.386	.149	.065	.031	2.25	(6, 61)	.139
Step 4 **RBS**	**.517**	**.267**	**.181**	**.118**	**9.63**	**(7, 60)**	**.003**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Finally, RBS and demographic variables accounted for a significant portion of variance on the Amnesia for Complex Behavior scale, R^2 change = .22, F change (5, 62) = 19.02, $p < .001$ (Table 51). The addition of Fs and FBS-r did not add significant incremental validity to the model when entered after RBS. However, FBS-r and Fs significantly predicted performance when entered in step two following demographics, though RBS still explained further variance above and beyond these measures (Tables 52, 53, and 54). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 2.23. The assumptions of homoscedasticity and normality of residuals were also met through inspection of a scatterplot, histogram, and p-p plot.

Table 51

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Amnesia for Complex Behavior scale

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.253	.064	.005	.064	1.07	(4, 63)	.376
Step 2 **RBS**	**.533**	**.284**	**.228**	**.220**	**19.02**	**(5, 62)**	**.000**
Step 3 FBS-r	.545	.297	.228	.013	1.13	(6, 61)	.291
Step 4 Fs	.545	.297	.215	.000	.012	(7, 60)	.914

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 52

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Amnesia for Complex Behavior scale with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.253	.064	.005	.064	1.07	(4, 63)	.376
Step 2							
FBS-r	**.389**	**.151**	**.083**	**.088**	**6.40**	**(5, 62)**	**.014**
Step 3							
RBS	**.534**	**.285**	**.215**	**.134**	**11.41**	**(6, 61)**	**.001**
Step 4							
Fs	.545	.297	.215	.012	.994	(7, 60)	.323

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 53

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Amnesia for Complex Behavior scale with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.253	.064	.005	.064	1.07	(4, 63)	.376
Step 2							
Fs	**.438**	**.192**	**.127**	**.128**	**9.82**	**(5, 62)**	**.003**
Step 3							
RBS	**.545**	**.297**	**.228**	**.105**	**9.09**	**(6, 61)**	**.004**
Step 4							
FBS-r	.545	.297	.215	.000	.012	(7, 60)	.914

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 54

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Amnesia for Complex Behavior scale with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.253	.064	.005	.064	1.07	(4, 63)	.376
Step 2 **Fs**	**.438**	**.192**	**.127**	**.128**	**9.82**	**(5, 62)**	**.003**
Step 3 FBS-r	.460	.212	.134	.020	1.53	(6, 61)	.221
Step 4 **RBS**	**.545**	**.297**	**.215**	**.085**	**7.27**	**(7, 60)**	**.009**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

FBS-r and demographic variables explained 12% of the variance on the Pain Interferes with Memory scale of the MCI (Table 55). RBS and Fs did not provide significant incremental validity to the model and FBS-r continued to explain significant variance above and beyond Fs and RBS when entered at various points in the model (Tables 56, 57, and 58). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 1.85. Homogeneity of variance was observed on a scatterplot while residuals appeared normally distributed on a histogram and p-p plot.

Table 55

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Pain Interferes with Memory scale

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.317	.100	.043	.100	1.76	(4, 63)	.149
Step 2 FBS-r	**.468**	**.219**	**.143**	**.119**	**.063**	**(5, 62)**	**.003**
Step 3 RBS	.469	.220	.143	.001	.06	(6, 61)	.802
Step 4 Fs	.469	.220	.129	.001	.050	(7, 60)	.824

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 56

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Pain Interferes with Memory scale with RBS in step two, FBS-r in step three, and Fs in step four

Variable sig	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change
Step 1 Demographics	.317	.100	.043	.100	1.76	(4, 63)	.149
Step 2 RBS	.359	.129	.059	.029	2.05	(5, 62)	.157
Step 3 FBS-r	**.469**	**.220**	**.143**	**.090**	**7.06**	**(6, 61)**	**.010**
Step 4 Fs	.469	.220	.129	.001	.050	(7, 60)	.824

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 57

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Pain Interferes with Memory scale with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.317	.100	.043	.100	1.76	(4, 63)	.149
Step 2							
Fs	.363	.132	.062	.031	2.23	(5, 62)	.141
Step 3							
RBS	.373	.139	.054	.007	.52	(6, 61)	.476
Step 4							
FBS-r	**.469**	**.220**	**.129**	**.081**	**6.26**	**(7, 60)**	**.015**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 58

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Pain Interferes with Memory scale with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.317	.100	.043	.100	1.76	(4, 63)	.149
Step 2							
Fs	.363	.132	.062	.031	2.23	(5, 62)	.141
Step 3							
FBS-r	**.468**	**.219**	**.142**	**.087**	**6.82**	**(6, 61)**	**.011**
Step 4							
RBS	.469	.220	.129	.001	.101	(7, 60)	.751

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

The addition of FBS-r after demographic variables resulted in statistically significant prediction in the Amnesia for Antisocial Behavior scale when entered in step two (Table 59) but did not predict significant variance when entered after RBS and Fs (Tables 60, 61, and 62). Together, the variables explained 19% of the variance and Fs and RBS did not add significant predictive utility to the model. Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 2.12. The assumptions of homoscedasticity and normality of residuals were also met through inspection of a scatterplot, histogram, and p-p plot.

Table 59

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Amnesia for Antisocial Behavior scale

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.370	.137	.082	.137	2.49	(4, 63)	.052
Step 2 **FBS-r**	**.439**	**.193**	**.128**	**.056**	**4.33**	**(5, 62)**	**.042**
Step 3 RBS	.445	.198	.119	.005	.38	(6, 61)	.539
Step 4 Fs	.451	.203	.110	.005	.39	(7, 60)	.536

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 60

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Amnesia for Antisocial Behavior scale with RBS in step two, FBS-r in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.370	.137	.082	.137	2.49	(4, 63)	.052
Step 2							
RBS	.417	.173	.107	.037	2.76	(5, 62)	.101
Step 3							
FBS-r	.445	.198	.119	.025	1.86	(6, 61)	.177
Step 4							
Fs	.451	.203	.110	.005	.39	(7, 60)	.536

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 61

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Amnesia for Antisocial Behavior scale with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.370	.137	.082	.137	2.49	(4, 63)	.052
Step 2							
Fs	.419	.175	.109	.039	2.92	(5, 62)	.093
Step 3							
FBS-r	.449	.202	.123	.026	2.02	(6, 61)	.161
Step 4							
RBS	.451	.203	.110	.001	.098	(7, 60)	.755

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 62

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and MCI Amnesia for Antisocial Behavior scale with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.370	.137	.082	.137	2.49	(4, 63)	.052
Step 2							
Fs	.419	.175	.109	.039	2.92	(5, 62)	.093
Step 3							
RBS	.430	.185	.105	.010	.72	(6, 61)	.398
Step 4							
FBS-r	.451	.203	.110	.018	1.36	(7, 60)	.248

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Prediction of ability test performance on the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) by MMPI-2-RF Fs, FBS-r, and RBS, controlling for demographic characteristics

To address question #4, scores on the RBANS substantive scales were compared by dividing the sample into participants identified as over-reporting on at least one MMPI-2-RF validity scale versus valid respondents. A moderate effect size was observed between groups on the RBANS Delayed Memory Index. Those who failed at least at least one MMPI-2-RF over-reporting scale compared to those produced valid results tended to perform more poorly than those who did not fail at least one MMPI-2-RF over-reporting scale (Table 63).

Table 63

Mean and standard deviations on RBANS based on MMPI-2-RF over-reporting scales pass/fail classification status

RBANS scale	MMPI-2-RF valid *M (SD)*	MMPI-2-RF invalid *M (SD)*	Cohen's *d*
Immediate Memory	84.05 (15.71)	83.47 (15.79)	0.03
Delayed Memory	87.68 (14.95)	78.88 (13.38)	0.62
Visuospatial/Const.	86.90 (17.26)	82.18 (19.73)	0.25
Language	91.10 (11.04)	87.05 (12.18)	0.35
Attention	86.47 (16.61)	87.06 (19.94)	0.03

Note. RBANS: Repeatable Battery for the Assessment of Neuropsychological Status.
*Significant at the 0.05 level

Pearson correlations were also conducted to examine the relationship among continuous results (Table 64). Moderate, negative relationships were observed among RBS, FBS-r, and Fs in comparison to the Delayed Memory subtest. This suggests that as scores on the Delayed Memory subtest decreased, items on each MMPI-2-RF scale were endorsed more frequently. RBS also demonstrated moderate, negative relationships with the Immediate Memory, Visuospatial/Constructional, and Language subtests.

Table 64

Linear correlations between Green's MSVT scales and the MMPI-2-RF over-reporting scales

RBANS subtests	RBS	FBS-r	Fs
Immediate Memory	-.31*	-.13	-.14
Delayed Memory	-.46**	-.29**	-.30**
Visuospatial/Constructional	-.24*	-.25*	-.20
Language	-.28**	-.21	-.17
Attention	-.22	-.11	-.01

Note. RBANS: Repeatable Battery for the Assessment of Neuropsychological Status; RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.
* Significant at the .05 level
**Significant at the .01 level

Hierarchical linear regression analyses were used to predict performance on the RBANS individual subtests, including immediate and delayed memory, visuospatial/constructional skills, language, and attention. As in the previous linear regression analyses, the independent variables were entered in four blocks. Demographic variables were entered in the model in the first block to determine their influence in the model, followed by the MMPI-2-RF over-reporting variables. The order was varied until each option was exhausted in these analyses to determine the predictive value of each scale.

On the RBANS Immediate Memory Index, demographic variables significant predicted 16% of the variance, $R^2 = .21$, $F\ (4, 72) = 4.66$, $p < .01$ (Table 65). Additional hierarchical regression analyses revealed that ethnicity accounted for a significant portion of the variance when entered in the first step, though none of the other demographic characteristics added significantly to the model, $R^2 = .21$, $F\ (4, 72) = 4.66$, $p < .01$. In

addition, RBS explained an additional 11% of the variance when entered in step two. Fs and FBS-r did not add significant incremental validity to this model and RBS significantly predicted performance on this measures, regardless of when each scale was entered into the model (Tables 66, 67, 68). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 2.42. The assumptions of homoscedasticity and normality of residuals were also met through inspection of a scatterplot, histogram, and p-p plot.

Table 65

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Immediate Memory Index

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	**.396**	**.157**	**.109**	**.114**	**3.31**	**(4, 71)**	**.015**
Step 2							
RBS	**.520**	**.271**	**.219**	**.114**	**6.30**	**(5, 71)**	**.014**
Step 3							
Fs	.521	.271	.209	.001	.001	(6, 70)	.795
Step 4							
FBS-r	.521	.198	.198	.000	.000	(7, 69)	.887

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 66

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Immediate Memory Index with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	**.396**	**.157**	**.109**	**.157**	**3.31**	**(4, 71)**	**.015**
Step 2							
FBS-r	.435	.189	.131	.032	2.75	(5, 70)	.102
Step 3							
RBS	**.484**	**.234**	**.168**	**.045**	**4.08**	**(6, 69)**	**.047**
Step 4							
Fs	.487	.237	.158	.003	.238	(7, 68)	.627

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 67

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Immediate Memory Index with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	**.396**	**.157**	**.109**	**.157**	**3.31**	**(4, 71)**	**.015**
Step 2							
Fs	.415	.172	.113	.015	1.28	(5, 70)	.262
Step 3							
RBS	**.485**	**.235**	**.169**	**.063**	**5.72**	**(6, 69)**	**.020**
Step 4							
FBS-r	.487	.237	.158	.001	.126	(7, 68)	.723

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 68

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Immediate Memory Index with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	**.396**	**.157**	**.109**	**.157**	**3.31**	**(4, 71)**	**.015**
Step 2							
Fs	.415	.172	.113	.015	1.28	(5, 70)	.262
Step 3							
FBS-r	.436	.190	.120	.018	1.54	(6, 69)	.219
Step 4							
RBS	**.487**	**.237**	**.158**	**.047**	**4.16**	**(7, 68)**	**.045**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

On the RBANS Delayed Memory Index, RBS accounted for an additional 18% of the variance after demographic variables were accounted for when entered in step two (Table 69). When FBS-r and Fs were entered in step two, each significantly predicted performance on the Delayed Memory Index, though RBS consistently added incremental validity when it was included after these scales (Tables 70, 71, 72). Each scale demonstrated significant predictive validity, though not above and beyond what was explained by RBS.

Fs and FBS-r did not add significant predictive validity to this model. Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 2.26. Homoschedasticity and normality of residuals were demonstrated through inspection of a scatterplot, histogram, and p-p plot.

Table 69

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Delayed Memory Index

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.219	.048	-.006	.141	.90	(4, 71)	.470
Step 2 **RBS**	**.478**	**.229**	**.175**	**.181**	**19.47**	**(5, 71)**	**.000**
Step 3 Fs	.480	.231	.165	.002	.154	(6, 70)	.696
Step 4 FBS-r	.484	.234	.156	.003	.290	(7, 69)	.592

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 70

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Delayed Memory Index with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.219	.048	-.006	.048	.90	(4, 71)	.470
Step 2 **FBS-r**	**.405**	**.164**	**.105**	**.116**	**9.73**	**(5, 70)**	**.003**
Step 3 **RBS**	**.510**	**.260**	**.195**	**.095**	**8.90**	**(6, 69)**	**.004**
Step 4 Fs	.510	.260	.184	.000	.003	(7, 68)	.954

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 71

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Delayed Memory Index with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.219	.048	-.006	.048	.90	(4, 71)	.470
Step 2 **Fs**	**.359**	**.129**	**.067**	**.081**	**6.50**	**(5, 70)**	**.013**
Step 3 **RBS**	**.501**	**.251**	**.185**	**.122**	**11.19**	**(6, 69)**	**.001**
Step 4 FBS-r	.510	.260	.184	.009	.855	(7, 68)	.358

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 72

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Delayed Memory Index with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.219	.048	-.006	.048	.90	(4, 71)	.470
Step 2 **Fs**	**.359**	**.129**	**.067**	**.081**	**6.50**	**(5, 70)**	**.013**
Step 3 **FBS-r**	**.425**	**.180**	**.109**	**.051**	**4.33**	**(6, 69)**	**.041**
Step 4 **RBS**	**.510**	**.260**	**.184**	**.079**	**7.30**	**(7, 68)**	**.009**

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

With respect to the Visuospatial/Constructional Index of the RBANS, only FBS-r provided a significant contribution to the model, though only when entered prior to RBS. Once RBS was included, no scales significantly predicted variance in this measure after accounting for demographic variables (Tables 73, 74, 75, and 76). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 1.95. The assumptions of homoscedasticity and normality of residuals were also met through inspection of a scatterplot, histogram, and p-p plot.

Table 73

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Visuospatial/Constructional Index with RBS in step two, Fs in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.228	.052	-.001	.052	.989	(4, 72)	.419
Step 2							
RBS	.303	.092	.028	.039	3.09	(5, 71)	.083
Step 3							
Fs	.318	.101	.024	.009	.009	(6, 70)	.393
Step 4							
FBS-r	.346	.120	.031	.019	.019	(7, 69)	.228

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 74

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Visuospatial/Constructional Index with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.228	.052	-.001	.052	.989	(4, 72)	.419
Step 2							
FBS-r	**.454**	**.206**	**.149**	**.152**	**6.61**	**(5, 70)**	**.012**
Step 3							
RBS	.454	.206	.137	.001	.05	(6, 69)	.813
Step 4							
Fs	.455	.207	.125	.000	.031	(7, 68)	.862

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 75

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Visuospatial/Constructional Index with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.228	.052	-.001	.052	.989	(4, 72)	.419
Step 2							
Fs	.397	.158	.098	.106	2.25	(5, 70)	.138
Step 3							
RBS	.410	.168	.096	.010	.86	(6, 69)	.355
Step 4							
FBS-r	.455	.207	.125	.039	3.30	(7, 68)	.074

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 76

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Visuospatial/Constructional Index with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.228	.052	-.001	.052	.989	(4, 72)	.419
Step 2							
Fs	.397	.158	.098	.106	2.25	(5, 70)	.138
Step 3							
FBS-r	**.455**	**.207**	**.138**	**.049**	**4.23**	**(6, 69)**	**.043**
Step 4							
RBS	.455	.207	.125	.000	.02	(7, 68)	.883

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

With respect to performance on the Language Index, RBS predicted significantly more variance than demographic variables only when entered in step two, though this was not significant in terms of the overall model (Tables 77, 78, 79, and 80). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 1.88. Homoscedasticity and normality of residuals were demonstrated through inspection of a scatterplot, histogram, and p-p plot.

Table 77

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Language Index

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.271	.073	.022	.073	1.42	(4, 72)	.235
Step 2							
RBS	**.365**	**.133**	**.072**	**.060**	**4.91**	**(5, 71)**	**.030**
Step 3							
Fs	.369	.136	.062	.003	.248	(6, 70)	.620
Step 4							
FBS-r	.370	.137	.049	.000	.026	(7, 69)	.872

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 78

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Language Index with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.271	.073	.022	.073	1.42	(4, 71)	.235
Step 2							
FBS-r	.352	.124	.061	.051	3.33	(5, 70)	.072
Step 3							
RBS	.395	.156	.082	.032	2.63	(6, 69)	.109
Step 4							
Fs	.398	.158	.072	.002	.19	(7, 68)	.662

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 79

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Language Index with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.271	.073	.022	.073	1.42	(4, 71)	.235
Step 2							
Fs	.352	.124	.061	.042	3.32	(5, 70)	.073
Step 3							
RBS	.395	.156	.082	.032	2.63	(6, 69)	.109
Step 4							
FBS-r	.398	.158	.072	.002	.19	(7, 68)	.662

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 80

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Language Index with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.271	.073	.022	.073	1.42	(4, 71)	.235
Step 2							
Fs	.352	.124	.061	.042	3.32	(5, 70)	.073
Step 3							
FBS-r	.370	.137	.062	.013	1.06	(6, 69)	.306
Step 4							
RBS	.398	.158	.072	.021	1.72	(7, 68)	.194

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Finally, none of the MMPI-2-RF over-reporting measures predicted a significant amount of variance on the RBANS Attention Index when entered at varying stages in the model (Tables 81, 82, 83, and 84). Variance inflation factors raised no significant concerns about multicollinearity. Independence of errors was also found, Durbin Watson Test = 1.57. The assumptions of homoscedasticity and normality of residuals were also met through inspection of a scatterplot, histogram, and p-p plot.

Table 81

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Attention Index

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1 Demographics	.189	.036	-.019	.053	.65	(4, 72)	.631
Step 2 RBS	.383	.080	.014	.056	2.05	(5, 71)	.157
Step 3 Fs	.305	.093	.014	.013	.01	(6, 70)	.322
Step 4 FBS-r	.305	.093	.000	.000	.00	(7, 69)	.974

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 82

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Attention Index with FBS-r in step two, RBS in step three, and Fs in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.189	.036	-.019	.053	.65	(4, 72)	.631
Step 2							
FBS-r	.200	.040	-.030	.004	.31	(5, 70)	.578
Step 3							
RBS	.255	.065	-.018	.025	1.82	(6, 69)	.182
Step 4							
Fs	.282	.079	-.017	.014	1.05	(7, 68)	.309

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 83

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Attention Index with Fs in step two, RBS in step three, and FBS-r in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.189	.036	-.019	.053	.65	(4, 72)	.631
Step 2							
Fs	.189	.036	-.034	.000	.00	(5, 70)	.948
Step 3							
RBS	.282	.079	-.002	.044	3.23	(6, 69)	.077
Step 4							
FBS-r	.282	.079	-.017	.000	.00	(7, 68)	.989

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Table 84

Hierarchical regression analysis of the MMPI-2-RF over-reporting scales and RBANS Attention Index with Fs in step two, FBS-r in step three, and RBS in step four

Variable	*R*	R^2	$AdjR^2$	R^2 *change*	*F*(change)	*df*	change sig
Step 1							
Demographics	.189	.036	-.019	.053	.65	(4, 72)	.631
Step 2							
Fs	.189	.036	-.034	.000	.00	(5, 70)	.948
Step 3							
FBS-r	.205	.042	-.042	.007	.47	(6, 69)	.497
Step 4							
RBS	.282	.079	-.017	.037	2.71	(7, 68)	.105

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale.

Sensitivity, specificity, positive predictive power, and negative predictive power of the MMPI-2-RF over-reporting scales in relation to SVT performance

To address question #4, Hit Rate, Sensitivity, Specificity, Positive Predictive Power, and Negative Predictive Power were calculated at varying cutoff scores (Table 85). However, given the small sample size, these results are provided as proposed, but should not be considered as clinical guidelines. Sensitivity denotes the proportion of individuals who demonstrated negative response bias (via MSVT failure) who were identified by the MMPI-2-RF over-reporting scales while specificity refers to those who did not demonstrate negative response bias (via MSVT pass) who were identified as having produced valid results on the MMPI-2-RF over-reporting scales.

When analyses were performed, optimal hit rates were achieved for FBS-r by *T* scores ≥ 110 with a hit rate of .79, though it is important to mention that no participants

produced invalid results on both FBS-r and the MSVT, thus limiting the generalizability of this data. The highest hit rate for RBS was achieved at T ≥ 80, though the sensitivity of the measure suffered as a result. Based on this data, it appeared as though the optimal cutting score was T ≥ 100, as currently recommended for interpretation. Similarly, Fs achieved the strongest hit rate when a T ≥ 90 was implemented. The measure's sensitivity was negatively affected here, also. The current recommended cutting score of T ≥ 99 produced the best rates for sensitivity and specificity.

A review of negative predictive power (NPP) results and crosstabulation frequencies revealed that no patients failed both the MSVT and FBS-r at any of the implemented cut-scores. Subsequently, recommendations for FBS-r based on NPP will not be made. With respect to RBS, three patients produced invalid results on both the MSVT and RBS when the recommended cutting score of 99 was used, demonstrating an NPP of .75. Twelve out of the 63 patients (19%) who scored below a *T* score of 100 on RBS produced invalid results on the MSVT. When the threshold was lowered to *T* scores of 90 and 80, NPP fell to .44 and .31, respectively.

With respect to Fs, only one participant scored above the recommended cutting score of 99 and also produced an invalid profile on the MSVT, thus producing a NPP of .08. Of the 58 patients who scored below a *T* score of 99 on Fs, 14 patients (24%) invalidated the MSVT. When the threshold was lowered to a *T* score of 90, 45 participants scored below this score. Of these, 10 participants performed in the invalid range on the MSVT, thus demonstrating a NPP of .27. Lowering the *T* score threshold to 80 did not improve this rate, as NPP was calculated to be .21.

The MMPI-2-RF over-reporting scales produced good positive predictive power (PPP) at different cutting scores. When the recommended cutting *T* score of 99 was used for Fs, a PPP rate of .76 was demonstrated. However, PPP improved to .81 when the threshold was lowered to T ≥ 90. Positive predictive power did not increase when the threshold was raised above the recommended cutting score. Similarly, RBS demonstrated its strongest PPP at T ≥ 80. Increasing the threshold required for an invalid result subsequently decreased PPP. Finally, FBS-r demonstrated relatively consistent rates of PPP, likely due to the fact that no participant produced invalid results on both the MSVT and FBS-r at any threshold utilized.

Table 85

Hit rates, sensitivity, specificity, positive predictive power, and negative predictive power for the FBS-r, Fs, and RBS scales at varying cut scores

MMPI-2-RF Scale	*Cut Scores*	*Hit Rate*	*Sensitivity*	*PPP*	*Specificity*	*NPP*
FBS-r	*T* ≥ 80	.77	.53	.77	.74	0
	T ≥ 90	.77	1.00	.77	.93	0
	T ≥ 99	.78	1.00	.78	.97	0
	T ≥ 105	.78	1.00	.78	.99	0
	T ≥ 110	.79	1.00	.79	1.00	0
Fs	*T* ≥ 80	.78	.67	.78	.68	.20
	T ≥ 90	.81	.80	.81	.86	.27
	T ≥ 99	.76	.93	.76	.89	.08
	T ≥ 105	.76	.95	.79	.94	0
	T ≥ 110	.76	1.00	.79	.96	0
RBS	*T* ≥ 80	.88	.27	.88	.97	.31
	T ≥ 90	.87	.47	.87	.97	.44
	T ≥ 100	.81	.80	.81	.93	.75
	T ≥ 105	.75	.97	.75	.97	0
	T ≥ 110	.78	1.00	.78	1.00	0

Note. RBS: Response Bias Scale; FBS-r: Fake Bad Scale—Revised; Fs: Infrequent Somatic Symptoms Scale; PPP = positive predictive power; NPP = negative predictive power.

DISCUSSION

The current study was designed to expand the knowledge base surrounding the efficacy and utility of the MMPI-2-RF in clinical neuropsychological settings. Recent statements from the American Academy of Clinical Psychology and the National Academy of Neuropsychology have called for use of embedded and stand-alone validity measures to assess cognitive effort and symptom exaggeration over the course of a neuropsychological battery, especially when involved in forensic evaluation. Since the MMPI-2-RF is a relatively new measure, it is important to explore the reliability and validity of scales on this measure with other instruments or measures that have established research bases. Results of this study would contribute to the assessment of symptom validity in clinical neuropsychology.

A limitation of some past research on symptom exaggeration has been the reliance on feigned symptom exaggeration. Gervais and colleagues have conducted multiple studies in true patient samples. This present research sought to expand on this literature in a meaningful way by exploring data from actual patients from a private neuropsychology practice. It was hypothesized that elevated scores on the RBS, FBS-r, and Fs would be associated with reduced performance on a cognitive symptom validity test (Green's MSVT) and a cognitive ability screening measure (RBANS), in addition to increased subjective memory complaints. Sensitivity, specificity, positive predictive power, and negative predictive power for RBS, FBS-r, and Fs were also explored.

MMPI-2-RF scales and symptom validity testing

Findings of the current study provide evidence for the utility of RBS over the FBS-r and Fs in predicting symptom validity test failure. However, this study is limited by the small number of participants who produced any elevations on over-reporting scales. When the validity scale scores were compared between the groups who produced valid results on the MSVT versus those who did not, a large effect was observed for RBS (0.88) and a medium effect was noted for FBS-r (0.62), but only a small effect was indicated for Fs (0.10). As expected, the group who failed the MSVT scored higher on RBS than the group who passed the MSVT and consequently demonstrated a large effect size. Regression analyses showed that RBS accounted for the most variance on all MSVT scales when entered in step two after accounting for demographic variables with statistically significant contributions each MSVT scale. The addition of Fs and FBS-r did not add incrementally to the RBS in predicting MSVT performance when RBS was entered in step two. However, FBS-r significantly predicted performance when entered prior to RBS on the MSVT Delayed Recall, Paired Associates, and Consistency Index. The RBS still provided incremental validity above and beyond that explained by FBS-r and Fs on each MSVT subtest, though not on the Consistency Index. A series of binary logistic regressions revealed that RBS provided significant contribution in determining whether or not a patient passed or failed the MSVT. Pearson correlations demonstrated statistically significant mild to moderate positive relationships between RBS and all MSVT scales. Correlational analyses from FBS-r indicated mild positive relationships with the Delayed Recall and Paired Associates trials of the MSVT, though comparisons with Fs did not reflect any statistically meaningful relationships.

This data aligns with past research and development of the RBS. Most recently, Gervais, Wygant, Sellbom, and Ben-Porath (2012) demonstrated a significant association between symptom validity test failure and elevated scores on the MMPI-2-RF validity and substantive scales. While FBS-r significantly predicted performance on portions of the MSVT, the RBS consistently outperformed Fs and FBS-r in this study, as Fs and FBS-r did not add significant incremental explanation above and beyond what was explained by RBS, with the exception of the Consistency Index. Similar results were found in the initial validation research with RBS, such that RBS reliably predicted performance on four symptom validity measures above and beyond what was predicted by the F-family of the MMPI-2 (Gervais et al., 2007).

The findings for Fs and FBS-r support past research that demonstrates the superiority of RBS in detecting symptom validity test failure. While FBS-r did provide significant predictive utility for performance on the MSVT, it did not contribute significantly when RBS was entered into the model prior to entering FBS-r. This may reflect its development as a measure of neurocognitive and somatic symptom validity, though findings are still surprising, given that many patients in the sample presented with at least comorbid pain-related issues; however, measures were included that assessed cognitive complaints and objective deficits rather than exaggerated pain or physical complaints. It is likely that results on Fs and FBS-r may have demonstrated significant relationships with symptom validity measures that assessed exaggerated somatic symptoms (Ben-Porath, 2012), though none were incorporated in the design of this study. These findings may have also been affected by the small sample size and, subsequently, the small number of patients who were classified as over-reporting on FBS-r based on T

≥ 99 criteria likely contributed to this underwhelming finding. Future research should examine this scale in a sample where Fs and FBS-r are more frequently elevated in relation to measures of exaggerated somatic symptoms.

MMPI-2-RF scales and subjective memory complaints

It was proposed that performance on RBS, FBS-r, and Fs would predict subjective memory complaints. Linear regression analyses indicated that RBS independently predicted performance on MCI scales, including general memory problems, numerical information problems, visuospatial memory problems, verbal memory problems, memory interferes with work, impairment in remote memory, and amnesia for complex behavior. However, once again, FBS-r also significantly predicted performance on these measures when entered before RBS. The RBS still provided incremental validity above and beyond what was explained by FBS-r when entered after FBS-r. Furthermore, FBS-r significantly predicted increased scores on scales assessing pain that interferes with memory and amnesia for antisocial behavior. Neither RBS nor Fs provided significant predictive utility on these measures, even when the order of entry into the model was varied. Fs did not provide significant incremental validity on any of the scales of the MCI. Overall, RBS predicted performance on functional aspects of subjective memory aimed at different cognitive domains while FBS-r independently predicted performance on a somatic pain scale.

These findings are consistent with the goals of scale development for both the RBS and FBS-r. Based on this data, RBS and FBS-r are related to subjective memory complaint scales that are similar in content. It appears that those who exaggerate

memory difficulties on the MCI may tend to respond to items with similar content on the MMPI-2-RF and may subsequently increase respective scores on RBS or FBS-r. Pearson correlations demonstrated significant, positive correlations between RBS and scales assessing probable and improbable memory complaints. Similarly, FBS-r also showed significant positive correlations that were small to moderate in strength while performance on Fs indicated significant positive correlations that were small in strength. It is important to note that correlations observed on the improbable complaints scales of the MCI may be attributed to range restriction, as there are few items on these scales that have a generally low rate of endorsement. These correlation analyses align with the findings of Gervais et al. (2010) who found that RBS demonstrated the strongest relationship with mean memory complaints. Findings from the 2010 study reflect the incremental validity provided by RBS in identifying exaggerated subjective memory complaints while demonstrating little to no relationship with objective memory dysfunction, after controlling for symptom validity test results.

MMPI-2-RF scales and performance on the RBANS

Few studies to date have examined performance on embedded and stand-alone symptom validity measures in comparison to performance on tests of cognitive ability. Recently, Armistead-Jehle, Gervais, and Green (2012) examined subjective memory complaints compared to objective memory data and found that as performance on various symptom validity tests worsened, there was an increase in subjective memory complaints. Furthermore, non-significant correlations were found between subjective memory

complaints and performance on objective memory measures for those who passed symptoms validity measures in the same study.

In this study, it was hypothesized that as scores on the MMPI-2-RF over-reporting scales increased, performance on a cognitive abilities screening measure would decrease. Pearson correlations revealed significant negative relationships between the performance on the Delayed Memory scale of the RBANS and RBS, FBS-r, and Fs. Small to moderate negative relationships were observed between RBS and performance on tasks assessing immediate working memory, visuospatial/constructional ability, and language. Results from regression analyses indicated that RBS independently predicted performance on the Immediate and Delayed Memory Indexes but did not significantly predict performance on other indexes assessing language, attention, and visuospatial and constructional skills. Both FBS-r and Fs also significantly predicted delayed memory performance, though only when entered prior to RBS. Based on these data, it appears there is a significant relationship among worsening performance on measures assessing patients' ability to retain novel information both immediately and following a delay for those who produced elevated scores on RBS. This finding supports the hypothesis that ability test scores are reduced as over-reporting increases, though it is specific to scales and measures similar in content. The RBS has been demonstrated to be specifically associated with subjective memory complaints (Ben-Porath, 2012). Therefore, it makes sense that it would provide predictive utility on objective measures of immediate and delayed memory.

While FBS-r and Fs did not provide incremental validity beyond RBS in detecting memory performance, it is important to emphasize that these measures may also serve as

useful tools that clinicians may use to provide further evidence when determining whether or not a patient is exaggerating symptoms, especially as it pertains to memory complaints. These scales provided significant prediction above and beyond demographic variables for performance on attention, language, and visuospatial/constructional tasks, though these discrepancies were not significant in terms of the overall model. Additional research with a larger sample size is necessary to clarify this finding, though it may provide insight into performance across a neuropsychological test battery when exaggeration is suspect.

Cutting scores for the MMPI-2-RF over-reporting scales

Hit Rate, Sensitivity, Specificity, Positive Predictive Power and Negative Predictive Power were examined; however, the small sample size precluded useful calculation of cutoff scores. Subsequently, the values provided should inform future research but should not be utilized as clinical guidelines. Based on the results obtained, the current cutting score for RBS of $T \geq 100$ minimized false positives (specificity = .93) while retaining a good sensitivity of .80. These data suggest that a clinician would have an 81% probability of being correct in suspecting symptom exaggeration when given a positive finding on the RBS. The same clinician would have a 75% probability of being correct of suspecting a patient was not attempting to exaggerate symptoms if given negative findings on the RBS. Though a stronger hit rate was found for a cutting score of $T \geq 80$, sensitivity was negatively affected as a result. Limited data were gleaned for both FBS-r and Fs, as few patients produced invalid results on each scale and Green's MSVT at the current recommended cutting scores. When the threshold was lowered for Fs,

however, the hit rate and positive predictive power both increased, though negative predictive power still remained low. In conclusion, these scales demonstrated good utility in detecting symptom exaggeration; however, the sample size of this study limits clinical utility and future studies should evaluate current cutoff scores.

Strengths, limitations, and future directions

A discussion of strengths and limitations of the current study in relation to other research in this area may help guide future research. One advantage of the current study was the use of a clinical sample from a private neuropsychology practice, which increased the ecological validity of this study. Most symptom validity research to date has taken place with samples instructed to feign symptoms of neurologic, medical, and psychiatric disorders. The inclusion of actual patients incorporated many factors that may have been absent from a population instructed to feign difficulties associated with varying conditions. Referrals for neuropsychological evaluations typically take place after the patient, a treating physician, attorney, or governing body suspect cognitive decline. Patients' internalized responses to these deficits are variable and depend on the level of deficit, individual coping strategies, comorbid psychiatric, medical, or neurologic conditions, and social support. By including a clinical sample in this study, individual variations were captured that may not have been apparent in a feigned sample.

Conversely, use of an actual patient sample introduced methodological variance that is typically controlled for in research settings. Patients were exposed to different assessment batteries depending on the referral question and assessments included in this study were administered at any given point in the course of the evaluation. This may have affected performance on these measures, as patient motivation, fatigue, and test

stamina could not be controlled or assessed. Furthermore, patients were grouped based on performance on specific validity scales when between-groups comparisons were made. In feigned samples, groups are known and predictive analyses leave little room for suspicion. Groups in this sample included those suspected of over-reporting based on negative bias versus accurate responding, per the cutting scores suggested in prior research of the respective MMPI-2-RF scales, though no definitive classification could be gleaned based on available data.

The most significant limitation of this study is the sample size. Future cross-validation research should employ a sample size of at least 100 participants who have been administered similar neuropsychological batteries. Larger samples would be desirable for calculations of Hit Rate, Sensitivity, Positive Predictive Power, and Negative Predictive Power.

Another limitation is the issue of secondary gain. It is unknown if patients might have engaged in negative responding for reasons other than incentives arising from legal involvement. The sample size was too small to empirically evaluate this issue. Other incentives for negative responding may have been present but were not assessed and subsequently not incorporated into this study design. Given the findings that RBS predicted performance on measures with similar cognitive constructs, it would have been interesting to include other measures of physical exaggeration and pain complaints that were conceptually similar FBS-r and Fs. Future research might examine different groups based on the type of complaints presented, such as pain-related disability and a more specific somatic response bias in comparison to those who present primarily cognitive deficits. Findings from this study may provide insight to different types of symptom

exaggeration in a neuropsychological setting to determine what neuropsychological correlates exist in those feigning somatic complaints in comparison to other types of exaggerated presentations. Since the MMPI-2-RF is still a relatively new clinical assessment tool, further research is still necessary to investigate relationships among different types of symptom validity tests and the validity scales of the MMPI-2-RF. While the current findings support the use of RBS and its superiority in comparison to other over-reporting scales in detecting cognitive malingering, other validity scales may aid in detecting psychiatric or somatic symptom exaggeration.

The test selection procedure that took place when developing the subject database may also be considered a limitation of the study. During a review of individual test batteries, participants were chosen who had been administered Green's MSVT, Green's MCI, and the RBANS as part of a neuropsychological evaluation. These tests were chosen based on their assessment constructs in addition to their frequency in which they were utilized. In practice, neuropsychologists typically choose flexible test batteries that are adapted to referral questions and concerns discussed in an initial clinical interview with the neuropsychologist. Patients who were administered batteries that included these specific tests may have fit a symptom profile at the time of intake. It could be that symptom exaggeration was suspected upon the first meeting, thus introducing a potential selection bias with patients administered tests to detect symptom exaggeration, purely based on what patients were administered which measures. Chart reviews revealed diverse presentations and background information; therefore, no motivations were apparent for test selection among these patients and an equal mix of litigating versus non-litigating patients was included in this study.

Furthermore, while use of the RBANS provided interesting insight regarding the relationship between RBS and performance on memory measures, it has historically been used as a screen for impairment to subsequently conduct further testing in areas of concern. Future research between the MMPI-2-RF over-reporting scales and performance on ability measures should include a more in-depth assessment, such as the Weschler Memory Scale—Fourth Edition or the Wide Range Assessment of Memory and Learning. These assessments would allow for further exploration of the role of these scales in predicting performance on visual and verbal memory tasks, in addition to attention, concentration, and recognition as a function of overall memory performance.

Summary and clinical implications

The current study found RBS was predictive of pass/fail classification status on a cognitive symptom validity test, subjective memory complaints that pertained to cognitive functioning, and performance on immediate and delayed memory measures. The FBS-r provided significant predictive utility on these measures also, though not above and beyond what was explained by RBS to a statistically significant degree. However, the study was underpowered to detect small effects. The FBS-r tended to predict increased scores on Green's MCI that pertained to pain complaints and memory. The Fs scale significantly predicted performance on Green's MCI Memory Interferes with Work and Amnesia for Complex Behavior scales but Fs did not provide incremental validity above and beyond RBS for any of the measures employed in this study. This may have been attributed to the use of measures that assessed cognitive functioning rather than somatic complaints or pain exaggeration. Furthermore, RBS, FBS-r and Fs demonstrated good utility in predicting delayed memory performance on a brief

neurocognitive screening measure, though here too, RBS had superior results in comparison to FBS-r and Fs.

The results of the current study support the utility of RBS as part of a neuropsychological assessment, as it appears to detect symptom exaggeration and cognitive response bias on both objective and subjective measures that subsequently influence performance on neuropsychological testing of memory functioning. The utility of FBS-r was also demonstrated in these data and it should be included as a supplement to RBS when considering symptom exaggeration in patients. Furthermore, these scales may provide insight into performance on objective measures of memory. Based on the relatively recent implementation of the MMPI-2-RF and even more recent inclusion of RBS in the scoring program, it is recommended that those new to this measure become familiar with this scale's development and its contribution to various clinical interpretations.

Although the RBS was superior to the FBS-r and Fs in this sample in detecting cognitive symptom exaggeration, it is important to emphasize that it should not be used in isolation and that other scales of the MMPI-2-RF, measures of validity, and clinical judgment should be employed when there is a question of effort. Slick and colleagues recommended routine use of at least two well-validated symptom validity assessments as a core of neuropsychological assessment (1999). In this study, there was no difference in performance for those with pending litigation and those who did not have apparent secondary gain. It is subsequently recommended that symptom validity testing tailored to specific symptom complaints (e.g., somatic, cognitive, etc.) be utilized in all adult neuropsychological batteries, especially when there is a potential benefit for reduced

performance. It should be noted, however, that the potential for false positive error rates increases with the use of multiple symptom validity tests. To minimize this potential, clinicians should utilize several well-validated symptom validity measures, which will also aid in reducing the false-negative rate.

engage in a thorough review of all objective data, the clinical interview, behavioral observations, and collateral information gleaned from other sources prior to assuming the patient engaged in volitional symptom exaggeration. If an external incentive is absent, DSM-IV-TR factitious or somatization disorders must be considered, as over-reporting in isolation is not indicative of malingering (Ben-Porath, 2012).

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