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The MMPI-2-RF: Clinical utility with a traumatic brain injury population

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The MMPI-2-RF: Clinical utility with a traumatic brain injury population

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The MMPI-2-RF: Clinical utility with a traumatic brain injury population

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The 567-item MMPI-2 is the most widely used personality measure; it requires a sixth-grade reading level, takes 60-90 minutes to administer, and reports robust psychometrics. However, traumatic brain injury (TBI) sequelae can cause cognitive deficits that affect test-taking abilities and item endorsement during differential diagnoses of neurological and personality factors. Therefore, this study examined the clinical utility of the shortened 338-item MMPI-2-RF inventory with a post-acute TBI population as a practical alternative. The MMPI-2-RF requires a fifth-grade reading level and takes 35-50 minutes to administer. The MMPI-2-RF also includes revised versions of the MMPI-2 Validity Scales and new substantive scales that may better psychometrically account for personality in TBI sequelae, such the Somatic/Cognitive Scales.

This study conducted an incremental validity analysis of the MMPI-2-RF with a non-litigating, post-acute care TBI population in Central Texas. The goal of the study

was to explore the measure's performance, or its ability to capture functional dimensions in a TBI sample. More specifically, the study examined the construct validity of MMPI-2 to MMPI-2-RF Validity and Restructured Clinical Scales, and criterion validity for the Somatic/Cognitive Scales with neuropsychological and neurobehavioral functioning measures.

An archival neuropsychological database (N = 60) was analyzed of patients who participated in TBI rehabilitation treatment at a Central Texas hospital. MMPI-2-RF profiles were retrospectively scored with MMPI-2 archival data. Statistical analysis between MMPI-2 to MMPI-2-RF Validity and Restructured Clinical Scales was conducted. MMPI-2-RF Somatic/Cognitive Scales and criterion measures of Weschler Adult Intelligence Scale, 4th Edition (WAIS-IV), The Weschler Memory Scales, 4th Edition (WMS-IV), The Booklet Category Test, 2nd Edition (BCT), and the Neurobehavioral Functioning Inventory (NFI) were examined. Patient demographics and measurement qualities were reported with the sample.

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Chapter One: Introduction

Traumatic brain injury (TBI) is an insult to the brain from an external mechanical force, possibly leading to altered state of consciousness or short- or long-term neurobehavioral impairments in domain areas, such as physical, cognitive, emotional, and personality functioning. Each year, an estimated 1.7 million people, at an average age of 38, sustain a TBI (civilian, non-military). Of these reported TBI cases, an estimated 52,000 die, 275,000 are hospitalized, and 1.365 million (nearly 80%) are treated and released from emergency care (Centers for Disease Control [CDC], 2010). Approximately 5.3 million Americans have a long-term disability related to a TBI (Thurman, Alverson, Dunn, Guerrero, & Sniezek, 1999). Direct medical costs and indirect costs (such as lost of productivity) for TBI patients totaled an estimated $60 billion in the United States in 2000 (Finkelstein, Corso, & Miller, 2006). Because of the demands on the health care system, TBI is considered to be a significant public health problem (CDC, 2003).

The factors affecting TBI recovery are complex. Accordingly, the individualized complexity of both biological responses to different localizations of brain injuries and pre-morbid and co-morbid psychosocial and health conditions tend to complicate measurement and post-injury status (Lezak, 1987; Lezak, Howieson, Loring, Hannay, & Fischer, 2004). In attempts to clarify the diagnostic picture, a long history of neuropsychological research has established that brain-behavior relationships after TBI must be assessed with sound psychometric assessment instruments (Lezak et al., 2004;

Weschler, 2009a). As a result, differential diagnoses can eliminate other hypotheses or alternative possibilities to a patient's condition, and narrow understanding of patient cognitive strengths and weaknesses in functional areas, such as memory, attention/concentration, and problem solving (Freud, 1953; Heilman & Valenstein, 2003; Russell, 1971; Teasdale & Jennett, 1974; Weschler, 2009a). Neuropsychological assessment provides baselines to TBI cognitive functioning that enable future comparisons for improvement or decline (Heilman & Valenstein, 2003; Howieson & Lezak, 2010; Lezak et al., 2004).

In the last 20 years, emerging research suggests that a significant contribution to a TBI patient's recovery and cognitive functioning is co-morbid personality functioning (Dikmen, Machamer, Fann, & Temkin, 2010; Gervais, Ben-Porath, & Wygant, 2009; Temkin, Corrigan, Dikmen, & Machamer, 2009). Personality factors, such as mood conditions, pathologies, and general attitudes and behaviors, can affect the identification and treatment of medical conditions (Arbisi & Butcher, 2004), as well as adversely impact patient compliance and associated TBI rehabilitation outcomes (Warriner & Velikonja, 2006). However, personality functioning tends to be more difficult to measure, less visible, and impacts patient recoveries long after physical scars heal (Koponen et al., 2002). Therefore, having sound psychometric personality assessments validated with TBI patients in the same tradition as cognitive tests is clinically responsible and necessary (Weschler, 2009a; Arbisi & Butcher, 2004). Practitioners may be better able to target treatment interventions if they understand how measures capture personality dimensions

(Arbisi & Butcher, 2004; Gervais, Ben-Porath, Wygant, & Sellbom, 2010; Lezak et al., 2004; Lezak, 1987; Weschler, 2009a).

The Minnesota Multiphasic Personality Inventory, 2nd Edition (MMPI-2; Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989) is a gold standard for personality assessment. Its clinical utility has been thoroughly documented, and current research indicates that the 567-item MMPI-2 is the most widely used personality assessment measure with both with healthy and non-healthy populations. The MMPI-2 has also been found to be an adequate measure of psychiatric symptoms, attitudes, and interpersonal functioning with TBI patients (Butcher, Graham, Ben-Porath, Tellegen, Dahlstrom, & Kaemmer, 2001).

However, there are few prospective studies that examine personality adaptation status and post-acute TBI outcomes (Oddy, Coughlan, Tyerman, & Jenkins, 1985). Additionally, psychological factors and personality functioning during TBI rehabilitation have not been conclusively studied longitudinally (Morton & Wehman, 1995). As a result, the literature suggests that additional research is needed to psychometrically account for personality functioning in post-injury TBI populations through validation and group comparison studies, in order to appropriately shape diagnostics and treatment outcomes (Borgaro, Prigatano, Kwasnica, & Rexer, 2003; Gervais et al., 2010; Kinsella, Moran, Ford, & Ponsford, 1988).

The literature suggests that personality research with TBI patients has been challenging for a few reasons. First, it is difficult to measure personality and affective

changes with a TBI population, as most population-normed personality measures have not been validated on TBI and do not thereby adjust for non-psychiatric etiology of symptoms (Arbisi & Ben-Porath, 1999). Second, the MMPI-2 requires approximately a sixth-grade reading level, and takes 60-90 minutes to administer due to overlapping test items; part of TBI sequelae includes fatigue, mental dullness, and possible cognitive impairment, which can affect test-taking motivation and ability, as well as self-report consistency (Lezak et al., 2004). Third, co-morbid TBI conditions, such as posttraumatic stress disorder, depression, and pain, can mimic neurological symptoms, which thereby complicate measurement of the patient's self-reports and the associated diagnostic picture (Garden, Sullivan, & Lange, 2010); baseline or pre-morbid personality functioning information may not be available to neuropsychologists (Mooney, 1988).

Another posited reason for research challenges is litigation participation, which can obscure self-reports (Thomas & Youngjohn, 2009). Of note, the majority of MMPI-2 and MMPI-2-RF validity studies to-date have been conducted with simulated head injury samples, or TBI samples meeting the legal definition for head injury; however, most samples typically lack a neurological diagnosis. Further, in meeting criteria for a TBI, research subjects have traditionally also been participating in legal proceedings and disability claims with potential financial gain, which has been correlated with symptom exaggeration (Butcher et al., 1989; Dikmen et al., 2010; Gervais et al., 2009; Gervais et al., 2010; Greiffenstein, Gola, & Baker, 1995; Sellbom, Toomey, Wygant, Kucharski, & Duncan, 2010; Tellegen & Ben-Porath, 2008; Thomas & Youngjohn, 2009).

A newer, shortened 338-item version, the Minnesota Multiphasic Personality Inventory-2nd Edition-Restructured Form (MMPI-2-RF; Ben-Porath & Tellegen, 2008), may prove to be more practical and psychometrically informative for TBI patients. The MMPI-2-RF requires a fifth-grade reading level, takes 35-50 to administer. The MMPI-RF represents a factor-analyzed version of the MMPI-2 Validity Scales, as well as new scales to track personality and psychopathology factors. Ben-Porath & Tellegen (2008) claim that the MMPI-2-RF helps mitigate aforementioned test-taking difficulties and symptom reporting patterns; it provides richer information after psychometrically removing aggregated and overlapping items from the MMPI-2 that can complicate results. However, the MMPI-2-RF has yet to be adequately validated on a TBI population, and more validity studies are needed (Gervais et al., 2009; Gervais et al., 2010; Youngjohn, Wershba, Stevenson, Sturgeon, & Thomas, 2011). Therefore, this study intends to evaluate the clinical utility of the MMPI-2-RF with a non-litigant TBI rehabilitation patient sample from a private hospital in Central Texas.

A psychometric approach to validating updated versions of assessment measures is incremental validity (Garb, 2003; Gervais et al., 2010; Haynes & Lench, 2003; Hunsley & Meyer, 2003; Sechrest, 1963). The literature suggests that one of three main goals guide incremental validity study procedures: (a) to determine whether a new test predicts a diagnosis or treatment outcome; (b) to explore whether test results inform clinical judgment or decision-making in patient care; or (c) to explore whether a new or updated form of a test is a valid alternative measure for a specific population (Garb,

2003; Haynes & Lench, 2003; Hunsley & Meyer, 2003; Sechrest, 1963; Tellegen & Ben-Porath, 2008). Since this investigation intended to assess the performance of the MMPI-2-RF with a TBI population, the latter goal - incremental validity to investigate the performance of an updated form of a test measure - was the guiding principle and procedure for the study.

Research evidence suggests that incremental validity research for validation of a new measure is performed when clinicians want to determine if newly developed assessment measures provide supportive or additional data over previous versions (Garb, 2003; Haynes & Lench, 2003; Hunsley & Meyer, 2003; Sechrest, 1963; Wood, Garb, Lilienfeld, & Nezworski, 2002). Haynes and Lench (2003) advocate that incremental validity analysis is helpful toward understanding a "phenomenon of interest" (p. 456) relative to other measures by examining "new measures from an existing assessment instrument, from the refinement of an existing instrument, or from a new assessment instrument" (p.457). They advise that incremental validity analysis can be conducted across "several dimensions, such as sensitivity to change, diagnostic efficacy, content validity, treatment design and outcome, and convergent validity" and "can vary depending on the criterion measures, comparison measures, and individual differences in samples" (p. 456).

The literature suggested that traditional steps are to (1) conduct a zero-order correlation matrix, and (2) run regression analysis on statistically significant relationships (Garb, 2003; Gervais et al., 2010; Haynes & Lench, 2003; Hunsley & Meyer, 2003;

Sechrest, 1963; Tellegen & Ben-Porath, 2008). Incremental validity studies have reported results using a variety of correlation and regression methods to illuminate measure properties, such as discriminant and convergent function analysis (Sellbom, Ben-Porath, Graham, Arbisi, & Bagby, 2005; Thomas & Youngjohn, 2009), hierarchial multiple regression (Wygant et al., 2009), logistic regression and sensitivity/specificity analysis (Dearth et al., 2005; Locke et al., 2010), and receiver operating characteristic (ROC) analysis (Larabee, 2008). Hunsley and Meyer (2003) suggested that choosing measures and analysis procedures depends on the researcher's goal of the study, and domains of interest.

In agreement with these general principles, Haynes and Lench (2003) advised that to select the appropriate dimension of incremental validity, the researcher must

> (a) decide how the new measure is to be used… (b) select the criteria on which validity inferences are to be based, (c) select the alternative measures with which the new measure will be compared, and (d) identify the population with which it is to be used and select a representative sample of that population (p. 457).

Hunsley and Meyer (2003) suggest that an incremental validity analysis for validation of a new form of a test measure can examine correlations for discriminant and convergent relationships, as well take a new source of data, or external correlates, and examine "contribution to improving on the prediction of a clinically relevant criterion" (p. 448). Incremental validity as a validation of a new measure can "justify how the new scale provides information that was formerly unavailable or less adequately obtained," or

provide the relative performance of one test scale to another (Hunsley & Meyer, 2003, p. 449).

Further, the correlation matrix can show independent strength of the scale relationships between versions by examining construct validity; stronger magnitudes will indicate more scale redundancy and interchangeability across versions, or shared variance (Ben-Porath & Tellegen, 2008; Garb, 2003; Haynes & Lench, 2003; Hunsley & Meyer, 2003). Further, regression equations that regress variables from the version of interest on external correlates will help the researcher to better understand criterion relationships, or illuminate the best set of variables associated with the external correlate. Regression maximizes the correlation between scale and external correlate relationships in a given context (Aiken & West, 1991; Stevens, 2007).

Research also suggests that examining group comparison data, in addition to the actual performance of any shortened measure, is important when conducting incremental validity research (Ben-Porath & Tellegen, 2008; Gervais, et al., 2010; Haynes & Lench, 2003). Group comparison research has shown evidence for the incremental validity for the MMPI-2-RF to the MMPI-2 with psychiatric, out-patient, substance abuse, college student, simulated brain injury, and forensic populations by comparing correlation patterns on Validity Scales to determine that the scales functioned similarly (Tellegen & Ben-Porath, 2008). Previous research has also established evidence for the MMPI-2-RF in better detecting invalid response sets – particularly a patient's overreporting or underreporting of symptomology - by comparing reported somatic and cognitive

complaints with invalid profile indicators in certain populations (Arbisi & Ben-Porath, 2004; Gervais, Ben-Porath, & Wygant, 2009). Studies also indicate that examining correlates between relevant MMPI-2-RF scales and external correlates in memory, attention/concentration, and executive functioning (or problem-solving) can be diagnostically helpful to distinguish the contribution of personality to cognitive functioning and the self-report of medical complaints for a specific group, or to better understand what dimensions the scales capture (Gervais et al., 2009; Gervais et al., 2010; Locke et al., 2010).

In general, it appears that conducting validity studies for group comparison can help elucidate appropriateness of the MMPI-2-RF for specific populations (Ben-Porath & Tellegen, 2008). Therefore, group comparison studies specifically conducted with a TBI population not participating in litigation or disability claims, or non-litigant TBI patients, could establish evidence for the usefulness of the MMPI-2-RF during TBI recovery and rehabilitation (Thomas & Youngjohn, 2009).

One example of incremental validity analysis procedures for validating a reformatted measure was a study conducted by Gervais et al. (2010). The researchers studied whether MMPI-2-RF Validity Scales were more efficient and sensitive measures of symptom overreporting with a disability claimant sample who did not report history of a head injury. More specifically, researchers tested the incremental validity of "(a) the MMPI-2-RF overreporting validity scales relative to their corresponding MMPI-2 validity scales, and (b) the RBS relative to the MMPI-2-RF overreporting scales, in

assessing the veracity of memory complaints" (Gervais et al., 2010, p. 3). At the time of this study, the RBS, or the Response Bias Scale, was an experimental index to capture test-taker attempts of exaggerated symptom reporting.

Gervais et al. (2010) examined correlations between MMPI-2 to MMPI-2-RF Validity Scales with non-head-injury litigants. Once the magnitude of the correlations confirmed that scales functioned similarly, the researchers used regression analysis with select MMPI-2-RF Validity Scales, the Memory Complaints Scale, and the California Verbal Learning Test, 2nd Edition to test whether a new RBS index would better measure response bias and exhibit sensitivity to change in detecting memory functioning for the sample (Gervais et al., 2010). The researchers reported MMPI-2-RF effect sizes, t-test for dependent correlations, magnitude of validity coefficients, and variance accounted for by stepwise regression model variables. They used theoretical statistical cut-offs (Cohen, 1988) and group comparison cut-offs (Ben-Porath & Tellegen, 2008) as benchmarks for their incremental validity analysis. For full results, please see Gervais et al., 2010.

Another example of incremental validity procedures was a study conducted by Handel and Archer (2008), in which the researchers examined the efficiency of the MMPI-2 with an inpatient population. They reported the magnitudes of convergent and discriminant correlations between MMPI-2 RC and Clinical Scales with the sample, examined descriptive statistics for scale means and standard deviations, and reported regression results that analyzed the psychometric properties of the MMPI-2 to external correlates of symptom validity and psychiatric symptom reporting, as measured by the

Symptom Validity Checklist 90-Revised, and the Brief Psychiatric Rating Scale. For full results, please see Handel and Archer, 2008.

As mentioned previously, Haynes and Lench (2003) stated that by examining a measurement's properties with external correlates, or criterion measures, incremental criterion validation research can provide information about measure performance with a population. Therefore, conducting an incremental validity analysis that explores the MMPI-2-RF's ability to psychometrically account for personality with TBI sequelae may help determine whether the MMPI-2-RF is a practical and informative measure with TBI patients.

This study examined the incremental validity of the MMPI-2-RF with a TBI population with two specific goals. First, the study explored internal consistency reliability and construct validity for specific scale measures relevant to test-taking attitudes and item endorsement (MMPI-2 to MMPI-2-RF Validity Scales), and general personality functioning (MMPI-2-RF Validity to MMPI-2-RF Restructured Clinical Scales).

Second, after the analysis supported the MMPI-2-RF as an internally consistent and valid version of the MMPI-2 (as a significant body of research suggested), this study explored the performance of the MMPI-2-RF with a TBI population by examining the incremental validity of MMPI-2-RF scales with measures of the cognitive and neurobehavioral deficits that are commonly reported during TBI sequelae (Haynes & Lench, 2003; Lezak et al., 2004; Tellegen & Ben-Porath, 2008). The MMPI-2-RF

Somatic/Cognitive Scales were examined for psychometric capacity to detect neuropsychological and neurobehavioral functioning with non-litigant TBI patients. In particular, the study examined the criterion validity of the MMPI-2-RF Special Problems Somatic/Cognitive Scale by comparing it to (a) neuropsychological measures of attention/concentration, memory, executive, and neurobehavioral functioning, which included index scores from the Weschler Adult Intelligence Scale, 4th Edition (WAIS-IV: Weschler, 2009a), subtests scores of the Weschler Memory Scales, 4th Edition (WMS-IV, Weschler, 2009b), and total error scores on The Booklet Category Test (BCT; DeFillipis & McCampell, 1979), as well as with (b) neurobehavioral measures of depression, somatic, communication, aggression and motor skill functioning, as measured by the Neurobehavioral Functioning Inventory (NFI; Kreutzer, Seel, Marwitz, 1999).

Of note, the focus of this study was on psychometrics and measurement of personality functioning in adult TBI patients participating in post-acute rehabilitation. Because of the exploratory nature of this research and the emergent status of TBI research, the role of physiological sequelae, malingering, psychiatric illness, or developmental issues and functional outcome statuses in rehabilitation were beyond the scope of this study.

Chapter Two: Literature Review

This chapter provides a review of the literature regarding psychometric measurement of personality functioning and TBI. For initial context and to provide general understanding for the study, the first section broadly reviews TBI diagnostic parameters, perceived patient deficits following brain injury, or sequelae, and perceived neuropsychological assessment goals. The second section briefly discusses personality functioning after TBI for additional context. The third section summarizes findings on personality functioning research using versions of the Minnesota Multiphasic Personality Inventory, and concludes with information about the relevance of examining clinical utility of the MMPI-2-RF with a TBI population.

Traumatic Brain Injury – Diagnosis, Sequelae, and Assessment

TBI is diagnosed as mild, moderate, or severe, depending on the extent of loss of consciousness and the duration of posttraumatic amnesia (Kaufman, 2007). Posttraumatic amnesia tends to be categorized in minutes to one hour for a very mild to mild brain injury, one to 24 hours as moderate, one to seven days as severe, and greater than seven days as very severe (Russell, 1971).

Depending on injury severity, a person diagnosed with a TBI may experience physical, affective, or cognitive deficits. First, neurological deficits may limit physical functioning, such as loss of movement or impaired movement (paresis), lack of muscle coordination (ataxia), and muscle spasms or toning (spasticity); second, affective deficits may limit an individual's emotional functioning, such as personality changes and mood

disturbances, irritability, and aggression; and third, cognitive deficits may disrupt functional areas of memory, attention and concentration, orientation, and thinking (Kaufman, 2007; Lezak et al., 2004).

While domain-area deficits may be similar, research has suggested that TBI diagnoses and sequelae are highly individualized and complex. Neuroscience is continually uncovering the complex inter-flow of brain systems, and neurological diagnostic procedures, such as electroencephalography (EEG), magnetic resonance imaging (MRI), or computed tomography (CT) imaging, provide valuable medical insight to differences in cerebral pathology. However, personal biological, psychological, and social factors tend to confound measurement and research studies (Traumatic Brain Injury Model Systems [TBIMS] Program, 2008).

The literature suggests that helpful pre-morbid functioning data may not always be available to neuropsychologists for comparison, and personal conditions tend to be variable. Research has shown that pre-morbid age and education impact post-TBI functioning, as well as test behavior and performance when comparing neuropsychology results to healthy populations (Cattelani, Tanzi, Lombardi, Mazzucchi, 2002; Reitan & Wolfson, 1995). Additionally, research has shown that pre-morbid psychiatric and substance abuse status contribute to TBI post-injury status (Martens, Donders, & Millis, 2001), although studies have not been robustly replicated. Therefore, the research broadly suggests that personal conditions, such as education level, psychosocial functioning, medical history and status tend to complicate the neuropsychology and recovery picture

(Dash, Zhao, Hergenroeder, & Moore, 2010). Two people with similar injuries may have different neuropsychological profiles because of variable interactions between patient psychosocial and neurological conditions (Lezak et al., 2004). In short, no two brain injuries are alike.

As a result, neuropsychology research consensually declares that brain-behavior functioning after TBI helps mitigate the challenge by providing norm-based measurement and diagnostics (Heilman & Valenstein, 2003; Howieson & Lezak, 2010, 2002; Lezak et al., 2004). More specifically, in order to psychometrically account for deficits from brain disorders and injuries, patients must be assessed behaviorally.

Neuropsychological assessment results can enhance the diagnostic picture and provide insight into a patient's functional brain-behavior relationships by using population norm-referenced, standard scale test interpretations. As a result, neuropsychologists tend to pursue an indirect measurement of deficits (Howieson & Lezak, 2010; Lezak et al., 2004), which makes psychometric properties and validation research with TBI patients important. Neuropsychology provides interpretive data in key areas of intellectual, memory, attention/concentration, and executive functioning as organizing principles for a patient's strengths and weaknesses post-injury. By comparing the pattern of neuropsychological performance with population-normed neurological or psychological patterns, a deficit pattern may emerge. Therefore, robust assessment instrumentation must be validated on this complex population to best measure and illuminate brain-behavior functioning as organizing concepts for treatment and recovery.

Historically, neuropsychological assessment has focused on psychometrically accounting for cognitive impairments with TBI patients. Cognitive functioning appears to underlie behavior, and cognitive deficits tend to be the most observable and measurable (Heilman & Valenstein, 2003; Howieson & Lezak, 2010, 2002; Lezak et al., 2004). As a result, agreement appears to exist for neuropsychological assessment goals with TBI patients, which include to determine functional levels in attention/concentration, memory, and executive functioning (or higher-order supervising/problem-solving functions) to ascertain patient strengths and deficits using normative comparison standards (Heilman & Valenstein, 2003; Howieson & Lezak, 2010, 2002; Lezak et al., 2004).

Of these domains, research has shown that after TBI, attention and memory deficits are the most commonly reported subjective cognitive complaints, or specific functional area complaints (Dikmen et al., 2010; Heilman & Valenstein, 2003; Howieson & Lezak, 2010, 2002; Leclercq, Deloche & Rousseaux, 2002; Lezak et al., 2004). Attentional deficits can include difficulties with mental fatigue, slow information processing, sleepiness, and difficulty completing multiple tasks. Attentional deficits tend to impair overall executive functioning, such as cognitive productivity and thought processes that affect test-taking ability, even though fact recall may remain intact (Stuss et al., 1989).

In general, post-TBI deficit areas are traditionally estimated by the comparing patient's performance on intellectual and reading neuropsychological tests - such as the subtests of the Weschler Adult Intelligence Scale, 4th Edition (WAIS-IV; Weschler,

2009a) or the subtests of the Wide Range Achievement Test, 4th Edition (WRAT-4; Wilkinson & Robertson, 2006) - with standard deviations from population-based norms. In particular, research has established that verbal functioning and reading ability can estimate the comparison standard, or the estimated pre-morbid ability level (Johnstone & Wilhelm, 1996; Lezak et al., 2004; Wiens, Bryan, & Crossen, 1993).

Additionally, post-TBI functioning is compared with a patient's functioning on tests of executive functions, and memory. The Booklet Category Test, 2nd Edition (BCT-2; DeFilippis & McCampbell, 1997) is the most widely used measure of executive function and problem-solving with TBI patients (Greve, Bianchini, & Roberson, 2007). The BCT-2 is a booklet version of the Halstead Category Test, which helps illuminate a patient's diffuse problem-solving abilities through interpretation of errors scores; patients are given corrective-feedback about their concept formation and abstract reasoning while navigating a series of geometric patterns, with higher error scores indicating more diffuse brain injury. The Weschler Memory Scales, 4th Edition (WMS-IV; Weschler, 2009b) is one of the most commonly used measure to assess memory functioning. The WMS-IV asks patients to reproduce passage prose, semantically paired words, and visual designs in both immediate and delayed recall trials.

Of note, in addition to neuropsychological measures, TBI rehabilitation facilities may also use two medical measures to organize practitioner understanding about a patient's recovery status. Scores are typically unrelated to pre-morbid functioning (Cattelani et al., 2002). First, the Glascow Coma Scale (GCS; Teasdale & Jennett, 1974)

is a 15-point scale used in the field and emergency departments to assess eye opening, verbal, and motor responsiveness (with scores of 3-8 indicating coma or non-responsiveness). Second, the Rancho Los Amigos Scale (RLAS; Hagen, 1997) is an ten-stage measure of functional cognitive recovery levels typically observed in rehabilitation after a TBI (high scores on the RLAS suggest the observation of a patient's purposeful and appropriate actions, as well as orientation to person, place, and time).

Whereas cognitive and intellectual functioning appears to have the longest history of consistent research findings and results with TBI, a similar systematic and consensus of personality functioning is still being established. Personality or affective sequelae in TBI patients appears to be the most complex and least understood (Arbisi & Ben-Porath, 2004; Dikmen et al., 2010; Lezak et al., 2004). Recognizing the multifaceted impact of personality functioning on TBI recovery, neuropsychological theories have evolved in the last 30 years to encourage personality assessment in addition to measuring cognitive functioning in TBI patients (Howieson & Lezak, 2010; Lezak, 1987; Lezak et al., 2004). The next section intends to review possible personality factors affecting TBI patients, followed by a review of associated research studies using MMPI personality measures.

Traumatic Brain Injury and Personality Functioning

Research suggests that personality problems, such as social isolation, mood lability, and anhedonia tend to be the most pressing psychological problems affecting patient recovery and rehabilitation (Dikmen et al., 2010; Morton & Wehman, 1995; Warriner & Velikonja, 2006). Additionally, personality issues tend to persist long after

visible physical and cognitive effects of TBI sequelae remit. More specifically, while cognitive and physical impairments tend to be more observable deficits after TBI, personality and psychiatric sequelae tend to be more complicated and lasting, sometimes still affecting a patient's psychosocial functioning up to 30 years after injury (Koponen et al., 2002).

Personality factors can also affect the patient's level of symptom reporting and treatment compliance, as well as the medical team's observation and treatment of medical conditions (Arbisi & Butcher, 2004; Dikmen et al., 2010), all of which affect TBI rehabilitation outcomes (Warriner & Velikonja, 2006). Research suggests that rather than solely because of injury localization or severity itself, personality changes after TBI are due to the complex interplay of awareness and understanding of the injury, adjustment to the disability, and interpersonal stressors (Gainotti, 1993; Lezak et al., 2004; Rochat, Ammann, Mayer, Annoni, & Van der Linden, 2009).

The average age of reported TBI patients is 38 years old (TBIMS, 2008), and research has shown that TBI patients tend to have reduced opportunities for post-recovery employment, as well as increased incidence for social withdrawal, anxiety and depression, and dependence on others; as a result, strain on the social network and family system tends to occur during recovery (Cattelani et al., 2002; Dikmen et al., 2010; Lezak, 1987; Morton & Wehman, 1995; Temkin et al., 2009). Additionally, without clear diagnostic information about personality functioning during recovery, family systems and social networks may misattribute patient behaviors, such as mood swings, disinhibition,

fatigue, social hypersensitivity, and aggression, to laziness or secondary gain because of the lack of visible disability markers resembling physical injury, such as slurred speech, immobility, or scars (McClure & Abbott, 2009). As such, Matthews and Harrington (2000) suggested that personality issues are invisible markers of TBI sequelae that are important to understand during recovery.

However, personality research with TBI populations has proved challenging for several reasons. First, Arbisi and Ben-Porath (1999) noted the difficulty of measuring personality and affective changes during brain injury rehabilitation, as most population-normed personality measures do not correct for non-neuropsychiatric etiology of psychiatric symptoms. Second, the TBI sequelae includes fatigue, mental dullness, and possible cognitive impairment, which can affect test-taking motivation, ability, and symptom endorsement patterns routinely captured by validity scales (Handel, Ben-Porath, Tellegen, & Archer, 2010; Lezak et al., 2004).

Third, co-morbid TBI conditions - such as posttraumatic stress disorder, depression, and pain - can emulate neurological symptoms, and complicate patient self-reports and the associated diagnostic picture (Garden, Sullivan, & Lange, 2010). Fourth, baseline or pre-morbid personality functioning information may not be available to neuropsychologists to make concrete comparisons (Mooney, 1988).

There are few studies that prospectively examine personality adaptation status and outcomes during post-acute rehabilitative care (Oddy et al., 1985), and psychological factors and personality functioning during rehabilitation have not been conclusively

studied longitudinally (Morton & Wehman, 1995). As a result, the literature suggests that additional research is needed to psychometrically account for personality functioning in post-injury TBI populations through validation and group comparison studies in order to appropriately shape diagnostics and treatment outcomes (Borgaro et al., 2003; Gervais et al., 2009; Howieson & Lezak, 2010; Kinsella et al., 1988; Tellegen & Ben-Porath, 2008).

Assessing personality in a TBI population using the MMPI.

As mentioned, neuropsychological research consensus for post-TBI cognitive patterns appears established, whereas consensus for post-TBI personality patterns continues to emerge (Gervais et al., 2009; Howieson & Lezak, 2010; Lezak, et al., 2004; Weschler, 2009a). Therefore, the literature suggests that validity studies should specifically examine internal consistency reliability and validity in comparative groups across a range of treatment settings (Gervais et al., 2009; Lezak, et al., 2004; Locke et al., 2010; Tellegen & Ben-Porath, 2008). Psychometric studies help to illuminate how measures capture dimensions with different populations. These studies may thereby improve the diagnostic capabilities of the measure, and provide evidence to help clinicians select the measure that is most appropriate for his or her needs (Haynes & Lench, 2003; Tellegen & Ben-Porath, 2008).

There is a rich research history with MMPI versions and TBI. Researchers have also used other instruments to examine post-TBI functioning, such as the Personality Assessment Inventory (PAI) or the Millon Clinical Multiaxial Inventory, 3rd Edition (MCMI-III). However, research has concluded that the MMPI-2 is frequently utilized in

TBI research to assess personality and emotional functioning with better predictive validity than other personality measures (Lange, Sullivan, & Scott, 2010).

The original MMPI (MMPI; Hathaway & McKinley, 1943) and its second edition, the MMPI-2 (Butcher et al., 1989), are criterion-based measures that psychometrically differentiate psychopathology based on responses to traditional diagnostic statements (Gass, 1991). The MMPI-2 represented a simplified test item pool and updated population norms from the MMPI (Butcher et al., 2001). A third MMPI measure, the MMPI-2-RF (MMPI-2-RF; Ben-Porath & Tellegen, 2008), is a restructured measure that reduced the MMPI item pool to 338 items for improved psychometrics.

Early research used the original MMPI to test development of a neurobehavioral scale, or measures consistently with external neurobehavioral correlates, although studies have not been robustly replicated (LaChapelle & Alfano, 2005). MMPI-2 research with TBI patients has also been helpful to obtain consensus for post-TBI symptoms, such as emotional lability, anhedonia, and social and interpersonal hypersensitivity (Tsushima & Tsushima, 2009; Hessen & Nestvold, 2009). And, although embryonic, MMPI-2-RF research indicates that the shortened format has benefits in understanding cognitive and somatic complaints (Gervais et al., 2009). As the MMPI-2 and the MMPI-2-RF are the most updated MMPI versions and the impetus for this study, more detailed information about the MMPI-2 appears first below, followed by information about the MMPI-2-RF. More detailed psychometric and scoring information about the MMPI-2 and MMPI-2-RF versions appear in the Measures section.

The MMPI-2 is a 567-item true/false test that intents to measure emotional and behavioral aspects of an psychological functioning. It currently has the most research evidence for psychometrically accounting for personality factors (Greene, 1991; Lange et al., 2010). Patient MMPI-2 profiles result in Validity Scale scores to assess a respondent's test-taking attitude, Clinical Scales to assess mood and psychopathology, RC Scales to assess general personality factors, as well as interpretive scales, which include 1) Content Component Scales that represent individual items, 2) Harris-Lingoes Scales that are formulated on Clinical Scales to help interpret Clinical Scale elevations, and 3) Supplemental Scales that help interpret Validity and Clinical Scale elevations. The MMPI-2 requires a sixth-grade reading level, takes 60-90 minutes to administer with healthy patients, and reports robust psychometrics that aid in test interpretation and reliability of results for differential diagnosis (Butcher et al., 1989; 2001).

The MMPI-2-RF is an updated version of the MMPI-2, which represents re-factor-analyzed MMPI-2 items. Tellegen and Ben-Porath (2008) updated the keyed response approach of the MMPI-2 by using factor loadings to remove aggregated data and overlapping items. Tellegen et al. (2003) claimed that the MMPI-2 empirical keyed response approach tended to elongate patient test-taking, and also statistically resulted in inflated scale intercorrelations and dissimilar item content across MMPI-2 Clinical and RC Scales.

In particular, Tellegen and Ben-Porath (2008) removed redundant MMPI-2 test items that multi-loaded across scales as a first-order "demoralization" factor.

Demoralization was defined as reported attributes of "discouraged, helpless, having low self-esteem, or having failed in various aspects of their lives, and despairing" (Tellegen & Ben-Porath, 2008, p. 4). The substantive scales were also validated with external correlates across a range of settings, such as forensic, outpatient, and psychiatric inpatient milieu (Ben-Porath & Tellegen, 2008).

As a result, MMPI-2-RF psychometric changes have four main perceived benefits to psychometrically account for personality in a TBI population. First, the MMPI-2-RF has perceived practical advantages over the MMPI-2 because of its lower cognitive functioning requirements of a fifth-grade reading level, as well as its shortened 338-item format that takes an estimated 35-50 minutes to administer with healthy populations (Tellegen & Ben-Porath, 2008). Second, Tellegen and Ben-Porath (2008) suggest that the revised MMPI-2-RF Validity Scales are more psychometrically sensitive to somatic responses, overreporting and underreporting of symptoms, and psychopathological distress. At the time of this study, the MMPI-2-RF included revised versions of the MMPI-2 Validity Scales and a new Fs Validity Scale (Infrequent Somatic Responses), which Tellegen and Ben-Porath claim better statistically account for lower cognitive functioning in measuring aforementioned test-taking attitude patterns.

Third, Tellegen and Ben-Porath (2008) claim that the MMPI-2-RF RC Scales, in lieu of both the MMPI-2- Clinical and Content Scales, adequately account for general personality factors. As mentioned, Tellegen and Ben-Porath removed the MMPI-2 Clinical Scales because of statistically inflated scale intercorrelations due to test length

and item redundancy with multiple factor loadings, which resulted in a broad factor of "general maladjustment and subjective distress" (Rouse, Greene, Butcher, Nichols, & Williams, 2008, p. 435), or "demoralization" (Tellegen et al., 2003).

Fourth, the MMPI-2-RF, offers 28 new substantive scales, which include 23 new Specific Problems Scales to measure specific psychological concerns, three Higher-Order Scales (H-O) to as complementary diagnostic indicators to RC scale elevations and replace MMPI-2 codetype interpretations (Greene, 1991), and two Interest Scales that replace the MMPI-2 masculinity/femininity trait scales as indicators of hobbies or interests and general environmental connection. Additionally, five revised Personality Psychopathology Five (PSY-5) Scales represent dimensions of personality functioning (Ben-Porath & Tellegen, 2008; Harkness & McNulty, 1994).

One of the Specific Problems Scales, the Somatic/Cognitive Scales, includes five scales that most align with commonly reported symptoms in TBI sequelae. They include malaise, or poor health and physical debilitation (MLS); gastrointestinal complaints (GIC), such as appetite changes, and stomach upset; head pain complaints (HPC), or pre-occupation with head and neck pain, particularly when under stress; neurological complaints (NUC), such as tingling or numbness, spasms and dizziness; and cognitive complaints (COG), including disorientation, concentration, and memory difficulties. And more specifically, MMPI-2-RF validity studies concluded that the Somatic/Cognitive Scales did an adequate job of detecting self-inflated emotional, cognitive, and behavioral

problems in lower cognitive functioning populations (Gervais et al., 2009; Locke et al., 2010; Tellegen & Ben-Porath, 2008).

However, with MMPI-2-RF, there have been questions about its clinical utility with different populations. In developing the MMPI-2-RF, Tellegen and Ben-Porath called for instrument validation across a variety of clinical settings, and as a result, MMPI-2-RF research to-date has largely focused on incremental validity and group comparison studies (Tellegen & Ben-Porath, 2008). The next section will review some of the research studies conducted with TBI patients that appear to inform MMPI-2-RF research needs.

Personality research using MMPI-2 and MMPI-2-RF versions.

Research broadly suggests that the MMPI-2 and MMPI-2-RF have robust abilities to differentiate personality functioning domains (Butcher et al., 2001; Ben-Porath & Tellegen, 2008). Tellegen and Ben-Porath (2008) suggest that the MMPI-2-RF scales are more psychometrically sensitive than the MMPI-2, specifically to test-taking attitudes, special problems of cognitive and physical symptoms, interpersonal functioning, and psychopathology factors. Tellegen and Ben-Porath (2008) base these comments on group comparison studies in outpatient mental health centers, U.S. Dept. of Veterans Affairs psychiatric inpatient settings, and outpatient and substance abuse treatment centers, disability claimants, criminal defendants, and college students. At the time of this study, many of these results were pending publication in peer-reviewed journals or presented in conference papers. Additionally, while similar research evidence about head injury and

litigating TBI patients existed with forensic populations, validity evidence for the MMPI-2-RF with non-litigant TBI patients participating in rehabilitation was not available. Therefore, research is warranted (Gervais et al., 2010; Youngjohn et al., 2011).

A review of the MMPI-2, MMPI-2-RF, and TBI literature appeared to suggest three main research agendas for determining if the MMPI-2-RF is better suited for a TBI population. First, a group comparison study specifically conducted with a TBI population not participating in litigation or disability claims would provide evidence for its usefulness (Reitan & Wolfson, 1997; Thomas & Youngjohn, 2009). Second, exploring test response patterns and the performance of the general personality functioning measures may best be achieved by comparing MMPI-2 and MMPI-2-RF Validity Scales and RC Scales (Arbisi & Ben-Porath, 2004; Gervais et al., 2009; Gervais et al, 2010). Third, examining MMPI-2-RF personality measures with external cognitive functioning correlates would be diagnostically helpful to differentiate the role of personality on somatic functioning and complaints (Gervais et al., 2009), and advance the literature on how the MMPI-2-RF captures these dimensions with a TBI sample.

As mentioned, research has explored the clinical utility of the MMPI-2 and MMPI-2-RF versions across a wide range of settings, including, veterans, medical outpatients, and psychiatric inpatients. The following information provides a broad summary of MMPI-2 research, followed by a discussion of MMPI-2-RF research.

MMPI-2 studies have built evidence for the MMPI-2 Validity Scales as indicators of malingering and overreporting of symptoms in forensic settings, or disability claimant

and financial compensation cases. Thomas and Youngjohn (2009) established correlations between the MMPI-2 Validity, RC, and Clinical Scales in a litigant TBI population, and found an inverse relationship between the MMPI-2 Validity Scales and TBI severity when examining mild and moderate to severe TBI patients for effort. This finding suggested that as item endorsement and symptom exaggeration increased, injury severity ratings decreased in a TBI sample, or that more symptoms were reported by the more mildly injured patients participating in litigation. Interestingly, Thomas and Youngjohn (2009) concluded that RC3 (cynicism), a scale indicating mistrust and interpersonal hostility, was not a malingering or somatization indicator for many patients, regardless of injury severity. Additionally, Greiffenstein and Baker (2008) found a positive relationship between Validity Scale response bias measures, neurogenic amnesia, and complex re-experiencing PTSD symptomology with long-term disability TBI patients.

Only a few studies have specifically assessed the role of personality functioning on cognitive performance in a non-litigant TBI population. While some studies have demonstrated that invalid MMPI-2 response sets are common with TBI patients, Martens et al. (2001) also concluded that invalid response sets correlated with lower cognitive functioning and pre-morbid psychiatric and substance abuse histories with their sample of litigating TBI patients. However, studies that link these response patterns have not been robustly replicated with non-litigant TBI patients. Additionally, in examining archival data of two outpatient mild TBI samples, Ruttan and Heinrichs (2003) found that

depression indicators on the MMPI-2 and MCMI-III were not statistically significant mediators of cognitive deficits in non-TBI patients when analyzed with external correlates of the Halstead Category Test, and the Weschler Memory Scales-Revised (WMS-R). In other words, the researchers concluded that cognitive complaints were not confounded with mood symptoms in the non-litigating sample, as they appeared to be for disability samples.

Personality researchers have explored ways to correct for neurological concerns. Researchers attempted to establish a neurologically related item (NRI) correction (Arbisi & Ben-Porath, 1999), as well as create MMPI neurobehavioral scales (LaChapelle & Alfano, 2005). Both research studies intended to take cognitive deficits typically associated with brain injury into account when psychometrically accounting for personality. Additionally, researchers explored predictive discriminant validity for the original MMPI neurobehavioral scales with TBI and spinal cord injury patients (LaChapelle & Alfano, 2005). However, these research studies have neither been replicated with healthy control groups, nor with MMPI-2 or MMPI-2-RF versions. The correction factors for genuine neurological factors and emotional functioning with status-post TBI patients were deemed questionable at the time, possibly due to measurement errors and embryonic research agendas with the population (Arbisi & Ben-Porath, 1999; Alfano, Paniak, & Finlayson, 1993).

Personality researchers have also examined injury severity measures as predictors for MMPI-2 Clinical Scale elevations, although inconclusive. Most studies have tended

to generally assess for personality-cognitive links using severity groupings and select MMPI-2 Clinical Scale scores, although not specifically with ranges of adult TBI diagnoses, and without replication.

For example, Hessen and Nestvold (2009) tracked patients in Norway more than two decades after a mild pediatric TBI diagnosis to explore personality differences and post-concussive symptoms. They found that posttraumatic amnesia greater than 30 minutes predicted an abnormal elevation of the MMPI-2 Hysteria (Hy) Scale in adults 23 years later. The MMPI-2 Hy Scale reflects somatic symptoms in head, arms, and legs, as well as perceived socialization and social adjustment (Butcher et al., 2001; Greene, 1991). However, Wooten (1983) examined a sample of outpatient and inpatient brain injury patients (active duty males, and military spouses) referred to neuropsychological testing for unreported reasons, and did not find any statistically significant evidence linking MMPI-2 results with brain injury severity and localization.

Other personality-cognitive studies have examined the role of neurobehavioral functioning, brain injury severity, and select MMPI-2 Clinical Scale measures. Kruezter, Marwitz, Seel, & Serio (1996) examined neurobehavioral correlates between MMPI-2 Clinical Scales, (1) hypochondriasis, (2) depression, (3) hysteria, (7) psychasthenia, and (8) schizophrenia, and the six NFI scales of depression, somatic complaints, communication, attention/concentration, motor skills, and aggression (NFI; Kruezter, Seal & Marwitz, 1999). They concluded that neurobehavioral problems tended to be highly correlated with psychological concerns, or patients who reported more

neurobehavioral problems also reported more psychological distress on the five MMPI-2 Clinical Scales selected for the study.

Using MMPI and MMPI-2 foundations, personality researchers have explored the performance of the MMPI-2-RF with forensic populations. As mentioned, available evidence from Tellegen and Ben-Porath (2008) stated that MMPI-2-RF validity studies have focused on group comparison studies across a range of settings and conditions, such as forensic head injury patients participating in disability claims or legal proceedings, out-patient military veterans, and psychiatric patients. However, no known discussion of this research task with TBI patients has been published in peer-reviewed journals for group comparison.

Group comparison studies have advanced understanding about MMPI-2-RF psychometric performance with personal injury and disability claimants with head injuries (Wygant et al., 2007; Sellbom et al., 2010), and neuropsychological subjects asked to feign head injury (Dearth et al., 2005). Of note, in those studies, research subjects met criteria for the legal definition of head injury, but samples tended to lack a neurological TBI diagnosis (Arbisi, 2006; Tellegen & Ben-Porath, 2008).

In similar investigations of MMPI-2-RF performance, Wygant et al. (2009) concluded that the MMPI-2-RF Validity Scales showed incremental validity to detect overreporting or malingering in head-injured and simulated head-injured samples. Further, Gervais et al. (2010) compared select MMPI-2-RF items with neuropsychological memory criterion measures (The Memory Complaints Inventory, and

the California Verbal Learning Test, 2nd Edition) in a forensic disability sample. They found evidence for a Response Bias Scale, suggesting that select MMPI-2-RF items were incrementally effective in predicting subjective memory complaints. At the time of this study, the RBS, or the Response Bias Scale, was an experimental index to capture test-taker attempts of exaggerated symptom reporting.

Additionally, in studying the role of personality with personal injury and disability claimants, Gervais, Ben-Porath, and Wygant (2009) found a positive relationship between the COG facet scores of the Somatic/Cognitive Scales (as subjective cognitive and mood complaints) when analyzing MMPI-2-RF subscale measures with traditional neuropsychological measures of intelligence, achievement, memory, and symptom validity. Gervais et al. (2009) suggested that examining invalid sets due to lower cognitive functioning is accomplished by examining correlates between the new MMPI-2-RF Somatic/Cognitive Scales with Validity Scales, and external correlates of neurobehavioral functioning. Since the MMPI-2-RF Somatic/Cognitive Scales are new, similar evidence with a TBI population was not available for comparison at the time of this study. One independent study about MMPI-2-RF performance with a specific medical population was available in peer-reviewed journals at the time of this investigation. Discussion of this study's results follows.

Locke et al. (2010) examined the clinical utility of the MMPI-2-RF in an epilepsy medical monitoring unit by conducting group comparisons between diagnosed epilepsy patients, and diagnosed psychogenic non-epileptic seizures (NES) patients. They

conducted diagnostic MANCOVA group comparisons, and found incremental validity for the MMPI-2-RF RC1 Scale (somatic complaints) with the epilepsy patients compared to the MMPI-2 RC1 scale. They conducted sensitivity/specificity and likelihood analyses for effect sizes; they also used available medical histories to predict MMPI-2-RF scores using hierarchical regression analysis.

When examining the descriptive statistics, the researchers found that NES patients reported higher elevations in three key domains: 1) MMPI-2-RF Validity Scale indicators, Fs and FBS-r (indicating exaggeration of symptoms), 2) MMPI-2-RF RC Scale RC1 (somatic complaints), and 3) the Somatic/Cognitive Scales of malaise (MLS), gastrointestinal complaints (GIC), head pain complaints (HPC), neurological complaints (NUC), and the Internalizing Scales (INF). These results suggested that patients with psychogenic diagnoses reported more somatic, cognitive, and personality functioning complaints than patients with a medical diagnosis of epilepsy alone.

Chapter Three: Methods

Research Questions

The following section reviews the study's research questions, followed by a review of study participants and measures. The study explored incremental validity (i.e., validation and performance of an updated test measure) of the shortened MMPI-2-RF with a non-litigant TBI population to assess the measure's ability to account for cognitive test-taking demands while producing adequate psychometric floors to detect personality functioning.

The main analyses of this study were twofold. First, the study aimed to explore internal consistency reliability and construct validity of the MMPI-2-RF with a TBI population to detect test-taking attitudes and general personality functioning, and determine whether Validity Scales were largely interchangeable across versions when compared to other groups. Second, the study aimed to examine criterion validity with external correlates of neurobehavioral and neuropsychological functioning to better understand scale performance.

For the first goal, research questions 1 and 2 analyzed reliability and construct validity by examining (a) internal item consistency and (b) correlations between the MMPI-2 to MMPI-2-RF Validity Scales and MMPI-2-RF Validity and RC Scales.

For the second goal, research questions 3 and 4 examined criterion validity in two distinct ways with the MMPI-2-RF Somatic/Cognitive Scales. The study examined MMPI-2-RF scales with external measures of (1) subjective neurobehavioral functioning

and (2) objective neuropsychological functioning. The goal of these analyses was to explore the measure's performance, or its ability to detect subjective and objective cognitive functioning in the TBI sample. Tellegen and Ben-Porath (2008) have suggested that the Somatic/Cognitive Scales provide insightful information about specific problems about malaise, gastrointestinal, head pain, neurological, and cognitive complaints; further, research evidence has indicated that the COG facet of the Somatic/Cognitive Scale provide insightful information about subjective cognitive and emotional complaints with test-takers (Tellegen & Ben-Porath, 2008; Gervais et al., 2009; Gervais et al, 2010).

This approach was consistent with the literature on incremental validity procedures outlined by Haynes and Lench (2003) to examine 1) zero-order correlations and validity coefficient cut-offs to illuminate convergent/discriminant (construct) of scale performance, and 2) run regression models to better understand measure performance with external correlates and understand variable relationships and measurement variance. Tellegen and Ben-Porath (2008) expressed incremental validity goals for the MMPI-2-RF to better demonstrate psychometric properties and "efficiency" over previous MMPI versions to measure personality functioning (p. 11). Further, in their meta-analysis of incremental validity research, Haynes & Lench (2003), stated that "incremental validity supplements traditional psychometric dimensions of content, convergent, predictive, discriminant, and other forms of validity because it addresses the performance of a measure relative to others" (p. 456) to provide additional information to the measurement context than previous versions.

Research question 1 - reliability.

Is the MMPI-2-RF a reliable version of the MMPI-2, as demonstrated by a Cronbach's alpha, or measure of overall internal consistency?

Research question 2 - construct validity.

Does the MMPI-2-RF demonstrate incremental validity from the MMPI-2 to evaluate test-taking attitudes and general personality functioning? Will psychometrics between the MMPI-2 to MMPI-2-RF Validity Scales and the MMPI-2-RF Validity to Restructured Clinical Scales demonstrate that the MMPI-2-RF Validity Scales function similarly to the MMPI-2, or provide additional information?

Research question 3 - criterion validity/measure performance.

How will the MMPI-2-RF perform in detecting subjective symptomology in TBI sequelae? Will neurobehavioral complaints, as indicated by empirical correlates of the NFI subscales of 1) depression, 2) somatic, 3) memory/attention, 4) communication, 5) aggression, 6) motor functioning problems be good predictors of MMPI-2-RF Somatic/Cognitive Scales of malaise (MLS), gastrointestinal complaints (GIC), head pain complaints (HPC), neurological complaints (NUC), and cognitive complaints (COG)?

Research question 4 - criterion validity/measure performance.

How will the MMPI-2-RF perform in detecting objective symptomology in TBI sequelae? Will neuropsychological measures, including the four WAIS-IV composite indexes (i.e., FSIQ, WMI, PSI, PRI), the WMS-IV Auditory & Visual Memory (subtests of Logical Memory I/II and Visual Reproduction I/II), and The Booklet Category Test, be

good predictors of MMPI-2-RF Somatic/Cognitive Scales of malaise (MLS), gastrointestinal complaints (GIC), head pain complaints (HPC), neurological complaints (NUC), and cognitive complaints (COG)?

Participants

In this study, an archival dataset of 60 post-acute care non-litigant TBI patients between the ages of 17 and 60 was examined. Patients were TBI patients admitted to post-acute rehabilitative care in a Central Texas to access recovery services in physical, occupational, speech or other therapies. As part of standard practice at the rehabilitation facility, all participants completed an objective neuropsychological battery that assessed intellectual functioning, reading ability, sensorimotor performance, memory, attention/concentration, and executive functioning. Patients also completed subjective self-report measures of stress-preventive coping abilities, personality functioning, and neurobehavioral functioning.

Patients whose MMPI-2 test results in the database were invalid (as evidenced by MMPI-2 validity indices) were excluded from the study. Using T-score cutoffs for the MMPI-2 Validity Scales specified in the *Manual for Administration, Scoring, and Interpretation* (Butcher et. al, 2001), approximately 78% of the eligible participants produced a valid profile. Further, using T-score cutoffs for the MMPI-2-RF Validity Scales specified in the *Manual for Administration, Scoring, and Interpretation* (Ben-Porath & Tellegen, 2008), approximately 70% of the eligible participants produced a valid profile, for a final sample of 60. There were no additional exclusionary criteria.

The sample was 80.0% male, 88.3% Caucasian, 10.0% Hispanic, and 1.7% Asian. Individuals averaged 13 years of education (*SD* = 2.65), and the average age was 36 (*SD* = 15.34). English was the first language with the sample. Using the Russell Scale for injury severity (Table 1), 13.4 % of the participants met criteria for very mild to mild TBI, 13.3% met criteria for moderate TBI, and 73.4% met criteria for severe to very severe TBI (Russell, 1971).

Table 1.

Traumatic brain injury severity ratings

Duration of posttraumatic amnesia	Diagnostic category	Percentage
Less than five minutes	Very Mild	11.7
5 minutes to 1 hour	Mild	1.7
1 to 24 hours	Moderate	13.3
1 to 7 days	Severe	31.7
Greater than 7 days	Very Severe	41.7

Note. Russell, 1971

Average posttraumatic amnesia, or first recalled memory post-injury, was 12.23 days (reported minimum = absent; maximum = 55 days). Average days post-injury to evaluation was 85.75 days (reported minimum = 8; maximum = 1460). The majority of the sample (61.7%) reported TBI etiology due to motor vehicle, motorcycle, or cycling accidents, followed by TBI etiology due to fall from standing, or fall greater-than-standing (23.3%), and assault, sports, gunshot, or blunt force trauma (15.1%).

The WAIS-IV was used to assess intellectual functioning level, which was low average for the sample (M = 84.10; SD = 11.14). The WRAT-4 was used to assess reading level, which was average (M = 96.14; SD = 11.97).

Measures

The figure below is a chart to illustrate the study measures. The left column lists study measures used for research questions 1 and 2 (reliability and construct validity). The right column lists measures used for research questions 3 and 4 (criterion validity/measure performance).

Research questions 1 & 2	**Research questions 3 & 4**
Internal Consistency Reliability MMPI-2-RF items **Test-taking attitudes** MMPI-2 Validity Scales MMPI-2-RF Validity Scales **General personality factors** MMPI-2-RF Validity Scales MMPI-2-RF Restructured Clinical Scales (RC)	**Somatic/Cognitive Functioning** MMPI-2-RF Special Problems Somatic/Cognitive Scale **Neurobehavioral Functioning** Neurobehavioral Functioning Inventory (NFI) **Memory** Auditory and Visual Memory Subtests (WMS-IV) **Attention/Concentration** Working Memory Index (WAIS-IV) **Executive Functioning** The Booklet Category Test (BCT) **Intellectual Functioning** Composite Indices (WAIS-IV)

Figure 1. Study measures utilized to answer research questions.

The next section describes study measures in two sections, (1) personality measures, and (2) neuropsychology and neurobehavioral measures.

Personality Measures.

Minnesota Multiphasic Personality Inventory-2 Restructured Form (MMPI-2-RF; Ben-Porath & Tellegen, 2008). The MMPI-2-RF is an updated 338-item version of the MMPI-2 that intends to measure the emotional and behavioral aspects of an individual's psychological functioning. The MMPI-2-RF was psychometrically restructured to remove overlapping and redundant test items that inflated interscale correlations.

Response profiles results in eight validity scale scores to assess a respondent's test-taking attitude (from seven on MMPI-2), and nine RC Scales to assess general personality factors (scale names are the same from MMPI-2 to MMPI-2-RF). The MMPI-2-RF also produced 28 new substantive scales, which include three Higher-Order Scales to track emotional, thought, and behavior pathology, 23 Specific Problem Scales that target somatic/cognitive complaints, and two interest scales. Additionally, the test offers five revised personality pathology scales. Raw scores are converted to T-scores for interpretation. T-scores above 80 on VRIN-r and TRIN-r Validity Scales are considered invalid profiles for interpretation, whereas T-scores above 70 on VRIN-r and TRIN-r should be interpreted cautiously (Ben-Porath & Tellegen, 2008; Handel et al., 2010). Additionally, T-scores of L-r > 80, and F-r, Fp-r, Fs, FBS-r > 100 are likely invalid for interpretation. T-scores on L-R > 65 and K-r > 60 suggest underreporting, and are interpreted in the context of VRIN-r and TRIN-r scores.

T-scores above 65 on the RC Scales and Special Problems Scales are considered clinically significant elevations. Individual scales may also have interpretation ranges for

lower T score values. Long-term test-retest reliabilities range from .57 to .92. Several studies have shown evidence for construct validity of the MMPI-2-RF for somatic and cognitive functioning, general personal factors, psychopathology, and neurocognitive dysfunction with psychiatric patients, disability claimants, criminal defendants, and medical outpatients (Tellegen & Ben-Porath, 2008).

Minnesota Multiphasic Personality Inventory, 2nd Edition (MMPI-2; Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989). The MMPI-2 is a 567-item true/false test that is intended to measure the emotional and behavioral aspects of an individual's psychological functioning. Response profiles results in Validity Scale scores to assess a respondent's test-taking attitude, Clinical Scales to assess mood and psychopathology, Restructured Clinical Scales to assess general factors, as well as scores on three interpretive scales: 1) Content Component Scales, 2) Harris-Lingoes Scales, and 3) Supplemental Scales. Raw scores are converted to T-scores for interpretation. T-scores above 80 on VRIN and TRIN Validity Scales are considered invalid profiles for interpretation. Additionally, T-scores of L > 65, F, Fb > 100, K > 70, Fp > 100 are likely invalid for interpretation. A number of studies have shown construct validity for the MMPI-2 scales in measuring overreporting, psychopathology, and general personality factors (Butcher et al., 2001). T-scores > 65 on the Clinical Scales are considered clinically significant elevations.

Neuropsychological and Neurobehavioral Measures.

The Booklet Category Test, 2nd Edition (BCT; DeFilippis, M. A. & McCampbell, E., 1997). The BCT is a version of the Halstead Category Test that is designed to detect diffuse brain injured patients from non-brain injured patients. The test is a corrective-feedback task of concept formation and abstract reasoning with geometric patterns. Patient performance is measured in total errors of failing to shift mental sets and correctly identify the reasoning pattern; a higher score indicates greater impairment. Total errors are converted to a T-score for interpretation. T-scores on The BCT provide comparable scores to the parent version. Test-retest reliability at approximately three weeks was r = .913 in normal patients, r = .804 with alcoholic patients, and adequate levels of reliability with psychiatric patients, r = .700. Research shows strong validity evidence to distinguish patients with general neurological dysfunction (including patients with neurological syndromes, and diagnosed personality disorders and schizophrenia without brain damage) from normal patients (DeFilippis & McCampbell, 1997).

The Neurobehavioral Functioning Inventory, Patient Form (NFI; Kreutzer, Seel, & Marwitz, 1999). The NFI is a 76-item self-report inventory that asks patients to rate commonly experienced neurobehavioral symptoms and problems after TBI on a five-point Likert Scale from "never" to "always." The NFI results in six respective scores of depression, somatic, memory/attention, communication, aggression, and motor skills functioning. Raw scores are converted to T-scores for interpretation based on age, loss of consciousness. Descriptive ranges are from very high (> 1.5 SD above the mean) to very

low (> 1.5 SD below the mean). Below average T-scores (low to very low) indicate a resistance to report symptoms, or an attempt to present symptoms in a positive light, and possible agency with treatment compliance. Above average T-scores (high to very) indicate a possible use of compensatory strategies, or exaggeration and negative presentation of symptoms for secondary gain. The internal consistency reliability estimates ranged from $r = .86$ to $r = .95$ with an estimate for all items exceeding $r = .97$. No test-retest information is available. Studies have shown evidence for construct validity for depression, somatic, memory/attention, communication, aggression and motor difficulties with patients experiencing neurological disabilities (Kreutzer, Seel, & Marwitz, 1999).

Wechsler Adult Intelligence Scale, 4th Edition (WAIS-IV; Wechsler, 2009a). The WAIS-IV is the most widely used neuropsychological test of intellectual functioning. The WAIS-IV Full Scale Intelligence Quotient is comprised of the Verbal Comprehension Index (Vocabulary, Similarities, and Information subtests), the Perceptual Reasoning Index (Block Design, Matrix Reasoning, Visual Puzzles subtests), the Working Memory Index (Digit Span and Arithmetic), and the Processing Speed Index (Symbol Search and Coding subtests). Raw scores are converted to Scaled Scores for subtest interpretation, and Standard Scores for composite interpretations. Higher scores indicate the ability to complete tasks with increasing difficulty. Test-retest reliability for the WAIS-IV scales at one week to 11 weeks was $r = .88$. Studies have shown evidence for construct validity of

the WAIS-IV indices with a range of TBI severity, including a moderate effect size for subtests that surpassed Cohen's large effect size cutoff (r = .78) (Wechsler, 2009a).

Wechsler Memory Scales, 4th Edition (WMS-IV; Wechsler, 2009b). The WMS-IV is designed to test auditory and visual memory. Logical Memory subtests require a patient to listen to prose passages, and provide immediate recall and 20-minute delay recall (cues are given, if needed). Raw scores are converted to Scaled Scores for subtest interpretation, and Standard Scores for composite interpretations. Higher scores indicate better retention and recollection. Visual Reproduction subtests require a patient to copy five designs of increasing complexity, and recall and reproduce the same designs after a 20 minute delay. Raw scores are converted to Scaled Scores for subtest interpretation, and Standard Scores for composite interpretations. Higher scores indicate better retention and recollection. Test-retest reliabilities at approximately 10 weeks ranged from r = .64 to r = .76. Studies show evidence for construct validity with a range of TBI severity, with moderate effect sizes reported for Logical Memory and Visual Reproduction immediate recall subtests (r = .5 to .8), large effect sizes for Logical delayed recall subtests (r <.8) (Weschler, 2009a).

Wide Range Achievement Test, 4th Edition (WRAT-4; Wilkinson & Robinson, 2006). WRAT-4 subtests are designed to test reading, math, and spelling ability. The WRAT-4 Word Reading subtest detects decoding abilities to identify and read words; patient performance is recorded in total points for correctly read words. Raw scores are converted to Standard Scores for interpretation. Higher scores indicated better word

recognition, and are correlated with higher reading levels and education. Reading test-retest composite scores ranged from .95-.96 by grade. Alternate form test-retest reliabilities ranged from .78 to .89 for an age-based sample and from .86 to .90 for a grade-based sample.

Chapter Four: Results

The focus of this study was to use archival data to explore the incremental validity and subsequent clinical utility of the MMPI-2-RF with a non-litigant TBI population. The sample participated in neuropsychological assessment as part of standard, status-post TBI rehabilitation care. The literature suggests that there are several goals and methods for conducting an incremental validity analysis. This study was conducted in accordance with the principles outlined by Haynes and Lench (2003) and Hunsley and Meyer (2003) about examining both construct and criterion validity with an updated measure to test psychometric performance. Therefore, this study focused on construct validity of test-taking attitudes and general personality factors of the MMPI-2-RF, as well as criterion validity of the MMPI-2-RF Somatic/Cognitive Scale with neurobehavioral and neuropsychological measures.

Data Analysis

A secondary data analysis was conducted with a fixed sample dataset of 60 subjects. A secondary data analysis uses existing data to test out a new social science research direction apart from the original intention for data collection (Mochmann, 2011).

Prior to the formal analysis, a power analysis was conducted. Guidelines differ on power analysis for studies with a small, fixed sample size. Some researchers suggest a power analysis is "less needed when: secondary data analysis; post-hoc power, and pilot study to assess effect" (Kershaw, 2011, p. 6). Other researchers suggest "*a priori* power analyses are useless when *N* is fixed" and post-hoc power analyses with a small, fixed

sample are "of little use, because there is no clue as to which [alpha] level is reasonable given the limited sample size and the size of the effect to be detected" (Erdfelder, Faul, & Buchner, 1996, p. 2).

As one remedy, Erdfelder et al. (1996) suggested that a compromise power analysis is appropriate with a small, fixed sample dataset; a compromise power analysis allows the researcher to "specify the size of the effect to be detected, the maximum possible sample size, and the ratio $q:=\beta/\alpha$" (p.2). Faul, Erdfelder, Lang, & Buchner (2007) warned that "compromise power analyses can easily result in unconventional significance levels greater than .05 (in the case of small samples or effect sizes)," but further advise that "the benefit of balanced Type I and Type II error risks often offsets the costs of violating significance level conventions" (p. 177). In accordance with these principles, a compromise power analysis was conducted to determine an optimum critical value using G*Power (Erdfelder et al., 1996; Faul et al., 2007).

The first compromise analysis indicated that a total sample of 60 subjects would detect large effects (Pearson r =.5) with 97% power using a one-sample t-test point biserial correlation model with alpha at ~.05 (Cohen, 1988). The second compromise power analysis indicated that a total sample of 60 subjects would detect large effects (Cohen's f^2=.35) with 95% power using linear multiple regression fixed model (four predictors) and alpha at .05 (Cohen, 1988).

Based on the exploratory nature and research questions of the study, multiple analyses were conducted. Thus, based on the findings of the compromise power analysis,

it was acknowledged that any findings of this exploratory study were subject to measurement error due to sample size limitations. These limitations will be explored further in the Discussion section.

Additionally, a preliminary analysis of assumptions was conducted to explore data normality, linearity, and homogeneity of variance. The MMPI-2 data was scored by computer in Q-Local software. MMPI-2 profiles were retrospectively scored, or converted, using the Pearson MMPI-2-RF converter. MMPI-2 and MMPI-2-RF converted scores were transferred into SPSS for analysis. A Levene's test for the equality of variance indicated that population cell variances for objective neuropsychological tests of memory were unequal. However, a case analysis, as well as an inspection of plots, descriptive statistics, and data comparisons of standardized residuals, indicated that no observations altered the main study findings.

To answer the first research question about reliability for the shortened MMPI-2-RF in comparison to the MMPI-2, an internal consistency analysis was conducted using Cronbach's coefficient alpha (Nunnally, 1978). This approach is consistent with the literature that reliability must be established in order to examine measure performance (Kline, 2005). Similarly, Tellegen and Ben-Porath (2008) used an internal consistency correlation to compare MMPI-2 and MMPI-2-RF versions.

To answer the second research question, zero-order correlation matrices were constructed between the (a) MMPI-2 to MMPI-2-RF Validity Scales, and (b) MMPI-2-RF Validity Scales to MMPI-2-RF Restructured Clinical Scales to explore whether the

MMPI-2-RF was a valid, shortened alternative to the MMPI-2 with the sample. Analysis was conducted to compare the magnitude of correlations between versions, as well as to compare group study correlations specified in the MMPI-2-RF *Technical Manual* (Tellegen & Ben-Porath, 2008). Further, Ben-Porath and Tellegen (2008) state that establishing MMPI-2-RF Validity Scale performance is a critical step because validity scales "must be considered before scores on the substantive scales of the test are interpreted" (p. 26). Additionally, follow-up hierarchial regression analyses were conducted to examine variable and predictor relationships of the symptom validity (FBS-r) and new non-credible somatic symptom (Fs) scales. Last, mean T-scores were analyzed to determine if clinical elevations impacted results.

As noted, many analysis methods are possible, and this study was the first known investigation of the MMPI-2-RF with a TBI sample. Therefore, the study followed incremental validity theory and the extant literature regarding analysis of MMPI-2-RF validity and measurement properties. Study methods were consistent with general approaches to analyzing performance of measures, and specifically, the MMPI-2-RF in group comparison studies of psychiatric, outpatient mental health, and simulated litigant and non-litigant neuropsychological populations (Arbisi & Ben-Porath, 1998; Dearth et al., 2005; Sellbom et al., 2005; Wygant et al., 2007). In general, studies (a) reviewed MMPI-2 to MMPI-2-RF interscale correlations, (b) ran regression analysis on statistically significant relationships to test models and scale performance, and (c) examined descriptive statistics in according with the MMPI-2-RF *Technical Manual* for any

clinically significant elevations on measurement scales to determine general study sample trends (Arbisi & Ben-Porath, 1998; Dearth et al., 2005; Garb, 2003; Haynes & Lench, 2003; Hunsley & Meyer, 2003; Sellbom et al., 2005; Wygant, et al., 2007).

After acceptable ranges of reliability and validity correlations were analyzed with the MMPI-2-RF Validity Scales, criterion validity analyses were conducted to answer the third and fourth research questions. These procedures were conducted in accordance with (a) reliability theory (Nunnally, 1978; Kline, 2005), (b) incremental validity theory for validation of an updated measure (Cohen, 1988; Garb, 2003; Haynes & Lench, 2003; Hunsley & Meyer, 2003), and (c) information reported in the MMPI-2-RF *Technical Manual* (Tellegen & Ben-Porath, 2008). Descriptive statistics were also analyzed.

In summary, first, a zero-order correlation matrix was constructed between the five MMPI-2-RF Somatic/Cognitive Scales and the six NFI neurobehavioral measures of depression, somatic functioning, memory, communication, aggression and motor functioning. Second, a zero-order correlation matrix was constructed between MMPI-2-RF Somatic/Cognitive Scales and neuropsychological measures of WAIS-IV Indices; WRAT-4; WMS-IV LM I & II, VR I & II; and BCT total error scores. Next, multiple regression analysis was conducted on the statistically significant correlations from each matrix to both test predictive models and account for variance between the model's MMPI-2-RF, and neurobehavioral and neuropsychological variables. A report of the results follows according to each research question. Additional review and interpretation of these results appears in the Discussion section.

Research question 1: Reliability - internal consistency.

The first research question addressed whether the restructured 338 MMPI-2-RF test items would demonstrate internal consistency, as evaluated by Cronbach's alpha reliability coefficient. It was hypothesized that the shortened MMPI-2-RF would be a reliable and comparable measure of personality functioning with a TBI sample, which would allow for additional analysis. In analyzing item-level responses of the MMPI-2-RF with the sample, Cronbach's alpha coefficient was $r = .98$, which exceeds the minimally suggested level of .7 (Nunnally, 1978). Additionally, this value was consistent with test-retest statistics of the MMPI-2-RF (Tellegen & Ben-Porath, 2008). This finding suggested that the MMPI-2-RF items were internally consistent, comparable to the MMPI-2, and the considerably free of random measurement error (Nunnally, 1978).

Research question 2: Construct validity.

The second research question addressed whether the seven overlapping MMPI-2 to MMPI-2-RF Validity Scales and nine MMPI-2-RF RC Scales would demonstrate incremental construct validity. Table 2 presents the MMPI-2 to MMPI-2-RF Validity Scales correlations. Table 3 presents descriptive statistics of the MMPI-2-RF Validity Scales. Table 4 presents the MMPI-2-RF Validity Scale to RC Scales correlations.

In summary, for the second research question, it was hypothesized that the MMPI-2-RF Validity Scales would demonstrate adequate incremental validity from the MMPI-2 Validity Scales. To test this, an MMPI-2 to MMPI-2-RF correlation matrix was constructed to analyze the strengths of scale relationships (Table 2). This approach was

consistent with Haynes and Lench (2003) who suggested that examining the magnitudes of correlations helps to establish scale performance between versions. This approach was also consistent with extant literature methods of comparing correlations to group comparison studies (Tellegen & Ben-Porath, 2008).

The MMPI-2-RF Validity Scales analysis was conducted by assessing the magnitude of MMPI-2 to MMPI-2-RF matrix correlations using psychometric theory, such as guidelines suggested by Cohen (1998) regarding small (r = .10 to .29), medium (r = .30 to .49), and large (r =.50 to 1.0) correlations, as well as guidelines suggested by Tellegen and Ben-Porath (2008) based on group comparison studies. According to Haynes and Lench (2003) and Tellegen and Ben-Porath (2008), strong magnitudes were indications that the scales performed well, and exhibited redundancy. Additionally, for further examination, descriptive statistics were analyzed to assess study sample scale performance against relevant group comparison studies (Appendices).

Results are organized below according to traditional Validity Scale interpretation sequence of the MMPI-2-RF (Tellegen & Ben-Porath, 2008). As outlined previously, the MMPI-2-RF Validity Scales resulted in three clusters of scores for interpretation about test-taking attitudes and attention to items.

Study findings (Table 2) indicated the MMPI-2-RF Validity Scales were valid measures of (1) Inconsistent Responding Indicators (VRIN-r/TRIN-r) (2) Overreporting Indicators (F-r, Fp-r, FBS-r), and (3) Underreporting Indicators (L-r, K-r) with this TBI population.

Table 2.
Correlations - MMPI-2 to MMPI-RF Validity Scales

	VRIN-r	TRIN-r	F-r	Fp-r	Fs	FBS-r	L-r	K-r
VRIN	**.654****	.246	.338**	.238	.247	.008	-.214	-.505**
TRIN	.335**	**.470****	.504**	.404**	.402**	.206	.036	-.214
F	.549**	.365**	**.812****	.807**	.770**	.382**	-.295*	-.510**
Fb	.539**	.478**	.823**	.686**	.604**	.338**	-.281*	-.475**
Fp	.252	.327*	.501**	**.809****	.501**	.107	.156	-.159
FBS	.051	-.033	.353**	-.021	.387**	**.906****	.108	.005
L	-.351**	-.258*	-.348**	-.373**	-.324*	.041	**.891****	.576**
K	-.539**	-.329*	-.609**	-.507**	-.433**	-.145	.493**	**.876****

Note. ** Correlations are statistically significant at .01.
* Correlations are statistically significant at .05

For further analysis, descriptive statistics were examined (Table 3). The study sample performed within normal ranges of on MMPI-2 and MMPI-2-RF scales, or did not report any significant pathology or psychological distress that would impact study results (Tellegen & Ben-Porath, 2008).

Table 3.

Descriptive Statistics - MMPI-2-RF Validity Scales

	M	SD
VRIN-r	52.70	12.25
TRIN-r	57.30	9.19
F-r	57.23	15.22
Fp-r	55.48	15.69
FBS-r	53.68	12.01
L-r	60.10	12.02
K-r	52.88	10.02

Note. Means are reported as T-Scores

Accordingly, results were reported in these three cluster areas, below (i.e., inconsistent responding indicators, overreporting indicators, and underreporting indicators).

*Inconsistent Responding Indicators***.** The Variable Response Inconsistency (VRIN/VRIN-r) and the True Response Inconsistency (TRIN/TRIN-r) Scales on the MMPI-2 and MMPI-2-RF detect inconsistent responding (Butcher et. al, 1989; 2001; Ben-Porath & Tellegen, 2008). Further, the VRIN-r scale indicates the tendency to endorse items with opposite meanings, whereas the TRIN-r scale indicates the tendency to respond to items in a contradictory way (Tellegen & Ben-Porath, 2008; Handel et al., 2010).

In this study's VRIN/VRIN-r analysis, the correlation between the MMPI-2 and MMPI-2-RF with a TBI sample was r = .654. Consistent with interpretation principles outlined by Haynes and Lench (2003) and Tellegen and Ben-Porath (2008), a large magnitude correlation above .50 suggested the MMPI-2-RF adequately detected fixed and random responding patterns with this TBI sample, or exhibited adequate redundancy (Cohen, 1988). Findings of VRIN/VRIN-r analysis for this study were consistent with group comparison studies of simulated psychiatric, medical, and litigant head injury populations (Appendices). Findings were also consistent with the mean T-scores of the MMPI-2-RF VRIN-r Scale (Table 3), which indicated that the sample tended to consistently respond to test items, regardless of the prevalence of moderate to severe TBI diagnosis.

In the TRIN/TRIN-r analysis, correlations between the MMPI-2- and the MMPI-2-RF with this TBI sample were close to large magnitude, $r = .470$ (Cohen, 1988). Consistent with interpretation principles outlined by Haynes and Lench (2003) and Tellegen and Ben-Porath (2008), a medium magnitude correlation suggested the MMPI-2-RF adequately detected fixed and random responding patterns with this TBI sample. Additionally, findings of VRIN/VRIN-r analysis for this study were consistent with group comparison studies of simulated psychiatric, medical, and litigant head injury populations, which suggested adequate interchangeability (Appendices). Findings were also consistent with the mean T-scores of the MMPI-2-RF VRIN-r Scale (Table 3), which again, indicated that the sample tended to consistently respond to test items, regardless of the prevalence of moderate to severe TBI diagnosis.

*Overreporting indicators***.** The MMPI-2-RF Validity Scales have three indicators of overreporting, which include Infrequent Responses (F-r), Infrequent Psychopathology Responses (Fp-r), and Symptom Validity (FBS-r) scales (MMPI-2 counterparts F, Fp, and FBS, respectively). These three scales are measures of psychological, cognitive, and somatic symptoms complaints, and can help the practitioner understand when the respondent may either be overreporting symptoms, or have "genuine dysfunction" (Ben-Porath & Tellegen, 2008, p. 27).

In this sample, the MMPI-2 to MMPI-2-RF overreporting indicator correlations ranged from $r = .812$ (F-r) to $r = .906$ (FBS-r) (Table 2). Consistent with interpretation principles outlined by Haynes and Lench (2003) and Tellegen and Ben-Porath (2008),

these results suggested that the MMPI-2 to MMPI-2-RF scales performed in similar and adequate ways, and suggested that the scales were largely interchangeable in detecting overreporting, or exaggeration of symptoms with the TBI sample. Findings of VRIN/VRIN-r analysis for this study were consistent with group comparison studies of simulated psychiatric, medical, and litigant head injury populations (Appendices). For further examination, mean T-scores were assessed. The TBI sample reported average ranges of non-credible symptoms with FBS-r, Fp-r, and F-r (Table 3).

Underreporting Indicators. The MMPI-2-RF Validity Scales have two underreporting indicators, L-r and K-r scales, which detect respondent underreporting of symptoms or attempts to present themselves favorably and well-adjusted, and may be affected by the demands or reasons for evaluation (Ben-Porath & Tellegen, 2008). In the L/L-r and K/K-r analysis with this sample, the magnitude of the correlations between the MMPI-2 and MMPI-2-RF demonstrated a strong relationship (Table 2). Consistent with interpretation principles outlined by Haynes and Lench (2003) and Tellegen and Ben-Porath (2008), these results suggested that the underreporting scales functioned in similar and adequate ways. Findings of L/L-r and K/K-r analysis for this study were consistent with group comparison studies of simulated psychiatric, medical, and litigant head injury populations (Appendices). For further examination, mean T-scores were assessed (Table 3). The TBI population produced average T-scores on both the L-r and K-r scales, which suggested that the TBI sample did not significantly underreport any symptoms.

Restructured Clinical Scales. The second research question also hypothesized that the MMPI-2-RF Validity Scales to RC Scales would demonstrate construct validity. The RC Scales include demoralization (RCd), somatic complaints (RC1), low positive emotions (RC2), cynicism (RC3), antisocial behavior (RC4), ideas of persecution, (RC6), dysfunctional negative emotions (RC7), aberrant experiences (RC8), and hypomanic activation (RC9).

A correlation matrix was constructed to compare the relationship of MMPI-2-RF Validity Scales to the MMPI-2-RF Restructured Clinical Scales to assess the performance of the scales (Table 4).

Table 4.

Correlations - MMPI-2-RF Validity Scales to Restructured Clinical Scales

	RCd	RC1	RC2	RC3	RC4	RC6	RC7	RC8	RC9
VRIN-r	.481**	.372**	.008	.458**	.383**	.569**	.612**	.426**	.422**
TRIN-r	.263*	.157	-.250	.329*	.274*	.411**	.484**	.358**	.359**
F-r	.802**	.695**	.250	.415**	.542**	.618**	.778**	.659**	.598**
Fp-r	.485**	.402**	-.030	.563**	.510**	.582**	.608**	.604**	.529**
Fs	.594**	.665**	.179	.325*	.515**	.411**	.627**	.690**	.576**
FBS-r	.528**	.704**	.358**	-.200	-.041	.010	.375**	.235	.075
L-r	-.367**	-.063	-.194	-.167	-.496**	-.155	-.401**	-.347**	-.401**
K-r	-.720**	-.418**	-.250	-.666**	-.478**	-.547**	-.707**	-.414**	-.618**

Note. ** Correlations are statistically significant at .01

* Correlations are statistically significant at .05

For further examination, regression equations were conducted, and descriptive statistics were analyzed (Table 5). These steps were consistent with incremental validity steps taken by Tellegen and Ben-Porath (2008) in developing the MMPI-2-RF, as well as the principles outlined by Haynes and Lench (2003) to examine interrcorrelations and test

predictor relationships as part of validation for a new measure. These steps allowed for analysis of scale redundancy, variable relationships, as well as provide supporting evidence that "the new scale provides information that was formerly unavailable or less adequately obtained" (Hunsley & Meyer, 2003, p. 499). This approach was consistent with the research question to determine MMPI-2-RF performance and ability to detect personality functioning with this unique TBI sample.

Table 5.

Descriptive Statistics - MMPI-2-RF Restructured Clinical Scales

	M	SD
RCd	49.63	10.30
RC1	58.13	10.89
RC2	50.05	10.97
RC3	50.76	11.35
RC4	53.88	13.09
RC6	55.21	14.10
RC7	47.00	11.21
RC8	53.76	11.33
RC9	49.68	11.96

Note. Means are reported as T-Scores

Results are organized below in two distinct ways. First, findings are reported about general performance patterns with the MMPI-2-RF RC scales, and second, findings are reported about general performance patterns and the study's Validity Scale cluster indicators of interest.

In general, a pattern emerged that the RC Scales of RCd (demoralization) and RC7 (dysfunctional negative emotions) exhibited statistically significant correlations with all eight Validity Scales. Further, when examining performance of the Validity Scales,

three findings emerged. First, the F-r scale performed in the expected range based on the scale's intended function to compare symptom reporting with the general population. Second, the new Fs scale (non-credible somatic complaints), and the F-r, Fp-r, and FBS-r scales (overreporting and symptom validity indicators) were correlated with seven of eight Validity Scales. Additionally, correlations with the FBS-r scale were statistically significant across four MMPI-2-RF Validity Scales that measure somatic complaints and negative affect (RCd, RC1, RC2, RC7).

To better understand these results, additional examination of MMPI-2-RF RC negative affect scale correlations with MMPI-2-RF Validity Scale symptom reporting patterns were conducted. In this sample, RCd and RC7 had an inverse relationship with L-r and K-r, or the underreporting indicators, and a positive relationship with F-r, Fp-r, and FBS-r, or the overreporting indicators, with the strongest correlation relationships between symptom validity (FBS-r) and somatic complaints (RC1). As demoralization and dysfunctional negative emotions increased, underreporting tended to decrease with the sample. Alternatively stated, as reports of demoralization and dysfunctional negative emotions increased, overreporting of non-credible somatic concerns also tended to increase.

Additionally, results of the correlation matrix suggested that RC2 (low positive emotions) had a statistically significant relationship with FBS-r (symptom validity), although of medium magnitude (r = .358). As the reporting of low positive emotions increased, reports of non-credible symptoms also tended to increase with the sample.

Further, RC2 exhibited inverse relationships between contradictory answering (TRIN-r) and psychopathological symptoms (Fp-r), although not statistically significant.

In attempts to better understand the performance relationships and account for variance between the MMPI-2-RF Validity Scales and RC Scales, regressions on FBS-r and Fs were conducted. These predictors were chosen for three reasons. First, FBS-r and Fs exhibited statistically significant relationships with somatic complaint and negative affect scales, and regression helps explore variable relationships and variance that underlie measurement (Aiken & West, 1993; Stevens, 2007). Second, the Fs is a new scale intended to measure non-credible somatic complaints, which was hypothesized to provide helpful information for a TBI population over the MMPI-2. Third, the most research evidence existed at the time of the study for FBS-r as a revised scale to better detect symptom validity (Ben-Porath & Tellegen, 2008); it was hypothesized that the analysis would explore and advance the building research line of inquiry. In sum and as mentioned previously, this approach was consistent with group comparison research evidence for Fs and FBS-r scale evaluations that currently exist for a head injury population undergoing litigation or disability claims (Gervais et al., 2010; Wygant et al., 2007; Wygant et al., 2009).

A hierarchial multiple regression was conducted to assess the ability of negative affect scales (RCd, RC2, RC7) to predict reporting of non-credible somatic symptoms (FBS-r). After controlling for the influence of somatic complaints (RC1), results indicated that demoralization (RCd), low positive emotions (RC2), and dysfunctional

negative emotions (RC7) were significant predictors of symptom validity (FBS-r), $F(4, 55) = 13.40$, $p < .001$. RC factors accounted for 49% of the variance in FBS-r *(R^{Square}=.494).* The negative affect scales explained an additional 4.9% of the variance in non-credible somatic complaints, *R Square Change* = .042, *F Change* (4, 54) = 1.522. In the final model, somatic complaints (RC1) made the strongest contribution to the model (*b* = .570). Holding all other variables constant, as FBS-r increased, somatic complaint reports increased by .653, *t* (59) = 5.306, *CI* [.406, .900].

A hierarchial multiple regression was also conducted to assess the ability of negative affective scales to predict reporting consistency of somatic symptoms (Fs). After controlling for somatic complaints (RC1), the RC factors (except RC2) were significant predictors of Fs, $F(7, 52) = 15.883$, $p < .001$. RC factors accounted for 68.1% of the variance in Fs *(R^{Square} = .681).* The RC scales explained an additional 24% of the variance in Fs, *R Square Change* = .239, *F Change* (6, 52) = 6.497. In the final model, the strongest relationships were for somatic complaints (RC1) (*b* = .393), and aberrant sensory experiences (RC8) (*b* = .365). Holding all other variables constant, as Fs increased, somatic complaints increased by .623, *t* (59) = 3.950, CI [.306, .940], and aberrant sensory experiences increased by .565, *t* (59) = 3.191, *CI* [.210, .920].

An examination of the descriptive statistics (Table 5) was conducted. In accordance with guidelines in the MMPI-2-RF *Manual for Administration, Scoring, and Interpretation* (Ben-Porath & Tellegen, 2008), the sample did not report, on average, any severe pathology that interfered with daily functioning.

Research questions 3 & 4: Criterion validity

Research questions three and four addressed whether the new MMPI-2-RF Somatic/Cognitive Scales would demonstrate criterion validity with neurobehavioral and neuropsychological measures to detect subjective neurobehavioral complaints and objective cognitive performance with the sample. The following results sections are organized by each research question in accordance with steps outlined by incremental theory. Findings are described by (a) correlations between neurobehavioral measures with personality functioning, with follow-up regressions reported last, and (b) correlations between neuropsychological measures with personality functioning, with follow-up regressions reported last.

Research Question 3: MMPI-2-RF Somatic/Cognitive Scales to subjective neurobehavioral functioning

The third research question aimed to explore how the MMPI-2-RF Somatic/Cognitive Scales would perform in detecting subjective symptomology in TBI sequelae, as measured by the Neurobehavioral Functioning Inventory (NFI). The following section reports results in accordance with steps outlined by incremental theory. Results are organized below by reported findings for the correlations between neurobehavioral measures with personality functioning. Follow-up regressions are reported last.

Correlations - MMPI-2-RF Somatic/Cognitive Scales to neurobehavioral functioning

As the first step, correlation analysis was conducted to profile characteristics from MMPI-2- RF Somatic/Cognitive Scales, including malaise (MLS), gastrointestinal complaints (GIC), head pain complaints (HPC), neurological complaints (NUC), and cognitive complaints (COG) with the six NFI subscales of 1) depression, 2) somatic, 3) memory/attention, 4) communication, 5) aggression, 6) motor functioning. Table 6 presents the Somatic/Cognitive and neurobehavioral measure correlations. The strongest correlations for each neurobehavioral functioning category are bolded in the table.

Table 6.

Correlations - MMPI-2-RF Somatic/Cognitive Scales to NFI Scales

	NFI DEP	NFI SOM	NFI MEM	NFI COM	NFI AGG	NFI MOT
MLS	**.479****	**.451****	.411**	.094	.055	**.348****
HPC	.256*	.376**	.301*	.187	-.019	.205
NUC	.262*	.324*	.407**	.186	.193	.335**
GIC	.249	.347**	.394**	.015	-.103	.319*
COG	.439**	.419**	**.603****	.106	.154	.318*

** Correlations are statistically significant at .01
* Correlations are statistically significant at .05

The MMPI-2-RF Somatic/Cognitive Scales had positive correlations with four out of the six neurobehavioral functioning domains of subjective symptomology (Table 6). Study results indicated that the MMPI-2-RF Somatic/Cognitive Scales were positively correlated across the depression, somatic, memory/attention, and motor functioning scales in the TBI sample, with medium to large coefficients ranging from .256 to .603

(Cohen, 1988). There were no statistically significant relationships between communication and aggression neurobehavioral functioning domains and the MMPI-2-RF Somatic/Cognitive Scales.

Malaise, or self-reports of general poor health, as measured by the MMPI-2-RF MLS Scale, was most strongly associated with subjective neurobehavioral complaints of depression, somatic functioning, and motor skill functioning, whereas the self-report of cognitive difficulties, as measured by the MMPI-2-RF COG Scale, was most strongly associated with subjective neurobehavioral memory complaints. These results were consistent with the literature and interpretive recommendations outlined by Ben-Porath and Tellegen (2008), which suggest that the Somatic/Cognitive Scales are general indicators of mood, somatic, and motor skill functioning. Follow-up regression analyses were conducted to explore variable relationships and how well neurobehavioral measures predict MMPI-2-RF Somatic/Cognitive Scale scores.

Regression - MMPI-2-RF Somatic/Cognitive Scales to neurobehavioral functioning.

To assess the unique contribution of neurobehavioral functioning to the prediction of MMPI-2-RF Somatic/Cognitive Scale scores, regression analysis was conducted to examine how well neurobehavioral functioning of depression, memory/attention, somatic, and motor functioning would explain or predict personality measurements of physical and cognitive symptoms, as measured by the MMPI-2-RF Somatic/Cognitive Scales of reported cognitive dysfunction (COG), malaise and general poor health (MLS),

and head pain complaints (HPC), neurological complaint (NUC), gastrointestinal complaints (GIC).

Preliminary analyses were conducted to ensure no violation of assumptions of normality, linearity, homoscedasticity, and independence of residuals. A Levene's test for the equality of variance indicated that population cell variances for personality measures were unequal. Theory suggests that, as a result, findings could be an overestimate of variance not accounted for by the analysis (Stevens, 2007). However, a case analysis, as well as an inspection of plots, descriptive statistics, and data comparisons of standardized residuals, indicated that no observations altered the main study findings. Three regression equations (for COG, MLS, HPC) were conducted to further examine the statistically significant correlation findings from the correlation matrix.

First, neurobehavioral variables were entered in a model, with the MMPI-2-RF COG scale as the dependent variable, as it was the scale with the most research history at the time of the study. Depression, memory/attention, somatic, and motor functioning together accounted for approximately 42.5% of the variance in somatic and cognitive dysfunction ($R^{Square} = .425$), F (4, 55) = 10.144, $p < .001$ with the strongest relationship for memory ($b = .830$). Memory difficulty was a significant predictor of cognitive dysfunction, t (59) = 4.342, $p < .001$. Holding all other variables constant, as endorsement of cognitive difficulties increased, subjective memory complaints was estimated to increase by 1.18 [95% *CI*: .602, 1.635]. As cognitive complaints increased with the sample, subjective memory complaints tended to increase. These findings also suggested

that memory complaints were a positive predictor of MMPI-2-RF COG performance with this post-acute care TBI sample. These findings were consistent with the literature, which suggested that COG was a measure sensitive to subjective memory complaints.

Second, neurobehavioral variables were entered into a model, with the MMPI-2-RF MLS Somatic/Cognitive scale as the dependent variable. Depression, memory/attention, somatic, and motor functioning together accounted for 26.9% of the variance (R^{Square} = .269), F (4, 55) = 5.059, p < .05 in reports of general complaints of poor health and physical incapacitation, with the strongest relationship for depression (b = .345). Depressive complaints were a significant predictor of malaise, t (59) = 2.083, p = .042. Holding all other variables constant, as endorsements of malaise increased, depression was estimated to increase by .365 [95% *CI*: .014, .716].

Third, neurobehavioral variables were entered into a model, with the MMPI-2-RF NUC Somatic/Cognitive scale as the dependent variable. Depression, memory, somatic, and motor skill functioning complaints accounted for 17.2% of the variance in diffuse head and neck pain and developing head pain in response to stress (R^{Square} = .172), F(3, 55) = 2.848, p <.05. No variables made a unique contribution to the model. These results suggested that the NUC scale was an indicator of subjective generalized depression, memory, somatic, and motor skill functioning concerns.

Due to the exploratory nature of the study, regression models were also run to test generalized head complaints (HPC) and gastrointestinal complaints (GIC) as predictors of neurobehavioral complaints. In the HPC model, depression, memory, and somatic

functioning complaints accounted for 14.2% of the variance in diffuse head and neck pain and developing head pain in response to stress ($R^{Square} = .142$), $F(3, 56) = 3.078$, $p < .05$. No variables made a unique contribution to the model. Results suggested that the HPC Scale was an indicator of generalized subjective depression, memory, and somatic concerns.

In the GIC model, memory, somatic, and motor functioning complaints accounted for 16% of the variance in diffuse head and neck pain and developing head pain in response to stress ($R^{Square} = .160$), $F(3, 56) = 3.552$, $p < .05$. No variables made a unique contribution to the model. Results suggested that the GIC Scale was an indicator of generalized subjective memory, somatic, and motor skill functioning concerns.

For further inspection, the MMPI-2-RF Somatic/Cognitive Scales descriptive statistics were examined (Table 7). In accordance with guidelines in the MMPI-2-RF *Manual for Administration, Scoring, and Interpretation* (Ben-Porath & Tellegen, 2008), the mean T-scores for COG, MLS, NUC, HPC, and GIC were within average ranges with the sample, and patients, reportedly, were not preoccupied with poor health, and did not have pathological cognitive, neurological, generalized head pain, or gastrointestinal concerns that interfered with psychological functioning. An examination of the descriptive statistics for neurobehavioral factors indicated that subjective somatic complaints reported by the sample were average; depression, memory, and motor skill concerns were low average (Kreutzer, Seel & Marwitz, 1999). Overall, the sample did not report, on average, any severe neurobehavioral distress. Of note, interpretive

recommendations suggest that low average scores in depression, memory, and motor skill functioning may be treatment indicators of optimism, agency, and recovery for moderate to severe TBI diagnoses (Kreutzer, Seel & Marwitz, 1999).

Table 7.

Descriptive Statistics of MMPI-2-RF Somatic/Cognitive Scales and NFI Scales

	M	SD
MMPI-2-RF MLS	56.87	10.47
MMPI-2-RF HPC	54.82	11.04
MMPI-2-RF NUC	60.75	11.01
MMPI-2-RF GIC	52.10	11.74
MMPI-2-RF COG	54.33	13.80
NFI Depression	42.95	9.03
NFI Somatic	44.77	10.19
NFI Memory	42.58	10.24
NFI Communication	50.88	52.82
NFI Aggression	45.35	9.22
NFI Motor skills	41.67	11.85

Note. Means reported as T-Scores. MMPI-2-RF T-scores < 60 are average, or not clinically significant elevations. NFI T-scores < 56 are average, and T-scores < 44 are low average.

Research Question 4: MMPI-2-RF Somatic/Cognitive to objective neuropsychological functioning.

The fourth research question hypothesized that criterion validity would be supported for the MMPI-2-RF Somatic/Cognitive Scales and neuropsychological measures of cognitive functioning, which included intellectual functioning and reading (WAIS-IV indices and WRAT-4 reading); attention/concentration (WAIS-IV Working Memory Index); verbal and visual memory (WMS-IV Logical Memory I/II, Visual Reproduction I/II); and executive functioning, or problem-solving (BCT).

The following section reports results in accordance with steps outlined by incremental theory. Results are organized below by reported findings for (a) the correlations between neuropsychological measures that explore functional cognitive status via intellectual functioning and reading with personality functioning, and (b) the correlations between neuropsychological measures that explore memory/attention, and executive functioning with personality functioning. Follow-up regressions are reported last.

Correlations - MMPI-2-RF Somatic/Cognitive Scales to intellectual functioning

To answer research question four, the investigator first conducted a correlation matrix (Garb, 2003, 1984; Haynes & Lench, 2003; Hunsley & Meyer, 2003; Sechrest, 1963) to determine if relationships existed between the Somatic/Cognitive Scale and the neuropsychological criterion measures. Table 8 presents the MMPI-2-RF Somatic/Cognitive to neuropsychological functioning correlations for intellectual functioning. Table 9 presents the MMPI-2-RF Somatic/Cognitive to neuropsychological functioning correlations for memory and executive functioning.

On measures of intellectual functioning and pre-morbid verbal functioning indicators, study results indicated an inverse relationship between the NUC Somatic/Cognitive Scale, and neuropsychological measures of (a) intellectual functioning (WAIS-IV FSIQ and WRAT-4), (b) cognitive flexibility of attention/concentration (WAIS-IV Working Memory Index), and (c) verbal reasoning, fluency, and general verbal knowledge (WAIS-IV Verbal Comprehension Index) (Table 8).

Table 8.

Correlations - MMPI-2-RF Somatic/Cognitive Scales to intellectual functioning

	FSIQ	VCI	PRI	WMI	PSI	WRAT-Reading
MLS	.163	.065	.136	.068	.234	.036
HPC	.091	.069	.084	-.004	.174	.001
NUC	-.345**	-.314*	-.117	-.299*	-.226	-.147
GIC	.045	-.029	.105	.050	.062	-.105
COG	-.195	-.169	-.077	-.162	-.110	-.114

**Correlations are statistically significant at .01 level
*Correlations are statistically significant at .05 level

These correlations suggested that as the reporting of subjective neurological complaints increased - such as of dizziness, loss of balance, numbness, difficulty with motor functioning - scores of objective measures of intellectual functioning, general verbal functioning, and working memory abilities decreased with the sample. The magnitude of the correlations ranged from small (r = -.299) to medium (r = -.345).

There were no statistically significant correlations between the NUC Somatic/Cognitive Scale and neuropsychological measures of perceptual reasoning (WAIS-IV PRI), processing speed (WAIS-IV PSI), and reading level, or estimated pre-morbid verbal functioning (WRAT-4 Word Reading), with this sample.

Correlations - MMPI-2-RF Somatic/Cognitive Scales to memory and executive functioning.

On measures of memory and executive functioning, study results indicated statistically significant inverse relationships between the NUC Somatic/Cognitive Scale, and neuropsychological measures of working verbal memory and visual memory, and

delayed verbal and visual memory, as measured by the WMS-IV (Logical Memory I & II, Visual Reproduction I & II. (Table 9). Additionally, results indicated a statistically significant inverse relationship between the COG Somatic/Cognitive Scale, and delayed visual memory.

These correlations suggested that as the reporting of subjective neurological complaints increased - such as of dizziness, loss of balance, numbness, difficulty with motor functioning - verbal and visual memory performance reportedly decreased. Further, as subjective reports of cognitive difficulties with memory, concentration, or confusion increased, objective neuropsychological performance on delayed visual recognition and reproduction decreased. There were no statistically significant relationships between the MMPI-2-RF Somatic/Cognitive Scales and the neuropsychological measure of executive functioning (i.e., Booklet Category Test).

Table 9.

Correlations - MMPI-2-RF Somatic/Cognitive Scales to working memory and executive functioning

	WMS-IV Logical Mem I	WMS-IV Logical Mem II	WMS-IV Visual Rep I	WMS-IV Visual Rep II	Booklet Category Test Errors
MLS	.031	.125	-.090	.042	-.090
HPC	-.088	.059	.019	.119	.018
NUC	-.291*	-.295*	-.443**	-.420**	-.056
GIC	-.022	.020	-.210	-.054	-.077
COG	-.057	-.098	-.125	-.367**	-.208

Note. ** Correlations are statistically significant at .01
* Correlations are statistically significant at .05

Regression - MMPI-2-RF Somatic/Cognitive Scales to neuropsychological functioning.

Follow-up regression analysis was conducted on statistically significant correlations with to assess the unique contribution of neuropsychological functioning to the prediction of MMPI-2-RF NUC scores, or to examine how well neuropsychological functioning of intellectual functioning, attention/concentration, and memory would explain or predict personality scales of neurological concerns.

Preliminary analyses were conducted to ensure no violation of assumptions of normality, linearity, homoscedasticity, and independence of residuals. A Levene's test for the equality of variance indicated that population cell variances for personality measures were unequal. Theory states that, as a result, findings could be an overestimate of variance accounted for by the analysis (Stevens, 2007). However, a case analysis, as well as an inspection of plots, descriptive statistics, and data comparisons of standardized residuals, indicated that no observations altered the main study findings. One regression equation was conducted to further examine the statistically significant correlation findings from the matrix.

Neuropsychological variables were entered in the model, with the MMPI-2-RF NUC scale as the dependent variable. The model included Full Scale IQ (WAIS-IV FSIQ), working memory and attention/concentration (WMS-IV Working Memory Index), verbal comprehension and fluency (WAIS-IV Verbal Comprehension Index), immediate or working and delayed verbal memory (WMS-IV Logical Memory I & II),

and immediate or working and delayed visual memory (WMS-IV Visual Reproduction I & II). These factors together accounted for 29.1 % of the variance in subjective neurological complaints (R^{Square} = .291), F (7, 52) = 3.044, p <.05. However, no variables made a unique contribution to the model.

For further analysis, the descriptive statistics were examined. In accordance with guidelines in the MMPI-2-RF *Manual for Administration, Scoring, and Interpretation* (Ben-Porath & Tellegen, 2008), the mean T-score for NUC was not clinically elevated with the population, or more specifically, the sample did not report any pathology related to neurological complaints that might suggest a somatoform disorder or pathological indicators of psychologically converted physical symptoms (Table 7). In accordance with interpretive guidelines in the WAIS-IV *Technical Manual* (Weschler, 2009a), full scale IQ was low average, and performance on objective measures of working memory, verbal comprehension, immediate verbal memory, and immediate and delayed visual memory were low average (Table 10). These results are consistent with neuropsychological research findings about status-post TBI neuropsychological performance in attention/concentration, verbal, and visuomotor domains (Lezak et al., 2004; Strauss, Sherman, & Spreen, 2006).

Table 10.

Descriptive Statistics - neuropsychological measures of intellectual function and reading

	M	SD
WAIS Full Scale Intelligence Quotient	84.10	11.33
WAIS Verbal Comprehension Index	87.72	15.22
WAIS Perceptual Reasoning Index	88.65	11.39
WAIS Working Memory Index	91.17	13.54
WAIS Processing Speed Index	78.83	11.36
WRAT Reading	96.08	11.87
WMS-IV Logical Memory I	7.62	3.56
WMS-IV Logical Memory II	6.58	3.96
WMS-IV Visual Reproduction I	7.72	3.45
WMS-IV Visual Reproduction II	7.50	3.60

Note. WMS-IV scores are reported as Scaled Scores. WAIS-IV scores are reported as Standard Scores.

Further, to assess whether performance on neuropsychological measures was correlated with underreporting or overreporting of symptomology, descriptive statistics of the MMPI-2-RF Validity Scales (L-r, K-r, F-r, Fp-r, Fs, and FBS-r) were examined (Table 11). In accordance with guidelines in the MMPI-2-RF *Manual for Administration, Scoring, and Interpretation* (Ben-Porath & Tellegen, 2008), respondents in the sample did not report clinical significant levels of overreporting psychological distress, genuine psychopathology, exaggerated somatic symptoms, or non-credible somatic or cognitive symptoms. These findings support the hypothesis that the MMPI-2-RF Somatic/Cognitive NUC Scale was effective at detecting objective neuropsychological performance in intellectual functioning, attention/concentration, and verbal functioning.

Table 11.

Descriptive Statistics - MMPI-2-RF reporting indicators

	M	SD
MMPI-2-RF L-r	60.10	12.02
MMPI-2-RF K-r	52.88	10.02
MMPI-2-RF F-r	57.23	15.22
MMPI-2-RF Fp-r	55.48	15.70
MMPI-2-RF Fs	58.87	17.04
MMPI-2-RF FBS-r	53.68	12.02

Note. Means scores are reported as T-scores

Chapter Five: Discussion

This study investigated the clinical utility of the MMPI-2-RF as a more practical, alternative measure to the MMPI-2 with a non-litigant TBI sample by analyzing incremental validity with archival data. The investigation was conducted in two distinct ways. First, internal consistency was established by analyzing MMPI-2-RF item-level responses, and construct validity was examined by analyzing correlations and regressions between MMPI-2 to MMPI-2-RF Validity Scales and RC Scales. Second, criterion validity, specifically the performance of the MMPI-2-RF Somatic/Cognitive Scales, was explored with external correlates of neuropsychological and neurobehavioral measures to determine how the new MMPI-2-RF scales captured these dimensions with a TBI sample.

The study's approach was conducted in accordance with principles outlined by Haynes and Lench (2003) and Hunsley and Meyer (2003) who suggested that when conducting incremental validity research, (1) strong magnitudes of correlations can determine that "the measures are redundant, and each is unlikely to show significant increases in the proportion of variance accounted for in the criterion variable when added to a regression formula that includes the other" (p. 462), and (2) regressions and scale evaluations with external correlates can help illuminate variable and predictor relationships. This study was also consistent with the extant literature that explored psychometric performance via group comparison (Tellegen & Ben-Porath, 2008).

This study enabled several interpretations about the MMPI-2-RF performance with a TBI population. First, the results of the Cronbach alpha coefficient analysis resulted in a high coefficient (.98), and indicated that the MMPI-2-RF consistently measured the underlying attributes with the sample (Nunnally, 1973).

Second, the magnitude of the MMPI-2 to MMPI-2-RF Validity Scale correlations suggested that the shortened MMPI-2-RF scales functioned similarly across versions, or exhibited a strong magnitude of correlation for the ability to detect test-taking attitudes and approaches (Table 2). In general, results of this study suggested that the MMPI-2-RF adequately demonstrated the ability to detect three different types of threats to protocol validity over the MMPI-2 (Tables 2 & 3), including response consistency (VRIN-r/TRIN-r), symptom overreporting (F-r, Fp-r, FBS-r), and symptom underreporting (L-r, K-r). It also provided new information about how the MMPI-2-RF captured non-credible somatic complaints (Fs). The magnitudes of these correlations suggested that the scales provided adequate support for a step toward incremental validity of the updated MMPI-2-RF over the MMPI-2 in detecting overreporting of psychological dysfunction and psychopathology in the TBI sample (Haynes & Lench, 2003; Hunsley & Meyer, 2003; Tellegen & Ben-Porath, 2003). With these results, the MMPI-2-RF appeared be a practical alternative to the MMPI-2 with the sample.

Additionally, descriptively, the TBI sample reported an average level of fixed, contradictory, and symptom validity responding (Table 3), and produced no evidence of an uncooperative or inconsistent test-taking approaches (i.e., T-scores). Part of the

study's goal was to better understand symptom reporting patterns in a non-litigant TBI sample. Tellegen and Ben-Porath (2008) suggest that variable T-scores on the Validity Scales tend to occur in "settings in which there is strong incentive present oneself in a favorable and consistent manner" such as legal contexts (p. 28). As an example, group comparison samples that: (1) feigned head injury symptoms (Dearth et al., 2005), and (2) were participating in disability or personal injury litigation (Wygant, et al., 2007) tended to show more inconsistent or variable response patterns. Based on this study, the MMPI-2-RF Validity Scales appeared to support the interpretive recommendations of the MMPI-2-RF (Tellegen & Ben-Porath, 2008). T-scores on the MMPI-2-RF Validity Scales were adequate measures of protocol validity, or test-taking attitudes, regardless of the prevalence of moderate to severe TBI diagnosis with the non-litigating sample.

Third, another key finding of the study was the performance of symptom indicators from the MMPI-2-RF Validity Scales, specifically the FBS-r scale (symptom validity), and the new Fs scale, which was developed to help track less frequently reported or non-credible somatic symptoms. The MMPI-2 to MMPI-2-RF correlations suggested that the F-r, Fp-r, and FBS-r scales were largely interchangeable in detecting overreporting, or exaggeration of symptoms, in the sample (Table 2). Additionally, the TBI sample reported average ranges for FBS-r, Fp-r, and F-r (Table 3). Compared to a similar analysis with a disability/personal injury TBI sample in litigation (Wygant et al., 2007), this TBI sample's mean T-scores on symptom validity indicators were lower, and in the average ranges. As mentioned, Tellegen and Ben-Porath (2008) suggest that

examiner context, or demand characteristics such as those associated with litigation, tend to produce higher T-scores on these scales, rather than indicating presence of genuine dysfunction. These findings supported interpretive recommendations for the MMPI-2-RF (Ben-Porath & Tellegen, 2008). Results suggested that TBI patient symptom reporting may be different, or that the non-litigant TBI respondent sample tended to reflect less symptom exaggeration when responding to test items. More specifically, this non-litigant TBI sample tended to present an average range of symptom endorsement, or acknowledged appropriate levels of personal shortcomings or adjustment abilities when responding to test items.

The study also provided additional information about overreporting and symptom validity indicators, as analyzed with the MMPI-2-RF RC Scales. Correlations with the FBS-r scale were statistically significant across four Validity Scales that measured somatic complaints and negative affect (RCd, RC1, RC2, RC7) (Table 4), with the strongest correlation relationship between symptom validity (FBS-r) and somatic complaints (RC1). Moreover, in this sample, RCd (demoralization) and RC7 (dysfunctional negative attitudes) demonstrated a positive statistical association with F-r, Fp-r, and FBS-r, with the strongest relationship between F-r and RCd. Statistical trends suggested that as reports of demoralization and dysfunctional negative emotions increased, overreporting of symptoms also tended to increase with the sample. Further, RC2 (low positive emotions) had a statistically significant relationship with FBS-r, although of medium magnitude. As the reporting of low positive emotions increased,

reports of non-credible symptoms also tended to increase with the TBI patients. As mentioned previously, descriptive analysis indicated that there were no clinically elevated scales in the TBI sample, as evidence by T-scores (Table 5). These results suggested that the MMPI-2-RF Validity Scales were also indicators of how the RC Scales captured emotional distress.

After controlling for the influence of somatic complaints (RC1), additional investigation indicated that demoralization (RCd), low positive emotions (RC2), and dysfunctional negative emotions (RC7) were significant predictors of symptom validity for non-credible somatic and/or cognitive symptom reporting, and accounted for 49% of the variance in FBS-r. Additionally, findings suggested that negative affective scales predicted reporting consistency of somatic symptoms on the new Fs scale with the sample. After controlling for somatic complaints (RC1), the RC factors (except RC2) were significant predictors of the new Fs, and accounted for 68.1% of the variance in Fs, with the strongest relationships for somatic complaints (RC1), and aberrant experiences (RC8). The sample did not report, on average, any severe pathology that interfered with daily functioning on the MMPI-2-RF (i.e., T-scores > 60). These findings were consistent with interpretive recommendations for the MMPI-2-RF (Ben-Porath & Tellegen, 2008) as well as the study's hypothesis, which posited that the MMPI-2-RF would incrementally account for general personality functioning with the TBI sample, or would provide new information about MMPI-2-RF measurement and reporting patterns of somatic and cognitive complaints that are common during TBI sequelae.

For further context of interpretation, group comparison MMPI-2-RF studies were sought. While Tellegen and Ben-Porath (2008) acknowledged that ongoing validity studies are being conducted on MMPI-2-RF, this study appeared to be first evaluation of the performance of the MMPI-2-RF RC Scales with a non-litigant TBI population.

Last, another key set of findings with the study was how the new MMPI-2-RF Somatic/Cognitive Scales measures captured (a) subjective neurobehavioral functioning, and (b) objective neuropsychological symptomology (Figure 1) in TBI sequelae. In general, MMPI-2-RF to neurobehavioral and neuropsychological findings were consistent with the investigator's hypothesis that the MMPI-2-RF Somatic/Cognitive Scales would demonstrate patterns of neuropsychological and neurobehavioral complaints consistent with the TBI sequelae of memory, attention/concentration, problem-solving, as well as depression, somatic, and motor functions.

In summary, the study indicated that the MMPI-2-RF Somatic/Cognitive Scales were strongly correlated across the neurobehavioral domains of depression, somatic, memory/attention, and motor functioning scales in the TBI sample, or four of six neurobehavioral functioning categories (Table 6). Primarily, self-reports of malaise or general poor health (MMPI-2-RF MLS), were most strongly associated with subjective neurobehavioral complaints of depression, memory/attention, somatic functioning, and motor skill functioning. Self-reports of cognitive difficulties (MMPI-2-RF COG) were most strongly associated with subjective neurobehavioral memory complaints. These findings were consistent with interpretive recommendations for the MMPI-2-RF (Ben-

Porath & Tellegen, 2008). Accordingly, self-reports of neurological complaints (MMPI-2-RF NUC) appeared to be a generalized indicator of depressive, somatic, memory/attention, and motor skill complaints; self-reports of head and neck pain (MMPI-2-RF HPC) appeared to be a general indicator of memory/attention, depression, and somatic complaints; and, self-reports of gastrointestinal concerns (MMPI-2-RF GIC) appeared to be generally associated with memory/attention, somatic, and motor skill functioning with the sample. T-Scores on the Somatic/Cognitive Scales with the sample were within normal limits, or did not reflect pathological response patterns (i.e., T-scores were < 60) (Table 7). These results were consistent with the literature, which suggests that memory, mood, and physical complaints are common during TBI sequelae (Kaufman, 2007).

When examining subjective cognitive complaints (COG), depression, memory/attention, somatic, and motor functioning together accounted for approximately 43% of the variance in somatic and cognitive dysfunction, with the strongest contribution for memory. As reports of cognitive difficulties increased, subjective memory complaints were estimated to also increase. Further, reported subjective memory complaints and depressive symptoms on the NFI were low average with the sample (Table 7). Lower scores on the NFI suggested a possible underreporting of symptoms; however, NFI interpretation also advises that lower scores are treatment indicators of using compensatory strategies for neurobehavioral deficits in daily psychological functioning, particularly in moderate to severe TBI diagnosis (Kreutzer, Seel, & Marwitz, 1999). In

general, these findings were consistent with the study's hypothesis and available literature that the COG scale was a predictor of subjective cognitive complaints (Gervais et al., 2010). Results were also consistent with interpretive recommendations for the MMPI-2-RF (Tellegen & Ben-Porath, 2008). These findings advanced the understanding of how neurobehavioral measurement and symptom reporting patterns were represented in MMPI-2-RF measurement properties with the sample.

When examining subjective complaints of general poor health and physical incapacitation (MMPI-2-RF MLS), depression, memory/attention, somatic, and motor functioning together accounted for approximately 27% of the variance in the sample, with the strongest relationship for depression. As endorsement of malaise increased, depression was estimated to also increase. Results were consistent with interpretive recommendations for the MMPI-2-RF that the MLS scale was a general, subjective indicator of depressive complaints (Ben-Porath & Tellegen, 2008). Of note, subjective neurobehavioral somatic complaints reported by the sample were average, while memory and motor skill concerns were low average (Table 7). As mentioned, NFI interpretation recommendations suggest that lower T-scores are treatment indicators. These findings suggested that while TBI patients may reported some level of distress, their reporting was likely influenced by treatment participation, particularly in a moderate to severe TBI diagnosis (Kreutzer, Seel, & Marwitz, 1999).

Next, results indicated that depression, memory, somatic, and motor skill functioning complaints accounted for approximately 17% of the variance in neurological

complaints (MMPI-2-RF NUC). Together, depression, memory, and somatic functioning accounted for approximately 14% of the variance in diffuse head and neck pain (MMPI-2-RF HPC). Memory, somatic, and motor skill functioning complaints accounted for approximately 16% of variance in gastrointestinal complaints (MMPI-2-RF GIC). No neurobehavioral factors made unique contributions to any of the models. As mentioned, the sample did not report any somatic or general neurological complaints that contributed negatively to daily psychological functioning (i.e., MMPI-2-RF T-scores < 60). These results were consistent with interpretive recommendations for the MMPI-2-RF, and suggested that the MMPI-2-RF HPC, NUC, and GIC scales were general indicators of neurobehavioral concerns related to situational stress and concerns with mood, memory, and health problems with the sample (Ben-Porath & Tellegen, 2008). However, depression and memory scores were low average; consistent with previous interpretations, this finding suggested that any level of distress was likely mitigated by treatment participation (i.e., NFI T-scores < 44). Again, these findings advanced the understanding of how neurobehavioral measurement and symptom reporting patterns were represented by the MMPI-2-RF with the TBI sample.

Group comparison studies were sought for additional context of these results with the Somatic/Cognitive Scales. Youngjohn et al. (2011) found that the Somatic/Cognitive scales were significant predictors of test failure (FBS-r) with a litigating TBI sample. However, no research evidence was known or available to this investigator regarding the

performance of the Somatic/Cognitive Scale with measures of neurobehavioral functioning in a non-litigating TBI sample.

The concluding set of findings was how the MMPI-2-RF Somatic/Cognitive Scales performed in detecting objective cognitive functioning, as measured by neuropsychological measures of intellectual functioning and reading (WAIS-IV indices and WRAT-4 reading); attention/concentration (WAIS-IV Working Memory Index); verbal and visual memory (WMS-IV Logical Memory I/II, Visual Reproduction I/II); and executive functioning, or problem-solving (The Booklet Category Test).

The MMPI-2-RF NUC scale had a statistically significant inverse relationship with intellectual functioning, verbal reasoning and knowledge, and memory (Tables 8 & 9). These correlations suggested that as the reporting of subjective neurological complaints increased - such as of dizziness, loss of balance, numbness, difficulty with motor functioning - scores of objective measures of intellectual functioning, general verbal functioning, and working memory abilities decreased with the sample. In the regression analysis, no variable made a unique contribution to the model. As noted previously, NUC was not clinically elevated with the population, or more specifically, the sample did not report any pathology related to neurological complaints that might suggest a somatoform disorder or pathological indicators of psychologically converted physical symptoms (i.e., T-scores were < 60). These results were consistent with neuropsychological research findings about status-post TBI neuropsychological performance that memory, intellectual, and verbal functioning may reflect deficits during

TBI sequelae (Lezak et al., 2004; Strauss, Sherman, & Spreen, 2006). These findings also supported interpretive recommendations of the MMPI-2-RF the NUC as measuring general neurological complaints (Tellegen & Ben-Porath, 2008). Additionally, these results suggested that cognitive difficulties did not confound results with the sample, and the MMPI-2-RF appeared to be a practical alternative.

In summary, it appeared that the MMPI-2-RF was a reliable, incrementally valid shorter alternative with this non-litigating TBI sample in two key ways. First, the improved psychometric properties of the MMPI-2-RF, as evidenced by the magnitude of correlations and results of the regression analysis, provided a valuable step of evidence that the shortened Validity Scales were incrementally valid indicators of response consistency, underreporting, and overreporting. More specifically, the study provided evidence that the new MMPI-2-RF did an adequate job of psychometrically accounting for general personality functioning in this TBI sample. The study also confirmed previous findings that the revised FBS scale did an adequate job of tracking symptom validity (FBS-r). And, the MMPI-2-RF also offered additional contextual information to patient reporting patterns that were not available with earlier versions, as evidenced by results of the analysis between the new Fs scale and RC Scales.

Second, the new MMPI-2-RF Somatic/Cognitive Scales provided additional information to the measurement context. In this sample, MMPI-2-RF COG and MLS were indicators of subjective neurobehavioral complaints (depression, somatic, memory and motor functioning), whereas the MMPI-2-RF NUC, HPC, and GIC scales were

general indicators of objective intellectual and memory neuropsychological performance. Further, the MMPI-2-RF NUC scale was a general indicator of intellectual, memory, and verbal functioning neuropsychological performance associated with TBI sequelae, and provided evidence that cognitive difficulties did not appear to confound results. Based on the findings of this study, the new MMPI-2-RF Somatic/Cognitive Scales appeared to meet principles for incremental validity with the sample. The MMPI-2-RF appeared to be practical alternative to the longer MMPI-2, and the restructured version offered new, additional assessment information that could be clinically useful to practitioners working with TBI patients.

Strengths and Limitations

To the knowledge of this investigator, this study was the first to examine MMPI-2 to MMPI-2-RF Validity Scales and RC Scales with a non-disability or non-litigant TBI sample. Further, it was the first study to examine performance of the new MMPI-2-RF Somatic/Cognitive Scales with external correlates of neurobehavioral and neuropsychological functioning in a non-litigant TBI sample.

While the study's sample size was similar to group comparison studies assessing validity of the MMPI-2-RF, the primary limitation of this study was the smaller, fixed sample size. The literature states a need for MMPI-2-RF research with a non-litigant population, and also outlines the associated difficulty in ascertaining a non-litigant TBI dataset for myriad reasons, such as individual complexities in injury manifestation, and common litigious involvement due to the context of injuries (i.e., accidents). As a result,

exploring MMPI-2-RF scale performance with this archival dataset of non-litigating TBI patients was of guiding interest. While the investigator conducted an *a priori* compromise power analysis (q=ß/α) that was recommended for secondary data analysis (Erdfelder et al., 1996), it was likely that power was lost to detect statistically significant differences with such a small sample, or findings were subject to measurement error with multiple exploratory analyses. As a result, it was unclear whether MMPI-2-RF study findings were due to size or the nature of the sample. Research with larger sample sizes is warranted to better understand the performance of the MMPI-2-RF with a TBI population.

Additionally, the nature of the archival data was not primarily for research use. Because of the convenience sample and privacy policies dictating the nature of the data, medically related data regarding loss of consciousness, health status, and rehabilitation status were not available to elucidate whether other contextual medical factors during rehabilitation contributed to measurement. Therefore, this research design limits generalizability to other TBI patients participating in rehabilitation. While it may be tempting to conclude that personality functioning and neurobehavioral factors were affected by rehabilitation treatments, it should be noted that other equally plausible explanations for the findings could exist, including specific hospitalization factors, family relationships, and other personal or environmental stressors, all of which were beyond the scope of this study. Future studies could examine specific rehabilitation-related stressors to more thoroughly examine these possible relationships. Similarly, future studies could

employ observational measures of rehabilitation status to better illuminate how personality traits are expressed environmentally at different levels of recovery.

Again, to the investigator's knowledge, this was the first study that examined the performance of the MMPI-2-RF with a non-litigant TBI population. In the future, clinicians and researchers should be aware of the informative dimensions of the MMPI-2-RF, including the practical uses and clinical utility of the MMPI-2-RF Validity, RC, and Somatic/Cognitive Scales. This study provided evidence for the MMPI-2-RF's ability to psychometrically account for personality functioning with post-acute TBI patients.

Appendices

Group Comparison Tables (Ben-Porath & Tellegen, 2008, pp. 29-30)

Table A1.

MMPI-2/MMPI-2-RF Validity Scale Correlations – Arbisi & Ben-Porath (1998) Psychiatric Inpatient Overreporting Sample (N = 67)

	VRIN-r	TRIN-r	F-r	Fp-r	Fs	FBS-r	L-r	K-r
VRIN	.67	.00	-.25	-.18	-.18	-.05	.27	.40
trin	.26	.50	.25	.20	.21	.14	.09	-.15
f	-.01	.07	.95	.97	.95	.76	.23	-.48
f_b	-.02	.09	.97	.92	.90	.77	.22	-.53
F_p	.00	.08	.88	.99	.93	.72	.37	-.38
fbs	.07	-.04	.73	.66	.72	.97	.27	-.25
l	.26	-.14	-.02	.05	.10	.20	.86	.35
k	.12	-.31	-.47	-.42	-.45	-.26	.12	.87

Table A2.

MMPI-2/MMPI-2-RF Validity Scale Correlations – Sellbom et al. (2005) Medical Patient Overreporting Sample (N = 86)

	VRIN-r	TRIN-r	F-r	Fp-r	Fs	FBS-r	L-r	K-r
VRIN	.65	-.10	.39	.40	.41	.44	.06	-.42
trin	.16	.46	.10	.09	.14	.15	.20	-.13
f	.52	-.02	.96	.96	.89	.74	.24	-.49
f_b	.49	.02	.97	.94	.86	.75	.17	-.58
F_p	.58	-.03	.89	.98	.82	.64	.38	-.35
fbs	.33	.00	.72	.60	.79	.97	.19	-.36
l	.26	-.20	.06	.20	.10	.22	.86	.43
k	-.29	-.26	-.56	-.44	-.45	-.40	.21	.90

Table A3.

MMPI-2/MMPI-2-RF Validity Scale Correlations – Wygant, Sellbom, et al. (2007) Personal Injury/Disability Sample (N = 140)

	VRIN-r	TRIN-r	F-r	Fp-r	Fs	FBS-r	L-r	K-r
VRIN	.43	.20	.27	.38	.31	.23	-.08	-.47
trin	.11	.43	.32	.19	.15	.08	.01	-.29
f	.34	.24	.86	.82	.65	.52	-.06	-.62
f_b	.25	.32	.90	.69	.62	.58	-.06	-.65
F_p	.16	.21	.50	.73	.40	.28	.18	-.39
fbs	.17	.16	.58	.42	.62	.96	.01	-.40
l	-.07	-.08	-.20	-.09	-.13	.03	.91	.29
k	-.44	-.32	-.61	-.52	-.57	-.38	.21	.92

Table A4.

MMPI-2/MMPI-2-RF Validity Scale Correlations – Dearth et al. (2005) Neuropsychology Sample (N = 84)

	VRIN-r	TRIN-r	F-r	Fp-r	Fs	FBS-r	L-r	K-r
VRIN	.55	.06	.09	-.01	.04	.06	.16	-.13
trin	.14	.60	.35	.30	.25	.21	-.04	-.37
f	.02	.24	.76	.80	.66	.41	-.34	-.58
f_b	-.02	.33	.83	.84	.70	.49	-.23	-.55
F_p	.25	.25	.76	.97	.66	.48	.09	-.12
fbs	.42	.19	.72	.48	.80	.98	.18	.01
l	.35	-.10	-.06	-.10	-.06	.11	.90	.54
k	.26	-.24	-.13	-.10	-.14	.11	.52	.94

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Vita

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This dissertation was typed by the author.