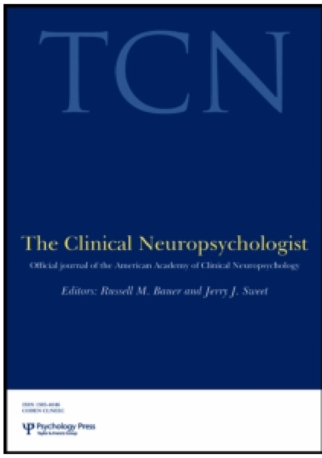

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Validity Testing in Dually Diagnosed Post-Traumatic Stress Disorder and Mild Closed Head Injury

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CE VALIDITY TESTING IN DUALLY DIAGNOSED POST-TRAUMATIC STRESS DISORDER AND MILD CLOSED HEAD INJURY

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Prospects for the coexistence of post-traumatic stress syndrome (PTSS) and mild traumatic brain injury (mTBI) rely exclusively on subjective evidence, increasing the risk of response bias in a compensatable social context. Using a priori specificities derived from genuine brain disorder groups, we examined validity failure rates in three domains (symptom, cognitive, motor) in 799 persons reporting persistent subjective disability long after mild neurological injury. Validity tests included the Test of Memory Malingering, MMPI-2 Fake Bad Scale, and Infrequency (F) scales, reliable digit span, and Halstead-Reitan finger tapping. Analyses showed invalidity signs in large excess of actuarial expectations, with rising invalidity risk conditional on post-traumatic complexity; the highest failure rates were produced by the 95 persons reporting both neurogenic amnesia and re-experiencing symptoms. We propose an "over-endorsement continuum" hypothesis: The more complex the post-traumatic presentation after mild neurological injury, the stronger the association with response bias. Late-appearing dual diagnosis is a litigation phenomenon so intertwined with secondary gain as to be a byproduct of it.

Keywords: Dual diagnosis; Late post-concussion syndrome; Malingering; Mild traumatic brain injury; Noncredible scores; Post-traumatic stress disorder; Validity testing.

INTRODUCTION

Head-neck trauma following traffic crashes can be associated with two separately diagnosed syndromes encountered by neuropsychologists: mild traumatic brain injury (mTBI) and post-traumatic stress syndromes (PTSS). Post-traumatic stress disorder (PTSD) is the most commonly researched form of PTSS (Koch, Douglas, Nichols, & O'Neill, 2006). There is no dispute that mTBI may occur when blunt head trauma causes brief anterograde memory loss with attendant subjective and objective neurocognitive deficits, typically of a transient nature (Belanger & Vanderploeg, 2005; Maroon et al., 2000; Rizzo & Tranel, 1996; Shaw, 2002). There is also little dispute that some persons exposed to life-threatening events shortly thereafter report social withdrawal, psychic numbing, intrusive re-experiencing of the event, and

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hyperarousal (American Psychiatric Association, 1994; Breslau et al., 1998; North, 2001). Both mTBI and PTSS are generally accepted as valid clinical phenomena, although PTSS is conceptually more problematic because of syndromal overlap and many nonspecific symptoms (Rosen, 2005).

A more controversial issue is whether a single trauma causes co-development of both conditions in the same person. There is a body of research examining PTSD prevalence in persons with mTBI (Berthier, Kulisevsky, Fernandez Benitez, & Gironell, 1998; Harvey & Bryant, 2000; Levin et al., 2001; McCauley, Boake, Levin, Contant, & Song, 2001; McMillan, 1996) and other research examining neurocognitive function in persons with primary PTSD (Vasterling, Brailey, Constans, & Sutker, 1998; Vasterling, Brailey, & Sutker, 2000; Verma et al., 2001). One view is that PTSD and mTBI can share the same trauma if one accepts self-report as the sole basis for diagnosis (Bryant, 1996). Layton and Wardi-Zonna, (1995) proposed a post hoc information-processing model to explain delayed PTSD complaints in two patients with remote head–neck injury, while Rattok (1996) argued for dual diagnosis based on questionnaire data. Others contend PTSD and mTBI are mutually exclusive, stressing lack of empirical support and face validity concerns: How could threat perceptions possibly be encoded in an amnesic state? Boake (1996) and Bontke (1996) considered low joint probability to question the high prevalence of dual PTSD–mTBI in the Rattok (1996) legal case series. Sbordone and Liter (1995) showed mTBI patients were unable to recall a single graphic injury detail, while all persons with PTSD provided event recall within 20 minutes of trauma.

An unexamined issue emerges from the dual-diagnosis literature: validity of self-report and response bias (Iversen & Lange, 2006). PTSD and mTBI claims frequently appear in a social context of compensatability (Arbisi et al., 2004; Blanchard et al., 1998b; McGuire, 1999; Rattok, 1996; Rosen, 2004). Dual diagnosis requires only subjective evidence under the control of respondents (Ohry, Rattok, & Solomon, 1996). Self-report is problematic because it communicates a private experience that is not falsifiable; it has repeatedly been shown that naïve respondents easily mimic post-traumatic problems through guessing (Burges & McMillan, 2001; Martin, Hayes, & Gouvier, 1996), acting scripts (Buckley, Galovski, Blanchard, & Hickling, 2003), or attorney coaching (Rosen, 1995). As an example of data quality problems created by self-report, some psychologists reported PTSD rates higher in compensatable mTBI cases than nonphysical psychological trauma cases. For example, Friedland and Dawson (2001) relied on post-accident questionnaire data and reported higher rates of post-traumatic stress syndrome (PTSS) in persons with mTBI than those without. Based on the premise that neurogenic memory loss should provide *some* protection against threat encoding, not lessen it, the higher rates of PTSS in some mTBI groups raise reasonable concerns about authenticity. Current literature also indicates that prevalence of invalidity signs is high in settings involving compensatable neurocognitive and psychological injury claims (Arbisi & Ben-Porath, 1997; Greiffenstein & Baker, 2006; Harris, Mulford, Solomon, van Gelder, & Young, 2005; Mittenberg, Patton, Canyock, & Condit, 2002; van Hout, Schmand, Wekking, Hageman, & Deelman, 2003). Hence a precondition for establishing plausible diagnoses is ruling out informant or test response bias.

To address the issue of symptom validity in dual reports, we collected validity test data from a large series of persons with various post-traumatic constellations following remote head-neck injury. Using a priori specificities of 0.90 and 0.99 based on clinical referent groups described in the literature, we hypothesized the rate of invalid performances should be in the 1–10% range if chronic PTSD—mTBI is not associated with response bias, but >10% (or 1%) if exaggeration is a factor. We applied the cutting scores to measure three forms of invalidity: symptom report, cognitive, and motor.

METHOD

Respondents

The target sample of respondents was 799 individuals consecutively examined from 2001–2005 for subjective disability claims arising from remote, minor head trauma. All respondents met criteria for late post-concussion syndrome (LPCS). To reduce prospects for genuine cerebral dysfunction in the target sample, diagnostic criteria for LPCS were: (1) nonpenetrating mild head–neck injury, (2) lowest admitting Glasgow Coma Scale >13/15 (Teasdale & Jennet, 1974), (3) post-traumatic amnesia no greater than 1 hour by self-report, (4) at least three persistent post-concussive complaints per ICD-10 criteria (World Health Organization, 1992), (5) post-accident interval of >6 months, (6) head CT/MRI findings negative for any intracranial changes (e.g., petechial hemorrhages), and (7) subjective disability for a major social role (work, driving, and/or school). All respondents underwent the semi-structured Psychiatric Diagnostic Interview-Revised (PDI-R) (Othmer, Penick, Powel, & Othmer, 1988) personally conducted by one of the authors. The total outpatient sample evaluated in our offices from 2001–2005 was 1237, but the remaining 438 cases were either referred for evaluation of conditions other than head trauma (e.g., learning disability, brain neoplasms, and many other conditions), or required an interpreter for lack of conversational English. Of these 799 consecutive referrals, all were either seeking compensation or litigating. It is noteworthy that not a single minor trauma case was clinically referred or not involved in seeking validation of the disability role, consistent with published failures to find clinical cases (Greiffenstein, Baker, & Gola, 1994; Lees-Haley & Brown, 1993; Youngjohn, Burrows, & Erdal, 1995). As one example, Youngjohn, Davis, and Wolf (1997) reported 40% of consecutively referred patients with severe head injury were not involved in litigation but all late post-concussion claimants were.

We further subdivided the LPCS sample into three groups relevant to the research question, based on responses to the standardized PDI-R. The PDI-R inquires into DSM-IV defined PTSD clusters: Re-experiencing symptoms (e.g., intrusive flashbacks); avoidance symptoms (e.g., driving phobia), and hyperarousal (e.g., irritability, insomnia). Details of the PDI-R procedure are outlined in the Assessment section below. Because our main interest was exploring the validity of atypical dual claims, we first sought respondents claiming both brief neurogenic amnesia and re-experiencing symptoms. The 95 respondents making such claims during PDI-R interviewing were termed the *dual-diagnosis* group. Based on the ideas of Hickling and Blanchard (1997) and Koch et al. (2006), LPCS respondents additionally reporting development of avoidance and autonomic hyperarousal symptoms but not re-experiencing symptoms formed the PTSD *subsyndromal group* ($N = 228$). The remaining 476 respondents not meeting criteria for either dual-diagnosis or subsyndromal PTSD were termed the *simple*LPCS group.

The 799 respondents were predominately involved in work- or non-working-related traffic crashes, with $< 5\%$ sustaining trauma in falls and assaults. The dual-diagnosis group showed a mean (*M*) post-accident interval of 27 months ($SD = 30.2$, range $= 6$–191); the subsyndromal group an *M* post-incident interval of 29.5 months ($SD = 35$, range $=$ 6–200); and the simple LPCS group 30.6 months ($SD = 33.9$, range $= 6$–306). These durations were not significantly different per an ANOVA. Chi-square tests were nonsignificant for injury mechanism (auto vs other), legal setting (Worker's Compensation vs auto negligence), or Hollingshead education level (seven ordinal levels). Demographically, the dual-diagnosis group had a mean age of 40 ($SD = 11$), the subsyndromal group mean was 42.8 years ($SD = 12$), and the simple post-concussion group had a mean of 42 years ($SD = 13.6$), differences that were not statistically significant per ANOVA. The total sample was predominately male (55.4%) and 92.5% reported English as their first language; the 7.5% with ESL did not require an interpreter, a condition for study inclusion. But the dual-diagnosis group was predominately female (58.7%), versus the subsyndromal (40.7%) and simple groups (43.7%). This distribution was significantly different with Pearson chi-square $= 8.9$ ($df = 2$, $p = .01$). Chi-square was not significantly different for ESL rates between subgroups. Otherwise there were no significant effects for Wechsler Test of Adult Reading, $F(2, 795) = 1.6$, $p = .2$, or for age, $F(2, 795) = 2$, $p = .13$. Hence the groups appeared naturally matched on key variables of chronicity of subjective disability, first language, premorbid cognitive baseline, education level, and age, but the dual-diagnosis group was biased toward female membership.

Quantitative and qualitative analysis of the total sample's medical records using the American Academy of Neurology sports concussion criteria (Kelly & Rosenberg, 1998; Maroon et al., 2000), showed that Grade I concussion was the most frequent injury type (85.6%), Grade II was 9% of the total LPCS sample, Grade II 1%, and 5.4% indeterminate. Using an alternative injury-grading system, subgroup analysis showed 92.2% of the dual-diagnosis sample presented with a Glasgow Coma Scale of 15 (fully coherent) in the emergency room, compared to 76.3% of the subsyndromal group and 68.8% of the simple group. Dichotomous treatment of GCS (15 or <15) suggested a significant but reverse dose-response relation (chi-square test for independence $= 24.1$, $df = 2$, $p < .00001$). This means the less severe the head injury, the more protean and multi-faceted the complaints. Severe orthopedic injury was rare, with only two of the 95 dual-diagnosis respondents reporting fractures (one left wrist fracture, the other multiple facial fractures), three fractures in the subsyndromal group (involving the skulls orbits), and none in the simple group. The number of reported deaths of others in the participants' accidents was one (1%) in the dual-diagnosis group and one in the subsyndromal group ($<1\%$) but none in the simple LPCS group. Overall, the traffic or work incidents were neither horrific or particularly life threatening.

Assessments

All respondents underwent neuropsychological testing, including tests with empirical sensitivity to three types of noncredible presentation: cognitive, symptom, and motor pseudo-abnormalities. Head injury with brief amnesia is rarely associated with acute focal motor/sensory deficits (Alexander, 1998) or major cognitive impairment. Hence, poor performances on simple tests >6 months post-injury are unlikely to reflect cerebral dysfunction.

Psychiatric diagnostic interview-revised (PDI-R). The PDI-R is a semi-structured interview based on a descriptive, syndromatic approach to psychological diagnosis (Othmer, Penick, Powell, Read, & Othmer, 1992). PDI-R guidelines require two standardized phases: Informal open-ended questions ("What kinds of things bother you that you blame on the accident?") followed by formal symptom inquiry ("Have you ever experienced [syndrome-specific symptom] in the last month?"). The PDI-R contains 17 modules to diagnose recognized syndromes, including a post-traumatic module that systematically explores DSM-IV Cluster B re-experiencing symptoms (nightmares and flashbacks), Cluster C (avoidance/numbing), and Cluster D (hyperarousal). Respondent reports of re-experiencing and other PTSD clusters were coded binomially (present or absent) by the author conducting the interview, regardless of whether the symptom was elicited during the open- or close-ended phase. Per the PDI-R manual (Othmer et al., 1992), percentage of diagnostic agreement with the Diagnostic Interview Schedule ranges from 85% to 100%. The PDI-R PTSD component correlates with experience of interpersonal violence (Steiner, Garcia, & Matthews, 1997).

Cognitive pseudo-abnormality. The Test of Memory Malingering (TOMM) (Tombaugh, 1995) and Reliable Digit Span (RDS)(Etherton, Bianchini, Greve, & Heinly, 2005b; Greiffenstein et al., 1994; Mathias, Greve, Bianchini, Houston, & Crouch, 2002) represented measures of exaggerated cognitive deficit. The TOMM is a 50-item, two-alternative pictorial memory test divided into three trials of 50 presentations each: Trial 1, Trial 2, and Retention. The TOMM is relatively insensitive to severe brain injury (Tombaugh, 1995) and is also unaffected by other conditions often associated with subjective post-traumatic disability such as pain (Etherton, Bianchini, Greve, & Ciota, 2005a) or clinical mood disorder (Rees, Tombaugh, & Boulay, 2001). Hence, TOMM is a specific measure particularly well suited to complex post-traumatic presentations. RDS is a modification of the classical digit span task; it is calculated by summing the longest string of digits repeated forward or backward without error on both standard trials. For example, a respondent who passed both trials of four digits forward, failed one trial of five forward, passed both trials of two digits backward, and failed one trial for three backward would earn a total RDS of 6 (reliable 4 forward plus reliable 2 backward). This measure of exaggerated attention deficit has proven sensitivity to both exaggerated personal injury (Etherton et al., 2005b) and simulated legal insanity (Duncan & Ausborn, 2002).

Symptom over-report. The MMPI-2 Infrequency scale T-score (MMPI-F) (Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989) and MMPI-2 Fake Bad Scale raw score (MMPI-FBS) (Greiffenstein, Baker, Axelrod, Peck, & Gervais, 2004; Lees-Haley, English, & Glenn, 1991) are validity scales embedded in the 567-item MMPI-2. The MMPI-F is a 64-item scale developed by selecting deviant responses endorsed by <10% of the standardization sample, although empirically the base rate was <5% for most items (Dahlstrom, Welsh, & Dahlstrom, 1975). High MMPI-F scores represent exaggeration of severe psychopathology. The MMPI-FBS is a 43-item scale designed to measure exaggerated suffering as it presents in personal injury lawsuits (Greiffenstein et al., 2004; Lees-Haley et al., 1991); it was recently integrated into the standard MMPI-2 validity scales because of proven sensitivity to atypical brain injury presentations (Ben-Porath & Tellegen, 2006). MMPI-F and MMPI-FBS are not completely independent; as they share five items in common (11.6% of FBS items and 7.8% of F).

Noncredible motor performance. Motor skills evaluation is a fundamental aspect of neuropsychological testing (Mitrushina, Boone, Razani, & D'Elia, 2005). Two frequently used measures are finger tapping (FT) (Arnold et al., 2005) and grip strength (GS) (Peterson, 1998; Reitan & Wolfson, 1993). FT score is calculated by the *M* of five consecutive 10-second trials for both hands, while GS measures peak grip intensity in kg on a dynamometer (Mitrushina et al., 2005). These simple motor tasks represent measures of motor pseudo-abnormalities in the context of minor head trauma, as neither unilateral nor bilateral deficits are expected in neurologically ambiguous injury (Alexander, 1997; Dikmen, Machamer, Winn, & Temkin (1995). The sum of right and left hand FT (or GS) scores has been used as an index of implausible motor deficit (Greiffenstein, Baker, & Gola, 1996; Larrabee, 2003), and that practice was followed in the present study.

Data Coding

The cognitive, motor, and symptom test scores were categorized binomially as valid/invalid based on two sets of cutting scores. We set a priori specificities of 0.90 (termed "probable" invalidity) and 0.99 (termed "definite" invalidity), meaning cutoffs corresponding to the bottom 10% and 1% of genuine brain-damage groups, summarized in Table 1. For example, cutting scores for summed finger tapping are derived from mentally retarded and severely brain-injured groups reported by Arnold et al. (2005). The other sources for clinical referent data were Heaton, Smith, Lehman, and Vogt (1978), Mittenberg, Rotholc, Russel, and Heilbronner (1996), Tombaugh (1995), Greve, Bianchini, Love, Brennan, and Heinly (2006), Miller and Donders (2001), and Etherton et al. (2005b). We selected the midpoint in cases where studies showed differences in percentile scores (e.g., 33.5 kg for GS 10th percentile cut point). The final probable and definite cutoffs, respectively, were: FT <63 and <59; GS <33.5 and 5 kg; TOMM Trial 2 <45 and <40; TOMM Retention <48 and <45; RDS <8 and <7; MMPI-FBS raw scores >22 and >28; MMPI-F >66-T and >95-T. Overall, we biased our method *against* finding feigned deficits by selecting low performance floors to reduce prospects for false positive diagnosis of exaggerated deficit.

Statistical Analyses

Positive likelihood ratios (+LR) were calculated where applicable. +LR indicates how much more likely a positive test is to be found in persons from the index group as opposed to persons from a reference group (Straus, Richardson, Glasziou, & Haynes, 2005). More specifically, the +LR is calculated by dividing percentage of people with the target test sign by the percentage of referents with the same test sign. A+LR ratio >1 indicates that the test sign is associated with the group of interest,

Table 1 Validity task scores associated with 90–99% specificity levels for genuine brain disturbance groups

First authzor (Year)	Group	Measure	10%ile "Probable"	≤ 1%ile "Definite"
Arnold et al. (2005)	24 patients with moderate to severe TBI	Finger tapping, sum	< 63	< 59
Arnold et al. (2005)	18 mentally retarded (IQ < 70)	Finger tapping, sum	< 63	< 59
Heaton et al. (1978)	16 moderate-severe head injury	Grip strength, sum both hands	< 37 kg	< 5 kg
Mittenberg et al., (1996)	40 brain injury, *Mdn* PTA = 24 h	Grip Strength; sum both hands	< 30 kg	< 5 kg
Tombaugh (1995)	45 TBI	TOMM Trial 2, # correct/50 items	< 45	< 40
Tombaugh (1995)	45 TBI	TOMM Retention trial, # correct/50 items	< 48	< 45
Greve et al. (2006)	132 heterogeneous brain disorders	MMPI-2 FBS raw	> 22	> 28
Miller & Donders (2001)	50 moderate-severe TBI	MMPI-2 FBS, raw	> 22	> 28
Greve et al. (2006)	132 heterogeneous brain disorders	MMPI-2 F, T-score	> 66	> 95
Etherton et al., (2005a)	53 Pain patients with objective disease	Reliable Digit Span	≤ 7	≤ 6
Etherton et al. (2005a)	69 moderate-severe TBI	Reliable Digit Span	≤ 7	≤ 6

Finger-tapping and strength scores represent the sum of average performances from both hands. PTA = post-traumatic amnesia. TBI = traumatic brain injury. TOMM = Test of Memory Malingering. MMPI-2 = Minnesota Multiphasic Personality Inventory, 2nd Edition.

and 95% confidence intervals (95-CI) express the certainty of associative strength. A 95-CI not including one means there is sufficient evidence for an association between variables, although not necessarily a causal connection. Effect sizes (ES) for dichotomous measures were calculated using the probit method (Lipsey & Wilson, 2001). Because this study dichotomized underlying continuous variables (e.g., tapping rate), we rejected the odds-ratio ES statistic to avoid gross overestimation. The probit method represents a transformation of a standardized mean difference score adjusting for dichotomization and represents an excellent estimate of the standardized mean difference. The logit transformation is best only if most measures are fundamentally dichotomous, which is not the case here.

RESULTS

Analysis 1: Invalidity Rates in Dual Diagnosis (mTBI + Cluster B, C, and D Claims)

Table 2 summarizes the prevalence of noncredible scores under stringent 0.9 and 0.99 specificity levels for the 95 persons with dual diagnoses (mTBI and PTSD re-experiencing symptoms. The shows noncredible performance exceeded both the 1% and 10% levels in 13 of 14 measurements. The most prevalent noncredible finding under the probable rule was symptom over-reporting as measured by FBS and

Table 2 Percent noncredible scores and likelihood ratios in dual-diagnosed persons with re-experiencing and neurogenic amnesia claims

		Probable rule		Definite rule	
Validity test	*N*	Percent failing (%)	LR (CI-95)	Percent failing (%)	LR (CI-95)
MMPI-2 FBS	95	88.4	6 (4.1–8.6)	49.5	3.1 (2.6–3.2)
TOMM Retention	93	68.4	3.3 (2.6–4)	57.9	3.5 (3–3.6)
TOMM Trial 2	93	58.9	2.8 (2.2–3.3)	49.5	2.9 (2.5–3)
MMPI-2 F	95	62.0	2.9 (2.2–3.5)	16.8	2 (1.6–2.2)
RDS	87	52.4	2.3 (1.8–2.3)	36.8	2.5 (2.1–2.6)
TAPTOTAL	91	40.0	2 (1.6–2.4)	37.9	2.5 (2.1–2.7)
GRIPSUM	91	25.3	1.6 (1.2–2)	1.1	1 (0.2–1.9)

N = Number of observations in a sample of 95. Probable Rule = <10th percentile of cerebral disorder referent groups; Definite Rule = 1st percentile of cerebral disorder referent group; LR = Positive Positive likelihood ratio and CI = 95 confidence intervals measured against cerebral disorder referent group; GRIPSUM = Sum of right and left hand peak grip strength with Smedley Dynamometer; MMPI-2 F = Infrequency scale; MMPI-2 FBS = Lees-Haley's Fake Bad Scale; SVT = Symptom validity test; TAPTOTAL = sum right and left hand average tapping scores; TOMM = Test of Memory Malingering; RDS = Reliable Digit Span.

MMPI-F. The prevalence of symptom over-reporting declined dramatically under the definite rule, especially in regards to F-scale invalidity. The F-scale is widely viewed as measuring misrepresentation of psychotic symptoms (Greiffenstein, Fox, & Lees-Haley, 2007), so markedly deviant scores are not expected in personal injury allegations. In contrast, noncredible cognitive scores were common under both the definite and probable rules. All associations except for GS resulted in Fisher exact tests significant at the $p < .01$ level. Calculation of positive likelihood ratios (the likelihood of the target finding in a population of interest divided by the likelihood of the target in a control) showed 95-CI not including zero except for GS under the definite rule.

All subsequent analyses were carried out under the "probable" rule because respondents with remote mild head–neck trauma are reasonably expected to perform better than the bottom 10% of persons with genuinely severe cognitive and motoric impairments.

Analysis 2: Dual-Diagnosis vs Subsyndromal Dual Claimants

The first analysis showed a significant number of respondents claiming both TBI and full-blown PTSD 6 months post-incident behaved as more impaired than persons with objectively severe cerebral disruption. That finding raises a new question: Do the high-validity failure rates have unique association with re-experiencing symptom (Cluster B) made in the context of mTBI, or can high failure rates be associated with other PTSD symptoms (Clusters C and D) in the context of minor head–neck trauma? To this end, we examined validity failures in the 228 respondents classified as LPCS with subsyndromal PTSD. Table 3 lists the base rates of invalid performances under the probable rule (10th percentile cutoff) in re-experiencing versus subsyndromal LPCS groups. First, head-injury claimants with subsyndromal PTSD presentations consistently exceeded the expected base rate of 10% on all seven

Table 3 Percent noncredible scores in dual-diagnosis claimants without and with re-experiencing symptom report

	Subsyndromal PTSD (LPCS without Cluster B)		Dual diagnosis (LPCS with Cluster B)		
Validity test	*N*	% Invalid	*N*	% Invalid	Effect size (*r*)
MMPI-2 FBS	217	75.1	95	88.4	.52 (.25)
TOMM Retention	223	60.5	93	68.4	.46 (.22)
TOMM Trial 2	223	48.7	93	58.9	.24 (.12)
RDS	192	43.8	87	52.4	.22 (12)
MMPI-2 F	223	56.1	95	62.0	.16 (.08)
TAPTOTAL	221	35.5	91	40.0	.11 (.05)
GRIPSUM	221	21.5	91	25.3	.11 (.05)

Effect size and *r* determined by probit method for dichotomous data (Lipsey & Wilson, 2001). Cluster B = DSM-IV re-experiencing criteria for post-traumatic stress disorder. *N* = Number of observations in sample of 228 without re-experiencing symptoms and 95 with that symptom. SVT = Symptom validity test.

validity indices. We calculated positive (+) LR for the subsyndromal group against the expected invalidity rate and found the following +LR (95-CI in parentheses): +LR = 2.5 for MMPI-2FBS (2.2–2.8); 2.4 (2–2.6) for TOMM Retention; 1.6 (1.5–1.8) for TOMM Trial 2; 1.6 (1.5–1.9) for RDS; 1.8 (1.6–1.9) for MMPI2-F; 1.4 (1.3–1.6) for summed FT; and 1.3 (1.1–1.4) for summed/average GS.

Second, Table 3 displays a trend of small differences but consistently higher prevalence of noncredible scores in the dual-diagnosis group. Third, four of the effect sizes were small in a direction of higher invalidity rates in the dual-diagnosis group, but both motor tasks were associated with trivial effect sizes. The generally accepted threshold for small ES is $>.2$ and moderate ES >0.5 (Cohen, 1988). Hence, diagnosis of dual conditions, which includes re-experiencing symptoms, is associated with mildly increased risk of noncredible cognitive and symptom report, but subsyndromal PTSD claims in conjunction with mild head trauma also show significant association with implausible scores.

Analysis 3: Local Invalidity Base Rates

The second analysis indicated subsyndromal PTSD claims conjoint with mTBI allegations showed significant association with invalid test score patterns, but the added claim of re-experiencing symptoms added mildly higher risk of validity test failure in two of three behavioral domains. This raised another issue for analysis: Do the high failure rates simply reflect local base rates for validity test failure in any subjective disability claim, or do dual diagnoses increase risk for validity test failure? To this end, we combined the two variants of dual diagnosis into a single post-traumatic syndrome group and compared pseudo-abnormality rates with those produced by the simple LPCS group ($N = 476$). Table 4 summarizes noncredible score rates under the probable rule and is organized by effect size in descending order. Three features are noteworthy. First, the prevalence of noncredible scores in the simple LPCS group is consistently above the 10th percentile of genuinely

Table 4 Rates of noncredible scores in late post-concussive syndrome cases without and with post-traumatic stress syndrome claims under the "probable" rule

	Simple LPCS		LPCS + PTSS		
Validity test	*N*	%Invalid	*N*	%Invalid	Effect size (r)
MMPI-2 FBS	453	56	312	79	0.65 (.31)
TOMM Trial 2	465	31	316	52	0.54 (.26)
TOMM Retention	465	45	316	63	0.47 (.22)
MMPI-2 F	471	44	318	58	0.35 (.17)
TAPTOTAL	458	27	312	37	0.27 (.13)
RDS	323	38	279	47	0.23 (.11)
GRIPSUM	459	17	312	25	0.22 (.11)

Effect size and *r* determined by probit method for dichotomous data (Lipsey & Wilson, 2001). LPCS = Late post-concussion syndrome. PTSS = Post-traumatic syndrome with or without re-experiencing symptoms.

impaired referent group; failure rates were especially prominent on the FBS and TOMM. Hence, there is still increased risk of invalidity in respondents with simpler subjective disability claims. Second, motor pseudo-abnormalities were less frequent but still surprisingly high, given that motor deficits are not expected in minor head-neck injury (Alexander, 1997, 1998). Third and most critical, all seven comparisons showed mild or moderate ES in the direction of higher failure rates in respondents reporting some combination of post-concussive and PTSD-like symptoms. In summary, Table 4 suggests dual syndromal claims of either type are associated with incrementally higher noncredible score rates.

Analysis 4: Conditional Risks of Invalidity Signs

The final analysis focused on conditional risks for invalidity patterns. Clinicians are concerned with base rates of target behaviors in a given sample when choosing tests for differential diagnosis. To this end, we reduced data into synthetic (derivative) variables to calculate the risks of noncredible presentations conditional on the various post-traumatic presentations. Three synthetic binomial variables were constructed: symptom validity (fail either MMPI-F or MMPI-FBS, or pass both), cognitive validity (fail either TOMM2 or TOMM-Ret or RDS, versus pass all three), and motor validity (fail GRIP or TAP, versus pass both).

Table 5 summarizes the conditional risks of failing the synthetic validity indicators in the three late post-concussion groups, the latter arranged in order of ascending post-traumatic complexity. Group complexity as used here is a rough ordinal ranking, not a scaled independent variable. First, Table 5 shows a general picture of increasing invalid cognitive, symptom, and motor signs with rising complexity of post-traumatic self-report. For example, the probability of showing a noncredible cognitive sign goes from 65% of the simple post-concussion group to 83% of those claiming neurogenic amnesia with re-experiencing symptoms. Second, the most common noncredible patterns were excessive symptom report and exaggerated cognitive defect; noncredible motor scores were least frequent but

Table 5 Conditional risks of probable invalid signs for the three late post-concussive groups

Synthetic invalidity signs	LPCS simple	LPCS subsyndromal	LPCS dual diagnosis
Cognitive sign	.65	.71	.83
Symptom sign	.70	.90	.93
Motor sign	.34	.42	.44
None	.14	.02	.01
Any combination*	.86	.98	.99
One (any)	.22	.26	.18
Two (any)	.41	.38	.37
Three (all present)	.24	.35	.45

LPCS = Late post-concussion syndrome. Subsyndromal = post-traumatic syndrome without re-experiencing symptoms. Dual diagnosis = post-traumatic syndrome including re-experiencing symptoms. Probable = performance at or worse than the 10th percentile of a genuine brain disorder group. Cognitive sign = any failure on reliable digit span, TOMM second trial or TOMM retention trial. Symptom sign = any excessive score on the MMPI-FBS or MMPI-F scale. Motor sign = any failure on finger tapping or grip strength.

*The summed probabilities of one, two, and three signs do not equate to the "any combination" probability because of rounding error.

still observed in a substantial minority. Third, inspection of combinatory data (lower half of Table 5) shows almost half the dual-diagnosis group produced all three invalid signs, nearly twice the rate seen in the simple LPCS group. This means persons claiming to have both neurogenic amnesia and re-experiencing symptoms also produce more blanket noncredible scores. Fourth, of special note is the probability of invalid signs being absent. Only 1–2% of the two PTSD-related mTBI groups produced valid test scores on all three synthetic indicators. With a 98–99% base rate of at least one form of invalidity, the implication is that history of complex post-traumatic outcome alone after remote mild trauma is sufficient grounds for skepticism before any testing is even performed. No psychological test can improve on base rate prediction in high prevalence circumstances (Meehl & Rosen, 1955).

DISCUSSION

This large, multi-year case series showed persons reporting subjective disability blamed on dual neurogenic-psychogenic disorders following remote (>6 months) head–neck trauma produce excessive pseudo-abnormalities during neuropsychological testing. In summary of the findings, our serial analyses showed: dual diagnosis (full PTSD + post-concussion) was associated with substantial validity failure rates in three behavioral domains (symptom, cognitive, and motor); small but incrementally higher invalidity rates in dual diagnosed persons with full versus subsyndromal PTSD claims; higher failure rates in both post-traumatic phenotypes relative to simple post-concussion claims; and increasing conditional risk of invalidity with increasing post-traumatic complexity. Invalid symptom and memory scores were more common than motor pseudo-abnormalities, although the prevalence of implausible motor scores was still inconsistent with the natural history of mild concussion (Alexander, 1997, 1998).

The Over-Endorsement Continuum Hypothesis

Our main conclusion is that response bias is so strongly associated with dual syndromal claims that clinical validity is in doubt. Derived from the work of Miller and Cartlidge (1972), we propose an "over-endorsement continuum" hypothesis to organize the data: The greater the symptom floridity (complexity) after minor neurological injury, the more comorbid diagnostic criteria will erroneously be met. This could explain, albeit in post hoc fashion, the increase in noncredible score rates as the number of reported post-traumatic symptom clusters increase in persons also claiming underlying mild brain injury. Dual diagnosis of mTBI with full PTSD requires more symptoms than mTBI with subsyndromal PTSD, and solitary post-concussion syndrome requires only three symptoms (APA, 1994; World Health Organization, 1992). Previously, Greiffenstein and Baker (2006) showed that symptom endorsement rates *within* post-concussion criteria are linearly associated with pseudo-abnormality rate.

The over-endorsement hypothesis might explain discrepancies in the dual-diagnosis literature. One noteworthy discrepancy is reported PTSD–mTBI comorbidity rates following traffic crashes markedly higher than PTSD-only rates in conscious victims of more toxic stressors. This is termed the subjunctive fallacy; meaning a subcategory (dual diagnosis) should not have greater frequency than the main category (all PTSD cases). Ohry et al. (1996) reported 33%, and Parker (1996) 90%, of traffic crash outpatients presented with dual diagnoses. But the conditional prevalence of DSM-IV-defined PTSD, when persons are asked about the *worst* stressors, is 14% (Breslau et al. 1998), and only 8% of immigrants exposed to serial political violence show PTSD signs (Eisenman, Gelberg, Liu, & Shapiro, 2003). There are many other examples of discrepant rates (see Vasterling & Brailey, 2005, for epidemiological reviews). The discrepancies may be resolved by considering method variance: Ohry et al. (1996) and Parker (1996) relied on samples at risk for exaggeration, while Breslau et al. (1998) and Eisenman et al. (2003) relied on unselected samples in contexts with limited compensatability. Rosen (1995, 2004) documented how PTSD rates are affected by litigation risk.

Our study lends further support to concerns that compensatable diagnoses relying solely on subjective evidence can easily be feigned or distorted, and that misrepresentation of somatic and psychological damages is a problem following different compensatable etiologies (Mittenberg et al., 2002; Peterson, 1998). Greiffenstein et al. (1994) found fewer validity test failures in persons with persistent post-concussion syndrome than examinees with quantitatively matched trauma but more protean claims.

Clinical Implications

The main clinical implication is to exercise greater caution in drawing diagnostic conclusions in persons with multi-faceted presentations than persons with simpler post-traumatic histories. Embellishment or malingering should be considered during differential diagnosis, although they are not the only considerations (Rogers, 1990; Rogers, 1997 ch. 1). Second, objective symptom validity tests rather than intuitive impression of effort should be standard evaluation tools in any compensatable post-traumatic condition (Arbisi et al., 2004; Vasterling & Brailey, 2005). Hickling, Blanchard, Mundy, and Galovski (2002) showed detection of PTSD simulation improves when clinicians are made cognizant of validity threats. However, in some settings, examiners still diagnose disabling PTSD on self-report alone despite blatantly invalid MMPI-2 profiles (Arbisi et al., 2004). In the latter case, it is unclear whether clinicians weight self-report more heavily, have access to critical extra-test information, or just avoid addressing objective validity considerations for personal reasons (Arbisi et al., 2004; Rogers, 1990). Third, the differential diagnosis should include not just malingering (McGuire, 1999), but somatization, factitious, and personality disorders (Binder & Campbell, 2004). Fourth, PTSD or mTBI can still be considered as stand-alone diagnoses in dual representation cases. Persons can certainly sustain genuine brain or psychological injury, only later "adding gloss" based on post-incident legal and media influences (Rosen, 1995, 1996), hasty misdiagnosis (Blanchard, Buckley, Hickling, & Taylor, 1998a; Sbordone & Liter, 1995), secondary gain (Binder & Rohling, 1996), or Internet research (Ruiz, Drake, Glass, Marcotte, & van Gorp, 2002). One should never discount all post-incident symptoms based on a PTSD–mTBI presentation, although the task is made difficult by misrepresentation.

Limitations and Caveats

The suspect validity of dual-diagnosis presentations is hardly encouraging. But there are methodological issues that limit conclusions and external validity. First, a case series design means response bias may not be the only association with dual claims, or necessarily the original cause of them. Hence, the current results should not be viewed as an epidemiological estimate of malingering in *acute* PTSD or mTBI cases. Second, the higher female representation in the dual-diagnosis sample may have biased the results on grip strength testing and to a lesser extent finger tapping. This is because sample sizes for sex-adjusted grip and finger-tapping scores were not sufficiently large or available for the referent samples we relied on. This is a minor issue however, as noncredible grip deficit was the least common and weakest invalidity pattern; sex is unrelated to the other tests. Regardless, sex-specific invalidity rates for simple motor tests need to be established in future studies. Third, we may have underestimated validity concerns; failure rates would have been higher if not for the stringently low performance floors we set as invalidity criteria. For example, the finger-tapping performance floors produced by our large late post-concussion sample are comparable to low levels seen only in neurodegenerative movement disorders (Butters, Goldstein, Allen, & Shemansky, 1998). Persons misrepresenting their neurocognitive or neuromotor status could still perform at median "impaired" levels indistinguishable from genuine patients (Greiffenstein & Baker, 2006; Prigatano, Smason, Lamb, & Bortz, 1997). In conclusion, our results are best generalizable only to a forensic context where long-term compensatability is based on subjective evidentiary components under the control of the participant (Rosen, 2004).

This study cannot definitively rule out the possibility that PTSD and neurogenic amnesia can co-exist in some cases, as it is impossible to prove a negative. King (1997) proposed a testable mechanism: Dual diagnoses could be linked to *separate* traumas, in so far as the blunt force trauma may cause neurogenic amnesia followed by sporadic lucidity ("islands of memory") sufficient to encode threat information. But it remains unclear under what specific conditions dual-diagnosis theory could be tested, given the necessary reliance on self-report. Psychophysiological measures of autonomic reactivity hold some promise because they are independent of self-report. This comes with the caveat that autonomic hyperarousal patterns can also be induced by asking persons to recall traumatic pseudomemories (McNally et al., 2004).

In conclusion, although rare cases of dual diagnosis cannot be ruled out, our findings strongly suggest late-appearing mTBI-PTSD claims are so intertwined with secondary gain that this dual diagnosis may only be a byproduct of it.

AUTHOR NOTE

This is an unfunded study. Neither author has any proprietary interest in the psychometric tests mentioned here. We presented data from 15 of these persons in a poster session at the 2002 Annual Convention of the American Psychological Association.

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