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Effort in Acute Traumatic Brain Injury: Considering More Than Pass/Fail

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Abstract

Purpose/Objective—Performance validity is often conceptualized as a dichotomous process. Effort likely lies on a continuum, however, and psychologists' tendency to rely on pass/fail descriptors of one's effort may not be the only approach. The current study aims to show that when performance validity is considered on a continuum, it may provide clinical information related to cognitive functioning.

Research Method/Design—Forty-four patients with moderate or severe traumatic brain injury were evaluated with the Repeatable Battery for the Assessment of Neuropsychological Status upon their emergence from posttraumatic amnesia. From this data, previously developed effort index scores and "other cognitive functions" index scores were calculated.

Results—Performance on the effort index significantly accounted for the patients' performance on a cognitive composite score after considering education and severity of injury.

Conclusions/Implications—Findings suggest that more in-depth analysis of validity test performance is beneficial to gauge a patient's level of effort and is important to consider when interpreting results and in treatment planning.

Keywords

effort; head injury; performance validity; traumatic brain injury

Introduction

Neuropsychological evaluations are often useful for uncovering cognitive and behavioral deficits that may not appear in functional images of the brain or in neurological exams. Patients may not always be exerting maximal effort on tasks, however, and poor effort greatly affects neuropsychological performance (Iverson, 2005). For the purposes of this article, we will define *effort* as the intensity with which one tries to perform to one's best ability on neuropsychological tests. Reduced effort may be due to the patient not being invested in the outcome of the testing. It may also reflect an external incentive to demonstrate diminished performance. There are many reasons why patients might want to appear more impaired than they actually are, most commonly to avoid a variety of social, financial, or personal consequences (Lezak, Howieson, & Loring, 2004). Many traumatic brain injuries (TBIs) are caused by motor vehicle accidents, on the job injuries, or other situations that may lead to lawsuits and the potential for compensation (Donders & Boonstra, 2007; Locke et al., 2008). Financial compensation has been shown to play a large role in probable response bias issues (Binder & Rohling, 1996; Cook, 1972; Miller, 1961; Paniak et al., 2002; Reynolds, Paniak, Toller-Lobe, & Nagy, 2003). Studies show that decreased performance on neuropsychological measures is associated with larger financial compensation (Bianchini, Curtis, & Greve, 2006; Binder & Rohling, 1996). In addition, poor performance validity has been shown to be related to cognitive performance in postacute TBI patients seen in outpatient rehabilitation settings (Donders & Boonstra, 2007; Locke, Smigielski, Powell, & Stevens, 2008).

It should be noted that volitional underperformance is not the only explanation for performance validity test failure. In fact, Boone (2007) argued that a general equating of underperformance with moral shortcoming is counterproductive. There are many phenomena that may lead to poor effort in the absence of external incentives, such as conversion disorder, psychological and physiological stressors, anxiety, depression, diagnosis threat, glucocorticoid elevation in the hippocampus, and organic deficits (Bigler, 2012; Metternich, Schmidtke, & Hull, 2009; Pollo & Benedetti, 2009; Suhr & Gunstad, 2005; Gorissen, Sanz, & Schmand, 2005; Metternich et al., 2009). In particular, performance validity tests have been shown to have poor specificity in patients with severe dementia, as well as individuals suffering a TBI (Dean, Victor, Boone, Philpott, & Hess, 2009; Merten, Bossink, & Schmand, 2007; Teichner & Wagner, 2004; Greve, Ord, Curtis Bianchini, & Brennan, 2008). In addition to organic brain dysfunction caused by TBI, apathy, a commonly occurring consequence of TBI (Marin & Wilkosz, 2005), may explain performance validity test failure. An apathetic patient may not attend appropriately to the test stimuli and may not put full effort into the task, resulting in a performance that falls below their ability. Because of potential reductions in alertness and effort, as well as the complex psychiatric and physical stressors that often co-occur in individuals with a TBI, performance validity testing is especially important to conduct in this population.

Recently, an effort index has been developed to evaluate performance validity on the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS; Randolph, Tierney, Mohr, & Chase, 1998; Silverberg, Wertheimer, & Fichtenberg, 2007). The RBANS is a battery of 12 subtests originally designed to screen for dementia. The RBANS has been used with various patient populations, including dementia (Beatty et al., 2003; Beglinger et al., 2010; Gontkovsky, McSwan, & Scott, 2002; Stellton, 2006), stroke (Holbrook & Skilbeck, 1983; Keith, Granger, Hamilton, & Sherwin, 1987; Larson, Kirschner, Bode, Heinemann, & Goodman, 2005; Wilde, 2006, 2010), schizophrenia (Gold, Queern, Iannone, & Buchanan, 1999; Hobart, Goldberg, Bartko, & Gold, 1999; Wilk et al., 2004), multiple sclerosis (Aupperle, Beatty, Shelton Fde, & Gontkovsky, 2002), end-stage liver disease (Mooney et al., 2007; Sorrell, Zolnikov, Sharma, & Jinnai, 2006), and TBI (McKay, Casey, Wertheimer, & Fichtenberg, 2007; Mc-Kay, Wertheimer, Fichtenberg, & Casey, 2008). In the acute rehabilitation setting, the RBANS is particularly useful given its brevity as well as its alternate forms, allowing for the assessment of change over time.

The RBANS “effort index” (Silverberg et al., 2007) was based on the RBANS Digit Span and List Recognition subtests. The authors indicated that because forced choice tests are successful in detecting performance validity issues, the List Recognition subtest of the RBANS is an appropriate component to include in the effort index. In addition, they noted that because Digit Span is one of the simplest neuropsychological tasks and because Reliable Digit Span has been shown to be an adequate indicator of poor effort (Greiffenstein, Baker, & Gola, 1994; Mathias, Greve, Bianchini, Houston, & Crouch, 2002), the Digit Span subtest of the RBANS was another suitable component to include in an effort index. As other subtests of the RBANS have been shown to be more closely associated with actual organic dysfunction, the effort index did not include any additional RBANS subtests (Silver-berg et al., 2007).

The sample used to derive the effort index included patients with a neurological and/or psychological disorder with no evidence of performance validity issues. For each of the RBANS List Recognition and Digit Span subtests, the raw scores corresponding with seven specified percentile ranges (i.e., 0, 0.1–1.9, 2–4.9, 5–8.9, 9–15.9, 16–24.9, and 25) were determined. A weighted score, ranging from 0 to 6, was then assigned. An effort index was obtained by summing a participant's weighted scores on each of the two subtests. The effort index score ranges from 0 to 12, with higher scores indicating worse performance level. In the derivation sample, effort index cut-off scores of >0, >1, >2, and >3 had specificity rates of .66, .75, .84, and .94, respectively (Silverberg et al., 2007).

In the subsequent development study (Silverberg et al., 2007), RBANS performance was investigated in five groups: clinical TBI ($n = 32$), clinical malingering ($n = 15$), control ($n = 24$), simulating naïve malingerers ($n = 28$), and simulating coached malingerers ($n = 24$). Effort index scores were computed for each participant and an index score >3 had perfect specificity (1.0) for clinical TBI and control groups and sensitivity of .464, .533, and .708 for the simulating coached, clinical malingerers, and simulating naïve groups, respectively. The authors therefore recommended that an index score greater than 3 be considered suspicious (Silverberg et al., 2007).

Additional studies have evaluated the proposed effort index in various patient samples, including geriatric (Armistead-Jehle, 2010; Duff et al., 2011; O'Mahar et al., 2012; Young, Baughman, & Roper, 2012), active duty military (Armistead-Jehle & Hansen, 2011), schizophrenia (Moore et al., 2013), amnesic disorders (Novitski, Steele, Karantzoulis, & Randolph, 2012), and Huntington's disease (Sieck, Smith, Duff, Paulsen, & Beglinger, 2013). The effort index has been shown to relate to cognitive functioning, participation in treatment, overall functioning, and social functioning (Barker, Horner, & Bachman, 2010; Moore et al., 2013). Whereas the effort index has been shown to result in an increased number of false positives in cognitively impaired samples (Duff et al., 2011; Hook, Marquine, & Hoelzle, 2009; O'Mahar et al., 2012), a downfall of many performance validity measures, the effort index has been shown to be more specific than an alternate RBANS effort scale (Novitski et al., 2012; Sieck et al., 2013). The RBANS effort index incorrectly classified 31% of medically ill geriatric patients not suspected of having any external incentive to malingering (Hook et al., 2009), but also demonstrated modest sensitivity in a different sample of geriatric patients with suspected underperformance issues (Barker et al., 2010). It has been shown to have modest sensitivity, but strong specificity in service members and veterans (Armistead-Jehle & Hansen, 2011; Young et al., 2012).

Despite the propensity for neuropsychologists to use pass/fail cutoffs to determine whether a patient was putting forth adequate effort during an evaluation, a large amount of literature indicates that effort lies on a continuum (Rogers, 2008; Walters, Berry, Rogers, Payne, & Granacher, 2009; Walters et al., 2008), and the tendency to dichotomize this construct presents a number of limitations. For example, there is a long history of criticizing the dichotomization of any continuous variable, as it results in a loss of information (Cohen, 1983; MacCallum, Zhang, Preacher, & Rucker, 2002; Maxwell & Delaney, 1993; Zhao & Kolonel, 1992).

It is possible, for instance, that patients who have passed performance validity testing based on a cut-off score criterion could still have evidence of differential effort captured by the magnitude of their performance validity test result. Adequately assessing and describing effort is critical when administering a neuropsychological battery. Reduced effort can cause patients to appear impaired when they are not and may lead to incorrect diagnoses, ineffective treatment planning and recommendations, and unnecessary imposed patient restrictions with the potential to lead to a myriad of negative consequences (e.g., depression, isolation, anger, perception of inability or inadequacy), as well as increased medical costs. Because of this, it is important to consider not only whether a patient "passes" or "fails" performance validity measures, but also their level of effort in the testing, which may not be accurately captured with standard performance validity test cutoffs. Moderate and severe TBI patients may be unmotivated or apathetic toward participating in testing, but nevertheless pass performance validity tests. Early identification of patients with reduced effort would be helpful for therapists providing psychotherapy, cognitive remediation, and speech, occupational, and physical therapy. For example, it could aid in identifying patients who might benefit from early interventions emphasizing strategies for maximizing effort and motivation throughout treatment. This information has the potential to be very valuable within rehabilitation settings. This is notably true for TBI patients whose organic

impairments may lead to reduced initiation, reduced motivation, and increased apathy (Lezak et al., 2004).

The current study aims to evaluate the relationship between degree of effort and cognitive performance by using the RBANS effort index as a continuous variable for a sample of patients with TBI that would not be considered to have suspicious performance validity (i.e., thought to have evidence of intentional underperformance). We chose this type of sample to investigate whether graded levels of effort relate to cognitive performance in patients considered to have passed a cut-off score criterion approach to effort. We hypothesized that for this sample, when RBANS effort index scores are used on a continuum, they would relate to cognitive functioning, even after considering education and severity of injury.

Method

Participants

Participants for this study were inpatients at an acute rehabilitation hospital who had sustained a moderate or severe TBI. Medical and neuropsychology chart reviews were carried out for consecutively evaluated patients over a 40-month period in a study approved by the Baylor College of Medicine Institutional Review Board. Participants were included if they met the following criteria: (a) primary language English; (b) available age adjusted RBANS normative data for participant; (c) participant able to complete RBANS under standard administration conditions; (d) available estimate of posttraumatic amnesia (PTA) length based on serial administration of the Galveston Orientation and Amnesia Test (Levin, O'Donnell, & Grossman, 1979); (e) PTA estimate within 4 *SD* of the mean PTA length for the group that satisfied the four prior criteria (this criterion was implemented so that PTA estimates entered for analysis were more closely reflective of the sample on the whole rather than outliers and only eliminated two potential participants); and (f) an RBANS effort index of 3 or less, so the sample only consisted of participants thought to be giving adequate effort per Silverberg et al. (2007). The charts of 126 individuals with TBI were reviewed. Fifty-one participants met Inclusion Criteria a through e, but seven of these participants did not meet Criterion f, leaving 44 participants for the main analyses.

Procedures

Neuropsychological testing was conducted an average of 6.0 days (*SD* = 4.5; range = 0–20) after emergence from PTA. As part of their routine neuropsychological testing, which took place over one to three 1-hr sessions, participants were given the RBANS. The RBANS was usually the first administered measure. As described by Silverberg and colleagues (2007), an effort index score was created for each participant. In addition, to evaluate the relationship between effort and cognitive performance, like Silverberg and colleagues we derived an “other cognitive functions” (OCF) index. This index consists of the three RBANS indices that do not include components of the effort index (i.e., Immediate Memory, Visuoconstructional, and Language). The OCF index was computed for each participant by summing the participants’ three index scores. Unlike Silverberg and colleagues (2007), we focused our investigation on participants with scores that fell below the effort index cut off score, indicating adequate effort.

Statistical Analyses

To examine the unique contribution of the RBANS effort index score on the OCF index, a hierarchical multiple regression analysis was performed. In Model 1, years of education and length of PTA were the predictor variables of the OCF index that served as the criterion variable. In Model 2, the RBANS effort index score was entered into the Model 1 equation as an additional predictor variable. Before the hierarchical multiple regression analysis was performed, the predictor variables were examined for multicollinearity. Statistical Package for the Social Sciences (SPSS for Mac OS X, version 19.0) was used for all statistical analyses.

Results

Sample Characteristics

The demographics and clinical characteristics of the study sample are presented in Table 1. Participants were considered to have emerged from PTA when their Galveston Orientation and Amnesia Test scores improved to 76 or above on two consecutive administrations, with length of PTA being operationalized as the number of days between injury occurrence and the first of the consecutive scores of 76 or above (Novack, Dowler, Bush, Glen, & Schneider, 2000). The range of PTA length was from 5 to 86 days ($M = 33.8$ days, $SD = 14.4$). The average age of the participants was 38.4 years ($SD = 14.2$; range = 19–63). Thirty-two (72.7%) were male and 12 were female. Mean education was 13.3 years ($SD = 2.1$; range = 9–18), with 57% of the sample having at least some college. Six (13.6%) identified as African American, 32 (72.7%) identified as Caucasian, four (9.1%) identified as Hispanic, and two (4.5%) identified as another race/ethnicity.

RBANS Effort Index and Overall

Cognitive Performance

For the 44 included participants, scores on the effort index ranged from 0 to 3, with a mean of 0.89 ($SD = 1.02$). The OCF index scores ranged from 160–282, with a mean of 225.91 ($SD = 29.10$). A hierarchical multiple regression was conducted to investigate predictors of OCF score. Results of the variance inflation factor (all less than 2.0) and collinearity tolerance (all greater than 0.86) suggested that multicollinearity was not an issue. The results of the final model, which included years of education, PTA length, and the RBANS effort index indicated that the variance accounted for by the predictors was statistically significant ($R^2 = .207$, $F(3, 40) = 3.487$, $p = .024$). In this model, only the RBANS effort index was significantly related to the RBANS composite score ($\beta = -.449$, $p = .005$), with lower (i.e., better) scores on the effort index related to better scores on the OCF index. The R^2 change attributable to the effort index was 17.5%. For complete results, please see Table 2.

Discussion

This study investigated the relationship between effort and overall cognitive functioning in a sample of inpatients with TBI in an acute rehabilitation hospital, all traditionally classified as putting forth a valid performance using the RBANS effort index as a dichotomous variable. Performance on the effort index significantly accounted for the OCF index score

after considering education and severity of injury, suggesting that relying on the typical pass/fail cutoff for the RBANS effort index may not be ideal.

Effort is especially important to consider in a rehabilitation setting, as these patients are likely to be retested to assess changes in cognition over time. For example, if a patient was not putting forth full effort during their initial testing session after emerging from PTA but does put forth full effort in subsequent testing sessions, their rate of improvement may be artificially inflated. This inflated rate of improvement could give false hope to patients, families, and providers regarding rate of recovery and subsequent treatment recommendations. In addition, information about effort gathered during neuropsychological assessment would be very valuable to the neuropsychologist and other therapists. It may influence the focus of interventions and how the therapists and others go about engaging the patient.

There are many reasons to support considering effort on a continuum, rather than as a dichotomous concept, especially in patients with an acute TBI. In addition to the general consensus that effort is best considered as dimensional rather than taxometric (e.g., Walters et al., 2009), there are a myriad of subtle and nonsubtle influences on these patients. The severity of their organic deficits, apathy, and/or physical and psychological distress likely contribute to their performance on measures of effort. Although intentional underperformance due to external incentives is often difficult to rule out, the patients in the current study were in a rather acute phase of their injury, recently emerging from PTA. It is unlikely that these patients would have adequately conceptualized issues associated with financial compensation, which has been shown to be related to increased likelihood of symptom validity test failure (e.g., Binder & Rohling, 1996), or would have had time to be coached by a lawyer, which has been shown to affect neuropsychological performance (e.g., Gorny & Merten, 2005).

Though litigation and related factors were likely not a concern at the time of testing for the current study, these patients are at increased likelihood of being involved in litigation and pursuing compensation in the future. Moore and Donders (2004) found that inpatient and outpatient rehabilitation patients with TBI seeking financial compensation were four times more likely than patients not seeking financial compensation to fail measures of performance validity. This demonstrates a clear need to assess performance validity in rehabilitation settings; however, because of the severity of their injuries, patients often do not have tolerance for long neuropsychological evaluations or long stand-alone performance validity tests. The RBANS is a useful tool in acquiring various neurocognitive data while considering time restraints. Its utility as a measure of performance validity is an additional benefit. The results from the current study indicate that additional information at the group level may be garnered about cognitive performance when considering effort on a continuum. A limitation of the current study is that performance validity was assessed with only one measure: the RBANS effort index. Although this has been shown to be an adequate measure of performance validity (Barker et al., 2010; Silverberg et al., 2007), it is not considered a “gold standard.” Unfortunately, as mentioned earlier, testing patients within an acute setting generally necessitates a briefer battery that is not conducive to the administration of additional performance validity measures. It seems likely that the findings from the current

study will generalize to other measures of performance validity in other populations; however, replication in different samples is necessary.

Despite this limitation, the current study suggests that analysis of effort as a continuous variable in patients who have “passed” the performance validity test may be beneficial to gauge level of effort in the testing session. There are a variety of factors outside of intentional underperformance that might affect effort test performance and that should be considered when interpreting suboptimal effort.

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Impact and Implications

- The current article is the first to demonstrate the utility of the Repeatable Battery for the Assessment of Neuropsychological Status effort index in patients with acute traumatic brain injury.
- It adds to the literature by showing the utility of considering effort on a continuum, rather than strictly based off of cutoffs in an acute rehabilitation setting.
- Implications for practice include that level of effort is important to consider even in patients who pass performance validity measures. This information is valuable for treatment providers in their provision of therapy, evaluation of improvement, and formation of recommendations.

Table 1

Demographics and Estimated Posttraumatic Amnesia (PTA) Length of the Study Sample (n = 44)

Demographic	<i>M (SD)</i>	No. (%)
Age	38.4 (14.2)	
Education	13.3 (2.1)	
Males		32 (72.7)
Race/Ethnicity		
African American		6 (13.6)
Caucasian		32 (72.7)
Hispanic		4 (9.1)
Other		2 (4.5)
PTA estimate	33.8 (14.4)	

Table 2

Hierarchical Regression Analysis Assessing the Relationship Between the Other Cognitive Functions Index and Length of Posttraumatic Amnesia (PTA), Years of Education, and Effort Index Score

Model	Beta	<i>T</i>	<i>F</i>	<i>R</i> ²	<i>p</i>	Change in <i>R</i> ²
1			.683	.032	.511	
PTA	−0.114	−0.736			0.466	
Education	0.124	0.801			0.428	
2			3.487	.207	.024	.175
PTA	0.009	0.059			0.954	
Education	0.25	1.687			0.099	
Effort index score	−0.449	−2.972			0.005	