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William F. McBride III, M.S.  
*Eastern Kentucky University*

Adam H. Crighton  
*Eastern Kentucky University*

Dustin B. Wygant, Ph.D.  
*Eastern Kentucky University*

Robert P. Granacher, Jr., M.D., M.B.A.  
*University of Kentucky College of Medicine*

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## **It's Not All in Your Head (or at Least Your Brain): Association of Traumatic Brain Lesion Presence and Location with Performance on Measures of Response Bias in Forensic Evaluation**

Willie F. McBride III, M.S.<sup>†</sup>, Adam H. Crighton<sup>†</sup>,  
Dustin B. Wygant, Ph.D.<sup>†</sup> and Robert P. Granacher, Jr., M.D., M.B.A.\*

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**This study examined the relationship between lesion presence and localization and performance on measures of cognitive response bias, specifically in individuals purporting to have a traumatic brain injury. Ninety-two participants, all of whom were involved in workers' compensation or personal injury litigation, were administered an extensive neuropsychological battery, including neuroimaging (magnetic resonance imaging and computed tomography), at a neuropsychiatric clinic in Lexington, KY. Those with evidence of intracranial injury on neuroimaging findings were placed in the head injury lesion litigation group and were coded based on the anatomical location and type of intracranial injury. Results demonstrated no significant relationships between lesion location and performance on performance validity tests (PVTs), as well as the Response Bias Scale of the Minnesota Multiphasic Personality Inventory-2 Restructured Form. Given the lack of research concerning lesions and performance validity tests, this study addresses important questions about the validity of PVTs as specific measures of response bias in patients who have structural changes secondary to traumatic brain injury. Copyright © 2013 John Wiley & Sons, Ltd.**

It is widely recognized that objective test data utilized in the examination of brain injury should be systematically reviewed for performance validity, a term used by Larrabee (2012), to denote performance on an ability measure, particularly in cases of mild traumatic brain injury (mTBI) in compensation-seeking cases. Despite Bigler's (2012) challenges of contemporary research in performance validity testing, it is commonly accepted, and even dictated by practice standards, that neuropsychological evaluation, particularly in forensic contexts, needs to include established measures of performance validity (Bush et al., 2005; Heilbronner et al., 2009). One issue raised by Bigler (2012) that the current study addressed is the absence of lesion-localization studies in performance validity research. The current study aimed to address this issue by specifically examining the relationship between the presence and location of structural brain abnormality (i.e., lesion) following traumatic brain injury (TBI) upon measures of cognitive response bias.

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\*Correspondence to: Robert P. Granacher, Jr., M.D., M.B.A., Lexington Forensic Neuropsychiatry and University of Kentucky College of Medicine, 1401 Harrodsburg Road, Suite A400, Lexington, KY 40504, U.S.A. E-mail: rgranacher@aol.com

<sup>†</sup>Eastern Kentucky University.

Understanding the relationship between TBI and performance or “effort” on performance validity tests (PVTs) is essential in forensic settings, given the implications of such determinations made by clinicians. This relationship has been examined in a variety of settings, where external incentives were present (e.g., Green, Iverson, & Allen, 1999; Green, Rohling, Lees-Haley, & Allen, 2001). Green *et al.* (1999) found that the mTBI group of litigants scored significantly lower on the Word Memory Test (WMT; Green, 2003) than the definite TBI group of litigants. Green *et al.* (2001) found that patients’ effort, as indicated by the WMT, had a substantially larger impact on neuropsychological test performance than brain injury status. Based on these results, Green and colleagues have concluded that effort is not associated with severity of TBI.

In the neuropsychiatric and psychiatric communities, significant attention is paid to the presence of lesions associated with claims of TBI, and/or the absence of documented lesions when analyzing forensic and/or compensation-seeking cases (Granacher, 2012a, 2012b). However, in the neuropsychological literature of performance validity testing in TBI, or organic-based mental conditions, there is a dearth of research explicitly examining whether brain lesions have an impact on a person’s ability to provide optimal effort and validity during neuropsychological assessment of brain trauma. In two of the recent texts on assessing malingered neuropsychological deficits or forensic neuropsychology, not a single mention of brain lesions vis-à-vis performance validity testing is found (Larrabee, 2007, 2012). Moreover, a recent performance validity assessment and malingering text regarding mTBI contains only a single chapter that examined the functional neuroanatomical bases of deceptive behavior in malingering, with no other references to whether brain lesions themselves affect performance validity or psychological validity in a traumatically brain-injured person (Browndyke, 2013).

Larrabee (2007) provided a recent review of malingering research designs and base rates in neuropsychological evaluation. The classic study to identify base rates in mTBI was completed by Mittenberg, Patton, Canyock, and Condit (2002) through a survey of the American Board of Clinical Neuropsychology diplomates who performed forensic work. The highest base rate of malingering was found in personal injury litigants alleging mild head injury (38.5%). Larrabee (2003) also published base rate figures in TBI litigants, which are quite similar to those in the study by Mittenberg *et al.*’s (2002) study. The base rates of Mittenberg *et al.* (2002) and Larrabee (2003) are very similar to the results of an insurance investigation by Carroll, Abrahamse, and Vaiana (1995), who found that 35–42% of all medical costs submitted in support of automobile injury claims were excessive. Thus, malingering is a serious problem in forensic settings. As a result, the National Academy of Neuropsychology and the American Academy of Clinical Neuropsychology have recommended that performance validity testing be performed in all forensic settings (Bush *et al.*, 2005; Heilbronner *et al.*, 2009).

There have been few studies explicitly examining whether a lesion site affects performance during performance validity testing. Flaro, Green, and Robertson (2007) found that workers’ compensation claimants with brain injury did significantly better on the WMT (Green, 2003) effort subtests than a group of claimants who had no brain abnormalities, indicating that the brain lesions did not impact effort on the performance validity test. Rohling and Demakis (2010) highlighted several studies that found TBI had a much smaller effect on neuropsychological test performance than poor effort during testing. Re-examining data from Bowden, Shores, and Methias

(2006) and Green et al. (2001), they concluded that effort explained approximately five times more of the variance in composite neuropsychological test scores than TBI severity.

## Current Study

The literature demonstrates a paucity of research on neuropsychological effort and its relationship to the direct effects of lesions following TBI. While earlier PVT studies (e.g., Flaro et al., 2007; Green et al., 2001) reported that head injury status and severity [based on neuroimaging findings among other variables such as loss of consciousness and Glasgow Coma Scale (GCS) scores] are not related to response bias, few studies directly examined the potential impact of brain lesions on PVT performance.

The current study examined the relationship, if any, between presence and location of brain lesion and performance on measures of cognitive response bias. By looking specifically at lesions, and classifying individuals into four different groups based on lesion location, this study adds incrementally to previous literature where participants with lesion abnormalities were all classified into one group (e.g., Flaro et al., 2007). This study also utilized a control group of patients who showed no neuroimaging evidence of structural brain injury. Consistent with the notion that cognitive response bias measures are specific to misrepresentation of neurocognitive dysfunction (and not genuine neurological impairment), it was hypothesized that there would be no significant relationship between lesion location and performance on PVTs. In addition, the current study examined a non-performance-based measure associated with cognitive response bias, the Minnesota Multiphasic Personality Inventory-2 Restructured Form (MMPI-2-RF; Ben-Porath & Tellegen, 2008) Response Bias Scale (Gervais, Ben-Porath, Wygant, & Green, 2007).

## METHOD

### Participants

The current study used an archival sample of 92 individuals who were evaluated for the purpose of disability determination by a board-certified neuropsychiatrist (R.P.G.) at a neuropsychiatric facility in Lexington, KY, U.S.A. All subjects in this study provided informed consent for use of their data without disclosure of their identity. The datasets came from a prospective study of response bias in patients claiming TBI as a result of personal injury or industrial injury covered by Kentucky Workers' Compensation.

The head injury without lesion litigation group consisted of 68 patients who had a medically documented injury to the head, but no neuroimaging evidence of structural injury at their initial trauma evaluation. The structural brain screening was obtained through acute computed tomography (CT) of the head at injury and magnetic resonance imaging (MRI) at a subsequent neuropsychiatric examination (R.P.G.). This group was comprised of exclusively Caucasian patients, 56% male, with a mean age of 41.0 years ( $SD = 12.3$ ) and a mean education of 12.8 years ( $SD = 2.2$ ). The head injury without lesion group had a mean GCS score of 14.4 ( $SD = 1.2$ ) at the time of their injury and 47% experienced some degree of loss of consciousness.

The head injury lesion litigation group of 24 patients was comprised of individuals who had evidence of intra-axial or extra-axial injury verified at the time of their acute injury by CT examination of the head. This group also had MRI of the brain obtained within a two-year follow-up period after their acute head injury. The group was also exclusively Caucasian, 54% female, with a mean age of 38.2 years (SD = 13.5) and a mean education of 12.1 years (SD = 2.1). The head injury lesion litigation group had a mean GCS score of 11.6 (SD = 3.6) at the time of their injury and 83% experienced some degree of loss of consciousness.

The head injury without lesion litigation group was separated from the head injury lesion litigation group based upon the absence of neuroimaging evidence of structural injury versus individuals with bona fide structural injury verified by acute CT or post-injury MRI of the head or brain. The head injury without lesion litigation group and head injury lesion litigation groups did not differ in terms of age ( $t = 0.92$ ,  $p = 0.36$ ) education ( $t = 1.27$ ,  $p = 0.21$ ), or gender ( $\chi^2 = 1.30$ ,  $p = 0.26$ ). As expected, the head injury lesion litigation group had significantly lower GCS scores ( $t = 5.10$ ,  $p < 0.001$ ) and higher rates of loss of consciousness ( $\chi^2 = 9.61$ ,  $p = 0.002$ ) than the head injury without lesion litigation group.

## Measures

### *Victoria Symptom Validity Test*

The Victoria Symptom Validity Test (VSVT; Slick, Hopp, Strauss, & Thompson, 1997) is a forced-choice number recognition task that is administered via computer. The VSVT software classifies performance as valid, questionable, or invalid (i.e., below chance), but clinical researchers have determined a 90% cut-off that is more accurate in detecting insufficient effort (Grote, Kooker, Garron, Nyenhuis, Smith, & Mattingly, 2000; Sweet, 1999). It has been shown to be effective in predicting valid responses in healthy and non-litigating patients (i.e., 100% specificity) from malingering in people asked to feign post-concussion syndrome (i.e., 83% sensitivity) (Slick, Hopp, Strauss, Hunter, & Pinch, 1994).

### *Test of Memory Malingering*

The Test of Memory Malingering (TOMM; Tombaugh, 1996) is a commonly used symptom validity test that utilizes visual recognition. The TOMM has been found to be effective in differentiating people who are impaired neurocognitively from people asked to feign neurocognitive impairments (Rees, Tombaugh, Gansler, & Moczynski, 1998).

### *Letter Memory Test*

The Letter Memory Test (LMT; Inman et al., 1998) is a forced-choice letter recognition task that is administered via computer. Previous research found that the LMT demonstrated a sensitivity of 0.84 among malingerers and 0.95 among TBI patients, and a specificity of 1.00 for non-litigating neurological patients at a cut-score of 93% (Inman et al., 1998).

## *Response Bias Scale*

The Response Bias Scale (RBS; Gervais et al., 2007) is composed of 28 items from the MMPI-2-RF (Ben-Porath & Tellegen, 2008) and was developed to differentiate people who have failed cognitive PVTs from people who have passed cognitive PVTs. RBS has been researched in a variety of contexts, including criminal forensic (Wygant et al., 2010) and disability evaluations (Gervais, Ben-Porath, Wygant, & Green, 2007; Gervais, Ben-Porath, Wygant, & Green, 2008; Wygant et al., 2010; Wygant, Anderson, Sellbom, Rapiet, Algeier, & Granacher, 2011), as well as Veterans Administration patients (Whitney, Davis, Shepard, & Herman, 2008), and has shown to be an effective self-report measure of response bias.

## RESULTS

Individuals were classified dichotomously into those exhibiting objective neuroimaging evidence of brain lesion ( $n = 24$ ) and those with no discernible evidence of lesion based on MRI and CT scan ( $n = 68$ ). Eighty-seven percent of the sample contained both CT and MRI results. Of the remaining 12 participants, nine included MRI results and three included CT results.

With regard to the 24 participants who had objective evidence of brain lesion, 58% showed intra-axial damage to the right frontal region, 54% to the left frontal region, and lower rates of intra-axial damage to the posterior region (17% to both the left and right posterior regions). Regarding extra-axial damage, the rates of injury were higher in the frontal region (38% right, 33% left) than in the posterior region (8% right, 4% left).

The relationship between presence of brain lesion and performance on performance validity and symptom validity was measured in several ways. First, a zero-order correlation (Spearman's  $\rho$ ) between the presence of lesions and scores from the TOMM, VSVT, LMT, and the MMPI-2-RF RBS was calculated. These results are presented in Table 1. The correlations were small, ranging from  $-0.02$  (TOMM Trial 2) to  $-0.16$  (VSVT easy items), and all were non-significant.

Some patients had multiple lesion locations identified by neuroimaging. Among the 24 patients with brain lesions, 88% were injured in more than one location. The mean number of lesions in this group was 2.3 ( $SD = 0.96$ ). In order to determine whether lesion severity (as indicated by more extensive presence of brain lesions) could potentially be associated with response bias, a Pearson's correlation between the total number of lesions and the present symptom validity measures was calculated. Similar to the initial correlational analyses, the results were all non-significant [ $r$  ranged from  $-0.01$  (VSVT easy items) to 0.15 (RBS),  $p > 0.05$ ] (Table 2). Correlations, however, between

Table 1. Correlation (Spearman's  $\rho$ ) between presence of lesion and performance on cognitive response bias measures

|                   | TOMM<br>Trial 2 | VSVT<br>Easy | VSVT<br>Difficult | VSVT<br>Total | LMT<br>Total | MMPI-2-RF<br>RBS |
|-------------------|-----------------|--------------|-------------------|---------------|--------------|------------------|
| Spearman's $\rho$ | -0.02           | -0.16        | -0.05             | -0.06         | -0.09        | 0.10             |

Note. TOMM, Test of Memory Malinger; VSVT, Victoria Symptom Validity Test; LMT, Letter Memory Test; RBS, Minnesota Multiphasic Personality Inventory-2-Restructured Form Response Bias Scale.

Table 2. Correlation (Pearson's *r*) between number of lesions indicated by neuroimaging and performance on cognitive response bias measures

|          | TOMM<br>Trial 2 | VSVT<br>Easy | VSVT<br>Difficult | VSVT<br>Total | LMT<br>Total | MMPI-2-RF<br>RBS |
|----------|-----------------|--------------|-------------------|---------------|--------------|------------------|
| <i>r</i> | 0.06            | -0.10        | -0.04             | -0.04         | 0.06         | 0.15             |

Note. TOMM, Test of Memory Malinger; VSVT, Victoria Symptom Validity Test; LMT, Letter Memory Test; RBS, Minnesota Multiphasic Personality Inventory-2-Restructured Form Response Bias Scale.

the various response bias indicators (see Table 3) were all significant and in the moderate to large range. Thus, while measures of response bias were strongly associated with each other, they were not related to brain lesion status, either dichotomously or dimensionally.

Next, in order to examine specific scores on various response bias measures, a series of *t*-tests were calculated comparing patients with lesions at various locations to the head injury without lesion litigation group with no brain lesion. In the first analysis (see Table 4), mean scores of the response bias measures between the patients with objective lesion findings (*n* = 24) were contrasted with those from the head injury

Table 3. Correlation between response bias measures

|                         | 1 | 2      | 3      | 4      | 5      | 6       |
|-------------------------|---|--------|--------|--------|--------|---------|
| 1. TOMM Trial 2         | - | 0.70** | 0.66** | 0.72** | 0.71** | -0.35*  |
| 2. VSVT Easy items      |   | -      | 0.57** | 0.71** | 0.82** | -0.32*  |
| 3. VSVT Difficult items |   |        | -      | 0.98** | 0.71** | -0.42** |
| 4. VSVT Total score     |   |        |        | -      | 0.79** | -0.43** |
| 5. LMT Total            |   |        |        |        | -      | -0.44** |
| 6. MMPI-2-RF RBS        |   |        |        |        |        | -       |

Note. TOMM, Test of Memory Malinger; VSVT, Victoria Symptom Validity Test; LMT, Letter Memory Test; RBS, Minnesota Multiphasic Personality Inventory-2-Restructured Form Response Bias Scale.

\**p* ≤ .01, \*\**p* ≤ .001

Table 4. Presence of lesion and performance on cognitive response bias measures

| Measure <sup>a</sup> | No lesion detected<br>( <i>n</i> = 68) |           | Lesion present<br>( <i>n</i> = 24) |           | <i>t</i> (91) | <i>p</i> |
|----------------------|--|-----------|------------------------------------|-----------|---------------|----------|
|                      | <i>M</i>                               | <i>SD</i> | <i>M</i>                           | <i>SD</i> |               |          |
| TOMM Trial 2         | .96                                    | .09       | .98                                | .03       | .02           | .98      |
| VSVT Easy            | .98                                    | .07       | .98                                | .03       | .24           | .80      |
| VSVT Difficult       | .81                                    | .24       | .79                                | .22       | .21           | .83      |
| VSVT Total           | .89                                    | .14       | .89                                | .12       | -.94          | .35      |
| LMT Total            | .91                                    | .17       | .93                                | .09       | -.30          | .76      |
| RBS                  | 78.92                                  | 18.62     | 82.62                              | 15.99     | .73           | .47      |

Note. TOMM, Test of Memory Malinger; VSVT, Victoria Symptom Validity Test; LMT, Letter Memory Test; RBS, Minnesota Multiphasic Personality Inventory-2-Restructured Form Response Bias Scale.

<sup>a</sup>Symptom validity test scores are presented as percentage correct.



without lesion litigation group ( $n = 68$ ). Consistent with the correlational analyses, the differences between the two groups were all non-significant ( $t$  ranged from  $-0.094$  to  $0.73$ ,  $p > 0.05$ ). Next, in order to examine whether specific lesion locations might show some relationship with response bias,  $t$ -tests were calculated between the control ( $n = 68$ ) and patients exhibiting frontal injuries ( $n = 21$ ) and posterior ( $n = 8$ ) injuries separately. These results are presented in Tables 5 and 6 and are similar to the overall  $t$ -tests presented in Table 4. Indeed, however the groups were compared, there was no significant relationship between the presence (and location) of lesion and PVTs or the MMPI-2-RF RBS.

## DISCUSSION

The U.S. Centers for Disease Control currently reports that there are more than 1.7 million TBIs per year in the U.S. These range from mild concussions to the most severe form of TBI (CDC, 2013). Given the rates of malingering of head injury symptoms, estimated to be between 30% and 40% (Larrabee, 2003; Mittenberg

Table 5. Presence of lesion and performance on cognitive response bias measures

| Measure <sup>a</sup> | No lesion detected<br>( $n = 68$ ) |       | Frontal lesion present<br>( $n = 21$ ) |       | $t(87)$ | $p$  |
|----------------------|------------------------------------|-------|--|-------|---------|------|
|                      | $M$                                | $SD$  | $M$                                    | $SD$  |         |      |
| TOMM Trial 2         | 0.96                               | 0.09  | 0.98                                   | 0.03  | 0.20    | 0.85 |
| VSVT Easy            | 0.98                               | 0.07  | 0.98                                   | 0.04  | 0.71    | 0.48 |
| VSVT Difficult       | 0.81                               | 0.24  | 0.77                                   | 0.23  | 0.65    | 0.52 |
| VSVT Total           | 0.89                               | 0.14  | 0.87                                   | 0.12  | -0.70   | 0.48 |
| LMT Total            | 0.91                               | 0.17  | 0.92                                   | 0.10  | -0.13   | 0.90 |
| RBS                  | 78.92                              | 18.62 | 83.58                                  | 14.58 | -1.0    | 0.32 |

Note. TOMM, Test of Memory Malingering; VSVT, Victoria Symptom Validity Test; LMT, Letter Memory Test; RBS, Minnesota Multiphasic Personality Inventory-2-Restructured Form Response Bias Scale.

<sup>a</sup>Symptom validity test scores are presented as percentage correct.

Table 6. Presence of lesion and performance on cognitive response bias measures

| Measure <sup>a</sup> | No lesion detected<br>( $n = 68$ ) |       | Posterior lesion present<br>( $n = 8$ ) |       | $t(74)$ | $p$  |
|----------------------|------------------------------------|-------|---|-------|---------|------|
|                      | $M$                                | $SD$  | $M$                                     | $SD$  |         |      |
| TOMM Trial 2         | 0.96                               | 0.09  | 0.98                                    | 0.04  | 0.00    | 1.00 |
| VSVT Easy            | 0.98                               | 0.07  | 0.98                                    | 0.03  | -0.43   | 0.67 |
| VSVT Difficult       | 0.81                               | 0.24  | 0.84                                    | 0.17  | -0.36   | 0.72 |
| VSVT Total           | 0.89                               | 0.14  | 0.91                                    | 0.10  | -0.52   | 0.61 |
| LMT Total            | 0.91                               | 0.17  | 0.93                                    | 0.12  | -0.23   | 0.82 |
| RBS                  | 78.92                              | 18.62 | 88.33                                   | 22.67 | -1.16   | 0.25 |

Note. TOMM, Test of Memory Malingering; VSVT, Victoria Symptom Validity Test; LMT, Letter Memory Test; RBS, Minnesota Multiphasic Personality Inventory-2-Restructured Form Response Bias Scale.

<sup>a</sup>Symptom validity test scores are presented as percentage correct.



et al., 2002), it is crucial to examine the legitimacy of claims of dysfunction secondary to head injury, particularly in compensation-seeking settings. Furthermore, due to the established relationship between head injuries and neurocognitive dysfunction, it is necessary to examine whether or not lesions can impact performance on various measures of cognitive response bias (i.e., PVTs). Indeed, this issue is apparent when psychiatrists or psychologists are asked by lawyers; “How do you know my client did not provide poor effort *because* of his (or her) traumatic brain injury?” When framed within the adversarial context of the court, such a question could potentially appear compelling in the mind of the average juror.

The current study sought to determine if the presence of lesion (as well as lesion location) in a TBI influenced performance on performance and symptom validity measures. Participants with a documented head injury seeking workers’ compensation were examined and coded as a control or a subject based on the presence of a lesion on neuroimaging findings. Based on the location of the lesion in the subject group, they were classified into four different anatomical groups based on the location of intracranial injury.

Using correlational analyses and *t*-tests, the overall results suggest no significant relationships between lesion presence and PVT measures, as well as the MMPI-2-RF RBS. Although evaluating the possible effects of a lesion on PVT performance was the central goal of the study, the current study also accounted for the variability of lesion location, which adds incrementally to the previous literature. Neither the lesion quadrant nor the type of intracranial lesion (extra-axial vs. intra-axial) showed a statistically significant association with performance on PVTs. These findings may also help to answer concerns about whether or not lesions affect symptom validity performance (Bigler, 2012). Furthermore, the results suggest that measures of performance and symptom validity accurately capture response bias regardless of a documented brain injury. These results address one of the criticisms of the neuropsychological response bias literature discussed by Bigler (2012), specifically the paucity of lesion-localization studies in PVT research. These findings also suggest, as has been discussed in earlier studies, that symptom validity tests appear to be specific to response bias and not genuine impairment.

The results of the current study build upon previous research examining the relationship, if any, between the presence of lesion localization in a brain injury litigant and PVTs. To date, only a few case studies (Goodrich-Hunsaker & Hopkins, 2009; Palmer, Boone, Allman, & Castro, 1995; Wu, Allen, Goodrich-Hunsaker, Hopkins, & Bigler, 2010) have examined the relationship of brain injury and performance on PVTs, but due to small sample sizes, results generated would greatly under-represent any significant findings. The authors of these studies found that patients with brain damage were able to pass measures capturing response bias. Another case study examined an individual with documented severe TBI and lesions, as well as evidence of feigning psychiatric symptoms and feigning on symptom validity measures (Berry & Granacher, 2009), further suggesting that the severity of a brain injury and performance validity measures are not mutually exclusive, which has also been established in several empirical studies (e.g., Green, 2007; Green et al., 2001).

The current study is also the first to examine the association between structural brain damage and a non-performance-based measure of cognitive response bias: the MMPI-2-RF RBS. Results suggest that there is no association between RBS scores and brain lesion. The implications of these findings suggest that the presence of brain

injury will not artificially inflate scores on the RBS. Thus, this validity scale on the MMPI-2-RF appears to be specific to response bias even in the context of brain injury.

While the study sample of 92 patients is larger than those of earlier studies examining the relationship between PVT and neuroimaging results (e.g., Wu, Allen, Goodrich-Hunsaker, Hopkins, & Bigler, 2010), it is still comparatively small. Thus, additional studies will need to document further the lack of association between brain lesion and measures of response bias. Moreover, this sample exclusively was comprised of Caucasian patients. Thus, any additional research in this area should include more diverse patient samples. Additional research should also examine the extent to which lesion size may impact performance validity.

## CONCLUSION

In conclusion, the results of this study suggest that performance on direct measures of cognitive response bias (i.e., PVT), as well as proxies of cognitive response bias (in this case, the MMPI-2-RF RBS), does not appear to be impacted by organic brain injury. These results suggest that PVTs are valid measures of response bias in patients who have structural changes secondary to TBI (i.e., lesions), thus addressing concerns of the absence of lesion-localization studies in performance validity research. Therefore, performance on cognitive response bias measures appear to be unaffected by both lesion presence and lesion location in individuals with TBI.

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