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Performance Validity Testing in Multiple Sclerosis

Rachel Galioto[1,2], Kaltra Dhima[2], Ophira Berenholz[2] and Robyn Busch[2,3]

[1]Mellen Center for Multiple Sclerosis, Cleveland Clinic, Cleveland, OH, USA
[2]Department of Neurology, Cleveland Clinic, Cleveland, OH, USA
[3]Epilepsy Center, Cleveland Clinic, Cleveland, OH, USA

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Abstract

Objective: Performance validity tests (PVTs) are designed to detect nonvalid responding on neuropsychological testing, but their associations with disease-specific and other factors are not well understood in multiple sclerosis (MS). We examined PVT performance among MS patients and associations with clinical characteristics, cognition, mood, and disability status. **Method:** Retrospective data analysis was conducted on a sample of patients with definite MS ($n = 102$) who were seen for a clinical neuropsychological evaluation. Comparison samples included patients with intractable epilepsy seen for presurgical workup ($n = 102$) and patients with nonacute mild traumatic brain injury (mTBI; $n = 50$). Patients completed the Victoria Symptom Validity Test (VSVT) and validity cutoffs were defined as <16/24 and <18/24 on the hard items. **Results:** In this MS cohort, 14.4% of patients scored <16 on the VSVT hard items and 21.2% scored <18. VSVT hard item scores were associated with disability status and depression, but not with neuropsychological scores, T2 lesion burden, atrophy, disease duration, or MS subtype. Patients applying for disability benefits were 6.75 times more likely to score <18 relative to those who were not seeking disability. Rates of nonvalid scores were similar to the mTBI group and greater than the epilepsy group. **Conclusions:** This study demonstrates that nonvalid VSVT scores are relatively common among MS patients seen for clinical neuropsychological evaluation. VSVT performance in this group relates primarily to disability status and psychological symptoms and does not reflect factors specific to MS (i.e., cognitive impairment, disease severity). Recommendations for future clinical and research practices are provided.

Keywords: Multiple sclerosis, Effort, Performance validity, Cognition, Assessment

INTRODUCTION

Data validity is important in neuropsychological evaluations to ensure accurate interpretation and appropriate recommendations. Nonvalid responding can occur for a number of reasons, including motivation to exaggerate the presence or severity of cognitive deficits due to external incentives, such as in the context of applying for disability benefits or litigation (Bush et al., 2005; Greher & Wodushek, 2017). Additional factors such as emotional distress, sleep disturbance, pain, fatigue, and medication side effects have also been shown to impact neuropsychological test performance (Greher & Wodushek, 2017). As such, the incorporation of performance validity tests (PVTs) that are designed to detect nonvalid responding is integral in the practice of clinical neuropsychology.

PVT performance has been well-characterized in select patient groups, including mild traumatic brain injury (mTBI) and presurgical epilepsy patients. Prior studies have shown relatively low rates of PVT failure among presurgical epilepsy patients, and this group is often used to represent individuals without presumed external incentives to underperform on neuropsychological testing (Grote et al., 2000; Loring, Lee, & Meador, 2005; Keary et al., 2013). Conversely, a large proportion of patients with mTBI demonstrate lower than expected performance on neuropsychological testing and reduced scores on PVT measures, which is likely due to relatively higher rates of litigation involvement (Greiffenstein, 2009; Belanger, Curtiss, Demery, Lebowitz, & Vanderploeg, 2005; Binder & Rohling, 1996; Mittenberg, Patton, Canyock, & Condit, 2002; Bianchini, Curtis, & Greve, 2006; Green, Rohling, Lees-Haley, & Allen, 2001).

In contrast, typical performance on PVTs in patients with multiple sclerosis (MS) is essentially unknown. In fact, only one study has specifically examined PVT performance in MS (Suchy, Chelune, Franchow, & Thorgusen, 2012) using the Victoria Symptom Validity Test (VSVT; Slick, Hopp, Strauss, & Thompson, 1997). In that study, 11% of patients produced nonvalid VSVT scores (as defined by VSVT hard

Correspondence and reprint requests to: Rachel Galioto, 9500 Euclid Ave., P-57, Cleveland OH, 44195, USA. E-mail: galiotr@ccf.org

items ≤16 correct). Nonvalid responders were younger and less educated than valid responders, had earlier symptom onset, and reported higher levels of depressive symptoms. This relatively high rate of nonvalid PVT performance among patients with MS has yet to be independently validated.

Interestingly, in the Suchy et al. study, a subset of patients were confronted with their nonvalid VSVT performance, and 68% of them produced valid scores on readministration, suggesting that nonneurologic factors impacted PVT performance in this group. It is possible that some patients with MS may be motivated by external incentives (e.g., seeking disability benefits) when presenting for neuropsychological evaluations for the purpose of documenting cognitive impairment. Research has shown a greater likelihood of PVT failure among patients who are applying for disability across a wide range of populations including epilepsy, traumatic brain injury, and fibromyalgia (Ferrari & Russell, 2016; Grote et al., 2000). While this clearly could impact PVT performance in MS, this has not been formally examined. It is also possible that high levels of emotional distress typically observed in MS (Morrow, Rosehart, & Pantazopoulos, 2016; Leavitt et al., 2019) could contribute to PVT performance in this group, given the association between mood and performance in other samples (Greher & Wodushek, 2017).

Conversely, nonvalid PVT performance could reflect greater disease severity or relate to cognitive factors specific to MS. In addition to Suchy and colleagues' (2012) findings that nonvalid VSVT performance related to earlier symptom onset in MS, studies in other populations have shown associations between VSVT performance and measures of processing speed, working memory, and episodic memory (Loring, Larrabee, Lee, & Meador, 2007; Macciocchi, Seel, Alderson, & Godsall, 2006; Keary et al., 2013), all of which are cognitive functions that are often affected in MS (Chiaravalloti & DeLuca, 2008).

The goal of the current study was to further examine PVT performance in patients with MS and its association with demographic and disease variables, mood and anxiety symptoms, and disability status. Specifically, we sought to replicate the findings of Suchy et al. (2012) in a large sample of patients with MS seen for a clinical neuropsychological evaluation. We also sought to extend existing findings by examining associations between VSVT performance and clinical characteristics, demographics, neuropsychological test performance, mood, and disability status. Furthermore, VSVT performance was compared between MS patients and two other patient groups (i.e., mTBI, presurgical epilepsy) to put these findings into a broader context.

METHOD

Patients and Procedures

Data for this retrospective study were obtained from IRB-approved clinical neuropsychological registries (i.e., MS, epilepsy, mTBI) within Cleveland Clinic. MS patients were referred from a provider at the Mellen Center for MS for a clinical neuropsychological evaluation due to concerns about cognition by the patient, a family member, or the treating provider. While all evaluations were clinical in nature, patients and their providers were not prohibited from using the results of the neuropsychological evaluation to support a disability application. Patients from the MS registry ($n = 163$) were included in the study if they met the following inclusion criteria: (1) adults aged 18 years and over, (2) English as primary language, (3) diagnosis of definite MS, and (4) completed a comprehensive clinical neuropsychological evaluation that included the VSVT. Four patients were excluded because English was not their primary language. An additional 57 were excluded because they were either not administered a PVT ($n = 34$) or were administered a PVT other than the VSVT ($n = 23$). The final sample included 102 patients with MS.

Comparison samples included patients with intractable focal epilepsy seen for presurgical workup ($n = 102$) and patients with nonacute mTBI ($n = 50$) who were referred for evaluation due to cognitive complaints outside of the expected window of recovery for their injury. All of these patients were seen in the same neuropsychology clinic and were administered the VSVT. Given the availability of a large number of epilepsy ($n = 1256$), they were blindly matched to the MS sample based on age, gender, race, and education.

Measures

Performance validity

The VSVT (Slick et al., 1997) is a commonly used PVT that involves "easy" and "hard" forced-choice recognition of 5-digit number strings, with 24 strings for each category. Each target number string is presented on a computer screen for 5 s. Subsequently, two 5-digit number strings are presented and the patient must identify the target presented previously. The time between target presentation and recognition trial varies over the course of the test (i.e., 5, 10, and 15 s). Easy items contain no digit overlap between the target stimulus and the foil, making them easily distinguishable, while hard items contain overlap in all but two digits whose order has been switched. The VSVT manual recommends interpreting total correct hard item scores of ≥16 out of 24 as "valid," scores of 8 to 15 as "questionable," and scores of <8 as "invalid." Further research has suggested that these manual-recommended cutoffs may be too lenient and other cutoffs have been recommended. Specifically, a recent study has recommended using a cutoff of <18 on the VSVT hard items for mTBI litigants (Silk-Eglit, Lynch, & McCaffrey, 2016). This is consistent with another study showing 100% of noncompensation-seeking epilepsy patients scored above 18 on the VSVT hard items (Grote et al., 2000). While an even stricter cutoff of VSVT hard items ≤21 has also been suggested, this cutoff has been criticized for being too stringent (Keary et al., 2013; Loring et al., 2005). Thus, we examined two different cutoffs for the VSVT hard items score for nonvalid performance: the manual-recommended <16 and the more recently recommended <18.

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Neuropsychological tests

Norm-referenced standardized scores for the following neuropsychological measures were examined for the MS sample only. The Digit Span subtest from the Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV; Wechsler, 2008) was used as a measure of basic attention/working memory. Processing speed was measured using the Symbol Digit Modalities Test oral version (Smith, 1982), and episodic memory was assessed using the Brief Visuospatial Memory Test – Revised (BVMT-R; Benedict, 1997) and the California Verbal Learning Test – Second Edition (CVLT-II; Delis, Kramer, Kaplan, & Ober, 2000). Total immediate recall and delayed free recall were examined from memory measures.

Psychological variables

Depression and anxiety were assessed using the Beck Depression Inventory – Second Edition (BDI-II; Beck, Steer, & Brown, 1996) and the Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988), respectively. Total scores on both measures range from 0 to 63, and higher scores represent greater symptom severity. Scores on a subset of BDI-II items, which comprise the BDI-Fast Screen (BDI-FS; Beck, Steer, & Brown, 2000), were also examined for the MS sample only, as recommended for use in patients with MS to minimize overlap with neurological symptoms (Benedict et al., 2003).

Disability status

Disability status was assessed for MS patients *via* direct questioning during the evaluation and confirmed by chart review. Disability status was broken down into three groups: (1) patient has not previously applied, is not considering applying, and/or is retired; (2) patient is in the process of applying, has an application under review, or in the process of appealing a recent rejection; or (3) patient is currently on disability (social security disability or long-term disability).

Demographic and clinical characteristics

Demographic and clinical characteristics were obtained *via* medical chart review and patient interview and were contained in the registry. All MS participants underwent brain magnetic resonance imaging (MRI) as part of routine clinical care. Overall, T2 lesion burden and parenchymal volume loss were categorically rated (none, mild, moderate, severe) by the interpreting radiologist.

Statistical Analyses

Descriptive statistics were used to characterize the sample in terms of demographic and clinical variables and VSVT performance. Within the MS group, chi-square and independent samples t-tests were used to separately compare groups of patients who were and were not administered a PVT and to compare patients scoring above and below the VSVT cutoffs of <16 and <18 in terms of demographic, clinical, and psychological variables, as well as neuropsychological test scores. The neuropsychological tests were standardized into *T*-scores (mean = 50, *SD* = 10; SDMT, BVMT-R), z-scores (mean = 0, *SD* = 1; CVLT-II), or scaled scores (mean = 10, *SD* = 3; WAIS-IV Digit Span) per manual instructions using well-established normative data. Dichotomous variables were created (0 = not impaired, 1 = impaired) with impairment being defined as *T*-scores ≤ 35, *Z* scores ≤ −1.5, and scaled scores ≤5, coinciding with the cutoff for "mild impairment" (Heaton, Grant, & Matthews, 1991). For the MRI variables, dichotomous variables were also created (0 = none or mild, 1 = moderate or severe) for analysis.

Spearman correlations were conducted to examine the associations between VSVT hard item raw scores and demographic, neuropsychological, and disease variables. One-way analysis of variance (ANOVA) examined differences in VSVT hard item raw scores as a function of disability status. Chi-square analyses examined the association between VSVT outcome (valid/nonvalid) and impairment variables for each neuropsychological test and each VSVT cutoff separately. Logistic regression was used to examine the association between disability status and VSVT outcome (valid/nonvalid) for each VSVT cutoff separately. For each logistic regression, two dummy coded variables were entered as predictors (applying for disability, on disability) with not applying for disability used as the reference group and the VSVT outcome as the dependent variable. One-way ANOVA and chi-square analysis were used to examine group differences (MS, epilepsy, mTBI) in terms of demographics, psychological variables, and VSVT performance. Bonferroni *post hoc* analyses examined significant group differences identified by ANOVA. In order to correct for multiple comparisons, a more stringent threshold of significance ($p < .02$) was used.

RESULTS

Characteristics of the MS Sample

Independent samples t-tests revealed that patients who were administered a PVT (VSVT or other) were younger ($t(157) = 3.96$, $p < .001$) and less educated ($t(157) = 2.91$, $p = .004$) compared to those who were not administered any PVT. There were no differences in MS duration, BDI-II, or BAI scores. Chi-square analyses revealed significant differences in disability status distribution among patients who were administered any PVT compared to those who were not ($\chi^2 = 8.33$, $p < .02$). Of patients not applying for disability, 66.0% were administered a PVT while 34.0% were not. Of patients applying for disability, 86.7% were administered a PVT while 13.3% were not. Of patients already on disability, 84.4% were administered a PVT while 15.6% were not.

Table 1 provides sample characteristics. On average, MS patients were middle-aged (47.2 ± 11.4 years), highly educated

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Table 1. Characteristics of the sample and comparisons between groups

	MS ($n = 102$)	Epilepsy ($n = 102$)	mTBI ($n = 50$)	p
Age, years, mean ± *SD*	47.2 ± 11.4	47.2 ± 11.8	42.7 ± 13.5	.06
Education, years, mean ± *SD*	14.4 ± 2.6	14.3 ± 2.5	14.3 ± 2.1	.98
Female, %	73.5%	72.5%	62.0%	.30
White, %	84.3%	90.2%	96.0%	.09
Beck Depression Inventory-II, mean ± *SD*	19.9 ± 12.6 [a]	13.4 ± 9.7[a]	18.6 ± 12.5	**<.001**
Beck Anxiety Inventory, mean ± *SD*	15.9 ± 10.5 [a]	11.1 ± 10.0 [a]	15.6 ± 12.3	**<.01**
MS Type, %				
Relapsing-Remitting	71.6%	–	–	–
Secondary Progressive	16.7%	–	–	–
Primary Progressive	11.8%	–	–	–
MS Duration, years, mean ± *SD*	9.7 ± 9.4	–	–	–
Disability Status, %				
Not seeking	27.9%	–	–	–
Seeking	38.5%	–	–	–
Already receiving	33.7%	–	–	–

mTBI, mild traumatic brain injury; MS, multiple sclerosis; *SD*, standard deviation; a – denotes significant differences between the MS and epilepsy groups (BDI-II $p < .001$; BAI $p = .004$).

(14.4 ± 2.6 years), predominantly female (73.5%), and White (84.3%). The majority of patients had relapsing-remitting MS (71.6%) with average disease duration of 9.7 ± 9.4 years. On average, patients endorsed mild to moderate levels of depression (BDI-II = 19.9 ± 12.6; BDI-FS = 5.8 ± 4.5) and anxiety (BAI = 15.9 ± 10.5).

The patients were approximately equally distributed between those who were not seeking disability benefits at the time of the evaluation (27.9%), those who were seeking disability benefits (38.5%), and those who were already receiving disability benefits (33.7%).

VSVT Performance in MS

Scores on the VSVT ranged from 1 to 24 on the hard items and 6 to 24 on the easy items. All participants who scored ≤22/24 (6% of the sample) on the easy items also scored <16/24 on the hard items, suggesting that scores of ≤22/24 on the easy items were associated with nonvalid performance in this sample. As expected, rates of questionable VSVT performance varied by cutoff used: 14.4% scored <16 and 21.2% scored <18 (Table 2).

Table 2. Rates of nonvalid performance in MS patients by disability status and compared with epilepsy and mTBI groups

	VSVT Score	
	<16	<18
	Count (%)	Count (%)
MS	15 (14.4%)	22 (21.2 %)
Not seeking ($n = 29$)	2 (6.9%)	2 (6.9%)
Seeking ($n = 39$)	9 (22.5%)	13 (32.5%)
Already receiving ($n = 34$)	4 (11.4%)	7 (20%)
Epilepsy ($n = 102$)	3 (2.9%)	6 (5.8%)
mTBI ($n = 50$)	10 (20.4%)	12 (24.5%)

VSVT, Victoria Symptom Validity Test; MS, multiple sclerosis; mTBI, mild traumatic brain injury.

Associations with VSVT Performance in MS

Demographic and disease variables

There were no significant correlations between VSVT hard item raw scores and demographic variables, disease duration, or MS subtype, and there were no differences in these variables between patients who scored above or below the VSVT cutoff, for either cutoff used.

For MRI variables, a total of 90 patients had MRI data with time between MRI and neuropsychological testing initially ranging from 0 to 35 months; seven participants with intervals greater than 12 months were excluded. Of the remaining 83 participants, time between MRI and neuropsychological testing was on average 3.14 ± 3.0 months. There were no associations between MRI variables (lesions, atrophy) and VSVT hard items, and results were similar when controlling for time between testing and MRI (p's ranged from .001 to .06). There was no difference in these variables between patients scoring above and below the VSVT cutoffs for either cutoff. Tables 3 and 4 provide full results of analyses.

Neuropsychological test performance

Spearman correlation analyses showed significant associations between VSVT hard item raw score and performance on all neuropsychological tests (p's range from .007 to <.001; see Table 3). Independent samples t-tests showed that patients scoring below the VSVT hard item <18 cutoff performed more poorly on Digit Span scaled score ($p = .009$; Cohen's d = .78), SDMT T-score ($p = .007$; Cohen's d = .89), and BVMT-R delayed recall T score ($p = .002$; Cohen's d = .90).

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Table 3. Spearman correlation coefficients between VSVT hard item raw score and demographic, clinical, and cognitive variables

Variable	*r*	*p*
Age ($n = 102$)	.21	.04
Education ($n = 102$)	.21	.04
Female ($n = 102$)	.02	.86
White ($n = 102$)	.08	.45
BDI – II ($n = 102$)	−.29	**.003**
BDI-FS ($n = 92$)	−.27	**.009**
BAI ($n = 102$)	−.25	**.01**
MS Duration ($n = 102$)	.18	.06
Relapsing-Remitting ($n = 102$)	−.13	.19
MRI Lesions ($n = 90$)	−.05	.67
MRI Atrophy ($n = 90$)	−.01	.96
Digit Span scaled score ($n = 91$)	.44	**<.001**
SDMT oral version *T* score ($n = 70$)	.46	**<.001**
CVLT-II Total *T* score($n = 74$)	.31	**.007**
CVLT-II Long Delay Free Recall *Z* score ($n = 74$)	.38	**.001**
BVMT-R Total *T* score ($n = 72$)	.35	**.002**
BVMT-R Delay *T* score ($n = 72$)	.40	**.001**

MRI variables were dummy coded as follows (0 = none/ mild; 1 = moderate/ severe).

In contrast, chi-square analyses revealed no significant differences in rates of impairment on any neuropsychological test as a function of VSVT performance at either cutoff (*p*'s ranged from .05 to .58 for <16 cutoff and .03 to .72 for <18 cutoff).

Psychological symptoms

Spearman correlation coefficients were significant between VSVT hard item raw score and BDI-II ($r = -.29$, $p = .003$), BDI-FS ($r = -.27$, $p = .009$), and BAI ($r = -.25$, $p = .01$). Additionally, BDI-II ($p = .01$; Cohen's d = .77) and BDI-FS ($p = .005$; Cohen's d = .73) scores were significantly higher among patients scoring <18 than those scoring ≥18 and a similar group difference was near significance for BAI scores ($p = .02$; Cohen's d = .59). There were no group differences in BDI-II, BDI-FS, or BAI score for the <16 cutoff.

Disability status

One-way ANOVA showed significant differences in VSVT hard item raw score by disability status [$F(2,99) = 156.4$, $p = .001$]. *Post hoc* Bonferroni analysis showed that patients applying for disability scored significantly lower ($M = 18.3$, $SD = 6.0$) compared to those who were not applying ($M = 22.5$, $SD = 2.7$); $p = .001$, Cohen's d = .91. There were no other group differences. Logistic regression showed that patients applying for disability were 6.75 times more likely to score <18 on the VSVT hard items compared to those who were not applying (OR = 6.75; $p < .02$). Results were not significant for patients already on disability or for either groups for the <16 cutoff.

Comparison to Other Clinical Samples

One-way ANOVA revealed no significant differences between MS, epilepsy, and mTBI groups in terms of age ($p = .06$) or education ($p = .98$). There were significant differences between groups for BDI-II ($p < .001$) and BAI ($p < .01$) scores. Specifically, the MS group endorsed higher BDI-II ($p < .001$; Cohen's d = .58) and BAI ($p = .004$; Cohen's d = .47) scores compared to the epilepsy group. There were no other significant differences between groups.

Chi-square analyses showed no differences between the MS and mTBI groups in terms of VSVT performance at either cutoff. However, MS patients were more likely to produce nonvalid VSVT scores compared to the epilepsy group at either cutoff (<16: $\chi^2 = 8.77$, $p = .003$; <18: $\chi^2 = 10.60$, $p = .001$).

DISCUSSION

This study examined PVT performance using the VSVT (Slick et al., 1997) among MS patients seen for a clinical neuropsychological evaluation. Rates of nonvalid VSVT performance were high at both cutoffs used. Specifically, 14.4% scored below the manual-recommended cutoff (VSVT hard items <16/24) and 21.2% scored below the recently recommended more stringent cutoff (VSVT hard items <18/24; Silk-Eglit et al., 2016). While these relatively high rates of nonvalid scores are somewhat surprising, they are generally consistent with results of the only other study to examine VSVT performance in MS (Suchy et al., 2012); of note, Suchy and colleagues used a slightly different cutoff (VSVT hard items ≤16), and for comparison, we found that 17.3% of our sample scored ≤16 compared to 11.1% of their sample.

This study extends the current and limited literature on PVT performance in MS by examining factors related to nonvalid responding on the VSVT. Overall, we found that performance on the VSVT was associated with disability status and psychological symptoms and was not associated with markers of MS disease severity (T2 lesion burden, atrophy, disease duration, MS subtype). Specifically, patients applying for disability were 6.75 times more likely to produce nonvalid VSVT scores using the <18 hard item cutoff than those who were not applying for disability. This is not surprising given numerous prior studies showing that nonvalid PVT performance is common among compensation-seeking samples (Ferrari & Russell, 2016; Grote et al., 2000). The relatively high rate of nonvalid VSVT performance in our sample may be partially explained by the high rate of disability applicants in our sample (38.5%). Interestingly, two patients who were not seeking disability scored <16 on the VSVT hard items, suggesting that disability status does not entirely account for nonvalid responding in this sample. Rather, this could be explained by the finding of higher levels of depression and anxiety that were also associated with nonvalid VSVT performance at the <18 cutoff, although similar results were not seen for patients who scored <16. It is important to mention the possibility that higher scores on the BDI-II and

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Table 4. Demographic and clinical characteristics by VSVT outcome among MS patients

	VSVT < 16 Cutoff			VSVT < 18 Cutoff		
	Valid	Nonvalid	*p*	Valid	Nonvalid	*p*
Age, years, mean ± *SD* (*n* = 102)	47.8 ± 11.6	44.0 ± 9.8	.23	48.1 ± 11.8	43.9 ± 9.2	.12
Education, years, mean ± *SD* (*n* = 102)	14.4 ± 2.6	13.9 ± 2.4	.43	14.6 ± 2.6	13.6 ± 2.5	.12
Female, % (*n* = 102)	74.7%	66.7%	.51	75.0%	68.2%	.52
White, % (*n* = 102)	80.5%	93.3%	.23	83.8%*	77.3%	.48
BDI-II, mean ± *SD* (*n* = 102)	18.8 ± 12.4	26.1 ± 12.5	.05	17.9 ± 12.1	27.2 ± 12.1	**.01**
BDI-FS, mean ± *SD* (*n* = 92)	5.5 ± 4.4	7.6 ± 4.9	.11	5.1 ± 4.2	8.3 ± 4.6	**.005**
BAI, mean ± *SD* (*n* = 102)	15.2 ± 10.5	20.2 ± 9.7	.09	14.6 ± 10.1	20.7 ± 10.7	.02
MS duration, years, mean ± *SD* (*n* = 102)	9.9 ± 9.9	8.5 ± 5.5	.44	10.2 ± 10.1	7.6 ± 5.8	.12
Relapsing-Remitting, % (*n* = 102)	67.8%	93.3%	.04	67.5%	86.4%	.08
MRI Lesions,% (*n* = 90)						
None/Mild	72.4%	71.4%	.94	72.9%	70.0%	.80
Moderate/Severe	27.6%	28.6%	.94	27.1%	30.0%	.80
MRI Atrophy, % (*n* = 90)						
None/Mild	90.8%	92.9%	.80	91.4%	90.0%	.84
Moderate/Severe	9.2%	7.1%	.80	8.6%	10.0%	.84
Neuropsychological Tests, mean ± *SD*						
Digit Span, scaled score (*n* = 91)	8.4 ± 2.9	6.5 ± 1.8	.03	8.5 ± 2.9	6.6 ± 2.1	**.009**
SDMT-oral, T score (*n* = 70)	40.6 ± 13.7	29.4 ± 12.2	.02	41.2 ± 13.6	29.9 ± 11.6	**.007**
CVLT-II Total, T score (*n* = 74)	45.5 ± 13.4	40.6 ± 11.9	.26	46.2 ± 13.3	38.7 ± 11.8	.06
CVLT-II LDFR, *Z* score (*n* = 74)	−1.0 ± 1.6	−1.6 ± 1.7	.20	−0.9 ± 1.6	−1.8 ± 1.6	.06
BVMT-R Total (*n* = 72)	40.7 ± 15.6	34.8 ± 8.1	.30	41.3 ± 15.8	33.8 ± 8.0	.02
BVMT-R Delay (*n* = 72)	42.8 ± 16.5	31.8 ± 7.7	.07	43.6 ± 16.5	31.6 ± 9.3	**.002**
Neuropsychological Tests, % impaired						
Digit Span (*n* = 91)	16.7%	30.8%	.23	15.1%	33.3%	.08
SDMT-oral (*n* = 70)	34.4%	66.7%	.06	33.3%	61.5%	.06
CVLT-II Total (*n* = 74)	20.6%	45.5%	.08	20.0%	42.9%	.07
CVLT-II LDFR (*n* = 74)	42.9%	54.5%	.47	41.7%	57.1%	.29
BVMT-R Total (*n* = 72)	32.2%	20.0%	.34	31.3%	27.3%	.72
BVMT-R Delay (*n* = 72)	35.9%	62.5%	.15	33.3%	66.7%	.03

VSVT, Victoria Symptom Validity Test; BDI-II, Beck Depression Inventory – Second Edition; BDI-FS, BDI Fast Screen; BAI, Beck Anxiety Inventory; TMT, Trail Making Test; CVLT-II, California Verbal Learning Test – Second Edition; LDFR, Long Delay Free Recall; BVMT-R, Brief Visuospatial Memory Test – Revised.

BAI among patients applying for disability could reflect over-reporting or symptom exaggeration. Unfortunately, symptom validity scales, such as the MMPI-2 FBS or RBS scales, were not available. However, future studies should examine this possibility.

The relationship between VSVT performance and cognition is rather complicated. Correlational analyses revealed that lower VSVT hard item scores were associated with lower scores on all neuropsychological tests. Further, lower neuropsychological scores were found among patient with nonvalid VSVT scores compared to those with valid VSVT performance. While these findings are not unexpected, they cannot be interpreted to suggest that lower cognitive functioning is the cause of nonvalid VSVT scores as cognitive testing among patients with nonvalid VSVT scores is not reliable. To better clarify this association, we examined rates of impairment on neuropsychological tests (with impairment defined as *T*-scores ≤ 35, *Z* scores ≤ -1.5, and scaled scores ≤ 5) between groups with valid and nonvalid VSVT performance. The fact that there were no significant differences in rates of impairment on any neuropsychological test suggests that cognitive impairment does not sufficiently explain nonvalid VSVT scores. In other words, among patients who were impaired on any given neuropsychological test, the majority (64.7–90.3%) produced valid VSVT hard items scores.

In comparison to other samples, MS patients were similar to mTBI patients in terms of rates of VSVT valid and nonvalid scores; this is notable given that the importance of administering PVT measures when assessing mTBI patients is well-recognized by neuropsychologists. In contrast, MS patients were more likely to produce nonvalid VSVT scores compared to presurgical epilepsy patients, which was a group chosen for comparison due to the presence of a neurologic disorder but low likelihood of secondary gain. These findings may be partially explained by similar levels of depression and anxiety found in the mTBI and MS patients, compared to lower such symptoms in the epilepsy group. Unfortunately, information regarding litigation/compensation-seeking status was not available for the mTBI group, which represents a limitation of this study. While speculative, it is possible that if the rates of compensation-seeking patients were elevated in

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the mTBI group, as has been shown in other studies, this could account for similarities in PVT performance between the MS and mTBI groups, given findings of other studies on PVT performance in mTBI (Silk-Eglit et al., 2016; Bianchini et al., 2006; Green et al., 2001; Larrabee, 2003; Mittenberg et al., 2002). Specifically, previous research suggests a 40% pooled prevalence estimate of noncredible performance in neuropsychological settings among mTBI patients with the potential for secondary gain (Larrabee, 2003) which is highly similar to the observed rate of nonvalid PVT performance in MS patients who were seeking disability benefits (32.5%).

These results, in combination with previous findings by Suchy and colleagues (2012), demonstrate that nonvalid PVT performance occurs in MS patients seeking clinical evaluation at a rate that is greater than chance and highlight the importance of routine administration of PVTs in this group. However, current guidelines for cognitive evaluation in MS do not include a recommendation for assessment of performance validity (Kalb et al., 2018), and recommended cognitive batteries for MS patients (e.g., MACFIMS, BICAMS) do not include standalone PVTs (Benedict et al., 2002; Langdon et al., 2012). Both of these batteries include an embedded PVT, the CVLT-II forced choice recognition trial (FCR; Delis et al., 2000); however, its utility in MS has not been examined, and a recent systematic review showed that CVLT-II FCR has shown poor sensitivity to nonvalid responding in the absence of severe cognitive impairment (Schwartz et al., 2016). Notably, our clinical battery also included the CVLT-II FCR, but was not included in this study because it was only administered to 54 of the patients who were administered the VSVT. Interestingly, 14.8% of MS patients scored in the nonvalid range on FCR (≤14 items correct), but concordance with VSVT outcome was low. Specifically, of the 10 patients who scored below 16 on the VSVT hard items, only 2 scored below 14 on the FCR, and of the 13 who scored below 18 on the VSVT hard items, 3 scored below 14 on FCR. Thus, more research is needed to determine the most sensitive measures to nonvalid responding in MS. Nonetheless, such measures should be administered routinely during clinical neuropsychological assessments of MS patients, particularly when the patient may be considering applying for disability (or there is potential for other external incentive) or endorses psychological distress. Future studies should also examine rates of nonvalid PVT performance in research settings to determine whether inclusion of PVTs is necessary.

This study is not without its limitations. The decision about whether to give a PVT, or which PVT was used, was initially determined by the clinician before a formal protocol was established that required administration of the VSVT to all MS patients. It is unclear from the data available why some patients were not administered a PVT prior to the establishment of a standard MS battery. However, differences between patients who were administered the VSVT and those who were not administered a PVT could affect these results, possibly resulting in slight overestimation of the rates of questionable VSVT performance. Specifically, disability status appeared to be a determinant of whether or not a PVT was administered, thus the overall rates of nonvalid PVT performance in the MS group in general are likely somewhat lower. Additionally, we found that patients who completed a PVT were younger and less educated than to those who were not. The reasons for this finding are not entirely clear; however, follow-up analyses found a relationship between disability status and both age and education, such that patients who were already on disability were also older than both other disability groups, and patients who were not applying for disability were more highly educated than patients who were applying or who were already on disability. Thus, the relationships between PVT administration and age and education could also reflect disability status, as above. It should also be noted that only one PVT was examined in this study. Future studies should examine multiple PVTs to determine the most sensitive and specific measures for use in MS samples. Lastly, the mTBI group was smaller than both the MS and epilepsy groups. While no differences in demographic variables emerged between groups, differences in sample size could lead to slightly distorted rates of nonvalid PVT performance in the mTBI group.

In summary, this study demonstrates that nonvalid PVT performance is relatively common among MS patients seen for a clinical evaluation. Similar to studies in other populations, PVT performance in this group appears to reflect contribution from disability status and depression and does not reflect factors specific to MS, including severity of disease or cognitive impairment. That is, nonvalid PVT performance does not appear to simply reflect severe cognitive impairment or disease burden in MS. As such, we recommend the following: (1) measures of performance validity should be routinely administered during clinical neuropsychological evaluations of MS patients, (2) future research should identify the most sensitive and specific measures of performance validity in this group, and (3) rates of nonvalid PVT performance among patients seen in a research setting should be examined in order to determine the necessity of performance validity testing in those settings.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

Beck, A.T., Epstein, N., Brown, G., & Steer, R.A. (1988). An inventory for measuring clinical anxiety: Psychometric properties. *Journal of Consulting and Clinical Psychology*, *56*, 893–897.

Beck, A.T., Steer, R.A., & Brown, G.K. (1996). *Beck Depression Inventory* (2nd ed.). San Antonio, TX: The Psychological Corporation.

Beck, AT, Steer, RA, & Brown, GK. (2000). *BDI-Fast Screen For Medical Patients: Manual*. San Antonio, TX: Psychological Corporation.

Belanger, H.G., Curtiss, G., Demery, J.A., Lebowitz, B.K., & Vanderploeg, R.D. (2005). Factors moderating neuropsychological outcomes following mild traumatic brain injury: A meta-analysis. *Journal of the International Neuropsychological Society*, *11*(3), 215–227.

Benedict, R.H.B. (1997). *Brief Visuospatial Memory Test—Revised*. Odessa, Fla.: Psychological Assessment Resources.

Benedict, R.H., Fischer, J.S., Archibald, C.J., Arnett, P.A., Beatty, W.W., Bobholz, J., … Munschauer, F. (2002). Minimal neuropsychological assessment of MS patients: a consensus approach. *The Clinical Neuropsychologist*, *16*(3), 381–97.

Benedict, R.H., Fishman, I., McClellan, M.M., Bakshi, R., & Weinstock-Guttman, B. (2003). Validity of the beck depression inventory-fast screen in multiple sclerosis. *Multiple Sclerosis Journal*, *9*, 393–396.

Bianchini, K.J., Curtis, K.L., & Greve, K.W. (2006). Compensation and malingering in traumatic brain injury: A dose-response relationship? *The Clinical Neuropsychologist*, *20*(4), 831–847.

Binder, L.M. & Rohling, M.L. (1996). Money matters: A meta-analytic review of the effects of financial incentives on recovery after closed-head injury. *American Journal of Psychiatry*, *153*(1), 7–10.

Bush, S.S., Ruff, R.M., Troster, A.I., Barth, J.T., Koffler, S.P., Pliskin, N.H., … Silver, C.H. (2005). Symptom validity assessment: Practice issues and medical necessity, NAN Policy & Planning Committee. *Clinical Neuropsychology*, *20*, 419–426.

Chiaravalloti, N.D. & DeLuca, J. (2008). Cognitive impairment in multiple sclerosis. *The Lancet Neurology*, *7*(12), 1139–51. doi: 10.1016/S1474-4422(08)70259-X

Delis, D.C., Kramer, J.H., Kaplan, E., & Ober, B.A. (2000). *California Verbal Learning Test— Second Edition, Adult Version*. San Antonio, TX: The Psychological Corporation.

Ferrari, R. & Russell, A.S. (2016). Effort testing and symptom exaggeration testing are essential in assessing patients with fibromyalgia for disability. *The Journal of Rheumatology*, *43*(11), 2077.

Green, P., Rohling, M.L., Lees-Haley, P.R., & Allen III, L.M. (2001). Effort has a greater effect on test scores than severe brain injury in compensation claimants. *Brain Injury*, *15*(12), 1045–1060.

Greher, M.R. & Wodushek, T.R. (2017). Performance validity testing in neuropsychology: scientific basis and clinical application—A brief review. *Journal of Psychiatric Practice*, *23*(2), 134–140.

Greiffenstein, M.F. (2009). Clinical myths of forensic neuropsychology. *The Clinical Neuropsychologist*, *23*(2), 286–296.

Grote, C.L., Kooker, E.K., Garron, D.C., Nyenhuis, D.L., Smith, C.A., & Mattingly, M.L. (2000). Performance of compensation seeking and non-compensation seeking samples on the victoria symptom validity test: Cross-validation and extension of a standardization study. *Journal of Clinical and Experimental Neuropsychology*, *22*(6), 709–719.

Heaton, R.K., Grant, I., & Matthews, C.G. (1991). *Comprehensive Norms for an Extended Halstead-Reitan Battery: Demographic Corrections, Research Findings, and Clinical Applications*. Odessa, TX: Psychological Assessment Resources.

Kalb, R., Beier, M., Benedict, R.H., Charvet, L., Costello, K., Feinstein, A., … DeLuca, J. (2018). Recommendations for cognitive screening and management in multiple sclerosis care. *Multiple Sclerosis Journal*, *24*(13), 1665–1680. doi: 10.1177/1352458518803785

Keary, T.A., Frazier, T.W., Belzile, C.J., Chapin, J.S., Naugle, R.I., Najm, I.M., & Busch, R.M. (2013). Working memory and intelligence are associated with victoria symptom validity test hard item performance in patients with intractable epilepsy. *Journal of the International Neuropsychologist Society*, *19*, 314–323.

Langdon, D.W., Amato, M.P., Boringa, J., Brochet, B., Foley, F., Fredrikson, S., … Benedict, R.H. (2012). Recommendations for a brief international cognitive assessment for multiple sclerosis (BICAMS). *Multiple Sclerosis Journal*, *6*, 891–898. doi: 10.1177/1352458511431076

Larrabee, G.J. (2003) Detection of malingering using atypical performance: Patterns on standard neuropsychological tests. *The Clinical Neuropsychologist*, *17*(3), 410–425.

Leavitt, V.M., Brandstadter, R., Fabian, M., Sand, I.K., Klineova, S., Krieger, S., … Sumowski, J.F. (2019). Dissociable Cognitive Patterns Related to Depression and Anxiety in Multiple Sclerosis. *Multiple Sclerosis Journal*, 1–9.

Loring, D.W., Larrabee, G.J., Lee, G.P., & Meader, K.J. (2007). Victoria symptom validity test performance in a heterogenous clinical sample. *Clinical Neuropsychology*, *21*(3), 522–531.

Loring, D.W., Lee, G.P., & Meador, K.J. (2005). Victoria symptom validity test performance in non-litigating epilepsy surgery candidates. *Journal of Clinical and Experimental Neuropsychology*, *27*, 610–617.

Macciocchi, S.N., Seel, R.T., Alderson, A., & Godsall, R. (2006). Victoria symptom validity test performance in acute severe traumatic brain injury: Implications for test interpretation. *Clinical Neuropsychology*, *5*, 395–404.

Mittenberg, W., Patton, C., Canyock, E.M., & Condit, D.C. (2002). Base rates of malingering and symptom exaggeration. *Journal of Clinical and Experimental Neuropsychology*, *24*(8), 1094–1102.

Morrow, S.A., Rosehart, H., & Pantazopoulos, K. (2016). Anxiety and depressive symptoms are associated with worse performance on objective cognitive tests in MS. *The Journal of Neuropsychiatry and Clinical Neuroscience*, *28*(2), 118–123.

Schwartz, ES., Erdodi, L., Rodriguez, N., Ghosh, J.J., Curtain, J.R., Flashman, L.A., & Roth, R.M. (2016). CVLT-II forced choice recognition trial as an embedded validity indicator: A systematic review of the evidence. *Journal of the International Neuropsychological Society*, *22*(8), 851–858. doi: 10.1017/S1355617716000746

Silk-Eglit, G.M., Lynch, J.K., & McCaffrey, R.J. (2016). Validation of victoria symptom validity test cutoff scores among mild traumatic brain injury litigants using a known-groups design. *Clinical Neuropsychologist*, *31*, 231–245.

Slick, D.J., Hopp, G., Strauss, E., & Thompson, G.B. (1997). *VSVT: Victoria Symptom Validity Test, Version 1.0 Professional Manual*. Odessa, FL: Psychological Assessment Resources, Inc.

Smith, A. (1982). *Symbol Digit Modalities Test: Manual*. Los Angeles, CA: Western Psychological Services.

Suchy, Y., Chelune, G., Franchow, E.I., & Thorgusen, S.R. (2012). Confronting patients about insufficient effort: the impact on subsequent symptom validity and memory performance. *The Clinical Neuropsychologist*, *26*(8), 1296–1311.

Wechsler, D. (2008). *Wechsler Adult Intelligence Scale–Fourth Edition (WAIS–IV)*, vol. *22*, 498 p. San Antonio, TX: NCS Pearson.