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Brief Communication

Diagnostic utility of the Minnesota Multiphasic Personality Inventory-2 Restructured Form in the epilepsy monitoring unit: Considering sex differences

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ABSTRACT

Psychological assessment measures are frequently used to evaluate patients in epilepsy monitoring units. One goal of that assessment is to contribute information that may help with differential diagnosis between epilepsy and psychogenic nonepileptic seizures (PNES). The Minnesota Multiphasic Personality Inventory-2 Restructured Form (MMPI-2-RF) is one such measure. Del Bene et al. (2017) recently published an analysis that was the first to compare MMPI-2-RF scale elevations between diagnostic groups stratified by sex. The purpose of the present study was to replicate that analysis in a larger sample. Similar to previous work, we found that both men and women with PNES were more likely than men and women with epilepsy to report high levels of somatic complaints (2 to 5 times greater odds of somatic symptom reporting) and a variety of types of complaints. Mood disturbance scales were not significantly elevated in our PNES sample. Results contribute to the small body of research on sex differences in patients with PNES and suggest that somatization is a key characterization across sexes.

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1. Introduction

Psychogenic nonepileptic seizures (PNES) are seizure-like behaviors that can appear similar to epileptic seizures (ES) but that lack the expected electrocortical abnormalities. Despite a large literature attempting to identify clinical tools to differentiate PNES and ES, such differentiation remains challenging [1,2]. The Minnesota Multiphasic Personality Inventory-2 (MMPI-2) is a personality assessment tool used by neuropsychologists in epilepsy monitoring units (EMUs) to evaluate patients' psychological functioning and inform diagnostic comparisons of PNES and ES based on patient profiles [3,27]. Studies have found group differences between patients with PNES and ES in multiple somatic complaints scales using the MMPI-2 [4–6].

Previously, we evaluated the potential clinical utility of the MMPI-2 Restructured Form (MMPI-2-RF; [7,8]) with respect to differential diagnosis of ES and PNES [9] as it is a more uniform and reliable restructured version of the MMPI-2. We reported sensitivity, specificity, overall percentage of the sample classified correctly, and likelihood ratios for the MMPI-2-RF scales at different clinical cut points. We found that the restructured clinical somatic complaints scale (RC1), the somatic/cognitive subscales of head pain complaints (HPC), neurological complaints (NUC), and malaise (MLS), and the symptom validity (FBS-r) subscale showed the greatest potential for predictive utility of the MMPI-2-RF scales while controlling for the effects of sex and current psychotropic medications. Furthermore, adding the RC1 scale improved the predictive accuracy of a model that included demographic and clinical risk factors specifically sex, number of years of seizures, frequency of seizures, number of antiepileptic drugs (AEDs), current psychotropic medication, and psychiatric history.

Del Bene et al. [10] also explored whether there were greater odds of MMPI-2-RF scale elevations among patients with PNES versus patients with epilepsy. Consistent with our own research and that of others [9,11,12], Del Bene et al. [10] found that individuals with PNES, compared with individuals with ES, had overall greater odds of clinical elevations (scores of 65 or greater) and marked clinical elevations (scores of 80 or greater) on the RC1 and dysfunctional negative emotions (RC7) scales. They also examined sex differences and found that women with PNES had 3 to 6 times greater odds of scale elevations for RC1, RC7, and Suicidal/Death Ideation (SUI) than women with ES; men with PNES were 5 to 15 times more likely to score above the clinical

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threshold on RC1 and HPC than men with ES. This suggests that somatic complaints are relevant diagnostic indicators for both men and women with PNES but that there may be differences in other aspects of their presentations [13]. This echoes a larger literature suggesting men can manifest psychological concerns differently from women [14]. Furthermore, given that odds of elevation on the RC1 scale are greater in men with PNES versus men with epilepsy than in women with PNES versus women with epilepsy, these indicators may be more strongly predictive of PNES among men than among women.

As most patients with PNES are women [15–18], relatively few studies have evaluated sex differences in a large sample. In one prior study of patients with seizure disorders (95% epilepsy, 5% PNES), sex contributed significantly to the variance explained in regression models where MMPI-2-RF RC1 and RC7 scales were used to predict the corresponding MMPI-2 scales (Hypochondriasis and Psychasthenia, respectively), with women showing decreased odds of scale elevations compared with men; sex was not a significant contributor for other scales [19]. These results support the notion that sex can be a meaningful consideration when using the MMPI-2-RF as a diagnostic tool in seizure patient samples, particularly for clinical scales that have demonstrated diagnostic reliability in distinguishing PNES from epilepsy [5,9,10].

Thus, the objective of the present paper was to extend our previous findings by examining the MMPI-2-RF's predictive utility separately for men and women. This also provided an opportunity to replicate and compare our results with those of Del Bene et al. [10] using a much larger sample. We note that our sample overlaps with that reported in Locke et al. [9] and Locke and Thomas [5], with 12.3% of the present sample comprising new patients.

2. Methods

2.1. Participants

Our sample was drawn from 485 EMU patients with video-electroencephalography (video-EEG) confirmed diagnoses of either ES or PNES and who had completed the MMPI-2-RF or completed the MMPI-2, and it was rescored into the RF version (see below). Data from 429 of these participants were collected from 2001 to 2009 and were reported in Locke et al. [9] and Locke and Thomas [5], and data from an additional 56 patients were collected since 2010. The original 429 completed the MMPI-2, and the additional 56 patients completed the MMPI-2-RF. Diagnoses were made by a board-certified neurologist (for further detail, see [9]).

All MMPI-2-RF profiles were reviewed for invalid profiles due to missing data (cannot say >15) or random responding (variable response inconsistency [VRIN ≥ 80] scale and true response inconsistency [TRIN ≥ 80]). Thirty-two MMPI-2-RF protocols (20 from patients with ES and 12 from patients with PNES; 30 from our initial sample and 2 from patients added since 2010) were excluded from the analyses (6 cannot say >15; 9 VRIN ≥80; 15 TRIN ≥80; 2 VRIN and TRIN ≥80). In addition, one patient from the newly added sample did not report sex and, therefore, was not included in further analyses. Thus, our final sample consisted of 452 patients with complete and valid MMPI-2-RF profiles and included 323 women (136 = ES, 187 = PNES) and 129 men (85 = ES, 44 = PNES).

2.2. Procedure

The MMPI-2 was administered during a neuropsychological assessment that was part of routine clinical practice. Minnesota Multiphasic Personality Inventory-2 profiles were electronically rescored into the MMPI-2-RF using the QLocal rescoring procedure. QLocal is the scoring software for the MMPI-2/MMPI-2-RF sold by Pearson Assessments, the test publishing company that publishes the MMPI-2 and MMPI-2-RF products. Within the QLocal computerized scoring system, there is a process for automated rescoring of the 338 items that comprise the MMPI-2-RF from a prior administration of the 567 item MMPI-2.

Minnesota Multiphasic Personality Inventory-2 Restructured Form data, along with demographic information and clinical history, were entered into a database; any identifying information was subsequently removed. Because the database included only existing, de-identified information, the study was considered exempt by the Mayo Clinic Institutional Review Board.

2.3. Statistical analyses

As we did not previously examine sex differences [9], we examined in the current study diagnostic (PNES vs. ES) group differences in MMPI-2-RF scores, separately for men and women, using a multivariate analysis of covariance (MANCOVA) for each group of MMPI-2-RF scales of interest (validity, higher-order, restructured clinical, somatic/cognitive). We included current use of psychotropic medication as a covariate and used an alpha of 0.01 (see Table 2). Second, for scales with significant diagnostic group differences based on the MANCOVAs (see [9]), we calculated separately for women and men the sensitivities, specificities, likelihood ratios, and overall correct classification rate (calculated as correct classifications divided by all classifications: true positives + true negatives / true positives + true negatives + false positives + false negatives) of a PNES or epilepsy diagnosis based on a binarization of T-scores at both clinically elevated (T ≥ 65) and markedly elevated (T ≥ 80) thresholds (see [10]). For the scales showing significantly increased likelihood of elevation for men or women with PNES, we also calculated the odds ratios, positive and negative predictive values (PPV and NPV), false omission rates (FOR), and false discovery rates (FDR).

3. Results

3.1. Descriptive analyses: demographics and clinical history

Demographic and clinical history comparisons of PNES and ES without sex stratification are consistent with those reported in our prior paper and are not duplicated here. Table 1 presents a summary of demographic and clinical information for patients with ES and PNES separated by sex. For both women and men, those with epilepsy reported having seizures for a greater number of years and reported taking a greater number of AEDs upon admission than those with PNES; conversely, those with PNES were more likely to have a psychiatric treatment history and to be taking psychotropic medication than those with epilepsy. In addition, women with PNES reported more frequent seizures than women with epilepsy, whereas the difference in reported seizure frequency did not reach statistical significance for men.

3.2. Diagnostic accuracy of MMPI-2-RF scales by sex

Among women, we found diagnostic group differences for the FBS-r, adjustment validity (K-r), RC1, cynicism (RC3), HPC, NUC, and MLS scales. Women with PNES showed higher scores than women with epilepsy on all of these scales with the exception of RC3 on which they showed lower scores (see Table 2). Somatic complaints and NUC showed the largest effect sizes. In terms of correctly classifying women with PNES or epilepsy, the RC1 scale showed the best overall correct classification rate (67%) at the clinical symptom threshold (with classification rates of 65% for the NUC scale and 64% for the FBS-r scale) while the NUC scale showed the best overall correct classification rate (63%) at the markedly elevated symptom threshold (see Table 3).

Among men, we found diagnostic group differences for the RC1, NUC, and MLS scales; men with PNES had higher scores on these three scales than men with epilepsy. Somatic complaints and MLS showed the largest effect sizes (see Table 2) and correctly classified

Table 1
Demographic information and clinical history by diagnostic group stratified by sex.

Variable	*n*ES/*n*PNES	ES M (SD) or %	PNES M (SD) or %	χ^2 /*t*-Value	p-Value
Women (n = 323)					
Age	136/187	42.09 (15.25)	42.86 (13.73)	−0.48	0.63
Ethnicity	128/167	93% white	94% white	0.13	0.72
Years of education	128/167	13.80 (2.42)	13.98 (2.20)	−0.68	0.50
Employment	125/166	58% unemployed	60% unemployed	0.05	0.83
Full Scale IQ (FSIQ)	113/124	100.10 (11.55)	100.87 (13.51)	−0.47	0.64
AEDs at EMU admission	**128/166**	**1.54 (0.95)**	**1.04 (1.06)**	**4.18**	**<0.001**
Length of disorder (years)	**128/166**	**14.89 (14.68)**	**5.80 (8.86)**	**6.57**	**<0.001**
Seizure frequency	**107/142**	**45% daily/weekly, 33% monthly, 22% greater than monthly**	**78% daily/weekly, 13% monthly, 9% greater than monthly**	**29.36**	**<0.001**
General psychiatric history	**128/167**	**58% yes**	**81% yes**	**18.60**	**<0.001**
Current psychotropic medication	**128/167**	**30% yes**	**51% yes**	**13.41**	**<0.001**
Men (n = 129)					
Age	85/44	41.02 (14.58)	43.23 (14.79)	−0.81	0.42
Ethnicity	67/37	93% white	97% white	0.99	0.32
Years of education	76/44	14.26 (2.23)	14.09 (2.61)	0.38	0.70
Employment	67/36	37% unemployed	39% unemployed	0.03	0.87
FSIQ	61/29	100.97 (12.19)	102.59 (14.41)	−0.56	0.58
AEDs at EMU admission	**66/37**	**1.82 (1.16)**	**1.03 (1.01)**	**3.47**	**0.001**
Length of disorder (years)	**66/36**	**14.09 (13.51)**	**4.65 (7.13)**	**3.90**	**<0.001**
Seizure frequency	58/29	47% daily/weekly, 33% monthly, 21% greater than monthly	72% daily/weekly, 21% monthly, 10% greater than monthly	5.23	0.07
General psychiatric history	**67/37**	**43% yes**	**78% yes**	**11.90**	**0.001**
Current psychotropic medication	**67/37**	**18% yes**	**49% yes**	**10.97**	**0.001**

Note: Sample overlaps with that reported in Locke et al. [9] and Locke and Thomas [5]. Age, education, FSIQ, AEDs, and length of disorder have corresponding *t*-values. Ethnicity, employment, seizure frequency, psychiatric history, and psychotropic medication have corresponding χ^2 values.
Bold text indicates statistical significance.

Table 2
MMPI-2-RF differences by diagnostic group stratified by sex.

Scale	Women (*n* = 295)					Men (*n* = 104)				
	ES (M/SD) *n* = 128	PNES (M/SD) *n* = 167	F-value	p-Value	η_p^2	ES (M/SD) *n* = 67	PNES (M/SD) *n* = 37	F-value	p-Value	η_p^2
Validity scales										
VRINr	50.87 (10.26)	49.99 (9.38)	1.22	0.27	0.004	50.51 (10.01)	52.41 (10.49)	0.10	0.76	0.001
TRINr	57.26 (6.71)	57.41 (6.73)	0.03	0.85	<0.001	55.84 (6.19)	56.68 (5.98)	0.42	0.52	0.004
F-r	63.61 (15.92)	66.61 (15.27)	1.10	0.30	0.004	63.84 (15.42)	72.11 (19.01)	2.50	0.12	0.02
Fpr	52.05 (11.52)	51.87 (10.37)	0.43	0.51	0.001	51.09 (11.32)	58.38 (19.97)	3.43	0.07	0.03
Fs	71.08 (17.61)	76.26 (19.63)	3.31	0.07	0.11	70.87 (14.92)	78.51 (17.03)	3.25	0.08	0.03
FBS-r	**63.57 (12.72)**	**72.28 (13.04)**	**26.56**	**<0.001**	**0.08**	60.10 (13.37)	66.57 (12.02)	3.20	0.08	0.03
Lr	54.58 (10.83)	55.09 (10.54)	1.08	0.30	0.004	52.42 (8.38)	53.70 (11.19)	0.68	0.41	0.007
K-r	**48.97 (9.63)**	**51.74 (9.56)**	**8.15**	**0.005**	**0.03**	46.97 (9.91)	45.38 (9.22)	0.02	0.88	<0.001
Restructured clinical scales										
RCd	56.10 (11.56)	54.93 (10.04)	2.42	0.12	0.008	55.51 (11.34)	57.38 (11.79)	0.03	0.87	<0.001
RC1	**64.10 (13.02)**	**73.81 (12.41)**	**33.98**	**<0.001**	**0.10**	**61.10 (12.23)**	**73.32 (12.60)**	**13.62**	**<0.001**	**0.12**
RC2	56.95 (10.56)	57.21 (10.39)	0.01	0.91	<0.001	54.79 (11.45)	58.65 (13.53)	0.54	0.47	0.005
RC3	**49.48 (10.32)**	**45.51 (9.34)**	**10.75**	**0.001**	**0.04**	49.93 (9.25)	51.14 (10.10)	0.001	0.97	<0.001
RC4	48.22 (9.14)	47.50 (9.19)	1.01	0.32	0.003	53.27 (12.05)	53.03 (11.57)	0.66	0.42	0.006
RC6	53.05 (10.91)	51.53 (9.79)	2.72	0.10	0.009	54.81 (12.22)	58.76 (15.17)	0.85	0.36	0.008
RC7	49.87 (11.15)	49.66 (9.84)	0.42	0.52	0.001	50.28 (8.91)	52.81 (11.84)	0.06	0.81	0.001
RC8	57.78 (10.54)	59.01 (10.66)	0.50	0.48	0.002	58.36 (11.03)	64.27 (12.27)	4.80	0.03	0.05
RC9	43.90 (9.13)	43.34 (7.44)	0.61	0.44	0.002	48.90 (8.31)	53.59 (11.20)	2.88	0.09	0.03
Higher-order scales										
EID	55.38 (11.74)	54.59 (10.53)	1.36	0.25	0.005	54.78 (11.00)	57.24 (12.07)	0.01	0.91	<0.001
THD	54.63 (10.13)	56.13 (9.37)	1.06	0.31	0.004	55.40 (11.51)	61.89 (12.17)	4.36	0.04	0.04
BXD	45.34 (8.55)	44.41 (8.63)	1.51	0.22	0.005	52.40 (10.44)	53.24 (11.05)	0.03	0.86	<0.001
Somatic/cognitive scales										
HPC	**58.74 (12.92)**	**64.93 (11.76)**	**13.90**	**<0.001**	**0.05**	55.60 (12.82)	63.22 (12.23)	3.78	0.06	0.04
NUC	**71.10 (13.63)**	**82.16 (12.79)**	**41.28**	**<0.001**	**0.12**	**71.97 (11.88)**	**81.59 (13.41)**	**9.28**	**0.003**	**0.08**
MLS	**65.17 (12.83)**	**71.12 (12.05)**	**11.46**	**0.001**	**0.04**	**60.37 (11.52)**	**70.89 (10.82)**	**14.34**	**<0.001**	**0.12**
GIC	58.08 (15.20)	62.44 (16.92)	4.41	0.04	0.02	54.81 (13.80)	62.59 (14.65)	3.33	0.07	0.03
COG	66.01 (13.42)	66.68 (12.70)	<0.001	1.0	<0.001	64.82 (13.65)	67.65 (12.60)	0.45	0.50	0.004

Note: F-tests for each individual subscale are based on diagnostic group comparisons conducted separately for men and women controlling for psychotropic medication use. MANCOVA sample sizes are reduced because of 25 men and 28 women missing information on psychotropic medication use.
Abbreviations: VRINr = Variable Response Inconsistency; TRINr = True Response Inconsistency; F-r = Infrequent Responses; Fp-r = Infrequent Psychopathology Responses; Fs = Infrequent Somatic Responses; FBS-r = Symptom Validity; L-r = Uncommon Virtues; K-r = Adjustment Validity; RCd = Demoralization; RC1 = Somatic Complaints; RC2 = Low Positive Emotions; RC3 = Cynicism; RC4 = Antisocial Behavior; RC6 = Ideas of Persecution; RC7 = Dysfunctional Negative Emotions; RC8 = Aberrant Experiences; RC9 = Hypomanic Activation; EID = Emotional/Internalizing Dysfunction; THD = Thought Dysfunction; BXD = Behavioral/Externalizing Dysfunction; HPC = Head Pain Complaints; NUC = Neurological Complaints; MLS = Malaise; GIC = Gastrointestinal Complaints; COG = Cognitive Complaints.

Table 3
Sensitivity, specificity, likelihood ratio, and overall correct classification rate for MMPI-2-RF scales among women and men at clinical (T ≥ 65) and marked (T ≥ 80) thresholds.

Scale	Sensitivity (%)		Specificity (%)		Positive likelihood ratio		Negative likelihood ratio		Overall correct classification rate (%)	
	Clinical	Marked	Clinical	Marked	Clinical	Marked	Clinical	Marked	Clinical	Marked
Women										
FBS-r	69.50	35.80	56.60	83.80	1.60	2.21	0.54	0.77	64.09	56.04
K-r	10.20	–	93.40	–	1.54	–	0.96	–	45.20	–
RC1	79.10	32.60	51.50	85.30	1.63	2.22	0.41	0.79	67.49	54.80
RC3	7.50	–	86.00	–	0.54	–	1.08	0.99	40.56	–
HPC	59.90	8.60	63.20	91.90	1.63	1.06	0.63	0.99	61.30	43.65
NUC	91.40	64.20	29.40	62.50	1.30	1.71	0.29	0.57	65.33	63.47
MLS	69.00	35.80	50.00	80.90	1.38	1.87	0.62	0.79	60.99	54.80
Men										
RC1	70.50	20.50	67.10	91.80	2.14	2.48	0.44	0.87	68.22	67.44
NUC	86.40	63.60	21.20	71.80	1.10	2.25	0.64	0.51	43.41	68.99
MLS	65.90	31.80	69.40	88.20	2.15	2.70	0.49	0.77	68.22	68.99

Note: Analyses were not conducted for women on K-r at the marked threshold as no profiles scored ≥80 nor for RC3 at marked elevations as there was only 1 patient with PNES with scale elevations.
Abbreviations: VRINr = Variable Response Inconsistency; TRINr = True Response Inconsistency; F-r = Infrequent Responses; Fp-r = Infrequent Psychopathology Responses; Fs = Infrequent Somatic Responses; FBS-r = Symptom Validity; L-r = Uncommon Virtues; K-r = Adjustment Validity; RCd = Demoralization; RC1 = Somatic Complaints; RC2 = Low Positive Emotions; RC3 = Cynicism; RC4 = Antisocial Behavior; RC6 = Ideas of Persecution; RC7 = Dysfunctional Negative Emotions; RC8 = Aberrant Experiences; RC9 = Hypomanic Activation; EID = Emotional/Internalizing Dysfunction; THD = Thought Dysfunction; BXD = Behavioral/Externalizing Dysfunction; HPC = Head Pain Complaints; NUC = Neurological Complaints; MLS = Malaise; GIC = Gastrointestinal Complaints; COG = Cognitive Complaints.

between 67% and 69% of male patients at both the clinical symptom and markedly elevated symptom thresholds (see Table 3). The NUC scale correctly classified 69% of male patients at the markedly elevated symptom threshold but only 43% at the clinical symptom threshold (see Table 3).

3.3. Odds of MMPI-2-RF scale elevations by sex

Following the analyses used by Del Bene et al. [10], we used the crosstabs function in SPSS version 24 to calculate the odds ratios and confidence intervals for the relevant MMPI-2-RF scales. Odds ratios were considered significant if the low and high ranges of the 95% confidence interval were both greater than 1 [20]. We only calculated the PPV (true positive / true positive + false positive), NPV (true negative / true negative + false negative), FOR (1 − NPV), and FDR (1 − PPV) for the scales that had a statistically significant likelihood of elevation for patients with PNES. We present results stratified by sex in Tables 4 and 5.

Similar to the findings of Del Bene et al. [10], women with PNES in our sample were approximately 4 times more likely to have clinical

Table 4
Odds ratios for clinical and marked elevations on MMPI-2-RF scales for women.

Scale	Clinical								Marked							
	Odds ratio	95% CI	χ^2	p-Value	PPV (%)	FDR (%)	NPV (%)	FOR (%)	Odds ratio	95% CI	χ^2	p-Value	PPV (%)	FDR (%)	NPV (%)	FOR (%)
VRINr	0.55	0.24–1.24	2.15	0.14	–	–	–	–	–	–	–	–	–	–	–	–
TRINr	1.19	0.71–1.98	0.43	0.51	–	–	–	–	–	–	–	–	–	–	–	–
F-r	1.41	0.91–2.20	2.34	0.13	–	–	–	–	1.05	0.57–1.92	0.02	0.88	–	–	–	–
Fpr	0.84	0.45–1.45	0.32	0.57	–	–	–	–	0.97	0.21–4.40	0.002	0.97	–	–	–	–
Fs	1.31	0.81–2.13	1.20	0.27	–	–	–	–	**2.09**	**1.30–3.36**	**9.37**	**0.002**	**43.85**	**56.15**	**72.79**	**27.21**
FBS-r	**2.98**	**1.88–4.72**	**22.16**	**<0.001**	**69.52**	**30.48**	**56.62**	**43.48**	**2.89**	**1.68–4.99**	**15.23**	**<0.001**	**35.83**	**64.17**	**83.82**	**16.18**
Lr	1.19	0.68–2.10	0.36	0.55	–	–	–	–	0.87	0.26–2.91	0.05	0.82	–	–	–	–
K-r	1.60	0.70–3.65	1.25	0.26	–	–	–	–	–	–	–	–	–	–	–	–
RCd	0.51	0.30–0.88	5.97	0.02	–	–	–	–	0.72	0.20–2.54	0.26	0.61	–	–	–	–
RC1	**4.03**	**1.35–1.97**	**33.01**	**<0.001**	**79.14**	**20.86**	**51.47**	**48.53**	**2.81**	**1.60–4.94**	**13.45**	**<0.001**	**32.62**	**67.38**	**85.29**	**14.71**
RC2	0.84	0.51–1.39	0.46	0.50	–	–	–	–	1.67	0.50–5.54	0.71	0.40	–	–	–	–
RC3	0.50	0.24–1.03	3.61	0.06	–	–	–	–	1.00	0.98–1.01	0.73	0.39	–	–	–	–
RC4	1.10	0.48–2.53	0.05	0.82	–	–	–	–	–	–	–	–	–	–	–	–
RC6	0.50	0.26–0.96	4.48	0.03	–	–	–	–	0.60	0.18–1.99	0.72	0.40	–	–	–	–
RC7	0.84	0.42–1.67	0.25	0.62	–	–	–	–	1.09	0.18–6.44	0.01	0.92	–	–	–	–
RC8	1.19	0.73–1.94	0.47	0.49	–	–	–	–	1.26	0.48–3.30	0.23	0.63	–	–	–	–
RC9	0.28	0.05–1.48	2.52	0.11	–	–	–	–	–	–	–	–	–	–	–	–
EID	0.60	0.34–1.03	3.48	0.06	–	–	–	–	0.60	0.18–1.99	0.72	0.40	–	–	–	–
THD	1.29	0.68–2.45	0.58	0.45	–	–	–	–	1.28	0.37–4.47	0.15	0.70	–	–	–	–
BXD	2.22	0.44–10.65	0.99	0.32	–	–	–	–	–	–	–	–	–	–	–	–
HPC	**2.57**	**1.63–4.05**	**16.85**	**<0.001**	**59.89**	**40.11**	**63.23**	**36.77**	1.06	0.48–2.37	0.02	0.88	–	–	–	–
NUC	**4.45**	**2.37–8.37**	**23.90**	**<0.001**	**91.44**	**8.56**	**29.41**	**70.59**	**2.99**	**1.89–4.72**	**22.48**	**<0.001**	**64.17**	**35.83**	**62.50**	**37.50**
MLS	**2.22**	**1.41–3.51**	**11.93**	**0.001**	**68.98**	**31.02**	**50.00**	**50.00**	**2.36**	**1.40–3.98**	**10.73**	**0.001**	**35.83**	**64.17**	**80.88**	**19.12**
GIC	**1.77**	**1.08–2.91**	**5.16**	**0.02**	**35.29**	**64.71**	**76.47**	**23.53**	1.53	0.89–2.64	2.39	0.12	–	–	–	–
COG	1.10	0.71–1.71	0.17	0.68	–	–	–	–	1.01	0.61–1.68	0.001	0.98	–	–	–	–

Note: Analyses were not conducted for women on VRINr, TRINr, K-r, RC4, RC9, and BXD at the marked threshold as no profiles scored ≥80.
Abbreviations: VRINr = Variable Response Inconsistency; TRINr = True Response Inconsistency; F-r = Infrequent Responses; Fp-r = Infrequent Psychopathology Responses; Fs = Infrequent Somatic Responses; FBS-r = Symptom Validity; L-r = Uncommon Virtues; K-r = Adjustment Validity; RCd = Demoralization; RC1 = Somatic Complaints; RC2 = Low Positive Emotions; RC3 = Cynicism; RC4 = Antisocial Behavior; RC6 = Ideas of Persecution; RC7 = Dysfunctional Negative Emotions; RC8 = Aberrant Experiences; RC9 = Hypomanic Activation; EID = Emotional/Internalizing Dysfunction; THD = Thought Dysfunction; BXD = Behavioral/Externalizing Dysfunction; HPC = Head Pain Complaints; NUC = Neurological Complaints; MLS = Malaise; GIC = Gastrointestinal Complaints; COG = Cognitive Complaints.

Table 5
Odds ratios for clinical and marked elevations on MMPI-2-RF scales for men.

Scale	Clinical								Marked							
	Odds ratio	95% CI	χ2	p-Value	PPV (%)	FDR (%)	NPV (%)	FOR (%)	Odds ratio	95% CI	χ2	p-Value	PPV (%)	FDR (%)	NPV (%)	FOR (%)
VRINr	1.23	0.38–4.02	0.12	0.73	–	–	–	–	–	–	–	–	–	–	–	–
TRINr	1.56	0.60–4.06	0.85	0.36	–	–	–	–	–	–	–	–	–	–	–	–
F-r	**2.63**	**1.23–5.61**	**6.44**	**0.01**	**65.91**	**34.09**	**57.65**	**42.35**	1.90	0.79–4.57	2.10	0.15	–	–	–	–
Fpr	1.56	0.64–3.76	0.97	0.32	–	–	–	–	8.40	0.91–77.61	4.87	0.03	–	–	–	–
Fs	2.49	0.93–6.65	3.46	0.06	–	–	–	–	1.73	0.81–3.67	2.02	0.16	–	–	–	–
FBS-r	**2.23**	**1.06–4.70**	**4.53**	**0.03**	**52.27**	**47.73**	**60.46**	**39.54**	1.06	0.37–3.09	0.01	0.91	–	–	–	–
Lr	1.73	0.66–4.56	1.25	0.26	–	–	–	–	1.95	0.12–32.00	0.23	0.63	–	–	–	–
K-r	0.31	0.04–2.63	1.29	0.26	–	–	–	–	–	–	–	–	–	–	–	–
RCd	1.27	0.52–3.09	0.28	0.60	–	–	–	–	4.00	0.35–45.38	1.45	0.23	–	–	–	–
RC1	**4.85**	**2.20–10.70**	**16.44**	**<0.001**	**70.45**	**29.55**	**67.06**	**32.94**	2.87	0.99–8.31	3.98	0.05	–	–	–	–
RC2	2.13	0.95–4.76	3.45	0.06	–	–	–	–	8.40	0.91–77.61	4.87	0.03	–	–	–	–
RC3	1.76	0.55–5.60	0.93	0.33	–	–	–	–	–	–	–	–	–	–	–	–
RC4	0.96	0.39–2.35	0.01	0.92	–	–	–	–	1.98	0.27–14.53	0.46	0.50	–	–	–	–
RC6	1.81	0.78–4.21	1.91	0.17	–	–	–	–	2.05	0.56–7.51	1.22	0.27	–	–	–	–
RC7	3.03	0.90–10.17	3.46	0.06	–	–	–	–	–	–	–	–	–	–	–	–
RC8	1.92	0.88–4.19	2.71	0.10	–	–	–	–	3.20	0.85–12.00	3.23	0.07	–	–	–	–
RC9	**6.07**	**1.52–24.23**	**7.98**	**0.005**	**18.18**	**81.82**	**91.47**	**8.53**	0.96	0.89–1.02	3.92	0.05	–	–	–	–
EID	1.27	0.52–3.09	0.28	0.60	–	–	–	–	1.95	0.12–32.00	0.23	0.63	–	–	–	–
THD	2.24	0.88–5.69	2.98	0.08	–	–	–	–	3.50	0.80–15.41	3.06	0.08	–	–	–	–
BXD	1.35	0.51–3.60	0.37	0.55	–	–	–	–	1.95	0.12–32.00	0.23	0.63	–	–	–	–
HPC	**2.35**	**1.11–4.97**	**5.14**	**0.02**	**52.27**	**47.73**	**68.23**	**31.77**	4.00	0.35–45.38	1.45	0.23	–	–	–	–
NUC	1.70	0.62–4.65	1.09	0.30	–	–	–	–	**4.45**	**2.05–9.65**	**15.10**	**<0.001**	**63.64**	**36.36**	**71.76**	**28.24**
MLS	**4.39**	**2.02–9.53**	**14.79**	**<0.001**	**65.91**	**34.09**	**69.42**	**30.58**	**3.50**	**1.40–8.74**	**7.70**	**0.006**	**31.82**	**61.18**	**88.23**	**11.77**
GIC	**3.17**	**1.35–7.42**	**7.39**	**0.007**	**36.36**	**63.64**	**84.71**	**15.29**	1.60	0.55–4.63	0.76	0.39	–	–	–	–
COG	1.43	0.69–2.97	0.92	0.34	–	–	–	–	1.40	0.60–3.24	0.60	0.44	–	–	–	–

Note: Analyses were not conducted for men on MSF at the clinical threshold and VRINr, TRINr, K-r, RC3, and RC7 at the marked threshold as no profiles scored ≥80.
Abbreviations: VRINr = Variable Response Inconsistency; TRINr = True Response Inconsistency; F-r = Infrequent Responses; Fp-r = Infrequent Psychopathology Responses; Fs = Infrequent Somatic Responses; FBS-r = Symptom Validity; L-r = Uncommon Virtues; K-r = Adjustment Validity; RCd = Demoralization; RC1 = Somatic Complaints; RC2 = Low Positive Emotions; RC3 = Cynicism; RC4 = Antisocial Behavior; RC6 = Ideas of Persecution; RC7 = Dysfunctional Negative Emotions; RC8 = Aberrant Experiences; RC9 = Hypomanic Activation; EID = Emotional/Internalizing Dysfunction; THD = Thought Dysfunction; BXD = Behavioral/Externalizing Dysfunction; HPC = Head Pain Complaints; NUC = Neurological Complaints; MLS = Malaise; GIC = Gastrointestinal Complaints; COG = Cognitive Complaints.

elevations and approximately 3 times more likely to have marked elevations on the RC1 scale than women with epilepsy, and approximately 3 times more likely to have clinical elevations on the HPC scale. We also found that women with PNES had 3 times greater odds of clinical elevation on the FBS-r scale, approximately 2 times greater odds of clinical elevation on the MLS and gastrointestinal complaints (GIC) scales, and nearly 5 times greater odds of clinical elevation on the NUC scale. Additionally, the women with PNES in our sample were approximately 2 to 3 times more likely to have marked elevations on the infrequent somatic responses (Fs) and FBS-r scales as well as on the MLS and NUC somatic/cognitive scales (see Table 4). All of these findings were statistically significant. We did not find significantly greater odds of clinical elevation on the RC7 and suicidal/death ideation (SUI) scales as Del Bene et al. [10] did.

Similar to the findings of Del Bene et al. [10], men with PNES in our sample showed significantly greater odds of clinical elevations for the FBS-r, RC1, and HPC scales compared with men with epilepsy. Men with PNES in our sample also had significantly greater odds of clinical elevations than men with epilepsy on the following scales: infrequent responses (F-r; 3 times greater odds), hypomanic activation (RC9; 6 times greater odds), MLS (4 times greater odds), and GIC (3 times greater odds). Men with PNES also were approximately 3 times more likely to show marked elevations on the MLS scale and about 4 times more likely to show marked elevations on the NUC scale, findings which were statistically significant (see Table 5).

4. Discussion

The MMPI-2 is a widely used personality measure often included in neuropsychological assessments of patients admitted to EMUs. The restructured version (MMPI-2-RF) is a shorter assessment with the scales restructured to be more psychometrically sound and clinically relevant per current diagnostic practices [7]. Previously, we demonstrated the potential for specific MMPI-2-RF scales to differentiate patients with PNES versus patients with epilepsy in an EMU setting [9]. Here, using the same sample (with additional new patients), we examined separately in men and women whether the MMPI-2-RF was differentially predictive of PNES versus epilepsy.

Overall, the patients with PNES in our sample were more likely to report both clinically elevated and markedly elevated symptom levels (one standard deviation above the typical clinical cutoff) on multiple MMPI-2-RF scales compared with patients with epilepsy. Most notably, both men and women with PNES were more likely than men and women with epilepsy to report high levels of somatic complaints and a variety of types of somatic complaints. Our findings are consistent with research showing a tendency among patients with PNES to minimize psychological stress in favor of illness-based explanations for their distress (e.g., [21]), which may manifest as complaints of gastrointestinal problems, headaches, sleep disturbances, and other nonspecific physical ailments [22,23].

Consistent with the findings of Del Bene et al. [10], the women with PNES in our sample were more likely to report markedly elevated symptoms on multiple MMPI-2-RF scales. Somatic complaints, MLS, NUC, somatic symptoms not typically reported in a medical population (per the Fs validity scale), and psychological symptoms more broadly (per the FBS-r scale) all showed greater odds of marked elevations in women with PNES. Therefore, high levels of these symptoms may be particularly good indicators of a PNES diagnosis.

Men with PNES also showed greater odds of clinical symptom elevations for multiple scales: somatic complaints, hypomania, HPC, MLS, GIC, and general symptoms (per the Fs scale and the symptom validity scale). There were fewer scales for which men showed markedly elevated symptom levels. Malaise, which reflects an overall sense of physical debilitation, and NUC showed greater odds of elevation in men with PNES when using a markedly elevated symptom cutoff, suggesting that unusually high levels of these two sets of symptoms may be particularly important indicators when differentiating PNES from epilepsy in men. These results echo previous research showing that patients with PNES

are more likely to report physical symptoms (reviewed in [24]) and to have higher scores on the MLS and NUC scales [25] than patients with epilepsy, and extend these findings by examining men and women separately in a large sample.

In contrast to the findings of Del Bene et al. [10], we did not find significant odds of elevation on mood disturbance-related clinical scales for either men or women with PNES, with the exception that RC9 (e.g., restlessness, poor impulse control) was more likely among men with PNES versus men with epilepsy. In our sample, women with PNES did not show increased odds of elevation compared with women with epilepsy on the RC7 or suicidality scales as Del Bene et al. [10] found. Our findings are, however, more consistent with other research indicating that men with PNES demonstrate patterns of greater emotional maladjustment on the MMPI-2 (e.g., per the hysteria, depression, and hypochondriasis scales) compared with women [26].

It is important to point out that the sample in the current study is much larger than the sample of Del Bene et al. [10]; this may have provided more statistical power to reveal significant odds ratios, as the extent of somatic complaints in our PNES sample was greater than in the sample described by Del Bene et al. [10]. Furthermore, the differences noted between the findings of this study and those of Del Bene et al. [10] may potentially relate to the demographic and geographic differences in the samples. For instance, although not reported, the ethnic characteristics of a New York City sample presented in Del Bene et al. [10] might be more diverse than that of our participants in the Southwestern U.S. leading to potential differences in psychological factors associated with development of PNES.

Our results add to the literature documenting that the restructured clinical somatic complaints scale, the somatic/cognitive complaints scales, and the symptom validity scales of the MMPI-2-RF are key metrics for distinguishing patients with PNES from patients with epilepsy (Locke et al., 2009; [6,9,10]) in both men and women. Our findings suggest that symptoms of MLS and NUC may be emergent diagnostic indicators for men with PNES. A key implication of our findings is that, despite some differences for specific scales and choice of clinical cutoffs, the MMPI-2-RF can be used successfully as a clinical tool for both men and women in the EMU to contribute to differential diagnosis of PNES.

Conflict of interest

The authors have no conflict of interest.

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