

Validation of the Italian version of the Northhoff Catatonia Rating Scale

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Summary. Purpose. Catatonia is a psychomotor syndrome characterized by heterogeneous motor, behavioral and affective alterations, and, in some cases, neurovegetative abnormalities that can be life-threatening. Although the prevalence estimates of catatonia are 10-20% of the hospitalized population, its clinical recognition remains a challenge for most clinicians. Differently from other catatonia rating scales, the Northhoff Catatonia Rating Scale (NCRS) also evaluates the affective alterations that patients experience during catatonia and thus provides a more inclusive assessment of the alterations associated with this condition. To provide clinicians with a valuable tool for diagnosis, we translated the NCRS in Italian and validated it on a sample of 52 hospitalized patients with psychiatric disorders. **Methods.** An Italian version of the NCRS was prepared using the forward-backwards translation from English and administered to a sample of 52 in-patients (age 46.9±2.37 years). The inter-rater reliability, score correlations, internal coherence and decision statistics were computed. **Results.** The inter-rater agreement was higher for the motor subscale (100% agreement) than for the behavioral (94%) or affective subscales (92.3%). The inter-rater agreement was 100% for the diagnosis of catatonia. The NCRS correctly identified all patients with catatonia according to DSM-5 (sensitivity= 100%) and had a specificity of 88.9%, and its subscale scores were highly inter-correlated. **Conclusions.** This validation shows that the NCRS yields a good accuracy in diagnosing catatonia and high inter-rater reliability. Moreover, the high correlation between its subscales supports the view that catatonia is a multi-faceted truly psycho-motor syndrome. In conclusion, the validation and Italian translation of the NCRS provides the clinicians with a helpful tool for diagnosing catatonia which is easy to use and assesses the full psychomotor complexity of the syndrome.

Key words. Bush-Francis Catatonia Rating Scale, catatonia, DSM-5, Northhoff Catatonia Rating Scale, schizophrenia, validation.

Validazione della versione italiana della Northhoff Catatonia Rating Scale.

Riassunto. Scopo. La catatonia è una sindrome psicomotoria caratterizzata da varie alterazioni della motricità, del comportamento e dell'affettività e, talvolta, da anomalie autonome potenzialmente letali. Nonostante la prevalenza della catatonia si attesti al 10-20% della popolazione ospedalizzata, il suo riconoscimento clinico permane difficoltoso. A differenza di altre scale di valutazione, la Northhoff Catatonia Rating Scale (NCRS) valuta anche le alterazioni dell'affettività di cui possono avere esperienza i pazienti durante la catatonia, e quindi garantisce una valutazione più completa delle alterazioni associate a questa condizione. Abbiamo tradotto e validato la NCRS su un campione di 52 pazienti ospedalizzati per disturbi psichiatrici per fornire uno strumento affidabile per la diagnosi della sindrome. **Metodi.** Una versione italiana della NCRS è stata preparata con un processo di traduzione forward-backward dall'inglese e somministrata a 52 pazienti (età 46,9±2,37 anni). Sono state calcolate la concordanza inter-esaminatore, le correlazioni tra i punteggi, la coerenza interna e le statistiche del test. **Risultati.** La concordanza inter-esaminatore è risultata più alta per la sottoscala motoria (100%) rispetto a quella comportamentale (94%) o affettiva (92,3%). La concordanza per la diagnosi di catatonia è 100%. La NCRS ha identificato correttamente tutti i pazienti con catatonia secondo il DSM-5 – sensibilità 100% – e ha mostrato una specificità del 88,9%. I punteggi alle sottoscale sono altamente inter-correlati. **Conclusioni.** La NCRS ha una buona precisione diagnostica per la catatonia e alta concordanza inter-esaminatore. Inoltre, l'elevata correlazione tra i punteggi alle sottoscale supporta l'ipotesi che la catatonia sia una sindrome psicomotoria poliedrica. In conclusione, la validazione e traduzione della NCRS fornisce ai clinici un utile strumento per la diagnosi della catatonia che è semplice da usare e cattura la complessità psicomotoria di questa sindrome.

Parole chiave. Bush-Francis Catatonia Rating Scale, catatonia, DSM-5, Northhoff Catatonia Rating Scale, schizofrenia, validazione.

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Introduction

Catatonia is a psychomotor syndrome that can be characterized by a wide range of motor, behavioral, and affective signs^{1,2}. Although historically known for their association with schizophrenia, catatonic symptoms can be a feature of a variety of medical³⁻⁵ and psychiatric disorders⁶, or present as a syndrome *per se*⁷. The psychomotor alterations typical of catatonia are as prevalent as frequently under-recognized^{8,9}, especially in nonpsychiatric medical settings. Approximately 40 signs of catatonia have been described¹⁰, which encompass the motor domain (e.g., stereotypes, waxy flexibility, immobility), the behavioral domain (e.g., automatic obedience, echo phenomena, grimaces), the affective domain (e.g., ambivalence, affective flattening or lability), and dysautonomic signs (temperature, blood pressure and heart rate variations)². Given its epidemiological relevance – approximately 10% of the hospitalized population is affected by catatonia to some extent¹¹ and the possibility of effectively treating the condition when recognized, some rating scales have been developed to aid the clinician in diagnosing catatonia¹¹. Most of these scales are based on the definition of catatonia as a purely motor-behavioural syndrome¹²⁻¹⁵ (as also defined in the current and previous versions of the Diagnostic and Statistical Manual of Mental Disorders - DSM¹⁶), thus neglecting the aspects related to affective symptoms from the evaluation. For this reason, affective symptoms during episodes of catatonia had been little investigated with respect to hyperkinetic or hypokinetic motor manifestations, leading to a gap of knowledge regarding the symptoms experienced by patients¹⁷. To fill this gap, Northoff and colleagues² published and validated the Northoff Catatonia Rating Scale (NCRS). The NCRS is a clinician-administered scale that assesses 40 symptoms and signs of catatonia, grouped into three clusters: motor, behavioural and affective domains. Although NCRS could represent a fruitful standardized research tool for studying the affective symptoms of catatonia including its clinical diagnosis, its worldwide adoption has been mainly limited by the small number of validations in languages other than English¹⁸. Here, we wanted to partially address this issue by reporting the results of the Italian translation and validation of the NCRS.

Methods

FORWARD AND BACK-TRANSLATION

The process of back and forward translation, and semantic equivalence, was conducted according to the Sartorius et al.'s protocol¹⁹. Two indepen-

dent translations into Italian were done by two bilingual researchers independently (DO, MS). The first translation was then back-translated into English by two other translators (FS, GP), and a third researcher assessed adequacy with the original scale (GP). Lastly, based on the two sets of translations and their suitability with the original version of the scale, a semantic and conceptual consensus was reached by the researchers and two psychiatrists (FS, DO, MS).

VALIDATION OF THE SCALE

The Italian version of the Northoff Catatonia Rating Scale was then applied to patients (aged 18 years or more) admitted to the Psychiatric Inpatient Unit of the Psychiatric Clinic at Padua University Hospital, Italy, between July and September 2019. Two trained examiners (IR, AG) administered the rating scale and independently evaluated catatonic symptoms according to Fink's standardized criteria. A brief clinical interview followed the ratings to assess the affective symptoms experienced by the patients (IR, AG). After the clinical interview, the examiners compared their findings to what could be observed during clinical rounds to complete the assessment of symptoms that might not have manifested during the interview (e.g., autonomic instability, mutism). The validation of the scale included 52 patients, aged between 19 and 84 years (mean age \pm standard deviation, 46.9 ± 2.37). The most represented diagnoses in this sample were mood disorders (48.1%), psychotic disorders (34.6%), or alcohol/substance use disorder (5.8%). More than 80% of the patients were receiving at least one antipsychotic medication, 73.1% benzodiazepines, 55.8% mood stabilizers and 44.2% antidepressants. There were no statistically significant demographic differences (at $p < 0.05$) between the group of patients with catatonia and those without it (table 1).

STATISTICAL ANALYSIS

Means were compared through t-Student tests for independent samples. The inter-rater reliability was assessed with Cohen's K. Correlations between the subscales of the NCRS, the total scale score and DSM-5 criteria or Bush-Francis Catatonia Rating Scale (BFCRS) were calculated through Kendall's τ . The internal coherence of the NCRS subscales and the total scale was computed through Cronbach's α . The prevalence, sensitivity, specificity, positive and negative predictive value, Youden's J Statistic, and positive and negative Likelihood Ratio were compared for the NCRS to the DSM-5 criteria and the BFCRS. The analyses were conducted using Jamovi 2019.

Table 1. Sample characteristics.

| | Northhoff Criteria | | DSM-5 Criteria | |
|----------------------------------|---------------------------|--------------------------|-----------------------|--------------------------|
| | With catatonia | Without catatonia | With catatonia | Without catatonia |
| No. cases | 12 | 40 | 7 | 45 |
| Age [mean (SD)] | 53.58 (16.63) | 44.90 (16.95) | 55.00 (16.15) | 45.64 (17.09) |
| Diagnosis (%) | | | | |
| Mood Disorders | 6 (50.0) | 19 (47.5) | 4 (57.1) | 21 (46.7) |
| Schizophrenia Spectrum Disorders | 5 (41.7) | 15 (37.5) | 3 (42.9) | 17 (37.8) |
| SUD/AUD | 0 (0.0) | 2 (5.0) | 0 (0.0) | 2 (4.4) |
| Other | 1 (8.3) | 4 (10.0) | 0 (0.0) | 5 (11.1) |
| Females [No. (%)] | 6 (50.0) | 21 (52.5) | 4 (57.1) | 23 (51.1) |
| Current treatment | | | | |
| Any Mood Stabilizer (%) | | | | |
| No | 3 (25.0) | 20 (50.0) | 2 (28.6) | 21 (46.7) |
| Yes | 9 (75.0) | 20 (50.0) | 5 (71.4) | 24 (53.3) |
| Any Antidepressant (%) | | | | |
| No | 5 (41.7) | 24 (60.0) | 4 (57.1) | 25 (55.6) |
| Yes | 7 (58.3) | 16 (40.0) | 3 (42.9) | 20 (44.4) |
| Any Antipsychotic (%) | | | | |
| No | 0 (0.0) | 9 (22.5) | 0 (0.0) | 9 (20.0) |
| Yes | 12 (100.0) | 31 (77.5) | 7 (100.0) | 36 (80.0) |
| Any Benzodiazepine (%) | | | | |
| No | 4 (33.3) | 10 (25.0) | 2 (28.6) | 12 (26.7) |
| Yes | 8 (66.7) | 30 (75.0) | 5 (71.4) | 33 (73.3) |

Legend: AUD= Alcohol Use Disorder; SUD= Substance Use Disorder; SD= standard deviation.

ETHICAL STATEMENT

All participants expressed their will to participate in the study and signed an informed consent form. This research was performed following the Helsinki Declaration of 1975 guidelines.

Results

We first compared the NCRS score of patients with catatonia (diagnosed with the DSM-5 criteria or according to the BFCRS) to patients without catatonia. Regardless of diagnostic criteria, patients with catatonia scored significantly higher in NCRS than patients without catatonia (table 2). Pertaining to the inter-rater reliability of the total NCR scale, subscales, and individual items, we show that the inter-rater agreement was higher for the motor subscale (100% agreement, Cohen's $K=1$, $p<0.001$) than for the behavioral (94% agreement, Cohen's $K=.867$, $p<0.001$) or affective subscales (92.3% agreement, Cohen's $K=0.77$, $p<0.001$). When considering the diagnosis of catatonia according to the NCRS (i.e., each subscale

with a score >1 and a total score >7 to conclude on its presence vs absence), the inter-rater agreement was 100% (Cohen's $K=1$, $p<0.001$, table 3). Then, we analyzed the correlations between the NCRS and BFCRS or DSM-5 scores. In both cases, we observed a statistically significant correlation between the scales, irrespective of the rater examining patients for catatonic symptoms, with stronger correlations between NCRS and BFCRS than between NCRS or BFCRS and DSM (table 4).

According to the DSM-5 criteria, our sample consisted of 7 out of 52 patients with catatonia and 45 without it. NCRS correctly identified all patients with catatonia according to DSM (7/7, sensitivity= 100%) and considered five more patients, without catatonia according to DSM-5, to have the syndrome (i.e., five false positives, specificity= 88.9%). With a prevalence of catatonia of 13.4% in our sample (according to DSM-5), the positive predictive value of NCRS is 58.3%. The negative predictive value is 100%, with an overall accuracy of 90.4% and a Youden's J Statistic of 0.889 (see table 5A and 5B). On the other hand, according to the BFCRS score, 14 out of 52 patients in

Table 2. Score differences between patients with or without catatonia.

| Criteria: DSM-5 | | | | | | | | | | |
|-----------------|-----------|---------------------|------|--------|--------------------|----------------------------|---------|----------------|----------------------------|---------|
| Examiner | Subscale | t-test Statistic | df | p | Mean difference | 95% Confidence Interval | | Effect Size | 95% Confidence Interval | |
| | | | | | | Lower | Upper | | Lower | Upper |
| A | NCRS MA | -6.16 | 50.0 | <0.001 | -2.05 | -2.71 | -1.380 | -2.50 | -3.45 | -1.542 |
| | NCRS AA | -9.31 | 50.0 | <0.001 | -7.09 | -8.62 | -5.559 | -3.78 | -4.89 | -2.651 |
| | NCRS BA | -8.93 | 50.0 | <0.001 | -7.18 | -8.80 | -5.568 | -3.63 | -4.71 | -2.519 |
| | NCRS TOT | -10.84 | 50.0 | <0.001 | -16.30 | -19.32 | -13.278 | -4.40 | -5.61 | -3.178 |
| B | NCRS MA | -5.99 | 50.0 | <0.001 | -2.05 | -2.73 | -1.361 | -2.43 | -3.37 | -1.479 |
| | NCRS AA | -8.08 | 50.0 | <0.001 | -6.53 | -8.15 | -4.907 | -3.28 | -4.32 | -2.223 |
| | NCRS BA | -7.60 | 50.0 | <0.001 | -6.38 | -8.07 | -4.695 | -3.09 | -4.10 | -2.054 |
| | NCRS TOT | -9.66 | 50.0 | <0.001 | -14.96 | -18.07 | -11.850 | -3.93 | -5.06 | -2.774 |
| A | BFCRS TOT | -9.31 | 50.0 | <0.001 | -13.59 | -16.52 | -10.658 | -3.78 | -4.89 | -2.651 |
| B | BFCRS TOT | -9.11 | 49.0 | <0.001 | -13.86 | -16.91 | -10.800 | -3.96 | -5.13 | -2.762 |
| A | DSM TOT | -16.69 | 50.0 | <0.001 | -4.40 | -4.93 | -3.873 | -6.78 | -8.39 | -5.151 |
| B | DSM TOT | -14.37 | 50.0 | <0.001 | -4.48 | -5.11 | -3.853 | -5.84 | -7.28 | -4.374 |
| C | CGI-S | -2.75 | 50.0 | 0.008 | -1.45 | -2.51 | -0.388 | -1.12 | -1.94 | -0.280 |
| A | NCRS MA | -4.33 | 50.0 | <0.001 | -1.252 | -1.83 | -0.6709 | -1.353 | -2.03 | -0.6604 |
| | NCRS AA | -8.91 | 50.0 | <0.001 | -5.365 | -6.57 | -41.547 | -2.784 | -3.66 | -18.946 |
| | NCRS BA | -9.13 | 50.0 | <0.001 | -5.575 | -6.80 | -43.489 | -2.855 | -3.74 | -19.536 |
| | NCRS TOT | -9.85 | 50.0 | <0.001 | -12.165 | -14.65 | -96.855 | -3.080 | -4.00 | -21.414 |
| B | NCRS MA | -4.70 | 50.0 | <0.001 | -1.350 | -1.93 | -0.7728 | -1.469 | -2.16 | -0.7638 |
| | NCRS AA | -7.63 | 50.0 | <0.001 | -4.898 | -6.19 | -36.098 | -2.387 | -3.20 | -15.597 |
| | NCRS BA | -8.73 | 50.0 | <0.001 | -5.211 | -6.41 | -40.114 | -2.729 | -3.59 | -18.480 |
| | NCRS TOT | -9.54 | 50.0 | <0.001 | -11.459 | -13.87 | -90.462 | -2.983 | -3.89 | -20.601 |
| A | BFCRS TOT | -9.47 | 50.0 | <0.001 | -10.523 | -12.75 | -82.905 | -2.960 | -3.86 | -20.415 |
| B | BFCRS TOT | -8.84 | 49.0 | <0.001 | -10.128 | -12.43 | -78.258 | -2.841 | -3.73 | -19.300 |
| A | DSM TOT | -7.47 | 50.0 | <0.001 | -2.673 | -3.39 | -19.546 | -2.337 | -3.14 | -15.170 |
| B | DSM TOT | -7.89 | 50.0 | <0.001 | -2.861 | -3.59 | -21.327 | -2.467 | -3.29 | -16.275 |
| C | CGI-S | -2.25 | 50.0 | 0.029 | -0.932 | -1.77 | -0.0991 | -0.703 | -1.33 | -0.0650 |

Legend: AA= Affective Alterations; BA= Behavioral Alterations; BFCRS= Bush-Francis Catatonia Rating Scale; CGI-S= Clinical Global Impression-Severity; df= degrees of freedom; DSM= Diagnostic and Statistical Manual of Mental Disorders; MA= Motor Alterations; NCRS= Northoff Catatonia Rating Scale; TOT= Total score.

Table 3. Inter-rater agreement for the single items of the NCRS (a Northoff Catatonia Rating Scale).

| Item | Inter-rater agreement | Cohen's K | p |
|--------------------------|-----------------------|-----------|------------------|
| NCRS TOT | 100% | 1 | <0.001 |
| Motor Alterations | 100% | 1 | <0.001 |
| Mannerisms | 100% | 1 | <0.001 |
| Stereotypy | 100% | 1 | <0.001 |
| Festination | 100% | 1 | <0.001 |

(Continue) **Table 3**

(Continue) Table 3.

| Item | Inter-rater agreement | Cohen's K | p |
|-----------------------------------|-----------------------|--------------|------------------|
| Athetotic Movements | 100% | 1 | <0.001 |
| Dyskinesias | 100% | 1 | <0.001 |
| Gegenhalten | 100% | 1 | <0.001 |
| Posturing | 100% | 1 | <0.001 |
| Catalepsy | 96.2% | 0.649 | <0.001 |
| Flexibilitas cerea | 98.1% | 0.66 | <0.001 |
| Rigidity | 100% | 1 | <0.001 |
| Muscular hypotonus | 100% | 1 | <0.001 |
| Sudden muscular tone alterations | 100% | 1 | <0.001 |
| Akinesia | 98.1% | 0.847 | <0.001 |
| Affective Alterations | 92.3% | 0.77 | <0.001 |
| Compulsive emotions | 100% | 1 | <0.001 |
| Emotional lability | 100% | 1 | <0.001 |
| Impulsivity | 96.2% | 0.84 | <0.001 |
| Aggression | 98.1% | 0.79 | <0.001 |
| Excitement | 100% | 1 | <0.001 |
| Affect-related behavior | 98.1% | 0.658 | <0.001 |
| Flat affect | 82.7% | 0.736 | <0.001 |
| Affective latence | 94.2% | 0.736 | <0.001 |
| Anxiety | 80.8% | 0.649 | <0.001 |
| Ambivalence | 96.2% | 0.779 | <0.001 |
| Staring | 90.4% | 0.779 | <0.001 |
| Agitation | 67.3% | 0.205 | 0.04 |
| Behavioral alterations | 94% | 0.867 | <0.001 |
| Grimacing | 100% | 1 | <0.001 |
| Verbigerations | 98.1% | 0.892 | <0.001 |
| Perseverations | 98.1% | 0.901 | <0.001 |
| Increased, compulsive-like speech | 96.2% | 0.49 | <0.001 |
| Abnormal speech | 90.4% | 0.716 | <0.001 |
| Automatic obedience | 96.2% | 0.889 | <0.001 |
| Echolalia/praxia | 94.2% | 0.703 | <0.001 |
| Mitgehen/mitmachen | 98.1% | 0.658 | <0.001 |
| Compulsive behavior | 98.1% | 0.66 | <0.001 |
| Negativismus | 96.2% | 0.729 | <0.001 |
| Autism/Withdrawal | 94.2% | 0.845 | <0.001 |
| Mutism | 100% | 1 | <0.001 |
| Stupor | 98.1% | 0.825 | <0.001 |
| Loss of initiative | 88.5% | 0.797 | <0.001 |
| Vegetative abnormalities | 98.1% | 0.658 | <0.001 |

Table 4. Score correlations between scales/subscales.

| Rater | | A | A | A | A | B | B | B | B | A | B | A | B |
|-------|-----------|---------|---------|---------|----------|---------|---------|---------|----------|-----------|-----------|---------|---------|
| | Subscale | NCRS MA | NCRS AA | NCRS BA | NCRS TOT | NCRS MA | NCRS AA | NCRS BA | NCRS TOT | BFCRS TOT | BFCRS TOT | DSM TOT | DSM TOT |
| A | NCRS MA | — | | | | | | | | | | | |
| A | NCRS AA | 0.397 | — | | | | | | | | | | |
| A | NCRS BA | 0.423 | 0.609 | — | | | | | | | | | |
| A | NCRS TOT | 0.556 | 0.838 | 0.777 | — | | | | | | | | |
| B | NCRS MA | 0.981 | 0.395 | 0.428 | 0.551 | — | | | | | | | |
| B | NCRS AA | 0.392 | 0.868 | 0.589 | 0.783 | 0.386 | — | | | | | | |
| B | NCRS BA | 0.400 | 0.595 | 0.900 | 0.728 | 0.390 | 0.563 | — | | | | | |
| B | NCRS TOT | 0.542 | 0.799 | 0.745 | 0.929 | 0.535 | 0.830 | 0.753 | — | | | | |
| A | BFCRS TOT | 0.488 | 0.662 | 0.701 | 0.735 | 0.476 | 0.616 | 0.658 | 0.699 | — | | | |
| B | BFCRS TOT | 0.502 | 0.583 | 0.705 | 0.700 | 0.514 | 0.577 | 0.655 | 0.691 | 0.855 | — | | |
| A | DSM TOT | 0.579 | 0.624 | 0.612 | 0.649 | 0.567 | 0.637 | 0.567 | 0.637 | 0.694 | 0.630 | — | |
| B | DSM TOT | 0.467 | 0.629 | 0.600 | 0.611 | 0.484 | 0.637 | 0.530 | 0.599 | 0.640 | 0.617 | 0.873 | — |

Legend: AA= Affective Alterations; BA= Behavioral Alterations; BFCRS= Bush-Francis Catatonia Rating Scale; DSM= Diagnostic and Statistical Manual of Mental Disorders; MA= Motor Alterations; NCRS= Northoff Catatonia Rating Scale; TOT= Total score.

Table 5. Decision statistics of the Northoff Catatonia Rating Scale when the gold standard is DSM-5 criteria.**Table 5A.** Confusion matrix.

| | DSM-5 Positive | DSM-5 Negative | Total |
|---------------|----------------|----------------|-------|
| NCRS Positive | 7 | 5 | 12 |
| NCRS Negative | 0 | 40 | 40 |
| Total | 7 | 45 | 52 |

Table 5B. Decision statistics.

| Statistics | Estimate | 95% Confidence Interval | |
|----------------------------------|----------|-------------------------|-------------|
| | | Lower limit | Upper limit |
| Apparent prevalence | 23.1 % | 12.5 % | 36.8 % |
| True prevalence | 13.5 % | 5.6 % | 25.8 % |
| Test sensitivity | 100.0 % | 59.0 % | 100.0 % |
| Test specificity | 88.9 % | 75.9 % | 96.3 % |
| Diagnostic accuracy ^a | 90.4 % | 79.0 % | 96.8 % |
| Positive predictive value | 58.3 % | 27.7 % | 84.8 % |
| Negative predictive value | 100.0 % | 91.2 % | 100.0 % |

(Continue) **Table 5B**

(Continue) Table 5B.

| Statistics | Estimate | 95% Confidence Interval | |
|---|----------|-------------------------|-------------|
| | | Lower limit | Upper limit |
| Proportion of subjects with the outcome ruled out | 76.9 % | 63.2 % | 87.5 % |
| Proportion of subjects with the outcome ruled in | 23.1 % | 12.5 % | 36.8 % |
| Proportion of false positives | 11.1 % | 3.7 % | 24.1 % |
| Proportion of false negative | 0.0 % | 0.0 % | 41.0 % |
| Youden's index ^b | 0.889 | 0.350 | 0.963 |
| Likelihood ratio of a positive test | 9.000 | 3.939 | 20.566 |
| Likelihood ratio of a negative test | 0.000 | 0.000 | NaN |

Legend: DSM= Diagnostic and Statistical Manual of Mental Disorders; NCRS= Northoff Catatonia Rating Scale.

^aProportion of all tests that give a correct result; ^bYouden's index is the difference between the true positive rate and the false positive rate. Youden's index ranges from -1 to +1 with values closer to 1 if both sensitivity and specificity are high (i.e., close to 1).

our sample presented catatonia. When the BFCRS was used as the gold standard tool for the diagnosis, the NCRS had a sensitivity of 71.4% and a specificity of 94.7%. Given the higher prevalence of catatonia according to the BFCRS score (26.9%), the positive pre-

dictive value is 83.3% and the negative predictive value 90%, with an overall accuracy of 88.5%. Youden's J Statistic is lower than the one reported above and is 0.662 (table 6A and 6B). The internal coherence of the total score with the motor subscale was higher (Cron-

Table 6. Decision statistics of the Northoff Catatonia Rating Scale when the gold standard is the BFCRS score.**Table 6A.** Confusion matrix.

| | BFCRS Positive | BFCRS Negative | Total |
|---------------|----------------|----------------|-------|
| NCRS Positive | 10 | 2 | 12 |
| NCRS Negative | 4 | 36 | 40 |
| Total | 14 | 38 | 52 |

Table 6B. Decision statistics.

| Statistics | Estimate | 95% Confidence Interval | |
|---|----------|-------------------------|-------------|
| | | Lower limit | Upper limit |
| Apparent prevalence | 23.1% | 12.5% | 36.8% |
| True prevalence | 26.9% | 15.6% | 41.0% |
| Test sensitivity | 71.4% | 41.9% | 91.6% |
| Test specificity | 94.7% | 82.3% | 99.4% |
| Diagnostic accuracy ^a | 88.5% | 76.6% | 95.6% |
| Positive predictive value | 83.3% | 51.6% | 97.9% |
| Negative predictive value | 90.0% | 76.3% | 97.2% |
| Proportion of subjects with the outcome ruled out | 76.9% | 63.2% | 87.5% |
| Proportion of subjects with the outcome ruled in | 23.1% | 12.5% | 36.8% |
| Proportion of false positives | 5.3% | 0.6% | 17.7% |
| Proportion of false negative | 28.6% | 8.4% | 58.1% |
| Youden's index ^b | 0.662 | 0.241 | 0.910 |
| Likelihood ratio of a positive test | 13.571 | 3.384 | 54.434 |
| Likelihood ratio of a negative test | 0.302 | 0.131 | 0.693 |

Legend: BFCRS= Bush-Francis Catatonia Rating Scale; NCRS= Northoff Catatonia Rating Scale.

^aProportion of all tests that give a correct result; ^bYouden's index is the difference between the true positive rate and the false positive rate. Youden's index ranges from -1 to +1 with values closer to 1 if both sensitivity and specificity are high (i.e., close to 1).

bach's $\alpha=0.894$) than the coherence with the affective (0.747) or behavioral (0.741) subscales (figure 1).

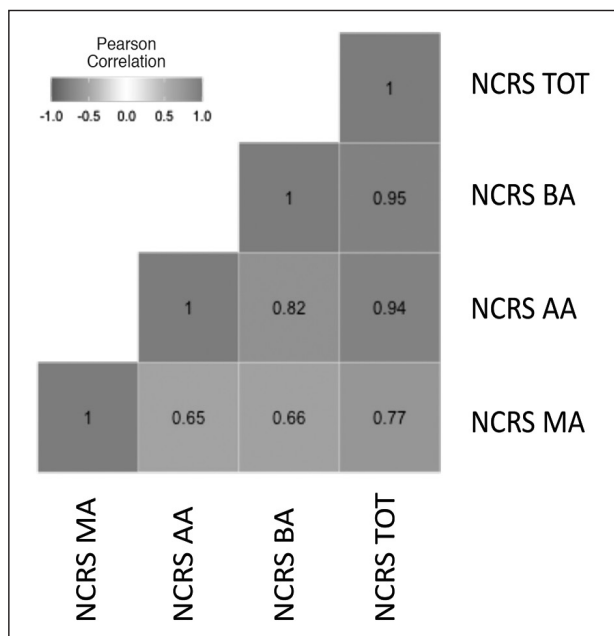


Figure 1. Correlations between the score of the subscales and the total score of the Northoff Catatonia Rating Scale.

Legenda: AA= Affective Alterations (subscale); BA= Behavioral Alterations; MA= Motor Alterations; NCRS= Northoff Catatonia Rating Scale.

Discussion and conclusion

Catatonia is a heterogeneous syndrome that entails motor and behavioral signs and affective symptoms. Due to the high variability of clinical presentations, catatonia has been extensively underdiagnosed, especially in non-psychiatric clinical settings. Most importantly, such a delay in diagnosis and prompt treatment, i.e., the total duration of untreated catatonia, could lead to serious physical consequences²⁰ and death²¹. In this study, we aimed to provide a rater-friendly tool for diagnosing catatonia by translating and validating the Italian version of the Northoff Catatonia Rating Scale (NCRS) for the diagnosis and clinical assessment of catatonia. This scale was validated in an in-patient sample of 14 patients with catatonia and 38 without, according to the Bush-Francis Catatonia Rating Scale (BFCRS), or seven patients with catatonia and 42 without according to the stricter DSM-5 criteria (table 1). The NCRS showed high accuracy and inter-rater agreement in discerning patients with catatonia from those without (table 2). In particular, we highlight that the inter-rater agreement for the diagnosis was 100%, with higher chances of agreement between the examiners for the assessment of motor alterations (100%) than for affective (92.3%) or behavioral (94%) ones (table 3). Although the NCRS guides the examiner through an in-depth and pains-

takingly assessment of the signs of catatonia, some affective and behavioral alterations (such as agitation and abnormal speech) are more difficult to objectify, probably due to their volatility. We also determined the correlation among the subscales of the NCRS, which showed high inter-subscale correlations, thus further supporting the evidence of a relationship between psychological and motor symptoms in catatonia in the Italian in-patient population (table 4). Furthermore, we computed the internal coherence of the NCRS and its subscales through Cronbach's α , which ranged from 0.74 to 0.89, thus showing good internal coherence. Lastly, we examined the prevalence of catatonia according to the NCRS, BFCRS and DSM-5 criteria. We showed that the DSM-5 criteria (motor and behavioral) are less prone to diagnose catatonia (estimated prevalence= 13%). On the contrary, the BFCRS is the most sensitive scale among the three for diagnosing catatonia (prevalence= 26%). The NCRS yields prevalence estimates of 23% (table 5-6). However, when comparing the assessment and diagnoses established with the NCRS or other rating scales, the examiner should also keep in mind that there is a lack of consensus on some definitions. For example, according to the NCRS, *mitgehen* is defined as «[the] Patients follow other persons in an inappropriate way either in their gait/walking movements»². In contrast, *mitgehen*, according to the BFCRS, is also termed “passive obedience”: «[the] Patient raises [an] arm in response to light pressure of [the] finger, despite instructions to the contrary»¹³. Moreover, posturing and catalepsy are equivalent terms for the BFCRS. In contrast, they are distinct for the NCRS: posturing is the autonomous taking of a posture, whereas catalepsy is the maintenance of a passively-induced (i.e., examiner-induced) posture.

Some limitations to the scale must be acknowledged. Compared to other scales (e.g., Bush-Francis CRS), the NCRS is composed of 40 items, and thus its administration is more time-consuming. A screening tool would mitigate this inconvenience, but it has not been produced yet. Lastly, a thoroughly detailed interviewing procedure for the scale administration has not been reported for the NCRS.

In conclusion, this study provides the translation and validation of the Italian version of the Northoff Catatonia Rating Scale, which can be used as a sensitive tool to diagnose catatonia in hospitalized patients.

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Conflict of interests: Marco Solmi received honoraria/has been a consultant for Angelini/Lundbeck; Giorgio Pigato received honoraria by Angelini/Lundbeck, Otsuka, Janssen, Takeda, Acadia Farmaceutica; Fabio Sambataro received honoraria/has been a consultant for Janssen Cilag SpA. The other authors have no conflict of interests to declare.

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