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Validity and Reliability of the Portuguese Version of Brief Motor Scale in Persons with Schizophrenia: A Preliminary Study *Validade e Confiabilidade da Versão Portuguesa da Brief Motor Scale em Pessoas com Esquizofrenia: Um Estudo Preliminar*

SUSANA CRISTINA MARQUES GUIMARÃES*¹, ANA SOFIA PEDROSA GOMES DOS SANTOS², PAULA LEBRE³

1. Doctor Degree Student Researcher, Faculdade de Motricidade Humana, Universidade de Lisboa, Cruz Quebrada, Portugal, <https://orcid.org/0000-0003-4033-5246>

2. Assistant Professor, Faculdade de Motricidade Humana, Universidade de Lisboa, Cruz Quebrada, Portugal; Centro de Estudos Educação Especial, Lisboa, Portugal; UIDEF – Instituto da Educação, Lisboa, Portugal, <https://orcid.org/0000-0002-6654-564X>

3. Auxiliary Professor, Faculdade de Motricidade Humana, Universidade de Lisboa, Cruz Quebrada, Portugal, <https://orcid.org/0000-0002-8440-2415>

Abstract

Introduction: Neurological soft signs (NSS) indicate non-specific cerebral dysfunction, those have been extensively documented in the clinical course of schizophrenia and have been considered as valuable symptoms to monitor the disorder. The Brief Motor Scale (BMS) has been widely used to assess motor neurological soft signs in patients with schizophrenia, but the Portuguese version is still unavailable. The aim of this study is the investigation of the validity and reliability of the Portuguese version of the scale (BMS_pt).

Material and Methods: The International guidelines for the cross-cultural process adaptation were considered. Forty three adults, between 23 to 63 years (39.74 ± 11.16), 38 males and 5 females, with a diagnosis of schizophrenia participated in this study.

Results: Content validity indexes (> 0.75) pointed out the content validity of the BMS_pt with a moderate/strong agreement among experts. Internal consistency was confirmed, with Cronbach alphas ranging from 0.82 to 0.87. Pearson correlations ranged from 0.93 and 0.99 ($p < 0.01$). Exploratory Factorial Analysis resulted in a two-factor model that explained 58.91% of total variance

Conclusion: Results showed that all BMS_pt items are relevant. BMS_pt seems to be a valid and reliable instrument to assess motor NSS in individuals with schizophrenia with the potential to be used in rehabilitation services.

Resumo

Introdução: Os sinais neurológicos discretos (NNS) indicam uma disfunção cerebral não específica e têm sido documentados no curso clínico da esquizofrenia, sendo considerados como sintomas importantes para a monitorização da doença. A *Brief Motor Scale* (BMS) tem sido amplamente utilizada para avaliar os sinais neurológicos discretos em pessoas com esquizofrenia, mas a versão portuguesa continua indisponível. O objetivo deste estudo é a investigação da validade e confiabilidade da versão portuguesa *Brief of Motor Scale* (BMS_pt).

Material e Métodos: As orientações internacionais para o processo de adaptação transcultural do instrumento foram consideradas. Participaram no estudo 43 adultos com esquizofrenia, entre os 23 e 63 anos ($39,74 \pm 11,16$), 38 homens e 5 mulheres.

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*Autor Correspondente/Corresponding Author: Susana Cristina Marques Guimarães | sus.guimaraes@gmail.com | Faculdade de Motricidade Humana, Universidade de Lisboa, Cruz Quebrada, Portugal | Estrada da Costa, 1499-002 Cruz Quebrada – Dafundo, Portugal | <https://orcid.org/0000-0003-4033-5246>

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Resultados: Os índices de validade de conteúdo ($>0,75$) da BMS_pt demonstraram um acordo moderado/forte entre os especialistas. A consistência interna foi confirmada, com alfa de Cronbach variando de 0,82 a 0,87. As correlações de Pearson variaram entre 0,93 e 0,99 ($p < 0,01$). A análise fatorial exploratória resultou num modelo de dois fatores que explicou 58,91% da variância total.

Conclusão: Verificou-se que todos os itens da BMS_pt são relevantes. A BMS_pt parece ser um instrumento válido e fiável para avaliar os sinais neurológicos motores discretos em pessoas com esquizofrenia, e com potencial para ser utilizado em serviços de reabilitação.

Keywords: Neurologic Manifestations; Psychomotor Performance; Reproducibility of Results; Schizophrenia

Palavras-chave: Desempenho Psicomotor; Esquizofrenia; Manifestações Neurológicas; Reprodutibilidade dos Testes

INTRODUCTION

Schizophrenia is a complex psychiatric disorder with a variety of symptoms often with severe consequences in social, academic, and professional life dimensions.¹ Schizophrenia is characterized by a range of symptoms that are present during a significant period in the person's life, in two or more of the following domains: delusions, hallucinations, disorganized speech, grossly disorganized or catatonic behavior, and negative symptoms.¹ It affects about 0.7% of the world population and is characterized by negative, positive, cognitive^{2,3} and psychomotor symptoms,³ like catatonia, extrapyramidal symptoms, psychomotor slowness, and neurological soft signs (NSS). The motor disorders are an important characteristic of the schizophrenia spectrum and have been reported in many phases of the disease, including before onset.⁴

Clinical investigations with unmedicated people with schizophrenia suggested that motor disturbances are intrinsic to schizophrenia disorder.⁵ Morrens *et al*⁶ found that adults with schizophrenia had a delay in their motor development and showed motor problems in childhood and adolescence⁷ when compared with a healthy peer group. Researchers refer that non-localizable neurological abnormalities are frequently found in patients with schizophrenia when compared to healthy persons. Those abnormalities can be referred to as neurological soft signs (NSS) and those have been understood as an early sign of a neurodevelopmental disorder and they could be indicators of a vulnerability to psychosis that may allow to monitor the course of the disorder.⁸

NSS are often organized in sensorial integration, motor coordination, motor sequencing,^{4,9-11} and primitive reflexes.^{9,12} These symptoms seem to be related to neuropsychological functions such as attention, learning and memory.¹³ The motor NSS (motor coordination and motor sequencing) are an intrinsic feature of schizophrenia and their presence can be easily identified in a clinical context through an evaluation of sensorimotor performance,¹⁴ and they are distinct from other somatic or cognitive symptoms characteristics on the course of the disease.¹⁵

Also, it has been reported that these motor impairments seem to discriminate from other psychotic disorders such as bipolar disorder.³ For example, delayed gait, limitations in the acquisition of sitting position and stand up

without support at an early age^{16,17} have been associated as predictors of the disease.¹⁸ Furthermore, a so-called schizophrenia psychomotor syndrome is proposed by some authors as an important nosological characteristic.^{3,4,19} As stated by Bachman *et al*¹⁸ neurological soft signs "may be used to monitor the disease process or to identify subjects with an increased vulnerability to developing schizophrenia". However, it is necessary to clarify motor NSS influence on clinical-therapeutic and psychosocial aspects, the functional level of people with schizophrenia and if the therapeutic interventions have an impact on the motor NSS.^{20,21}

The measurements of NSS had been increasing subtly in the last three decades. Among others, we mention the *Neurological Evaluation Scale – NES*,²² the *Heidelberg NSS Scale*,²³ the *Cambridge Neurological Inventory – CNI*²⁴ and the *Brief Motor Scale – BMS*.¹⁰ All these scales are a clinician rating test and the internal reliability reported for those confirmed good internal consistency, for NES,²² Heidelberg NSS²³ and BMS.¹⁰

NES²² and BMS¹⁰ have a 3-point scoring scale (0 - normal or no abnormality to 2 - maximum or marked deviation) and Heidelberg NSS²³ and CNI²⁴ have a 4-point score with similar aggravation. Only BMS¹⁰ evaluate exclusively motor NSS, comprises two dimensions (motor coordination and motor sequencing) and shows good reliability,^{10,11} which allows to focus mainly on the motor aspects. Moreover, due to its short form, fast application and non-invasive motor tasks, BMS appears to be a good choice for clinical settings and screening patients in prospective studies.¹⁰ We underline that none of the above-mentioned scales are validated for the Portuguese population. Only two investigations were conducted, in one of that was used the BMS for assessing motor NSS²⁵ and another one was used the NSS assessment in adolescents.²⁶

The *Brief Motor Scale – BMS*¹⁰ was developed in Germany and has been widely used to assess motor coordination and sequencing NSS in patients with schizophrenia and bipolar disorder.^{10,11,27} Motor tasks were selected due to its discriminating power between people with schizophrenia and people with typical development.¹⁰ BMS seems to be a better instrument than others are, because it is shorter and focusses only in motor NSS, which facilitate the application on clinical practical.

Like in other rehabilitation professional fields, the psychomotor therapy is supported by a methodology that should be based on evidence and the indicators should be obtained through valid assessments.²⁸ These indicators, where we may include the assessment of motor NSS, assume an important role in the early detection of neurodevelopmental disorders, in the design of therapeutic programs and in the assessment of the impact at the level of policies, practices and personal evolutions.²⁹ Varambally *et al*³⁰ recommend the need of standardized objective and valid measurement as well as the agreement on cut-off scores. Thus, the study of the motor NSS in people with schizophrenia may facilitate the understanding of psychomotor skills affected in these individuals, allowing better planning of the outcomes in psychomotor interventions.

In Portugal, there is a lack of evidence in this area and does not exist a valid scale to assess motor NSS. Also, the validation of instruments is now becoming a priority in the psychomotor therapy field.³¹ Traditionally, the measures used correspond to translated versions of original instruments and they are not validated for the Portuguese population.³² The most recent developments in the field and the analyses of existent tools justify this cross-cultural study that intends to extend the work in the field. The greater insight into the psychometric characteristics will contribute to a more evidence-based use of the scale in this population. Therefore, this study conducted a cross-cultural translation and adaptation of the Portuguese version of the Brief Motor Scale (BMS_pt), analyzing the scale validity and reliability, contributing to more evidence-based use of the scale. It is expected that a valid and reliable instrument for the assessment of motor coordination and motor sequencing in adults with schizophrenia, in clinical setting, can have an impact on future treatment response, in psychomotor intervention planning and monitoring as well as in early detection of these signs.

MATERIAL AND METHODS

a. Sample

For the test-field, the Portuguese version of BMS was done to 43 adults, between 23 and 63 years (39.74 ± 11.16), 5 females (11.6%) and 38 males (88.4%), with schizophrenia spectrum disorder diagnose: 35 (81.4%) with paranoid schizophrenia (F20.0, CID-10), 3 (7%) with hebephrenic schizophrenia (F20.1, CID-10), 3 (7%) residual schizophrenia (F20.5, CID-10) and 2 (4.7%) with non-specific schizophrenia (F20.9, CID-10). The mean age of symptom onset was 20.62 years (± 5.54). Most of participants reported at least one previous psychiatric hospitalization. The mean of academic habilitations was 9.5 years ($+3.7$) ranged between 4 and 16 years. The participants were attending a community rehabilitation center and all persons with schizophrenia were selected. The diagnose was validated by a clinical form signed by a psychiatrist.

b. Instrument

The BMS_pt (Portuguese version of BMS¹⁰) is an instrument developed originally in Germany which evaluates

exclusively the motor NSS of adults with schizophrenia spectrum disorders.^{10,11,27} BMS_pt is organized in ten items distributed in two domains: Motor Coordination (Item 2_Diadochokinesia, Item 3_Upper limbs coordination (Oseretsky), Item 5_Foot tapping, Item 9_Bilateral rhythm tapping and Item 10_Gaze impersistence) and Motor Sequencing (Item 1_Pronation-Supination, Item 4_Finger thumb opposition, Item 6_Ideational Praxia I (Fist-Ring), Item 7_Ideational Praxia II (Fist-edge-palm) and Item 8_Rhythm structure). Each item is classified according to the quality of performance: 0 = no disturbance or difficulty in movement, 1 = some difficulties or disturbances in movement, 2 = greater difficulty or disturbance of the movement. Six items are assessed in the right and left side and the score is obtained by arithmetic mean. The domains score and total score are obtained through the average of respective items, with a maximum score of 2 (maximum difficulty) and a minimum of 0 (without difficulty).

It has been demonstrated that BMS is a reliable instrument with identical psychometrics characteristics compared to other extensive versions.^{10,11} Interrater reliability presented Cohen's kappa, scored higher than 0.70, confirming the content validity.¹⁰ The internal reliability with Cronbach's alpha was acceptable to both groups of participants: 0.83 for the healthy group and 0.77 for the participants with schizophrenia.¹⁰ In temporal stability it shows good test-retest reliability across two weeks ($r_{total} = 0.84$, $r_{mot\ coord} = 0.74$, $r_{mot\ seq} = 0.73$, $p < 0.01$). The subscales were confirmed by PCA with values ranged 0.52 and 0.79 for motor coordination domain and 0.53 and 0.79 for motor sequencing domain.¹⁰ BMS score equal or more than 1.5 (cut point) indicated the presence of motor NSS with 84.1% of sensibility and 87.9% of specificity.¹⁰

c. Procedures

After the ethical approval (Ethics approved n° 32/2017, from Ethics Committee of Faculdade de Motricidade Humana, Universidade de Lisboa) the permission to translate the BMS into the Portuguese language was asked to the original authors. After this authorization, the forward and back-translation process was performed. Two Portuguese-native speaker-independent, both experts in mental health, translated the original scale to a Portuguese version and then, an English native-speaker was selected to backward translate the Portuguese version. Both versions were compared to assure the content equivalence and the item's comprehension. No significant disagreements were found. A pre-final version was established and then analyzed by 10 experts selected by their research (methodological expertise) and practical (assessment and intervention) experience on the field. All these experts had a master's or a PhD degree in psychomotor therapy, special education, human kinetics, or psychiatry, and three of them were also experts in instrument validation. The number of experts selected was according with the suggestions of the literature, thus between three and ten.^{33,34} Each expert received a document explaining the study goals, a copy of the Portuguese version, as well as a questionnaire elaborated for rating relevance, clarity, simplicity, and ambiguity of each item.

After this, the contacts with institutions that provide support in mental health, particularly with persons diagnosed with schizophrenia, were initiated. All participants signed a written informed consent statement, explaining the study goals and procedures, and ensuring the data confidentiality and participant's anonymity. All BMS_pt applications were performed by psychomotor therapists trained by the researchers of this study and the assessment was conducted individually, in a calm and comfortable environment with no distracting stimulus. Each assessment took up to 15 to 20 minutes and the items were applied according to the original scale protocol.¹⁰ Then, a test-field was conducted with a sample of subjects with schizophrenia (n=43). The data was analyzed with the Excel version 1812 and IBM Statistical Package for the Social Sciences (SPSS) Statistics 25.

RESULTS

The analysis of content validity was suggested by international guidelines.³⁵ A first descriptive approach³⁴⁻³⁶ to

content validity was based on a literature review about the motor NSS and its features. Then, it was carried out by a board of 10 experts (5 researchers/professors, 3 psychomotor therapists, 2 psychiatrists), which assessed each item's adequacy.³⁷ Each item was rated according to its relevance, clarity, simplicity and ambiguity, by a four-point Likert scale, ranging from non-relevant¹ to very relevant.⁴ Afterward, the ratings 1 and 2 were transformed into a single non-relevant category and the 3 and 4 options into the relevant category.^{33,34,36}

Content validity was evaluated for each item and the scale. Several indexes were calculated: content validity index for each item (I-CVI), scale universal and average content validity (CVI-UA and CVI-A, respectively) (Table 1) and Cohen's kappa coefficients (Table 2). Although the CVI is a common method for assessing experts' agreement,^{33,34,36} this measure does not provide the adjustment degree expected by chance³⁶ and some other indexes (e.g.: Cohen kappa) were calculated and analyzed.

Table 1. Content validity index (CVI), scale universal (CVI-UA) and average content validity (CVI-A)

	Relevance	Clarity	Simplicity	Ambiguity
1.Pronation-Supination	1.00	0.90	0.91	0.91
2.Diadochokinesia	1.00	0.90	.91	0.82
3.Upper limbs coordination (Oseretzky)	1.00	1.00	0.82	0.91
4.Finger thumb opposition	1.00	1.00	0.91	0.91
5.Foot tapping	1.00	0.90	0.91	0.82
6.Ideational Praxis I (Fist-Ring)	1.00	0.90	0.82	0.91
7.Ideational Praxis II (Fist-edge-palm)	1.00	1.00	0.91	0.91
8.Rhythm structure	1.00	0.90	0.91	0.82
9.Bilateral rhythm tapping	1.00	1.00	0.91	0.91
10.Gaze impersistence	1.00	0.90	0.91	0.82
S-CVI-UA	1	0.94	0.89	0.87
S-CVI-A	1	0.94	0.98	0.96

According to the results, all items were relevant and only six items needed some adjustment concerning the simplicity and ambiguity. Therefore, the decision was to maintain all items (CVI>0.80). According to Polit and Beck,³⁴ CVI-UA scores should be at least 0.80 and the CVI-A above 0.90, thus our findings corroborate the content validity of the scale (Table 1).

Following the typically acceptance standards of Cohen's kappa coefficients, which range between -1 (disagree) to 1

(agree), varying as poor if under 0.40, moderate if scores range between 0.40 and 0.60,^{36,39} significant between 0.61 and 0.80, and excellent if above 0.90.³⁹ Moderate to an excellent agreement was found (Table 2), except in the agreement between experts 3 and 6, leading for a non-agreement or a random concordance. However, it was decided to continue with the two experts' assessments due to their expertise and recognition in this scientific area.

Table 2. Cohen's kappa

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
E1	-									
E2	1	-								
E3	0.97	0.90	-							
E4	1	0.95	1	-						
E5	1	0.95	0.96	0.60	-					
E6	1	0.92	0	0.61	0.82	-				
E7	1	0.94	1	0.56	1	0.56	-			
E8	1	0.94	0.97	0.50	0.91	0.95	0.78	-		
E9	1	0.96	0.93	0.40	0.94	0.79	0.77	1	-	
E10	1	0.92	0.95	0.39	0.85	0.75	0.87	0.69	0.84	-

E – expert

Table 3. Pearsons correlation coefficients of test-retest temporal stability and correlation coefficients item-to-item, domain-domain and domain-total

1_Pronation-Supination	0.96**	1										
2_Diadochokin.	0.93**	0.48**	1									
3_Upper limbs coordination (Öseretzky)	0.95**	0.59**	0.40**	1								
4_Finger thumb opposition	0.95**	0.59**	0.41**	0.64**	1							
5_Foot tapping	0.99**	0.77**	0.48**	0.45**	0.45**	1						
6_Ideational Praxia I (Fist-Ring)	0.97**	0.62**	0.31*	0.44**	0.62**	0.52**	1					
7_Ideational Praxia II (Fist-edge-palm)	0.96**	0.66**	0.23	0.36*	0.54**	0.45**	0.82**	1				
8_Rhythm structure	0.94**	0.50**	0.30	0.30*	0.49**	0.46**	0.56**	0.55**	1			
9_Bilat rhythm tapping	0.95**	0.42**	0.42**	0.39**	0.50**	0.48**	0.63**	0.53**	0.57**	1		
10_Gaze impersistence	0.98**	-0.01	-0.03	-0.17	0.05	0.23	0.21	0.30*	0.06	0.16	1	
Motor Coord.	0.94**	0.66**	0.66**	0.60**	0.60**	0.81**	0.63**	0.57**	0.48**	0.71**	0.45**	
Motor Sequenc.	0.97**	0.81**	0.42**	0.57**	0.79**	0.64**	0.88**	0.86**	0.77**	0.65**	0.15	
Total Score	0.99**	0.81**	0.56**	0.63**	0.77**	0.77**	0.84**	0.79**	0.70**	0.73**	0.30	

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Reliability involved the analysis of the internal consistency through the Cronbach alpha and the temporal stability examination, through the test-retest technique (2-week period) and the Pearson correlation coefficients (Table 3). Cronbach alpha above 0.80 are excellent, but Nunnally⁴⁰ emphasized the need for alpha above 0.90 for clinical purposes. Based on our findings, BMS_pt internal consistency was confirmed ($\alpha_{total} = 0.87$, $\alpha_{m.coord.} = 0.83$, $\alpha_{m.seq.} = 0.82$), with alpha Cronbach varying between 0.82 and 0.87. The Pearson correlation scores of test-retest ranged from 0.93 (item 2_diadochokinesia) to 0.99 (item 5_foot tapping and Total score) revealing strong temporal stability (Table 3). Correlations were considered moderate if $0.40 > r < 0.69$, high if $0.70 > r < 0.89$ and very high if above 0.90.³⁹

Pearson correlation item-to-item, domain-domain and domain-total (Table 3) revealed that almost all items have moderate to very high correlations ($0.41 > r < 0.95$). The item 2_Diadochokinesia is weakly correlated with both items 6_Ideational Praxis I ($r=0.31$) and item 3_Upper Limbs Coordination ($r=0.39$). The item 3 presents also low scores of correlations with items 7_Ideational Praxis II ($r=0.36$), 8_Rhythm Structure ($r=0.30$) and 9_Bilateral rhythm tapping ($r=0.39$). It is interesting to realize that item 10_Gaze Impersistent is only poorly correlated with item 7_Ideational Praxis I ($r=0.30$).

Table 4. Exploratory Factor Analysis pattern/structure matrix of the BMS_pt

Item	Component		Communalities
	1	2	
1.Pronation-Supination	0.71	0.24	0.57
2.Diadochokinesia	0.81	0.01	0.66
3.Upper limbs coordination (Oseretzky)	0.64	0.18	0.44
4.Finger thumb opposition	0.53	0.50	0.53
5.Foot tapping	0.54	0.39	0.44
6.Ideational Praxis I (Fist-Ring)	0.47	0.73	0.76
7.Ideational Praxis II (Fist-edge-palm)	0.36	0.80	0.77
8.Rhythm structure	0.45	0.58	0.54
9.Bilateral rhythm tapping	0.68	0.34	0.58
10.Gaze impersistence	-0.06	0.77	0.60
Eigen value	4.82	48.14	
Explained variance (%)	48.10	10.81	

The preliminary construct validity was analyzed through an exploratory factor analysis (EFA) with varimax rotation (Table 4). The EFA is a statistical technique that aims to identify relationships between measurable variables and organize them by factors and support the preliminary theoretical constructs. In this preliminary study was conducted an EFA to examine the potential framework from the sample data on Portuguese population. The EFA was based on the following criteria for extraction: eigenvalues higher than 1.00, factorial loadings higher than 0.50 and a minimum of 5% of variance explained per component. The structure matrix of BMS_pt pointed out that the 10 items are distributed in 2 components explaining 58.91% of the total variance. Both retained factors seem appropriate to describe the correlational structure.

DISCUSSION

This study aims to translate, adapt, and validate a Portuguese version of the Brief Motor Scale (BMS_pt). As far

as we know, there is only one non-published study in Portugal that uses the BMS for assessing motor NSS²⁵ and one that uses the NSS in adolescents²⁶ but none addresses the analysis of the psychometric properties of the instrument for people with schizophrenia. Having a valid and reliable instrument is particularly important for the characterization and identification of the motor NSS of people diagnosed with schizophrenia. Furthermore, this study might in the future contribute to improve the care and services for this subgroup and help in the design and implementation of individualized psychomotor programs.^{29,28} Moreover, it will allow monitoring the evolution of NSS along the course of the disease. Recognizing the need to use standardized instruments to delineate concrete, measurable and operational objectives,^{30,32} the current findings demonstrated that BMS_pt has the adequate properties in what concerns its content validity in the Portuguese version to be used in Portugal. An added benefit would be the possibility to

conduct cross-countries comparisons and the impact of expanding best practices.

Measuring and reporting instruments' content validity is one of the first steps to accomplish a validation process³⁴⁻³⁶ even when the items are not culturally sensitive. Like in the original version, items were selected based on extensive literature review and evidence-based about the representativeness of motor impairments, which are frequently found in psychiatric patients. Based on experts' (strong) agreement the final Portuguese version was defined. Analyses pointed out the relevance of items in this Portuguese version for the measurement of motor NSS of people with schizophrenia. According to international guidelines and criteria, no item was deleted. Nevertheless, based on experts' comments reformulations were performed for a better understanding of the items, trying to simplify its comprehension and minimize ambiguity. An additional task was added (although this is not used to calculate the final score) to register the laterality (look through a paper tube – eye preference and kick a little ball – foot preference). In Rhythm Reproduction score, an item was added on each partial score of items. The terminology of four items was changed to a better understanding in the Portuguese language: Oseretzky was changed to *Upper Limb Coordination*; Rhythm Production to *Rhythm Structure*, Fist-Ring to *Ideational Praxia I*, Fist-Edge-Palm to *Ideational Praxia II* and Finger-thumb-opposition to *Tamborilar*).

In expert's agreement reliability a moderate to an excellent agreement was found, except in one case (between expert 3 and expert 6). This could be solved by deleting one expert 6 but due to his/her expertise and based on the principle that Cohen's kappa is influenced by the disagreement types,³⁸ it was decided to maintain this expert's opinion. Based on CVI indexes, it was decided to keep the 10 original items. Concerning the reliability of BMS_pt it was found that, in general, the internal consistency was high, for all items and the total score, corroborating the original scores ($\alpha=.83$)¹⁰ and higher than other studies ($\alpha=.69$).²⁵ Nevertheless, Nunnally⁴⁰ reinforces the need for strong scores for clinical purposes due to its eventual impact in diagnosis or early detection of schizophrenia and better comprehension of motor neurological signs development. Therefore, more studies should be conducted with a larger and more representative sample allowing closer analysis of the scores since internal consistency may also be influenced by sample size. The Pearson correlation coefficients confirm the temporal stability along two weeks, which is also aligned with the original version ($0.73 > r < 0.84$),¹⁰ although our findings were higher than the original. Both measures (internal consistency and temporal stability) confirm BMS_pt reliability.

It was considered that the study sample is small compared to what is usually recommended. However, given the relevance of the study and the added value for the Portuguese scientific community, and the limited availability of more participants at this stage, it was decided to maintain the sample and proceed with the statistical study.

Pearson correlation coefficients of BMS_pt showed moderate to strong correlations between almost all items,

domains, and scale total, which is consistent with the original version.¹⁰ However, item Gaze Impersistence presented low scores indicating a weak correlation with one single item (Ideational Praxia I) and showing no correlations with other items, domains, or total score. This is not in line with the original version that found all items correlations higher than 0.50.¹⁰ The coefficients found, supported construct validity of the Portuguese version, with special reserves for item Gaze Impersistent.

To compare the organization of the variables by factors in BMS_pt and compare it with the original version, EFA was performed and identified 2 main components that explained 58.91% of the total variance of scale, which corroborates the original version.¹⁰ Both versions seem to be based on a two-factor model (motor coordination and motor sequencing) of motor NSS. Although our results seem to corroborate the original version structural matrix, the final Portuguese pattern tends to present a slight change in the structure of the item that needs a more profound analysis. In the Portuguese version, six items seem to be part of the Motor Coordination domain and four items seem to constitute the Motor Sequencing domain. However, there are three items that in BMS_pt appear in different domains: pronation-supination and finger thumb opposition appear in Motor Coordination domain and gaze impersistent appears in Motor Sequencing, which is not according to the original version.¹⁰ This study should be intensified in the future, with a larger sample and through a Confirmatory Factor Analysis, to clarify the factorial organization of MNSS assessed by BMS_pt.

CONCLUSION

The BMS_pt seems to be a valid and reliable instrument to assess motor NSS in persons with schizophrenia. Its use may be a step forward in the rehabilitation field, not only in early detection but also as a form to identify intervention strategies to allow more person-centered plans and to evaluate the effectiveness of such interventions. The content validity analysis aimed to go further than the mere translation, even if the motor development is not that culturally sensitive. The strong experts' agreement and all the content validity indexes, point out the relevance of such items for the measurement of motor disturbances in schizophrenia and they are supported by the reliability scores (internal consistency and temporal stability). Pearson coefficients tend to moderate to strong correlations between items, subscales and total. EFA pointed out a two-factor model. Like any other, this study presented some limitations. First, the content validity analysis does not include persons with schizophrenia, although the need to consider the target population's opinion.³⁵ Further research should consider a more significant and representative sample of persons with schizophrenia in Portugal. Moreover, a confirmatory factorial analysis should be conducted to establish the structure matrix of BMS_pt and to understand the item gaze impersistence. Some comparative studies between groups with other mental health conditions (e.g.: bipolar disorder) for the identification of motor NSS specificity in the early diagnosis of schizophrenia as well with healthy

peers for a better understanding of the main traits and the disease development, and its impact on daily life, should be performed. The validation of the conceptual model is also a future goal, as well as the identification of predictors and characteristics that may affect the presence of motor

neurological soft signs in persons with schizophrenia. In conclusion, this psychometric analysis introduces BMS_pt as a reliable and valid instrument to assess motor NSS of persons with schizophrenia.

Ethical Disclosures

Conflicts of Interest: The authors have no conflicts of interest to declare.

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Ethical Considerations: The study was carried out in compliance with the Helsinki Declaration, and the Ethic Committee approved all design and materials for Investigation of Faculdade de Motricidade Humana, Universidade de Lisboa (Ethic approved n° 32/2017).

All participants signed a written informed consent statement, explaining the study goals and procedures, and ensuring the data confidentiality and participant's anonymity.

Data Availability: Additional data are not available, due to ethical commitment, since sharing was not part of the participants' informed consent.

Confidentiality of Data: The authors declare that they have followed the protocols of their work center on the publication of data from patients.

Provenance and Peer Review: Not commissioned; externally peer reviewed.

Responsabilidades Éticas

Conflitos de Interesses: Os autores declaram não ter nenhum conflito de interesses relativamente ao presente trabalho.

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Considerações Éticas: Este estudo foi realizado em conformidade com a Declaração de Helsínquia, tendo sido aprovado pela Comissão de Ética da Faculdade de Motricidade Humana da Universidade de Lisboa (32/2017) todos os procedimentos e métodos da investigação.

Todos os participantes assinaram uma declaração de consentimento informado e esclarecido, explicando os objetivos e procedimentos do estudo e garantindo a confidencialidade dos dados e o anonimato dos participantes.

Disponibilização de Dados: Não estão disponíveis dados adicionais, devido ao comprometimento ético uma vez que a partilha não fazia parte do consentimento informado dos participantes.

Confidencialidade dos Dados: Os autores declaram ter seguido os protocolos da sua instituição acerca da publicação dos dados de doentes.

Proveniência e Revisão por Pares: Não comissionado; revisão externa por pares.

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