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Abstract

Objective

Negative symptoms are currently viewed as having a 2-dimensional structure, with factors reflecting diminished expression (EXP) and motivation and pleasure (MAP). However, several factor-analytic studies suggest that the consensus around a 2-dimensional model is premature. The current study investigated and cross-culturally validated the factorial structure of BNSS-rated negative symptoms across a range of cultures and languages.

Method

Participants included individuals diagnosed with a psychotic disorder who had been rated on the Brief Negative Symptom Scale (BNSS) from 5 cross-cultural samples, with a total $N = 1691$. First, exploratory factor analysis was used to extract up to 6 factors from the data. Next, confirmatory factor analysis evaluated the fit of 5 models: (1) a 1-factor model, 2) a 2-factor model with factors of MAP and EXP, 3) a 3-factor model with inner world, external, and alogia factors; 4) a 5-factor model with separate factors for blunted affect, alogia, anhedonia, avolition, and asociality, and 5) a hierarchical model with 2 second-order factors reflecting EXP and MAP, as well as 5 first-order factors reflecting the 5 aforementioned domains.

Results

Models with 4 factors or less were mediocre fits to the data. The 5-factor, 6-factor, and the hierarchical second-order 5-factor models provided excellent fit with an edge to the 5-factor model. The 5-factor structure demonstrated invariance across study samples.

Conclusions

Findings support the validity of the 5-factor structure of BNSS-rated negative symptoms across diverse cultures and languages. These findings have important implications for the diagnosis, assessment, and treatment of negative symptoms.

Introduction

Early factor-analytic studies indicated that negative symptoms are a domain of psychopathology that is distinct from psychosis and disorganization in individuals with schizophrenia.[1–3] These studies relied on *broad-bandwidth* rating scales such as the full Positive and Negative Syndrome Scale (PANSS) and the Brief Psychiatric Rating Scale (BPRS) that assess negative symptoms along with other symptoms of schizophrenia. However, the use of broad-bandwidth measures to adjudge the factor structure of negative symptoms is flawed because covariance patterns in the symptom data cause negative symptom items to aggregate together, making the construct arbitrarily unidimensional.

Factor analyses evaluating the structure of negative symptoms with *narrow-bandwidth* scales—ie, measures of negative symptoms alone, with no items included from other constructs—suggest that the structure of negative symptoms is multidimensional.[4] A 2-factor solution has commonly been reported for a range of narrow-bandwidth measures, including the Scale for the Assessment of Negative Symptoms (SANS), Schedule for the Deficit Syndrome (SDS), Brief Negative Symptom

Scale (BNSS), Clinical Assessment Interview for Negative Symptoms (CAINS), and negative symptom items of the PANSS.[5–15] The 2 dimensions reflect: (1) diminished expressivity (EXP), consisting of alogia and blunted affect items and (2) motivation and pleasure (MAP), consisting of avolition, asociality, and anhedonia.[5–12] These findings have led the field to widely accept the 2-dimensional structure of negative symptoms.[4] This 2-dimensional model has been very influential, impacting important decisions, such as how negative symptoms are described in the DSM-5, how treatment targets are defined, how scales are scored for statistical analysis, and how studies search for pathophysiological mechanisms.[13]

However, the 2-dimensional conceptualization of negative symptoms may be statistically or theoretically insufficient. Support for the 2-dimensional structure comes from studies using exploratory factor analysis (EFA), a data reduction method that infers the presence of latent factors responsible for shared variance among items in a scale.[14,15] EFA is limited in that it does not specify an underlying structure of negative symptoms, but rather assumes that each item in a scale could be related to each underlying latent factor.[15] Prior EFA studies were important for generating hypothesis about dimensions in negative symptoms. They are not, however, actual tests of the validity of a 2-factor structure and their exploratory nature does not allow direct assessment of their factorial validity relative to competing factor models of negative symptoms.[13] Moreover, Garcia-Portilla and colleagues[16] using EFA concluded that a 3-factor structure that distinguished inner-world experiences (ie, avolition and blunted affect) from external features (anhedonia and asociality), and alogia was preferable to a 2-factor model. The 3-factor model has yet to be replicated, but it shows that the consensus that 2 factors best describe the multidimensionality of negative symptoms is premature.

Confirmatory factor analysis (CFA) is required to test competing models and evaluate the dimensional structure of BNSS-rated negative symptoms. Published CFA studies have examined the SANS, and were problematic because they included items not part of the negative symptom construct, which limits conclusions that can be drawn.[17,18] Axelrod and colleagues[19,20] conducted 2 early CFA studies of negative symptoms measured with the Negative Symptom Assessment (NSA). In the first study of a 26-item NSA, they found that a multidimensional model that included communication, emotion/affect, social involvement, motivation, retardation, and gross cognition as 6 separable factors best described negative symptoms. In the second study, they used a 16-item version of the measure which now excluded items that originally loaded onto the "gross cognition" factor. The authors replicated 5 of the original factors—communication, emotion/affect, social involvement, motivation, and retardation. The statistical fit indices obtained in both studies favored their chosen 5 or 6-factor models over 1- to 4-factor solutions. Their chosen models, however, proved to be mediocre fits to the data based on statistical fit indices. Further, both 26- and 16-item versions of the NSA did not include items that assess anhedonia.

The 2005 NIMH-MATRICS consensus conference on negative symptoms sought to establish the scope of negative symptoms to advance the development of evidence-based measures and treatments.[21] The conference identified affective flattening, alogia, asociality, avolition, and anhedonia as domains of negative symptoms. These domains subsequently informed the content coverage of the BNSS and the CAINS. Strauss et al (Unpublished data) conducted CFA of 3 current negative symptoms scales, the BNSS (n = 192), CAINS (n = 400), and SANS (n = 268). The study found that with all 3 measures, a 5-factor model consistent with the NIMH-MATRICS domains and a hierarchical 5-factor model with MAP and EXP as second-order factors that influence the 5 factors provided excellent fit and outperformed other factor models. These findings suggest that the recent trend toward conceptualizing negative symptoms in relation to the MAP and EXP does not capture the complexity of negative symptoms.

The current study attempted to determine the correct factorial structure of BNSS-rated negative symptoms using data obtained across a range of cultures and languages. The study took both an empirical exploratory (EFA) and a model-based (CFA) approach to determining the correct factor structure. A model-based approach allowed (1) a comparison of the NIMH consensus 5-factor model with alternate models including—the unidimensional/1-factor model, MAP/EXP 2-factor, Garcia-Portilla et al.'s 3-factor model, and the hierarchical 5-factor model; and (2) testing the cross-cultural measurement invariance of the correct factor structure using data from 5 samples including N = 1691 participants from Italy, Spain, China, Switzerland, and the United States. The EFA extracting 1–6 factors from the data allowed (1) an examination of the relative viability of several factor models (eg, 4-factor and 6-factor models) in the absence of guiding theory or a priori evidence; (2) searching for converging evidence of the preferred factor structure from CFA and EFA; (3) an assessment of the preferential loading of BNSS items; and (4) in the absence of guiding theory the loading preference of item 4 "Lack of Normal Distress" in fitted factor models. Although not adjudged as a negative symptom in the 2005 NIMH-MATRICS conference, item 4 "Lack of Normal Distress" was included in the BNSS because of its association with reduced emotional expression and deficit symptoms. In previous studies, item 4 loads with BNSS factors albeit with lower saturation than other items.[11] EFA was used to adjudicate the correct factor location of this item. It was predicted that EFA and CFA will demonstrate preference for a 5-factor model of BNSS-rated negative symptoms over alternate models. In concert with Strauss et al (Unpublished data), the 5-factor and hierarchical models were expected to provide excellent fit to the data, with the 5-factor model producing the best fit. It was further predicted that the preferred factor structure would be cross-culturally invariant and produce strong fits in multinational cross-validation samples.

Methods

Participants

The data sets used to investigate the factorial structure of negative symptoms in the current study were drawn from several international investigations of the psychometric properties of the BNSS and its clinical utility. These included samples obtained from collaborations in Italy (*n* = 937), Spain (*n* = 115), China (*n* = 163), and Switzerland (*n* = 119) that used versions of the BNSS formally translated into Italian, Spanish, Chinese (simplified script), and German, respectively.[22–25] The study also included a USA-based sample (*n* = 357) obtained with the original English version.[11]Additional sample details are provided in the supplementary material. Table 1summarizes the demographic characteristics and clinical composition of the study samples. Participants from Italy, Spain, and the United States were evaluated to ensure that they met Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria for schizophrenia or schizoaffective disorder using the Structured Clinical Interview for DSM-IV (SCID). Swiss participants were adjudged as meeting DSM diagnostic criteria using the Mini-International Neuropsychiatric Interview (MINI). Participants from China were assessed with the International Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) criteria.

Table 1.

Characteristics of the Brief Negative Syndrome Scale (BNSS) Study Samples Used in the Analyses

Author	Source	Language	*n*	Population	Setting	Male, %	Age, M (SD)	BNSS, M (SD)	Internal Consistency	ICC
Mucci et al.[22]	Italy	Italian	937	Schizophrenia	Outpatient	69.6	40.1 (10.7)	35.83 (18.04)	0.994	0.98
Mané et al.[23]	Spain	Spanish	115	Schizophrenia	Outpatient	67.0	33.9 (8.82)	27.47 (13.65)	0.922	0.97
Yao et al.[24]	China	Chinese	163	Schizophrenia	Inpatient and outpatient	54.6	45.3 (8.6)	18.25 (12.67)	0.933	0.93
Bischof et al.[25]	Switzerland	German	119	Schizophrenia, schizoaffective	Inpatient and outpatient	72.3	32.4 (10.6)	27.34 (15.5)	0.944	0.97
Strauss et al.[11]	USA	English	357	Schizophrenia, schizoaffective	Outpatient	67.2	40.6 (11.9)	21.4 (15.9)	0.934	0.96

Note: ICC: intraclass correlation coefficient. Internal consistency values are Cronbach's alpha estimates. When a scale has more than 5 response categories, Cronbach's alpha produces robust estimates of internal consistency comparable to other methods of computing internal consistency for categorical outcomes such as ordinal alpha or McDonald's alpha.

Procedures

Each study administered the BNSS as part of broader research aims to illuminate the phenomenology and treatment of negative symptoms. Given that investigators in Italy, Spain, Switzerland, and China administered translated versions of the BNSS, a standard method of translation served to ensure the equivalence of the translated versions to the original English version. First, the BNSS was forward translated to the target language. Next, the translated version was independently back-translated and forwarded to the scale authors (BK and GS), who worked with the translators to reconcile the translation with the original English version.

The inter-rater reliability of the BNSS was established at each site through the use of gold-standard training videos and ratings of face-to-face interviews completed by the BNSS authors. All raters completed BNSS training using standardized training materials and received feedback from completing ratings on gold-standard videos. Raters in each study had at minimum, bachelors-level training, and/or extensive experience completing psychiatric interviews. BNSS raters in each parent study met minimum standards of inter-rater reliability with intraclass correlation coefficients that exceed 0.90 (table 1).

Data Analysis

The overall analytic strategy was to establish the factor structure of BNSS-rated negative symptoms in a calibration sample and then cross-validate the established factor structure across languages and cultures. Rather than test all factor models in every study sample, the decision was made to first estimate alternate factor models in a calibration sample and then cross-validate best fit models to: (1) decrease the number of separate factor models that would need to be estimated; and (2) decrease the likelihood that models with apparent fit in one sample but had capitalized on chance (type I error) are interpreted. The calibration sample included 566 cases (60.4%) drawn randomly from the largest study sample, the Italian dataset. The remaining 371 cases in the Italian dataset were designated as 1 of the 5 cross-validation samples; therefore, each language and data source served in the cross-validation of the preferred factor structure.

To examine the fits of evaluated models, BNSS ratings were factor analyzed with model estimation methods that are robust to distributional non-normality in BNSS ratings. EFA models ranging from 1 to 6 classes were estimated first excluding and then including item 4 “Lack of Normal Distress” to identify the item’s preferred factor location. EFAs were completed with the oblique Quartimin rotation. Unlike previous EFA studies, the preferred factor structure was adjudged by examining pattern loadings and objective fit indices (discussed below). Next, CFA was used to test competing hypotheses about the factor structure of negative symptoms. Five models estimated included a unidimensional/1-factor, MAP/EXP 2-factor, Garcia-Portilla et al's 3-factor, the NIMH consensus 5-factor, and the hierarchical 5-factor models. Items included on each factor within the 5 models are presented in table 2. The estimators were the weighted least squared estimator with standard errors and mean-and variance adjusted chi-square test (χ^2) that use a full-weight matrix (WLSMV), and the maximum likelihood with robust standard errors (MLR). All model estimations were carried out in M*plus* Version 5.0.[26] Model modification indices were obtained to assess and evaluate all fixed parameters (eg, specified loading patterns) to determine which fixed parameters if freely estimated would have improved the model being evaluated. By convention, modification indices are used jointly with theory to guide attempts to re-specify poor fitting models.

Table 2.

Confirmatory Factor Analysis Models of the Brief Negative Symptom Scale (BNSS)

BNSS Items and Domains	CFA Models					
	1-Factor	2-Factor	3-Factor	5-Factor	5-Factor Hierarchical	
					First Order	Second Order
Anhedonia						
1. Intensity of past-week pleasure	1	1	1	1	1	1
2. Frequency of past-week pleasure	1	1	1	1	1	1
3. Intensity of expected pleasure	1	1	1	1	1	1
Asociaility						
5. Asociality behavior	1	1	1	2	2	1
6. Asociality internal experience	1	1	1	2	2	1
Avolition						
7. Avolition behavior	1	1	2	3	3	1
8. Avoliton internal experience	1	1	2	3	3	1
Blunted affect						
9. Facial expression	1	2	2	4	4	2
10. Vocal expression	1	2	2	4	4	2
11. Expressive gestures	1	2	2	4	4	2
Alogia						
12. Quality of speech	1	2	3	5	5	2
13. Spontaneous elaboration	1	2	3	5	5	2

Several indices served to evaluate the *goodness-of-fit* of estimated factor models.[27–33]These include the χ^2 test, the root-mean-square error of approximation (RMSEA), the comparative fit index (CFI), the Tucker–Lewis index (TLI), the standardized root mean squared residual (SRMR), and the weighted root mean squared residual (WRMR), all of which help to access the absolute fit. Information criteria including Akaike information criteria (AIC), Bayesian information criteria (BIC), and the sample-size adjusted BIC (aBIC) are used for comparing the relative fits of alternate models. Models with lower values are preferred. RMSEA values of 0.08 and lower are considered adequate fit. CFI and TLI values of 0.95 and higher are considered indicative of strong fitting models. SRMR values range from 0 to 1 with values of 0.08 or lower indicative of good fitting models. WRMR values of about 1.00 and lower are considered strong fits. Additional details of fit indices are provided in the supplementary material.

Multi-group CFA was used to assess the measurement invariance of the BNSS-preferred factor structure across the multi-national samples. This comprised tests of configural, metric, scalar, and residual invariance that are conducted sequentially.[34,35] Configural invariance requires that items load on the same factor across subsamples. Metric invariance requires that factor loadings be equivalent across the multi-national samples. Scalar invariance requires that both factor loadings and intercepts are equivalent across study samples. Residual factorial invariance adds an additional constraint requiring that residual variances are equal across samples. Changes in chi-square (χ^2 diff), CFI, TLI, and RMSEA estimates as constraints were imposed on the model were used to evaluate the invariance models. CFI change has the most empirical support and values not exceeding 0.01 provide evidence that constraints imposed on model are tenable.[34–36]

Results

The study aims were addressed in 3 stages. First, EFA was used to extract up to 6 factors from the BNSS using the calibration sample. Two sets of EFAs were completed at this stage—BNSS ratings first excluding, and then including item 4 “Lack of Normal Distress.” Next, model-based CFAs were used to compare the relative fits of the 1-, 2-, 3-, 5-factor, and hierarchical models in the calibration sample. The favored factor models were tested in each of the 5 cross-validation samples. Finally, measurement invariance of the preferred factor structure across study samples was sequentially evaluated for metric, scalar, and residual invariance.

Table 1 summarizes the characteristics of the study samples. Cronbach’s alpha exceeded 0.90 in every study sample, suggesting that raters were able to reliable assess negative symptoms with the BNSS regardless of the language of administration or participants’ country of origin. Save for one participant in the Italian sample who was subsequently excluded from the analysis due to missing data, complete ratings were obtained for all BNSS items in all of the study samples. The variability in BNSS total score across samples likely reflects the illness acuity of participants recruited in the particular parent study.

EFA of the BNSS Calibration Sample

The results of EFA runs in the calibration sample are summarized in table 3. Although CFI and TLI estimates were acceptable for 1 through 4-factor models, high RMSEA estimates suggested that these were mediocre fits to the data. With or without item 4, the EFA 5-factor and 6-factor models were strong fits to the data with CFI, TLI, RMSEA, and SRMR that fell in the excellent-fit range. Without item 4, the AIC and other information criteria favored a 5-factor model over the 6-factor model. Moreover, the 6-factor solution produced 2 factors with single items.

Table 3.

Model Fit Results of the Exploratory Factor Analysis of BNSS Items

Italian Calibration Sample	LL	k	AIC	BIC	aBIC	χ^2	k	CFI	TLI	RMSEA	SRMR
Item 4 excluded											
1-Factor	−9660.29	84	19488.58	19853.02	19586.36	χ^2 (54) = 5525.09, P < .001	12	0.971	0.965	0.423	0.127
2-Factor	−9,080.54	95	18351.08	18763.24	18461.66	χ^2 (43) = 3311.48, P < .001	23	0.983	0.974	0.366	0.066
3-Factor	−8874.36	105	17958.72	18414.27	18080.95	χ^2 (33) = 2113.90, P < .001	33	0.989	0.978	0.334	0.050
4-Factor	−8575.45	114	17378.89	17873.49	17511.60	χ^2 (24) = 829.02, P < .001	42	0.996	0.988	0.243	0.022
5-Factor	**−8512.69**	**122**	**17269.39**	**17798.70**	**17411.40**	**χ^2 (16) = 53.90, P < .001**	**50**	**1.000**	**0.999**	**0.065**	**0.005**
6-Factor	−8516.94	129	17291.88	17851.56	17442.05	χ^2 (9) = 24.33, P = .004	57	1.000	0.999	0.055	0.004
Item 4 included											
1-Factor	−10563.52	91	21309.03	21703.85	21414.96	χ^2 (65) = 5842.81, P < .001	13	0.970	0.964	0.396	0.119
2-Factor	−9967.65	103	20141.30	20588.18	20261.20	χ^2 (53) = 3317.09, P < .001	25	0.983	0.975	0.330	0.061
3-Factor	−9672.65	114	19573.29	20067.89	19705.99	χ^2 (42) = 2005.66, P < .001	36	0.990	0.981	0.287	0.047
4-Factor	−9591.27	124	19430.54	19968.52	19574.88	χ^2 (32) = 651.91, P < .001	46	0.997	0.992	0.185	0.021
5-Factor	**−9565.03**	**133**	**19396.05**	**19973.08**	**19550.87**	**χ^2 (23) = 74.55, P < .001**	**55**	**1.000**	**0.999**	**0.063**	**0.007**
6-Factor	−9529.95	141	19341.89	19953.64	19506.03	χ^2 (15) = 38.65, P < .001	63	1.000	0.999	0.053	0.006

Note: LL, loglikelihood; *k*, number of free parameters; AIC, Akaike information criterion; BIC, Bayesian information criterion; aBIC, sample size adjusted BIC; CFI, comparative fit index; TLI, Tucker–Lewis index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual; WRMR = weighted root mean square residual. The preferred factor models are presented in bold. Both weighted least square (WLSMV) and maximum likelihood (MLR) estimators were used in the analyses. Chi-square for the baseline EFA model with item 4 excluded: χ^2 (66) = 190846.57, P < .0001. Chi-square for the baseline EFA model with item 4 included: χ^2 (78) = 194394.78, P < .0001.

With item 4 included in the model, the information criteria slightly preferred the 6-factor solution. Subsequent examination of the matrix of rotated loadings of the 6-factor solution showed that all BNSS items including item 4 weakly loaded on the sixth factor with all loading coefficients less than an absolute value of 0.11. This suggests that a sixth factor contributes little to explaining the pattern of covariances of BNSS items and the 6-factor solution should be rejected in favor of the more parsimonious 5-factor model.

The rotated 5-factor matrices for all factor solutions are presented in supplementary tables S1–S12. Item 4 cross-loaded onto 2 BNSS factors—anhedonia and asociality.

CFA of the BNSS-Rated Negative Symptoms in the Calibration Sample

The results of the CFAs conducted in the calibration sample are summarized in table 4. All CFA models excluded item 4 given that it was not a recognized negative symptom in the NIMH-MATRICS conference. The 1-factor, 2-factor, and the 3-factor models proved to be mediocre fits to the data. The 1-factor models were a poor fit due to mediocre CFI, RMSEA, and WRMR values. Although the CFI and the TLI for the 2-factor and 3-factor models exceeded the 0.95 threshold, both were poor fits to the data based on high RMSEA and WRMR values.

Table 4.

Confirmatory Factor Analysis of BNSS Items: Model Fit Results

	LL	*k*	AIC	BIC	aBIC	χ^2	CFI	TLI	RMSEA	WRMR
Italian calibration sample										
1-Factor	−9659.56	84	19487.13	19851.57	19584.91	χ^2 (8) = 818.89, *P* < .001	0.944	0.965	0.423	4.727
2-Factor	−9188.17	85	18546.35	18915.13	18645.29	χ^2 (13) = 660.10, *P* < .001	0.955	0.983	0.297	2.924
3-Factor	−9051.64	87	18277.27	18654.73	18378.54	χ^2 (11) = 548.36, *P* < .001	0.963	0.983	0.294	2.734
5-Factor	**−8715.77**	**94**	**17619.54**	**18027.36**	**17728.96**	**χ^2 (19) = 77.43, *P* < .001**	**0.996**	**0.999**	**0.074**	**0.487**
2nd-Order 5-factor	**−8909.74**	**86**	**17991.48**	**18364.60**	**18091.59**	**χ^2 (15) = 93.26, *P* < .001**	**0.995**	**0.998**	**0.080**	**0.878**
Cross validation samples										
5-Factor model										
Italian sample	−5801.92	107	11817.86	12236.89	11897.42	χ^2 (18) = 50.49, *P* = .001	0.997	0.999	0.070	0.399
American sample	−5222.13	94	10632.25	10996.76	10698.55	χ^2 (19) = 105.47, *P* = .000	0.989	0.995	0.110	0.709
Spanish sample	−2162.97	91	4507.94	4779.45	4491.48	χ^2 (19) = 34.30, *P* = .017	0.994	0.998	0.074	0.385
Swiss sample	−1701.47	91	3584.94	3837.84	3550.15	χ^2 (12) = 12.69, *P* = .3919	1.000	1.000	0.022	0.309
Chinese sample	−2055.19	88	4286.38	4558.63	4280.04	χ^2 (18) = 48.07, *P* < .001	0.989	0.996	0.101	0.468
2nd order 5-factor										
Italian sample	−5951.24	99	12100.49	12488.20	12174.10	χ^2 (13) = 28.48, *P* = .008	0.998	0.999	0.057	0.502
American sample	−5288.10	86	10748.20	11081.69	10808.85	χ^2 (17) = 63.49, *P* = .000	0.994	0.997	0.088	0.824
Spanish sample	−2254.80	84	4677.61	4928.23	4662.42	χ^2 (16) = 20.11, *P* = .215	0.998	0.999	0.042	0.462
Swiss sample	−1754.72	83	3675.43	3906.10	3643.70	χ^2 (12) = 27.43, *P* = .007	0.996	0.997	0.084	0.682
Chinese sample	−2168.61	77	4491.24	4729.46	4485.69	χ^2 (15) = 83.38, *P* < .001	0.975	0.990	0.167	0.942

Note: LL, loglikelihood; *k*, number of free parameters; AIC, Akaike information criterion; BIC, Bayesian information criterion; aBIC, sample size adjusted BIC; CFI, Comparative fit index; TLI, Tucker–Lewis index; RMSEA, root mean square error of approximation; WRMR, weighted root mean square residual. Preferred factor structures in the calibration sample based on fit indices are presented in bold font. Chi-square for the baseline model: χ^2 (5) = 14458.07, *P* < .001 (item 4 excluded). Both weighted least square (WLSMV) and maximum likelihood (MLR) estimators were used in the analyses. Monte Carlo-based numerical integration was used in the estimation of models to ease computation time. The number of Monte Carlo generated integration points ranged from 5000 to 6000. Chi-square for the baseline model in the Italian sample: χ^2 (5) = 9279.67, *P* < .001. Chi-square for the baseline model in the American sample: χ^2 (9) = 7885.97, *P* < .001. Chi-square for the baseline model in the Spanish sample: χ^2 (7) = 2531.37, *P* < .001. Chi-square for the baseline model in the Swiss sample: χ^2 (8) = 4029.90, *P* < .001. Chi-square for the baseline model in the Chinese sample: χ^2 (6) = 2760.20, *P* < .001.

The 5-factor and the hierarchical models produced CFI and TLI values that suggest strong fit to the data. The RMSEA values for both factor models just fell under the 0.08 threshold, suggesting adequate fits to the data. Both the 5-factor and hierarchical models also produced WRMR estimates that fell below 1.00, suggesting strong fits to the data.

The AIC and other information criteria favored the 5-factor model and the hierarchical model over the 1-, 2-, and 3-factor models. The information criteria slightly favored the 5-factor model over the hierarchical model.

Cross-validation in Multi-National Samples

Given their strong performance in the calibration sample, we tested both the 5-factor and hierarchical models in cross-validation samples. Table 4 summarizes the results of cross-validating the BNSS 5-factor and the hierarchical models. Both factor models proved to be strong fits to the data based on CFI and TLI estimates that far exceeded the 0.95 threshold in each sample. Across samples, the RMSEAs frequently fell below the 0.08 threshold that would suggest an adequate fit. The exceptions were the 5-factor models in the Chinese and American sample and the hierarchical model in the Chinese sample. Like the CFI and TLI however, the WRMR suggested strong fits for both models in all samples.

The AIC and other information criteria produced values that were lower for the 5-factor model than the hierarchical model in all of the samples. This suggests that although both the 5-factor and hierarchical models are cross-culturally valid, the 5-factor model is slightly stronger. Supplementary table S13 includes internal consistency estimates of the 5 factors for each of the study samples.

Assessment of Measurement Invariance Across Samples

We conducted tests of factorial invariance among the 5 multinational samples using the 5-factor model. The analysis was completed on the full study sample. Due to the unequal group sizes, which may bias estimates in favor of the larger Italian and USA-based samples, the analysis was also completed in a subsample of 575 individuals with 115 individuals from each subsample. To this end, 115 individuals were randomly drawn from the Italian, Chinese, Swiss, and American samples, whereas the entire Spanish sample was included. The results were not remarkably different. Table 5summarizes all the fit indices of the measurement invariance model. Fit values from the configural model showed that the 5-factor model held across all samples with CFI and TLI that exceed 0.99 and RMSEA falling below the 0.08 threshold. Metric invariance (equivalence of factor loadings) was similarly supported with CFI and TLI that exceed 0.99 and RMSEA close to 0.08. Scalar (equivalence of factor loading and intercepts) and residual (equivalence of loadings, intercepts, and factor residual variances) invariance was supported by high CFI and TLI values that decreased by less than 0.01 from the configural and metric models. The RMSEA value suggested a slight loss of absolute model fit however when assumptions of scalar invariance are violated. Using modification indices, it was determined that item 2 in the Italian sample had a higher intercept than in the other samples. When item 2 was freely estimated in the multigroup CFA, the RMSEA for scalar invariance model improves (CFI = 0.989, TLI = 0.998, RMSEA = 0.082). This suggests that Italian participants (all outpatients) tended to be rated as more impaired on item 2 "Frequency of Pleasurable Activities" compared to participants in other samples, particularly the Chinese sample (inpatients/outpatients).

Table 5.

Goodness-of-Fit Indices for the Invariance Testing of the BNSS 5-Factor Structure

Invariance Model	χ^2	χ^2 Difference Test	CFI	CFI Change	TLI	TLI Change	RMSEA
Configural model	χ^2 (87) = 252.36, P <.0001	—	0.996		0.999		0.074
Metric invariance	χ^2 (88) = 304.29, P <.0001	χ^2 (27) = 121.44, P <.0001	0.995	0.001	0.998	0.001	0.083
Scalar invariance	χ^2 (164) = 805.06, P <.0001	χ^2 (114) = 704.40, P < .0001	0.986	0.010	0.997	0.002	0.107
Residual invariance	χ^2 (163) = 681.81, P <.0001	χ^2 (36) = 282.13, P <.0001	0.988	0.008	0.998	0.001	0.090

Note: N = 1691. CFI, comparative fit index; TLI, Tucker–Lewis index; RMSEA, root mean square error of approximation. Chi-square for the baseline model: χ^2 (32) = 44760.07, P < .0001.

Discussion

Factor analysis served to investigate latent dimensions in BNSS-rated negative symptoms obtained from 5 samples of different cultures and languages. In both EFA and CFA runs, the 5-factor model proved to be the preferred structure of BNSS-rated negative symptoms. The hierarchical second-order 5-factor model also provided excellent fit, similarly supporting its factorial validity. Although a 2-factor model consistent with the MAP and EXP dimensions emerged from the EFA, this was rejected on the basis of its poor objective fit to the data. Previous studies erroneously accepted this solution for its parsimony and logic in the absence of objective fit indices. Evidence of factorial invariance across multinational samples indicated that the 5-factor loading pattern holds cross-culturally and can be studied across translations. The current study extends evidence of the 5-factor model of negative symptoms across 5 cultures and languages using translated or original English versions of the BNSS.

There are several important implications for these findings. First, the 5-factor structure is not culturally bound. This suggests that these 5 domains reflect core processes inherent to the diagnosis that are not dependent on language or cultural influences. Second, these results also demonstrate that not only are early views of negative symptoms as a single construct inaccurate, but the current trend toward viewing negative symptoms as a 2-dimensional construct is also not fully justified. Rather, negative symptoms are best conceptualized in relation to the 5 negative symptom domains identified in the 2005 NIMH consensus conference: anhedonia, avolition, asociality, alogia, and blunted affect.[21] The 2-dimensional conceptualization has had an important, but statistically unjustified influence on the field. For example, the DSM-5 describes negative symptoms in relation to the broad MAP and EXP dimensions, rather than the 5 consensus domains. This procedure may lead to underspecified diagnoses that do not capture the granularity of the construct. Future versions of the DSM should list and define each domain separately. Failure to do so will probably hamper efforts to identify the psychological and pathophysiological mechanisms of each domain. Treatments may also have differential efficacy for these 5 domains, and failing to evaluate the 5 domains separately may prevent observation of meaningful treatment effects that are domain-specific, rather than tied to the 2 broader dimensions. Treatment development efforts will be advanced by pharmacological and psychological treatments targeted to specific factors. Clinical trials testing such treatments should specify which of the 5 factors represent the primary target(s)/outcome(s).

The NIMH RDoC initiative provides a framework for exploring neurobiological processes associated with aspects of "positive valence systems" and "social processes" that map onto these 5 clinical domains.[37,38] Some of these pathophysiological processes may be broadly related to the MAP and EXP dimensions, whereas others may be tied to 1 of the 5 domains more specifically. Future investigations are needed to explore pathophysiology tied to each domain to promote targeted treatment development. Such trials should focus on one of the domains specifically. It is possible that trials already conducted have observed treatment effects, but these were masked by procedures for calculating overly broad scores. Reanalysis of large past studies with appropriate instruments may be warranted, and interpretation of future treatment trials would be strengthened by calculating scores for each of the 5 domains, rather than a global total score, or MAP and EXP dimensional scores, alone.

Strauss et al (Unpublished data) demonstrated that other measures besides the BNSS—the SANS and the CAINS—similarly captured the 5 domains. Developers of future negative symptom scales should endeavor to generate candidate items that capture each of these 5 domains. This will support a more focused creation of items for initial review and psychometric testing. It will also ensure that rating scales are brief yet comprehensive in their coverage of negative symptoms. The factorial validity of the hierarchical model also has implications for scale development. The MAP and EXP second-order factors represent higher-order broad dimensions that subsume the lower-order, narrow 5 domains. Measures like the BNSS and the CAINS that capture both narrow and broader facets of negative symptoms are potentially more comprehensive in their scope and maintain the relative advantages of capturing both broad and narrow facets of negative symptoms. Such measures have potentially better reliability and fidelity given that more items assess the broader, higher-order dimensions, and the narrow bandwidth domains within broad dimensions are inter-correlated.[39] These measures also maintain the relative advantages of narrow bandwidth assessments including: (1) severity ratings and differences on specific domains are captured; (2) the specific effects of narrow-band domains within broader dimensions on external variables can be captured when the same effects may be attenuated in broader dimensions; and (3) better interpretability when specific narrow facets are linked to external variables.[39,40]

The use of a multinational sample to cross-validate the 5-factor and hierarchical 5-factor models lends strong credence to conclusions about the factorial structure of negative symptoms. The results suggest that the 5-factor model is unbounded by culture, language, or setting. It represents rather a structure of negative symptoms that is pervasive, universal, and likely linked to distinct psychological and/or pathophysiological processes found across cultures. The strong cross-validation results provide additional evidence of the excellent psychometric characteristics of the translated versions of the measure. Practically, these findings suggest that the 5 factors are domains that exist globally and are assessable in different languages with good reliability and validity. Observed differences in the intercepts of item 2 is informative rather than prohibitive of the use of the BNSS cross-culturally. It may suggest that cultural norms impact the definition of “normal” vs “impaired” in adjudging the frequency of pleasurable activities. Sociocultural and contextual factors have been shown to influence the expression and clinical trajectory of schizophrenia symptoms.[41–44] It is therefore possible that the frequency of pleasurable activities exhibits cultural and contextual variation that warrants further study.

The current study did not evaluate the measurement invariance of the 5-factor model across other sources of symptom heterogeneity such as sex, diagnosis, and illness stage. These were adjudged as worthwhile for further validation of the 5-factor model but beyond the scope of the current study. In addition, the study did not examine the 5 factors in relation to the origin or form of negative symptoms.[45,46]Next is to determine if the 5-factor model is valid regardless of sex, negative symptom type, illness stage, or illness severity. Any determination of equivalence or nonequivalence of the 5 domains would be informative about the phenomenology of negative symptoms.

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Supplement to Ahmed et al.

CROSS-CULTURAL VALIDATION OF THE FIVE-FACTOR STRUCTURE OF NEGATIVE SYMPTOMS IN SCHIZOPHRENIA

Participants Details: The Italian sample comprised 937 individuals recruited from outpatient units, university psychiatric clinics, and community mental health centers that form part of the Italian Network for Research on Psychoses. The Spanish sample comprised 115 individuals recruited from three outpatient services in Oviedo and Barcelona. The Chinese sample included 163 individuals recruited from inpatient and outpatient settings in mainland China. The Swiss sample that was administered the German translation of the BNSS included 119 individuals recruited from inpatient and outpatient units at the Psychiatric Hospital, University of Zurich. The USA-based sample comprised 357 individuals recruited from outpatient clinics and community mental health programs affiliated with the Maryland Psychiatric Research Center (MPRC), University of Nevada Las Vegas (UNLV), and the State University of New York (SUNY) at Binghamton, New York.

Fit Indices for Evaluating Factor Models: The chi-square (χ^2) test evaluates the degree to which the hypothesized factor structure fits data[29]; however, it is sensitive to large sample sizes that may cause the rejection of well-fitting models. The root-mean-square error of approximation (RMSEA)[30] measures the discrepancy between the hypothesized factor model and the population covariance matrix when the model has unknown but optimally-chosen parameter values. RMSEA values of .08 and lower are considered adequate fit and values .05 and lower indicate excellent fits[31]; however, the RMSEA is sensitive to model complexity and smaller sample sizes may cause RMSEA to over-reject true population models.[29] The Comparative Fit Index (CFI) and the Tucker Lewis Index (TLI) are incremental fit indices that compare the hypothesized factor model with the less restricted nested baseline model.[32-33] The TLI however penalizes overly complex models. CFI and TLI values of .95 and higher are considered indicative of strong fitting models.[29] The information criteria indices including Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC) and the sample-size adjusted BIC (aBIC) are used for comparing non-nested models.[34-35] Information criteria consider the chi-square and the model complexity in penalizing models and therefore favor parsimonious models. Models with lower information criteria are preferred. The Standardized Root Mean Squared Residual (SRMR) and the Weighted Root Mean Squared Residual (WRMR) are residual-based indices based on the difference of the variance-covariance matrix of the hypothesized model and that of the observed sample data.[28,29] Both measure the average difference across all standardized residuals but WRMR uses a variance—weighted approach.[28-29,36] SRMR values range from 0 to 1 with values of 0.08 or lower indicative of good fitting models. WRMR values of about 1.00 and lower are considered strong fits.

Supplemental Tables S1

Rotated Factor Matrices of the BNSS Exploratory Factor Analysis for One-Factor Solution (Item4 Excluded)

	1
BNSS1	**0.854**
BNSS2	**0.840**
BNSS3	**0.843**
BNSS5	**0.805**
BNSS6	**0.774**
BNSS7	**0.855**
BNSS8	**0.822**
BNSS9	**0.891**
BNSS10	**0.899**
BNSS11	**0.895**
BNSS12	**0.795**
BNSS13	**0.817**

Note. Loadings greater than 0.30 are presented in bold font. Quartimin rotation used.

Supplemental Table S2

Rotated Factor Matrices of the BNSS Exploratory Factor Analysis for the Two-Factor Solution (Item4 Excluded)

	1	2
BNSS1	**0.952**	0.031
BNSS2	**1.041**	-0.079
BNSS3	**0.933**	0.020
BNSS5	**0.541**	**0.321**
BNSS6	**0.491**	**0.336**
BNSS7	**0.420**	**0.479**
BNSS8	**0.430**	**0.437**
BNSS9	-0.007	**0.960**
BNSS10	-0.039	**0.997**
BNSS11	-0.027	**0.976**
BNSS12	0.037	**0.807**
BNSS13	0.114	**0.757**

Note. Loadings greater than 0.30 are presented in bold font. Quartimin rotation used.

Supplemental Table S3

Rotated Factor Matrices of the BNSS Exploratory Factor Analysis for the Three-Factor Solution (Item4 Excluded)

	1	2	3
BNSS1	**1.013**	-0.052	0.016
BNSS2	**0.957**	0.033	-0.011
BNSS3	**0.850**	0.091	0.029
BNSS5	0.238	**0.588**	0.074
BNSS6	0.147	**0.682**	0.039
BNSS7	-0.040	**0.939**	0.044
BNSS8	-0.023	**0.968**	-0.028
BNSS9	0.018	-0.053	**0.992**
BNSS10	-0.035	0.029	**0.964**
BNSS11	-0.040	0.039	**0.951**
BNSS12	0.011	0.026	**0.808**
BNSS13	0.095	-0.019	**0.798**

Note. Loadings greater than 0.30 are presented in bold font. Quartimin rotation used.

Supplemental Table S4

Rotated Factor Matrices of the BNSS Exploratory Factor Analysis for the Four-Factor Solution (Item4 Excluded)

	1	2	3	4
BNSS1	**0.986**	-0.020	-0.003	0.019
BNSS2	**0.965**	0.006	-0.009	0.021
BNSS3	**0.860**	0.060	0.083	-0.033
BNSS5	0.226	**0.592**	-0.068	0.126
BNSS6	0.140	**0.697**	-0.068	0.078
BNSS7	-0.022	**0.881**	0.080	0.025
BNSS8	-0.040	**0.989**	0.017	-0.035
BNSS9	0.040	-0.042	-0.014	**0.975**
BNSS10	-0.026	0.031	0.002	**0.965**
BNSS11	-0.012	0.035	0.057	**0.886**
BNSS12	-0.025	0.021	**0.877**	0.081
BNSS13	0.049	0.001	**0.974**	-0.029

Note. Loadings greater than 0.30 are presented in bold font. Quartimin rotation used.

Supplemental Table S5

Rotated Factor Matrices of the BNSS Exploratory Factor Analysis for the Five-Factor Solution (Item4 Excluded)

	1	2	3	4	5
BNSS1	**0.999**	-0.007	-0.020	0.023	-0.015
BNSS2	**0.980**	0.008	-0.015	0.008	-0.003
BNSS3	**0.903**	0.001	0.050	-0.031	0.032
BNSS5	0.018	**0.967**	-0.021	0.015	0.030
BNSS6	0.065	**0.540**	0.316	0.046	-0.029
BNSS7	0.040	0.158	**0.636**	0.092	0.090
BNSS8	0.025	-0.018	**0.972**	0.011	0.011
BNSS9	0.034	0.039	-0.054	**0.957**	-0.011
BNSS10	-0.016	-0.010	0.037	**0.974**	-0.008
BNSS11	0.007	-0.022	0.039	**0.894**	0.051
BNSS12	-0.030	0.014	0.001	0.106	**0.859**
BNSS13	0.030	0.000	0.010	-0.051	**1.010**

Note. Loadings greater than 0.30 are presented in bold font. Quartimin rotation used.

Supplemental Table S6

Rotated Factor Matrices of the BNSS Exploratory Factor Analysis for the Six-Factor Solution (Item4 Excluded)

	1	2	3	4	5	6
BNSS1	**0.987**	-0.018	0.002	0.013	0.000	-0.008
BNSS2	**0.988**	-0.025	0.002	0.017	-0.001	-0.011
BNSS3	**0.889**	0.057	0.003	-0.027	0.012	0.037
BNSS5	0.046	0.088	**0.809**	0.040	0.056	0.038
BNSS6	0.059	**0.742**	0.154	0.063	0.060	0.043
BNSS7	-0.001	-0.082	0.089	0.018	**0.943**	0.027
BNSS8	0.071	0.192	-0.084	0.031	**0.777**	0.010
BNSS9	0.032	-0.056	0.073	**0.960**	-0.032	-0.018
BNSS10	-0.012	0.007	-0.008	**0.952**	0.037	0.002
BNSS11	0.006	0.077	-0.061	**0.887**	0.020	0.056
BNSS12	-0.042	0.012	-0.003	0.078	0.025	**0.880**
BNSS13	0.036	-0.011	0.009	-0.041	-0.012	**1.005**

Note. Loadings greater than 0.30 are presented in bold font. Quartimin rotation used.

Supplemental Table S7

Rotated Factor Matrices of the BNSS Exploratory Factor Analysis for the One-Factor Solution (Item4 Included)

	1
BNSS1	**0.862**
BNSS2	**0.849**
BNSS3	**0.851**
BNSS4	**0.617**
BNSS5	**0.811**
BNSS6	**0.780**
BNSS7	**0.857**
BNSS8	**0.826**
BNSS9	**0.885**
BNSS10	**0.892**
BNSS11	**0.888**
BNSS12	**0.788**
BNSS13	**0.812**

Note. Loadings greater than 0.30 are presented in bold font. Quartimin rotation used.

Supplemental Table S8

Rotated Factor Matrices of the BNSS Exploratory Factor Analysis for the Two-Factor Solution (Item4 Included)

	1	2
BNSS1	**0.996**	-0.037
BNSS2	**1.002**	-0.044
BNSS3	**0.899**	0.047
BNSS4	**0.432**	0.205
BNSS5	**0.480**	**0.355**
BNSS6	**0.432**	**0.360**
BNSS7	**0.384**	**0.493**
BNSS8	**0.382**	**0.456**
BNSS9	-0.015	**0.951**
BNSS10	-0.050	**0.995**
BNSS11	-0.035	**0.968**
BNSS12	0.039	**0.769**
BNSS13	0.104	**0.735**

Note. Loadings greater than 0.30 are presented in bold font. Quartimin rotation used.

Supplemental Table S9

Rotated Factor Matrices of the BNSS Exploratory Factor Analysis for the Three-Factor Solution (Item4 Included)

	1	2	3
BNSS1	**0.995**	-0.016	0.002
BNSS2	**0.976**	0.002	0.000
BNSS3	**0.870**	0.054	0.035
BNSS4	**0.339**	0.260	0.071
BNSS5	0.224	**0.599**	0.062
BNSS6	0.135	**0.712**	0.009
BNSS7	-0.022	**0.889**	0.083
BNSS8	-0.044	**1.012**	-0.040
BNSS9	0.023	-0.052	**0.979**
BNSS10	-0.047	0.025	**0.982**
BNSS11	-0.030	0.025	**0.954**
BNSS12	0.040	0.025	**0.757**
BNSS13	0.114	0.018	**0.720**

Note. Loadings greater than 0.30 are presented in bold font. Quartimin rotation used.

Supplemental Table S10

Rotated Factor Matrices of the BNSS Exploratory Factor Analysis for the Four-Factor Solution (Item4 Included)

	1	2	3	4
BNSS1	**0.982**	-0.032	-0.001	0.017
BNSS2	**0.953**	0.024	-0.008	0.002
BNSS3	**0.852**	0.047	0.088	-0.019
BNSS4	**0.363**	0.170	-0.081	0.185
BNSS5	0.214	**0.613**	-0.061	0.089
BNSS6	0.121	**0.710**	-0.068	0.052
BNSS7	-0.027	**0.862**	0.080	0.026
BNSS8	-0.048	**0.947**	0.024	-0.030
BNSS9	0.038	-0.046	-0.022	**0.973**
BNSS10	-0.025	0.026	0.008	**0.946**
BNSS11	-0.024	0.042	0.057	**0.879**
BNSS12	-0.020	0.012	**0.921**	0.032
BNSS13	0.057	0.005	**0.910**	0.001

Note. Loadings greater than 0.30 are presented in bold font. Quartimin rotation used.

Supplemental Table S11

Rotated Factor Matrices of the BNSS Exploratory Factor Analysis for the Five-Factor Solution (Item4 Included)

	1	2	3	4	5
BNSS1	**0.979**	-0.004	-0.005	0.005	0.006
BNSS2	**0.975**	-0.008	-0.004	0.004	0.006
BNSS3	**0.861**	0.042	0.043	0.010	0.011
BNSS4	**0.396**	**0.377**	-0.062	0.056	0.051
BNSS5	0.112	**0.619**	0.138	0.053	0.008
BNSS6	-0.005	**0.838**	0.027	0.022	0.029
BNSS7	0.001	-0.028	**0.934**	0.008	0.041
BNSS8	0.011	0.061	**0.877**	0.007	-0.028
BNSS9	0.052	-0.070	0.023	**0.982**	-0.030
BNSS10	-0.010	0.011	0.025	**0.935**	0.013
BNSS11	-0.038	0.099	-0.036	**0.894**	0.052
BNSS12	-0.041	0.008	0.011	0.024	**0.942**
BNSS13	0.051	-0.008	0.000	-0.015	**0.938**

Note. Loadings greater than 0.30 are presented in bold font. Quartimin rotation used.

Supplemental Table S12

Rotated Factor Matrices of the BNSS Exploratory Factor Analysis for the Six-Factor Solution (Item4 Included)

	1	2	3	4	5	6
BNSS1	**0.973**	0.023	-0.012	0.008	-0.016	0.006
BNSS2	**0.972**	0.022	-0.013	0.008	-0.016	0.007
BNSS3	**0.861**	-0.036	0.037	-0.048	0.078	0.003
BNSS4	**0.383**	-0.014	0.107	0.018	0.179	0.096
BNSS5	0.089	0.090	-0.016	-0.029	**0.681**	0.032
BNSS6	0.010	0.036	0.029	-0.009	**0.813**	0.007
BNSS7	0.027	**0.840**	-0.027	-0.049	0.023	0.022
BNSS8	-0.009	**0.912**	0.025	0.025	0.023	0.006
BNSS9	0.050	-0.044	-0.024	0.016	0.009	**0.957**
BNSS10	-0.023	0.022	0.005	0.007	0.000	**0.970**
BNSS11	-0.018	0.045	0.024	-0.044	-0.011	**0.894**
BNSS12	-0.054	-0.049	-0.018	**-0.880**	0.122	0.065
BNSS13	0.063	0.061	0.018	**-0.959**	-0.077	-0.018

Note. Loadings greater than 0.30 are presented in bold font. Quartimin rotation used.

Supplemental Table S13. Internal Consistency Estimates of the Five Factors for Each Study Sample

Study Sample	Full Scale Item 4 Included	Full Scale Item 4 Excluded	Anhedonia	Avolition	Asociality	Affect	Alogia
Italian Calibration Sample	0.957	0.959	0.962	0.882	0.923	0.960	0.937
Italian Cross-Validation	0.997	0.997	0.996	0.992	0.993	0.996	0.995
American Sample	0.934	0.935	0.861	0.887	0.907	0.938	0.959
Spanish Sample	0.930	0.930	0.927	0.859	0.887	0.937	0.933
Swiss Sample	0.944	0.946	0.948	0.895	0.909	0.957	0.936
Chinese Sample	0.933	0.938	0.946	0.864	0.896	0.920	0.880

Note. Internal consistency estimates based on Cronbach's alpha calculation. The BNSS has seven ordered response categories. When a scale has more than five response categories, Cronbach's alpha produces robust estimates of internal consistency comparable to other methods of computing internal consistency for categorical outcomes such as ordinal alpha or McDonald's alpha.