FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

Title Page: Brief Symptoms Inventory psychometric properties supports the hypothesis of a general psychopathological factor

Running head: Factorial structure of Brief Symptoms Inventory

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FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

Abstract

The existence of a general factor related to psychiatric symptoms is supported by studies using a variety of methods and in both clinical and non-clinical samples. This study aims to evaluate the replicability of internal structure of the Brief Symptom Inventory in a large Brazilian sample. Participants were 6,427 Brazilian subjects (81% female). The mean age was 42.1 years old ($SD = 13.6$, $Min = 13$, $Max = 80$). All participants fulfilled the online version of the Brief Symptom Inventory. This scale presents a general score (GSI), and nine specific clusters of symptoms (depression, anxiety, phobic anxiety, interpersonal sensibility, psychoticism, paranoid ideation, obsessive-compulsive, hostility, and somatization symptoms). Confirmatory factorial analysis was performed to assess the factorial BSI structure. Results support that the bifactorial solution was the best-fitting model and the general factor arise as the main dimension explaining most of the reliable variability in the data. Findings suggest that BSI internal structure was replicated in a non-clinical sample and the general factor is the most reliable score. However, it is necessary a better understanding about the meaning of the general factor scores in a non-clinical to increase the interpretability of its scores.

Keywords: psychological factors, reproducibility of results, mental disorders, psychometrics

FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

1. Introduction

The frontiers between psychiatric illnesses are much less established than those conceived in the diagnostic manuals of mental disorders. The lack of precise boundaries among mental illnesses has led the psychiatric diagnosis process to a gradual change from a categorical perspective to a dimensional one.¹ Current categories of mental disorders are highly comorbid among them, and such phenotypic covariance should not be neglected in the clinical practice. Some authors even argue that the symptomatic similarity between patients with specific disorders suggests a shared common core between mental disorders.^{2, 3}

Recently, Caspi and Moffitt⁴ pointed out that several psychopathologies often have the same biomarkers and risk factors, and that therapeutic strategies seem to work for a broad range of disorders. Hereupon, the assessment of psychopathological symptoms, despite their nosological classification, has significant clinical applicability to identify therapeutic targets and to assess interventions' clinical relevance. Carragher et al.⁵ even reason that symptom-level analyses allow us to “unpack disorders”, uncovering the empirically [nonarbitrary] based structure of psychopathology. In their study, a modified bifactor model, with three correlated specific factors (internalizing, externalizing, thought disorder) and one general psychopathology factor, the “p” factor, was found. The p factor has since been corroborated by studies in childhood and adolescence,⁶ and with adults,² a pattern likely to be stable throughout time.^{6, 7} In effect, if the p factor is not a spurious finding, it will consistently appear in the psychometric modeling of instruments measuring different types of psychopathological dimensions. Therefore, as in studies concerning constructs like the general intelligence factor, also called “g”, the psychometric analyses of instruments evaluating psychiatric disorders or psychological distress are a useful way to assess the hypothesis of the “p” factor.

The Brief Symptoms Inventory (BSI)⁸ is an instrument of self-reported psychological distress and psychopathological symptoms including nine dimensions: depression, anxiety, somatization, obsession-compulsion, interpersonal sensitivity, phobic anxiety, hostility, paranoid ideation, and psychoticism. The inventory also has a Global Severity Index (GSI), which includes all symptoms assessed by the scale. The scale was developed before the third edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-III)⁹ and remained in use for clinical and research purposes with psychiatric patients and in non-clinical samples.^{10, 11} Throughout the decades of its existence, the BSI was translated into several languages.¹²⁻¹⁸

FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

The nine factors structure of the BSI has been replicated through confirmatory and exploratory factor analysis in samples from several countries like Italy¹⁹ and Azerbaijan,²⁰ but a unidimensional factor structure has also been found in other countries, like USA²¹ and Greek.²² Those inconsistencies are usually due the communality of items measuring psychiatric symptoms. Thomas²³ pointed that these properties fit well with the classical conceptualization of bifactor models and proceed an evaluation of BSI considering its model. The bifactor model shown fits the data better than the unidimensional and the correlated nine factors models and also shown additional evidence of criterion-related validity by predicting more accurately DSM-IV-TR depressive, generalized anxiety, phobic and somatization disorders than those models. This result brings attention to the clinical relevance of the bifactorial structure to explain the variability in the respondents' responses. The bifactorial structure was replicated by Urbán et al,¹⁵ in a Hungarian sample, and Urbán et al.,²⁴ in Hungarian and Dutch samples, demonstrating better fit than other multidimensional and hierarchical structures. The bifactorial structure was replicated for both men and women, and the global scores were understood as a global distress factor, and the general factor seems adequate to represent a global psychological distress index.

Nonetheless, the bifactor solution was not always found in other populations, like, for example, in a Greek non-clinical sample.²² In this case, the authors argue that the BSI-properties does not justify the use of specific factors to assess psychopathology. However, even in that situation, the authors suggest that the BIS global score can be a proxy of psychological distress in non-clinical samples. The present study examined the latent factor structure of the Brief Symptom Inventory in a Brazilian non-clinical sample to: (a) replicate several plausible models reported on the literature; (b) compare those models to understand what best fits the Brazilian population; (c) provide evidences that allow the interpretability of BSI scores in regard of psychopathological symptoms. These analyses are essential to the understand of BSI scores strengths and limitations and contributes to the interpretation of the general and specific factor that could emerge from data.

2. Method

Participants

We included 6,427 (81% female) Brazilian subjects from all states of the country. The mean age was 42.1 years old (SD = 13.6, Min = 13, Max = 90). In regard of educational attainment, 68% were classified from 6 to 8 on the International Standard Classification of Education – 2011,²⁵

FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

51% are married or have a stable relationship and 2,468 (85.7% female) participants self-reported previous lifetime psychiatric diagnosis for at least one condition.

Procedure

Participants were recruited from the internet by a social media campaign in May-June 2020. The SurveyMonkey platform delivered all the questionnaires. The participants agreed with the informed consent before starting to answer the tests and questionnaires. Ethical procedures have been approved by the National Commission on Ethics in Research under process number CAAE: 30823620.6.0000.5149 following the Declaration of Helsinki.

Measure

The Brief Symptom Inventory (BSI) is a 53-item instrument designed to identify relevant psychological symptoms.⁸ The inventory covers nine symptom dimensions (Somatization, Obsession-Compulsion, Interpersonal Sensitivity, Depression, Anxiety, Hostility, Phobic Anxiety, Paranoid Ideation, and Psychoticism) plus three global indices of distress (Global Severity Index – GSI, Positive Symptom Distress Index – PSDI, and Positive Symptom Total – PST). The items were answered on a 5-points Likert scale from 0 (not at all) to 4 (extremely). It could be self or interviewer-administered and has norms for adolescents until 13 years old and adults for both clinical and nonclinical groups. The reliability reported on the original manual ranged from .71 on Psychoticism to .85 on Depression dimension. Test-retest reliability was provided by global indices, ranging from .87 (PSDI) to .90 (GSI) and for all dimensions that range from .68 (Somatization) to .91 (Phobic Anxiety).

Statistical procedures

Five models were subject to analyses. The Model 1 is the unidimensional model. Model 2 is the correlated nine factors model, based on factorial structure of BSI. Model 3 is the hierarchical model, comprising one second order (GSI) and nine first order factors with oblique correlations. Model 4 is the classical bifactor model, with one general factor and nine specific factors with correlations fixed to zero. And the Model 5 is the exploratory bifactor model, with one general factor and nine specific factors free to correlate with each other.

FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

A confirmatory factor analysis was conducted on lavaan package²⁶ in R software²⁷ using weighted least squares mean and variance adjusted estimation with Satorra-Bentler correction, to correct the standard errors and chi-squared estimates.²⁸ The global model fit was evaluated using the comparative fit index (CFI), Tucker-Lewis index (TLI) and the root mean square error of approximation (RMSEA). To interpret model fit, values equal or higher than .95 for CFI and TLI, and equal or less than .05 for RMSEA for the models.²⁹

The quality of the models has been verified by several indices. The H index was developed to evaluate the construct replicability, measuring the degree to which the indicators appropriately represent the latent variables. The threshold of .70 is generally accepted as a criterion for that index.³⁰ Coefficients omega (ω) and omega hierarchical (ω_H) have been shown. The omega hierarchical is useful for bifactor models for assessing the percent of the common variance attributable to the general factor, and Reise, Bonifay, and Haviland³¹ argues that higher the omega hierarchical, higher is the relevance of the general factor to explain the variance of the data. In that case, the general factor could reflect an essentially unidimensional structure that explains the variance in the examinees' scores.

To evaluate the unidimensionality of the factors, the common explained variances for general (ECV), specific (ECV_SG and ECV_GS) and item levels (I-ECV) were calculated. The ECV index evaluates the proportion of common variance explained by the general factor. The ECV_SG and ECV_GS explains common variances related to specific factors and the variance in each factor due to the general factor, respectively. It represents the proportion of the items variance that could be explained by the general factors.³⁰ The percent of uncontaminated correlations (PUC) specified the possible bias in data of interpreting multidimensional into unidimensional data and when is PUC > .90 it means that ECV, omega and omega hierarchical could be directly interpreted. The semPlot³² and BifactorIndicesCalculator³³ in R and the Jamovi software³⁴ were also used in the analysis.

3. Results

An appropriated solution has been found for all models and the results are presented in Table 1. However, for model 2 and model 5, where an oblique structure for the nine factors was allowed, the covariance matrix of latent variables was not positive definite which suggests that the factor solution was inadmissible.

FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

<<Table 1 around here>>

On both models it is probably because of the inflation of the correlation between Depression and Psychoticism dimensions (Model 2: $r = 1.047$, $p < 0.001$; Model 5: $r = 1.394$). Examining the correlation matrix of the latent variable for Model 2, we found that around 66% of the correlations are equal or superior of .750, indicating a high interdependence of the latent variables. When controlling by the general factor, on Model 5, around 42% of the correlations are not significant and the remain correlations are above .750, except for the Depression and Psychoticism correlation (Table 2).

<<Table 2 around here>>

Thus, the Models 1, 3, and 4 were compared to determine the best-fitting model. All the models were adequate due to CFI and TLI, and Model 1 and Model 3 were inadequate due high RMSEA values. A scaled chi-squared difference also pointed that Model 4 is the best-fitting model. The standardized item parameters are presented in the Table 3. Apart from item 3 (.255), all the items have factor loadings $> .40$ on the general factor. On the specific factor at least one item has a factor loading $< .40$, and for Depression, Paranoid Ideation and Psychoticism dimension just one item was above that level. The explained variability of the items from those three dimensions are strongly associated with the general factor, as demonstrate by I-ECV (Depression: Min = .884, Max = .985; Paranoid Ideation: Min = .609, Max = .819; Psychoticism: Min = .840, Max = 1.000).

<<Table 3 around here>>

<<Figure 1 around here>>

The general factor emerges as the central dimension to explain the variability of examinees' answers. The H index indicates that the general factor achieved the best construct replicability whereas the other dimensions have low estimates and suggested that they are not adequately defined, except the Phobic Anxiety dimension (Table 4). For GSI, the omega is .98 and omegaH is .95, which suggests that around 97% of the reliable variance is due general factor, 3% is due to the

FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

specific factors, and 2% squarely to random error.³⁰ For the specific factors, the omega ranges between .83 and .93 and are higher than their omega hierarchical values. Those results suggested an essentially unidimensional structure due to a strong general factor that explains most of the reliable variance and is less affected by the multidimensionality induced by specific factors.

<<Table 4 around here>>

The ECV of GSI explains 77% of the variance and, in conjunction with the PUC of .918, common variance might be interpreted as essentially unidimensional. Nevertheless, the comparison of ECV_SG and ECV_GS implies that most of the explained variance on the specific factors is due to the general factor and not to the items' composition of the dimensions itself. Also, most of the BSI items showed high communality in virtue of the GSI dimension, suggesting they are practical markers of measures of the general factor. Thus, evidence suggests that one general factor is sufficient to explain the score variability of the BSI.

4. Discussion

The present results provide replication of BSI internal structure models previously reported in different countries and samples. Five models have been examined and the bifactor model was the better representation for Brazil. Our results strongly support the idea of a unidimensional structure in the assessment of psychiatric symptoms by BSI. They are following those previously reported,^{15, 23} reinforcing the bifactorial nature of BSI regardless of cultural influences and mental health condition. That results also supports the hypothesis from Loutsiou-Ladd et al.,²² which suggests that BSI is unidimensional at least in non-clinical samples.

Our results suggest that the general symptom index presents the most robust psychometric properties compared to specific factors. The idea of a “p” factor is supported by previous psychometric studies, which argue that a bifactorial structure of symptoms explains most of the variability of presentation of psychopathological traits in the population. For example, Gluschkoff et al.,⁷ analyzed the results of interviews based on DSM criteria in a large non-clinical sample. They found that the clusters of symptoms related to specific diagnostics are explained by the bifactorial structure with specific symptom clusters of mania, generalized anxiety disorder, major depressive disorder, dysthymia, posttraumatic stress disorder, agoraphobia, panic disorder, social

FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

phobia, specific phobia, antisocial personality disorder, distress, externalizing disorder and internalizing disorder. Besides these specific factors, a general factor was also founded. It is interesting to note that this bifactor structure remains relatively stable throughout the longitudinal follow up of the sample, suggesting that despite changes in symptoms presentation, a general “p” factor continues to influence clinical presentation in psychopathology.

The “p” factor is also supported by its ecological relationship. Recently Pettersson et al.³⁵ assessed a large population sample and also found that the general psychopathological factor (assessed by general scores derived from self and other-report psychiatric scales) was associated to some adverse outcomes of both prescribed and illegal drugs use, criminality, and both low income and educational level.

Our results present a bifactor structure for BSI, and the GSI emerges as the main factor for screening mental health in the general population, while the specific scores have none or low discriminative power. Nonetheless, the use of specific factors seems to be useful to address specific questions in both clinical and research. For example, in recent studies concerning mental health related to pandemics, Wang et al.,³⁶ and Ellis et al.,³⁷ used hostility and depression subscales to address specific questions about psychological distress in cancer patients and adolescents in isolation, respectively. Thus, our results support a similar score interpretation approach to address specific mental health issues for the Brazilian BSI version.

Our study presents limitations that should be addressed by future studies. First of all, the gender imbalance in our sample can represent a bias. Future studies are needed to assess the gender invariance in BSI scores. The second limitation is that our sample was non-clinical, and even 38% has reported suffering from a psychiatric illness, we do not have an in-depth assessment to verify this information. Nonetheless, our data is similar to those reported by Viana et al.³⁸ in a Brazilian epidemiological study, and, therefore, our sample can be considered similar to those previously studied in Brazil.

As pointed by Loutsiou-Ladd et al.,²² symptoms expressed in clinical samples can be different from non-clinical and, therefore, can affect the factorial structure of symptom presentation. The third limitation is related to the period of data collection (from May to June 2020). Since the COVID-19 pandemic can impact population mental health, increasing distress symptoms in the population,³⁹ the non-clinical characteristic of our sample is, in a certain way, questionable. Therefore, future studies should assess if this factorial structure will remain in a similar community sample in a post-

FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

pandemic scenario. The investigation of evidences of validity of BSI scores are also important to understand exactly what it represents and how they might be interpreted.

Despite its limitation, our study reinforces the bifactorial structure of psychiatric symptoms, as assessed by BSI, corroborating the accumulated evidence which suggests the existence of a general psychiatric factor independent from specific clusters of psychiatric symptoms.

Acknowledgements

We acknowledge the governmental research funding agencies: Ministério da Saúde, CAPES, CNPq (grant number 401542/2020-3) and PAHO - Panamerican Health Organization (grant number SCON2020-00202).

FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

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FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

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FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

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FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

Table 1

Fit indexes of confirmatory factor analysis and model comparison for BSI

	Model	S-B χ^2	df	CFI	TLI	RMSEA	RMSEA 90% CI
1	One factor	52166.585	1325	.981	.980	.083	[.082 - .083]
2	Nine correlated factors ^a	21190.698	1091	.992	.991	.056	[.055 - .056]
3	Hierarchical	30708.836	1316	.989	.988	.063	[.062 - .064]
4	<i>Bifactor</i>	<i>25602.890</i>	<i>1276</i>	<i>.991</i>	<i>.990</i>	<i>.057</i>	<i>[.057 - .058]</i>
5	Exploratory bifactor ^a	15822.885	1240	.995	.995	.043	[.042 - .044]
	Model comparison	$\Delta\chi^2$	Δdf				
	Model 4						
	Model 3	2848.7	40	p < .001			
	Model 1	12643.8	9	p < .001			

Note. ^a Latent variables covariance matrix not positive definite. S-B = Satorra-Bentler; *df* = degrees of freedom; CFI = Comparative fit index; TLI = Tucker-Lewis index; RMSEA = Root mean square error of approximation; CI = Confidence interval. Italic text illustrates the best fitting model. All models were statistically significant ($p < .001$).

FACTORIAL STRUCTURE OF BRIEF SYMPTOMS INVENTORY

Table 2

Correlation matrix between latent dimensions for Model 2, on the lower diagonal, and Model 5, on the upper diagonal

	S	O	IS	D	A	H	PA	PI	P	GSI
S	1,00	0,22 ^a	-0,12 ^a	-0,17 ^a	0,28 ^a	-0,06 ^c	0,19 ^a	0,03	-0,06	0,00
O	0,75 ^a	1,00	0,01	-0,05	-0,13 ^a	0,06	0,01	0,08 ^c	0,06	0,00
IS	0,68 ^a	0,83 ^a	1,00	0,35 ^a	-0,27 ^a	0,25 ^a	-0,06	0,74 ^a	0,69 ^a	0,00
D	0,70 ^a	0,87 ^a	0,91 ^a	1,00	-0,15 ^a	-0,01	-0,01	0,04	1,39 ^a	0,00
A	0,78 ^a	0,79 ^a	0,77 ^a	0,83 ^a	1,00	-0,09 ^b	0,57 ^a	-0,25 ^a	-0,08	0,00
H	0,63 ^a	0,76 ^a	0,82 ^a	0,79 ^a	0,77 ^a	1,00	-0,05	0,33 ^a	0,26 ^a	0,00
PA	0,61 ^a	0,61 ^a	0,60 ^a	0,65 ^a	0,78 ^a	0,54 ^a	1,00	0,01	0,12 ^b	0,00
PI	0,65 ^a	0,75 ^a	0,92 ^a	0,78 ^a	0,69 ^a	0,78 ^a	0,55 ^a	1,00	0,58 ^a	0,00
P	0,75 ^a	0,89 ^a	0,96 ^a	1,05 ^a	0,85 ^a	0,84 ^a	0,67 ^a	0,91 ^a	1,00	0,00
GSI										1,00

Note. ^a $p < .001$, ^b $p < .01$, ^c $p < .05$; S = Somatization; OC = Obsession-Compulsion; IS = Interpersonal Sensitivity; D = Depression; A = Anxiety; H = Hostility; PA = Phobic Anxiety; PI = Paranoid Ideation; P = Psychoticism; GSI = Global Severity Index.

Table 3

Standardized item parameter estimates, and common variance explained for the Bifactor model

Item	S	O	IS	D	A	H	PA	PI	P	GSI	I-ECV
2	0,491									0,547	0,554
7	0,346									0,483	0,582
23	0,417									0,588	0,665
29	0,429									0,591	0,655
30	0,467									0,519	0,553
33	0,437									0,546	0,610
37	0,439									0,671	0,701
5		0,622								0,567	0,454
15		0,271								0,776	0,891
26		0,256								0,697	0,920
27		0,199								0,766	0,937
32		0,544								0,797	0,664
36		0,354								0,776	0,826
20			0,237							0,829	0,924
21			0,468							0,852	0,747
22			0,356							0,792	0,870
42			0,244							0,725	0,898
9				0,242						0,749	0,895
16				0,988						0,812	0,985
17				0,273						0,836	0,905
18				0,329						0,836	0,884
35				0,222						0,747	0,917
50				0,213						0,794	0,933
1					0,437					0,715	0,725
12					0,447					0,768	0,747
19					0,547					0,718	0,633
38					0,229					0,838	0,930
45					0,417					0,775	0,776
49					0,811					0,691	0,986
6						0,398				0,766	0,787
13						0,438				0,778	0,791
40						0,638				0,587	0,459
41						0,626				0,637	0,512
46						0,348				0,675	0,788
8							0,274			0,255	0,464
28							0,734			0,426	0,251
31							0,616			0,613	0,510
43							0,627			0,499	0,388
47							0,562			0,726	0,994
4								0,269		0,554	0,819
10								0,278		0,488	0,756
24								0,358		0,677	0,782

48	0,358	0,664	0,782
51	0,517	0,646	0,609
3	0,178	0,556	0,907
14	-0,375	0,859	0,840
34	0,244	0,673	0,884
44	-0,858	0,724	1,000
53	0,177	0,865	0,960
11		0,598	1,000
25		0,588	1,000
39		0,755	1,000
52		0,794	1,000

Note. S = Somatization; OC = Obsession-Compulsion; IS = Interpersonal Sensitivity; D = Depression; A = Anxiety; H = Hostility; PA = Phobic Anxiety; PI = Paranoid Ideation; P = Psychoticism; GSI = Global Severity Index, I-ECV - Item explained common variance.

Table 4

Reliability, sources of variances and replicability of the Bifactor Model for BSI

	ECV_SG	ECV_GS	ω	ωH	H	PUC
S	0,04	0,62	0,87	0,33	0,62	
O	0,03	0,77	0,92	0,19	0,56	
IS	0,01	0,85	0,91	0,13	0,34	
D	0,01	0,92	0,93	0,07	0,26	
A	0,03	0,79	0,94	0,18	0,54	
HO	0,04	0,66	0,93	0,30	0,65	
PA	0,04	0,50	0,84	0,38	0,71	
PI	0,02	0,74	0,83	0,21	0,45	
P	0,01	0,91	0,87	0,00	0,23	
GSI	0,77	0,77	0,98	0,96	0,98	0,92

Note. S = Somatization; OC = Obsession-Compulsion; IS = Interpersonal Sensitivity; D = Depression; A = Anxiety; HO = Hostility; PA = Phobic Anxiety; PI = Paranoid Ideation; P = Psychoticism; GSI = Global Severity Index; ECV_SG = Explained common variance – specific to group; ECV_GS = Explained common variance – group to specific; ω = Omega; ωH = Omega hierarchical; H = Construct replicability coefficient, PUC = percent of uncontaminated correlations.

Figure 1
Graphical illustration of the bifactor model for BSI

Note. S = Somatization; OC = Obsession-Compulsion; IS = Interpersonal Sensitivity; D = Depression; A = Anxiety; HO = Hostility; PA = Phobic Anxiety; PI = Paranoid Ideation; P = Psychoticism; GSI = Global Severity Index