

Brief assessment of schizotypal traits: A multinational study

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Abstract:

The Schizotypal Personality Questionnaire-Brief (SPQ-B) was developed with the aim of examining variations in healthy trait schizotypy, as well as latent vulnerability to psychotic-spectrum disorders. No previous study has studied the cross-cultural validity of the SPQ-B in a large cross-national sample. The main goal of the present study was to analyze the reliability and the internal structure of SPQ-B scores in a multinational sample of 28,426 participants recruited from 14 countries. The mean age was 22.63 years ($SD = 7.08$; range 16–68 years), 37.7% ($n = 10,711$) were men. The omega coefficients were high, ranging from 0.86 to 0.92 for the total sample. Confirmatory factor analysis revealed that SPQ-B items were grouped either in a theoretical structure of three first-order factors (Cognitive-Perceptual, Interpersonal, and Disorganized) or in a bifactor model (three first-order factors plus a general factor of schizotypal personality). In addition, the results supported configural but not strong measurement invariance of SPQ-B scores across samples. These findings provide new information about the factor structure of schizotypal personality, and support the validity and utility of the SPQ-B, a brief and easy tool for assessing self-reported schizotypal traits, in cross-national research. Theoretical and clinical implications for diagnostic systems, psychosis models, and cross-national mental health strategies are derived from these results.

Keywords: Schizotypy | Schizotypal personality | Psychosis | Cross-cultural | SPQ-B | Psychosis risk

Article:

1. Introduction

In the past two decades, the early and reliable identification of individuals potentially at-risk for psychotic-spectrum disorders, based on psychometric indices, has become a focus of extensive and expanding research and debate (Addington et al., 2015, Fonseca-Pedrero et al., 2016b, Fusar-Poli et al., 2014, Kline and Schiffman, 2014, Mason, 2015). The identification of specific subgroups of individuals at high risk for psychotic-spectrum disorders may help us to elucidate both risks factors and protective factors, as well as etiological mechanisms and developmental pathways that mitigate, delay, or even prevent the onset of clinically significant psychotic disorders (Barrantes-Vidal et al., 2015).

Schizotypal traits are considered to be a phenotypic-indicator of schizotypy (Meehl, 1962), a latent personality organization reflecting a putative liability for schizophrenia-spectrum disorders (Barrantes-Vidal et al., 2015, Fonseca Pedrero and Debbané, 2017, Lenzenweger, 2010). Schizotypal traits encompass anomalies and deficits across cognitive (e.g., paranoid ideation, ideas of reference), social/emotional (e.g., anhedonia, no close friends), and behavioral (e.g., odd behavior and language) systems (Cohen et al., 2015, Fonseca-Pedrero et al., 2017). Previous findings support the notion of assumed phenomenological, temporal, and etiological continuity between the subclinical and clinical psychosis phenotype and lend validity to the concept of schizotypal traits (Cohen et al., 2015, Ettinger et al., 2014, Linscott and van Os, 2013).

Several measurement instruments allow clinicians and researchers to document the presence, frequency, and severity of schizotypal traits (Fonseca-Pedrero et al., 2016b, Mason, 2015). These tools have been developed with the aim of examining variation in healthy trait schizotypy, as well as latent vulnerability to psychotic-spectrum disorders, in both clinical and non-clinical populations (e.g., general population, clinical, and genetic high risk samples). The Schizotypal Personality Questionnaire (SPQ) (Raine, 1991), in its brief version (SPQ-B) (Raine and Benishay, 1995), or its brief revised version (SPQ-BR) (Cohen et al., 2010), measure a broad range of psychotic-like traits— originally nine identified subordinate traits based on the operational definition of Schizotypal Personality Disorder (SPD) (American Psychiatric Association, 1987), and is among the more widely-used measured of this type.

The SPQ-B has been used with patients and relatives of patients with schizophrenia-spectrum disorders (Compton et al., 2007, Moreno-Izco et al., 2015), adolescents (Fonseca-Pedrero et al., 2009), twins (Ericson et al., 2011), outpatients (Axelrod et al., 2001), and college students (Compton et al., 2009a, Fonseca-Pedrero et al., 2011, Mata et al., 2005, Raine and Benishay, 1995). The psychometric properties of the SPQ-B have been examined previously. For instance, the reliability of scores and several sources of evidence of validity have been demonstrated (e.g., Fonseca-Pedrero et al., 2016b, Mason, 2015). Moreover, translations of the measure have been validated in several countries (e.g., France, China, Spain, Turkey, Switzerland) (e.g., Aycicegi et al., 2005, Ma et al., 2015, Ortuño-Sierra et al., 2013).

Examination of the SPQ-B factor structure has yielded factorial solutions of two (Aycicegi et al., 2005), three (Compton et al., 2009a, Fonseca-Pedrero et al., 2011, 2009; Ma et al., 2015, Mata et al., 2005, Ortuño-Sierra et al., 2013, Tran et al., 2015), and four factors (Cohen et al., 2010, Fonseca-Pedrero et al., 2010). The three-factor model characterized by Cognitive-Perceptual (e.g., hallucinations, ideas of reference, magical thinking or paranoid ideation), Interpersonal (e.g., blunted affect, social anxiety or lack of close friends), and Disorganized (e.g., odd behavior and speech) dimensions has been widely replicated across studies. However, although the underlying structure of schizotypal personality, as assessed via the SPQ-B, has been analyzed, previous research has produced some contradictory results. These mixed findings are partially explained by variations in sampling method (random, convenience), sample characteristics (clinical, non-clinical, and country), and the data-analytic approach employed (exploratory vs. confirmatory factor analysis).

To the best of our knowledge, no previous studies have validated the psychometric quality of SPQ-B scores across multiple countries. For instance, we have little information about the factorial structure of SPQ-B scores and its possible variation across countries, particularly non-Western countries. Moreover, as previous studies have demonstrated with the SPQ, alternative models (e.g., Barron et al., 2017, Preti et al., 2015) may better explain the latent structure of SPQ-B scores. Thus, it is important to gather new information about the validity of this tool through cross-cultural research and collaborative multinational studies. Furthermore, and despite the globalization of psychosis research, no previous study has analyzed the psychometric quality of psychosis risk screeners in multinational samples.

The purpose of the present study was to analyze the psychometric properties of SPQ-B scores in a large sample recruited from 14 countries. Derived from this main goal are the following specific objectives: a) to estimate the reliability of SPQ-B scores across countries; b) to study the internal structure of SPQ-B scores across countries; and c) to analyze the measurement invariance of SPQ-B scores across countries. We hypothesized that the three-factor model of the SPQ-B would have adequate goodness-of-fit indices across samples. Moreover, we hypothesized that new measurement models, such as a bifactor model, would fit adequately. In addition, we further hypothesized that SPQ-B scores would show configural measurement invariance across samples.

2. Method

2.1. Participants

Participants were gathered from 24 sites across 14 countries (Australia, Austria, Belgium, Canada, China, Germany, Greece, Italy, Mauritius, New Zealand, Spain, Tunisia, United States of America, and United Kingdom). Partial data from the present study has been published elsewhere (Fonseca-Pedrero et al., 2017). The overall sample consisted of 28,426 participants. The mean age was 22.63 years ($SD = 7.08$; range 16–68 years). A total of 14.5% ($n = 4113$) of participants did not provide age. Participants were 10,711 males (37.7%) and 17,208 females (60.5%); 507 (1.8%) did not specify gender. Thus, 27,919 (98.2%) participants reported gender and 22,888 (80.52%) reported age. In this study, we considered information at country level and not at research level. Information about the age, gender, and other participant characteristics are

reported in Table 1. Information about sampling procedures and demographic characteristics of the samples across sites are presented in the Supplementary Materials.

Table 1. Demographic characteristics of the sample.

	Country		Gender		Age		
	<i>n</i>	%	Male	Female	<i>M</i>	<i>SD</i>	Range
US	10,477	36.9	3162	7212	22.0	6.7	16–55
Spain	1123	4.0	224	899	20.2	2.0	18–29
New Zealand	1698	6.0	515	1183	20.1	3.0	17–51
Italy	649	2.3	305	344	24.3	3.5	19–38
Australia	1931	6.8	634	1294	28.5	11.2	17–55
Belgium	893	3.1	245	648	24.9	9.1	17–55
UK	1199	4.2	404	795	22.8	6.5	16–68
Tunisia	458	1.6	137	321	20.4	1.4	18–29
China	4907	17.3	2973	1533	19.7	1.0	17–24
Canada	1849	6.5	562	1287	20.8	2.9	18–53
Greece	1041	3.7	390	651	32.4	9.9	17–55
Mauritius	1201	4.2	688	513	23.4	1.2	21–27
Austria	611	1.4	294	317	33.2	12.6	19–66
Germany	389	2.1	178	211	32.7	13.2	19–66
Total	28,426	100	10,711	17,208	22.63	7.08	16–68

2.2. Instrument

2.2.1. The Schizotypal Personality Questionnaire-Brief (SPQ-B)

The SPQ-B provides a common index of schizotypal traits across all countries. The SPQ-B is a 22-item (*True/False*) self-report scale based on the SPQ (Raine, 1991) for the assessment of SPD traits as defined by *DSM-III-R* diagnostic criteria (American Psychiatric Association, 1987). The SPQ-B includes items that fall within three domains: Cognitive-Perceptual (ideas of reference, paranoid ideation, magical thinking, and unusual perceptual experiences), Interpersonal (social anxiety, no close friends, blunted affect, and paranoid ideation), and Disorganized (odd speech and behavior). In the present study, the items of the brief version were extracted from the original SPQ validated for each country. Item selection was based on the original brief SPQ: English (Raine, 1991), Spanish (Fonseca-Pedrero et al., 2014b), Italian (Fossati et al., 2003), Chinese (Chen et al., 1997), Arabic (Lahmar et al., 2014), French (Dumas et al., 2000), Creole (Reynolds et al., 2000), Greek (Tsaousis et al., 2015), and German version (Klein et al., 1997).

2.3. Procedure

Conventions for obtaining informed consent required by each investigator's research institution, as well as IRB or ethical committees were followed. All participants provided written informed consent prior to participation. The study was conducted in accordance with the guidelines of the Declaration of Helsinki (World Medical Association, 2013). In the present study the SPQ-B scores being reported are derived from the administration of the full 74 item SPQ (see Fonseca-Pedrero et al., 2017). Similarly, the SPQ was sometimes administered in the context of larger studies (see Supplemental Material for further information).

2.4. Data analyses

Descriptive statistics for the items of the SPQ-B were calculated as the first step. In order to test the reliability of SPQ-B scores, and due to the limitations of Cronbach's α (Dunn et al., 2014), coefficient ω was estimated (Zinbarg et al., 2005). Next, in order to analyze the internal structure of SPQ-B scores, and based on previous studies, several confirmatory factor analyses (CFAs) were conducted at the item level. Considering the categorical nature of the data, we used the robust mean-adjusted weighted least square method (WLSMV) for parameter estimation (Muthén and Muthén, 1998–2012). The following goodness-of-fit indices were used: Chi-square (χ^2), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), and Weighted Root Mean Square Residual (WRMR). CFI and TLI values > 0.95 are preferred and those close to 0.90 are considered acceptable; RMSEA values should be under 0.08 for a reasonable fit, and under 0.05 for a good fit, whereas WRMR values < 0.08 are considered evidence of a good model (Brown, 2006, Hu and Bentler, 1999).

Taking into account previous studies, different measurement models were tested: a) a unidimensional model; b) a bidimensional solution with a Cognitive-Perceptual, and a Negative factor (Siever and Gunderson, 1983); c) the Raine et al. (1994) model that includes Cognitive-Perceptual, Interpersonal, and Disorganized dimensions with Items 7, 9, 14, and 17 overlapping (i.e., cross-loading) in both the Cognitive-Perceptual and Interpersonal dimensions; d) the Raine and Benishay (1995) three-factor solution with no item cross-loadings allowed, and; e) a bifactor model that includes a general factor of schizotypal personality and three first order factors (Cognitive-Perceptual, Interpersonal, and Disorganized). Correlations among error terms were not permitted. Finally, and with the aim of studying measurement invariance across countries, we conducted successive multi-group CFAs models (MGCFAs models) for categorical outcomes (Muthén and Asparouhov, 2002).

The relatively few missing values in the data were replaced by regression-based estimates, to which an error component was added, based on the SPSS Missing Value Analysis module. SPSS 22.0 (IBM Corp Released, 2013), Mplus 7.4 (Muthén and Muthén, 1998–2012), FACTOR 10.5 (Ferrando and Lorenzo-Seva, 2017), and R (R Development Core Team, 2011) were used for the data analyses.

3. Results

3.1. Descriptive statistics and internal consistency of the SPQ-B scores

Means and standard deviations for the SPQ-B items for all countries are shown in Table 2. Internal consistency values for SPQ-B scores in the total sample and by country are shown in Table 3. Omega coefficients were adequate for data from all participating countries. Values for the total sample were 0.86, 0.91, 0.89, and 0.92 for the Cognitive-Perceptual, Interpersonal, and Disorganized subscales, and the Total score, respectively. Across countries, values ranged from 0.77 (Cognitive-Perceptual for China) to 0.94 (total score for the United States, Interpersonal and Disorganization for Germany).

Table 2. Descriptive statistics for the SPQ-B across countries and total sample.

Items	USA (n = 10,477)		Spain (n = 1123)		New Zealand (n = 1698)		Italy (n = 649)		Australia (n = 1931)		Belgium (n = 893)		UK (n = 1199)		Tunisia (n = 458)		China (n = 4907)		Canada (n = 1849)		Greece (n = 1041)		Mauritus (n = 1201)		Austria (n = 390)		Germany (n = 610)		Total sample (N = 28,426)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
1	0.32	0.47	0.46	0.50	0.23	0.42	0.38	0.49	0.42	0.49	0.47	0.50	0.42	0.49	0.53	0.50	0.31	0.46	0.30	0.46	0.43	0.50	0.41	0.49	0.29	0.45	0.26	0.44	0.34	0.48	
2	0.4	0.49	0.30	0.46	0.38	0.49	0.26	0.44	0.51	0.50	0.34	0.47	0.48	0.50	0.36	0.48	0.45	0.50	0.29	0.45	0.23	0.42	0.26	0.44	0.27	0.44	0.27	0.45	0.38	0.49	
3	0.31	0.46	0.30	0.46	0.28	0.45	0.31	0.46	0.26	0.44	0.33	0.47	0.34	0.47	0.54	0.50	0.31	0.46	0.27	0.45	0.28	0.45	0.47	0.50	0.15	0.36	0.15	0.36	0.31	0.46	
4	0.24	0.43	0.34	0.48	0.25	0.44	0.27	0.45	0.33	0.47	0.28	0.45	0.31	0.46	0.37	0.48	0.69	0.46	0.24	0.43	0.35	0.48	0.19	0.39	0.13	0.34	0.11	0.31	0.34	0.47	
5	0.36	0.48	0.46	0.50	0.25	0.43	0.32	0.47	0.39	0.49	0.30	0.46	0.33	0.47	0.68	0.47	0.85	0.36	0.30	0.46	0.35	0.48	0.37	0.48	0.25	0.43	0.23	0.42	0.44	0.50	
6	0.16	0.37	0.42	0.49	0.14	0.34	0.09	0.29	0.17	0.38	0.10	0.30	0.26	0.44	0.12	0.33	0.13	0.34	0.12	0.33	0.07	0.26	0.18	0.38	0.12	0.32	0.12	0.33	0.16	0.37	
7	0.24	0.43	0.17	0.37	0.17	0.38	0.29	0.45	0.15	0.35	0.25	0.44	0.24	0.43	0.57	0.50	0.09	0.29	0.23	0.42	0.38	0.49	0.61	0.49	0.13	0.34	0.07	0.26	0.22	0.42	
8	0.19	0.39	0.13	0.34	0.13	0.34	0.18	0.38	0.14	0.35	0.28	0.45	0.23	0.42	0.48	0.50	0.37	0.48	0.17	0.37	0.15	0.36	0.28	0.45	0.19	0.4	0.16	0.37	0.22	0.41	
9	0.30	0.46	0.18	0.38	0.31	0.46	0.12	0.33	0.28	0.45	0.22	0.41	0.38	0.49	0.27	0.44	0.16	0.36	0.27	0.44	0.17	0.37	0.34	0.48	0.15	0.35	0.12	0.33	0.25	0.44	
10	0.35	0.48	0.22	0.42	0.34	0.48	0.12	0.33	0.34	0.47	0.13	0.34	0.36	0.48	0.24	0.43	0.21	0.41	0.32	0.47	0.13	0.33	0.36	0.48	0.38	0.49	0.31	0.46	0.30	0.46	
11	0.38	0.49	0.34	0.48	0.33	0.47	0.15	0.35	0.45	0.50	0.30	0.46	0.36	0.48	0.50	0.50	0.29	0.45	0.30	0.46	0.22	0.42	0.58	0.49	0.18	0.38	0.15	0.36	0.35	0.48	
12	0.15	0.35	0.10	0.30	0.14	0.35	0.09	0.28	0.17	0.37	0.17	0.37	0.25	0.43	0.16	0.37	0.19	0.39	0.08	0.27	0.15	0.35	0.18	0.39	0.15	0.36	0.20	0.40	0.15	0.36	
13	0.37	0.48	0.41	0.49	0.42	0.49	0.25	0.44	0.35	0.48	0.46	0.50	0.46	0.50	0.45	0.50	0.43	0.50	0.32	0.47	0.27	0.44	0.36	0.48	0.28	0.45	0.30	0.46	0.38	0.47	
14	0.45	0.50	0.47	0.50	0.38	0.49	0.59	0.49	0.29	0.45	0.42	0.49	0.50	0.50	0.68	0.47	0.25	0.43	0.42	0.49	0.56	0.50	0.73	0.45	0.38	0.49	0.38	0.49	0.42	0.49	
15	0.35	0.48	0.41	0.49	0.28	0.45	0.16	0.36	0.25	0.44	0.34	0.48	0.38	0.49	0.38	0.49	0.53	0.50	0.35	0.48	0.47	0.50	0.26	0.44	0.34	0.47	0.32	0.47	0.37	0.48	
16	0.30	0.46	0.36	0.48	0.30	0.46	0.24	0.43	0.34	0.47	0.31	0.46	0.40	0.49	0.28	0.45	0.21	0.41	0.25	0.44	0.26	0.44	0.43	0.50	0.18	0.39	0.16	0.37	0.29	0.45	
17	0.30	0.46	0.24	0.43	0.24	0.43	0.19	0.40	0.21	0.41	0.44	0.50	0.36	0.48	0.72	0.45	0.22	0.41	0.23	0.42	0.46	0.50	0.55	0.50	0.19	0.39	0.11	0.32	0.29	0.45	
18	0.23	0.42	0.12	0.33	0.17	0.38	0.06	0.24	0.15	0.36	0.16	0.36	0.26	0.44	0.22	0.42	0.12	0.33	0.22	0.41	0.14	0.34	0.37	0.48	0.26	0.44	0.22	0.42	0.20	0.39	
19	0.27	0.44	0.13	0.33	0.19	0.39	0.11	0.31	0.17	0.37	0.36	0.48	0.29	0.46	0.31	0.46	0.07	0.26	0.20	0.40	0.11	0.32	0.23	0.42	0.15	0.36	0.14	0.35	0.20	0.40	
20	0.24	0.43	0.17	0.38	0.14	0.35	0.14	0.35	0.17	0.38	0.29	0.45	0.29	0.45	0.39	0.49	0.31	0.46	0.20	0.40	0.21	0.41	0.33	0.47	0.17	0.38	0.17	0.37	0.24	0.43	
21	0.34	0.47	0.35	0.48	0.31	0.46	0.18	0.39	0.25	0.43	0.28	0.45	0.33	0.47	0.38	0.49	0.16	0.36	0.28	0.45	0.22	0.42	0.38	0.49	0.15	0.36	0.12	0.33	0.28	0.45	
22	0.48	0.5	0.54	0.50	0.43	0.50	0.47	0.50	0.37	0.48	0.59	0.49	0.51	0.50	0.66	0.47	0.04	0.20	0.48	0.50	0.48	0.50	0.52	0.50	0.46	0.50	0.42	0.49	0.40	0.49	
Subscales																															
POS	2.41	2.07	2.21	1.79	2.21	1.88	1.62	1.71	2.57	1.92	2.18	1.84	2.86	2.09	3.09	1.81	2.97	1.55	1.99	1.87	2.10	1.80	2.69	1.90	1.71	1.84	1.52	1.62	2.44	1.93	
INT	2.79	2.42	2.86	2.09	2.29	2.24	2.28	1.79	2.32	1.99	2.82	2.20	2.99	2.36	3.92	2.11	1.79	1.63	2.58	2.28	2.90	2.23	3.86	2.08	2.18	2.13	1.95	1.94	2.58	2.35	
DIS	1.55	1.70	1.57	1.41	1.30	1.46	1.08	1.38	1.26	1.51	1.82	1.53	1.88	1.80	2.30	1.62	1.62	1.41	1.28	1.53	1.10	1.34	1.84	1.68	1.06	1.47	1.03	1.44	1.51	1.59	
Total score	6.74	4.99	6.64	3.91	5.80	4.27	4.98	3.83	6.15	4.04	6.82	4.29	7.73	4.89	9.31	4.16	6.37	3.46	5.85	4.43	6.09	4.17	8.39	4.65	4.95	4.28	4.50	3.79	6.54	4.50	

Note. SD = standard deviation; POS = positive; INT = interpersonal; DIS = disorganized.

Table 3. Omega coefficients for the SPQ-B scores across countries and total sample.

SPQ-B	US	Spain	NZ	Italy	Australia	Belgium	UK	Tunisia	China	Canada	Greece	Mauritus	Austria	Germany	Total
Positive	0.88	0.84	0.87	0.87	0.84	0.85	0.86	0.79	0.77	0.87	0.88	0.83	0.88	0.91	0.86
Interpersonal	0.93	0.90	0.93	0.89	0.88	0.91	0.92	0.85	0.88	0.92	0.92	0.86	0.92	0.94	0.91
Disorganization	0.91	0.85	0.92	0.91	0.91	0.84	0.93	0.85	0.88	0.90	0.90	0.86	0.92	0.94	0.89
Total score	0.94	0.89	0.93	0.93	0.91	0.91	0.93	0.88	0.89	0.93	0.92	0.91	0.92	0.93	0.92

Note. NZ = New Zealand.

Table 4. Goodness-of-fit indices of the models tested in the confirmatory factor analysis.

	χ^2	<i>df</i>	CFI	TLI	RMSEA (90% CI)	WRMR
Model a: unidimensional						
US	13,644.01	209	0.820	0.801	0.085 (0.084–0.081)	6.825
Spain	5375.73	209	0.700	0.668	0.090 (0.088–0.092)	4.469
New Zealand	2717.42	209	0.775	0.751	0.084 (0.081–0.087)	3.178
Italy	743.17	209	0.826	0.808	0.063 (0.058–0.068)	1.709
Australia	2730.01	209	0.740	0.713	0.079 (0.076–0.082)	3.220
Belgium	1505.39	209	0.748	0.722	0.083 (0.079–0.087)	2.423
UK	2654.50	209	0.761	0.736	0.099 (0.095–0.010)	3.188
Tunisia	598.52	209	0.783	0.754	0.064 (0.061–0.066)	1.523
China	4309.68	209	0.772	0.751	0.064 (0.062–0.067)	3.904
Canada	3036.70	209	0.785	0.762	0.086 (0.083–0.088)	3.371
Greece	1578.64	209	0.793	0.774	0.080 (0.079–0.082)	2.475
Mauritus	741.28	209	0.921	0.912	0.046 (0.042–0.050)	1.564
Austria	721.908	209	0.803	0.782	0.079 (0.073–0.086)	1.727
Germany	971.177	209	0.749	0.723	0.077 (0.072–0.082)	1.998
Total sample	42,494.65	209	0.768	0.743	0.084 (0.084–0.085)	12.104
Model b: bidimensional						
US	14,069.65	208	0.855	0.839	0.080 (0.079–0.081)	6.960
Spain	1479.03	208	0.742	0.713	0.074 (0.070–0.077)	2.423
New Zealand	2285.08	208	0.814	0.793	0.077 (0.074–0.080)	2.921
Italy	667.05	208	0.850	0.834	0.058 (0.053–0.063)	1.611
Australia	2430.40	208	0.774	0.748	0.072 (0.068–0.074)	3.042
Belgium	1357.85	208	0.783	0.749	0.078 (0.074–0.081)	2.305
UK	2,293.71	208	0.796	0.774	0.091 (0.088–0.095)	2.968
Tunisia	525.48	208	0.817	0.796	0.058 (0.052–0.064)	1.415
China	3870.22	208	0.796	0.773	0.060 (0.058–0.062)	3.703
Canada	2456.85	208	0.829	0.810	0.076 (0.074–0.079)	3.035
Greece	1205.26	208	0.853	0.838	0.073 (0.068–0.075)	2.164
Mauritus	608.31	208	0.940	0.934	0.040 (0.036–0.044)	1.412
Austria	580.94	208	0.856	0.841	0.069 (0.061–0.074)	1.531
Germany	801.94	208	0.805	0.783	0.068 (0.063–0.073)	1.814
Total sample	37,064.26	208	0.797	0.775	0.079 (0.078–0.080)	11.325
Model c: three factor model						
US	8297.27	202	0.915	0.903	0.062 (0.061–0.063)	5.184
Spain	990.75	202	0.840	0.820	0.059 (0.055–0.063)	1.943
New Zealand	1336.89	202	0.900	0.880	0.058 (0.055–0.060)	2.186
Italy	414.88	202	0.931	0.921	0.040 (0.035–0.046)	1.211
Australia	1180.56	202	0.899	0.885	0.050 (0.047–0.053)	2.054
Belgium	897.01	202	0.865	0.846	0.062 (0.058–0.066)	1.820
UK	1444.63	202	0.897	0.861	0.072 (0.068–0.075)	2.285
Tunisia	396.64	202	0.871	0.871	0.046 (0.039–0.053)	1.195
China	2847.80	202	0.852	0.831	0.052 (0.050–0.053)	3.170
Canada	1482.74	202	0.903	0.889	0.059 (0.056–0.061)	2.291
Greece	872.69	202	0.899	0.884	0.056 (0.053–0.060)	1.790
Mauritus	521.96	202	0.952	0.945	0.036 (0.033–0.040)	1.292
Austria	374.84	202	0.933	0.924	0.047 (0.039–0.054)	1.154
Germany	482.39	202	0.908	0.895	0.048 (0.042–0.053)	1.342
Total sample	22,683.56	202	0.876	0.859	0.063 (0.062–0.063)	8.727
Model d: three factor model (no overlap)						
US	10,267.63	206	0.895	0.882	0.068 (0.067–0.069)	5.860
Spain	1245.25	206	0.789	0.763	0.067 (0.063–0.071)	2.208
New Zealand	1675.86	206	0.868	0.852	0.065 (0.062–0.068)	2.476
Italy	510.998	206	0.901	0.889	0.048 (0.043–0.053)	1.383

	χ^2	<i>df</i>	CFI	TLI	RMSEA (90% CI)	WRMR
Australia	1474.20	206	0.869	0.853	0.056 (0.054–0.059)	2.333
Belgium	1020.36	206	0.842	0.823	0.067 (0.062–0.071)	1.971
UK	1.656.99	206	0.858	0.841	0.077 (0.073–0.080)	2.484
Tunisia	418.60	206	0.877	0.862	0.047 (0.041–0.054)	1.246
China	3552.65	206	0.813	0.791	0.058 (0.056–0.059)	3.541
Canada	1809.23	206	0.878	0.863	0.065 (0.062–0.068)	2.572
Greece	1124.98	206	0.861	0.845	0.065 (0.062–0.069)	2.063
Mauritus	614.40	206	0.939	0.932	0.041 (0.037–0.044)	1.414
Austria	484.997	206	0.893	0.880	0.059 (0.052–0.066)	1.362
Germany	701.291	206	0.837	0.817	0.063 (0.058–0.068)	1.671
Total sample	28,597.38	206	0.844	0.825	0.070 (0.069–0.070)	9.878
Model e: bifactor						
US	5847.31	187	0.941	0.927	0.054 (0.053–0.055)	4.123
Spain	687.21	187	0.898	0.875	0.049 (0.045–0.053)	1.544
New Zealand	902.85	187	0.936	0.921	0.047 (0.044–0.051)	1.695
Italy	338.92	187	0.950	0.939	0.035 (0.029–0.041)	1.051
Australia	1036.82	187	0.912	0.892	0.049 (0.046–0.051)	1.830
Belgium	695.55	187	0.901	0.878	0.055 (0.051–0.060)	1.532
UK	957.491	187	0.925	0.907	0.059 (0.055–0.062)	1.749
Tunisia	339.87	187	0.912	0.891	0.042 (0.035–0.049)	1.072
China	2124.12	187	0.892	0.866	0.046 (0.044–0.048)	2.640
Canada	1006.38	187	0.938	0.923	0.049 (0.046–0.052)	1.780
Greece	709.26	187	0.921	0.903	0.052 (0.048–0.056)	1.547
Mauritus	415.24	187	0.966	0.958	0.032 (0.028–0.036)	1.127
Austria	299.357	187	0.957	0.947	0.039 (0.031–0.047)	0.956
Germany	373.595	187	0.939	0.924	0.040 (0.034–0.046)	1.102
Total sample	17,695.42	187	0.904	0.881	0.057 (0.057–0.058)	7.357

Note. χ^2 = Chi square; *df* = degrees of freedom; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; RMSEA = Root Mean Square Error of Approximation; CI = Confidence Interval; WRMR = Weighted Root Mean Square Residual.

3.2. Internal structure of schizotypal traits

Goodness-of-fit indices for the analyzed models are presented in Table 4. As can be seen, the models that showed the best fit in all the countries were the bifactor and Raine et al. (1994) models (models c and e). The bifactor model displayed better goodness-of-fit indices, but, as explained below, the factor loadings in this solution revealed some inconsistencies. It is worth noting that, in several countries, some of the goodness-of-fit indices such as CFI and TLI were close to the standard cut-off values, but still inadequate. In particular, values of CFI lower than 0.90 were observed in both models, especially in the model of Raine et al. Nonetheless, RMSEA values in both factorial solutions were good for all of the countries analyzed. As noted by Yu (2002), the RMSEA index may be preferred for analysis with the WLSMV estimator and ordered categorical variables. Thus, by this standard, the goodness-of-fit indices for the analyzed models could be considered adequate.

Table 5, Table 6 show the factor loadings for each of the 22 items for the Raine et al. (1994) and the bifactor models, respectively. In addition, the means and range of the factor loadings for the SPQ-B items in the two models are presented. In the case of the Raine et al. (1994) model, correlations among the latent variables were calculated, with averages of 0.561 (Cognitive-Perceptual-Disorganized), 0.286 (Positive-Interpersonal), and 0.593 for the total sample. As can be seen, some factor loadings on the latent factors of the bifactor model were negative and

nominally not significant, thus suggesting that this model could be further improved. Factor loadings for the Raine et al. (1994) model were all adequate and statistically significant.

3.3. Measurement invariance of the SPQ-B scores across countries

Measurement invariance across all participating countries was studied for the two models that displayed best fit, namely the Raine et al. (1994) model ($\chi^2 = 19,973.89$; $df = 2828$; CFI = 0.912; TLI = 0.90; RMSEA = 0.055, with 95% CI: 0.054–0.055; WRMR = 8.62) and the bifactor model ($\chi^2 = 14,564.89$; $df = 2618$; CFI = 0.938; TLI = 0.924; RMSEA = 0.047 with 95% CI: 0.047–0.048; WRMR = 7.01). The configural invariance model, in which no equality constraints were imposed, showed an adequate fit to the data for both models. Next, a strong invariance model was tested with the item thresholds and factor loadings constrained to equality across groups. The Δ CFI between the constrained and the unconstrained models was over 0.01, indicating that strong invariance was not supported in the case of the bifactor model ($\chi^2 = 23,498.71$; $df = 3086$; CFI = 0.895; TLI = 0.890; RMSEA = 0.057 with 95% CI: 0.056–0.058; WRMR = 9.80). For the Raine et al. (1994) model, no convergence was found and the program did not allow us to calculate strong invariance parameters. The Δ CFI between the constrained and the unconstrained models was over 0.01, indicating that strong invariance was not supported. Hence, the results support configural invariance, whereas strong measurement invariance of the SPQ-B across the 14 countries studied was not tenable.

4. Discussion

The psychometric assessment of schizotypal traits offers distinctive benefits, such as being relatively inexpensive, non-invasive, and useful for screening large samples of the general population, as well as for identifying participants at increased risk for psychosis (e.g., Fonseca-Pedrero et al., 2016b, Lenzenweger, 2010, Mason, 2015). For these purposes, and in tandem with global mental health research strategies, there is a clear need for psychometrically sound tools for both psychosis risk and schizotypal screening, which are validated across countries, to use in international research studies and diverse cultural settings. To date, no study has attempted to validate the SPQ-B in a cross-national sample. Furthermore, it remains unclear whether the factorial structure underlying SPQ-B scores is invariant across multiple countries. Thus, the main goal of the present study was to analyze the reliability, internal structure and measurement invariance by country of SPQ-B scores in a multinational sample of participants recruited from 14 countries.

Our analyses highlighted several important findings. First, SPQ-B scores showed adequate levels of internal consistency across countries. The reliability of SPQ-B scores, estimated with coefficient omega, was generally above 0.8. This research provides further support for the reliability of the SPQ-B scores, extending previous findings to non-clinical samples from different countries and variable study contexts. Thus, the SPQ-B could be used as a screening instrument to identify individuals who may be at increased risk for psychosis-spectrum disorders as well as to examine variations in healthy trait schizotypy in cross-cultural studies.

Table 5. Factor loadings for the bifactor model.

	US	Spain	NZ	Italy	Australia	Belgium	UK	Tunisia	China	Canada	Greece	Mauritus	Austria	Germany	Total sample	Across samples	
																Mean	Range
General factor																	
1	0.68	0.47	0.73	0.39	0.37	0.57	0.64	0.42	0.53	0.61	0.54	0.66	0.66	0.54	0.58	0.55	0.37–0.73
2	0.32	0.18	0.18	0.33	0.23	0.19	0.27	0.21	0.20	0.24	0.22	0.51	0.51	0.30	0.27	0.25	0.18–0.50
3	0.57	0.37	0.41	0.67	0.53	0.56	0.50	0.44	0.54	0.47	0.49	0.63	0.63	0.49	0.54	0.51	0.37–0.67
4	0.38	0.22	0.33	0.49	0.37	0.27	0.30	0.18	0.07	0.30	0.15	0.33	0.33	0.49	0.20	0.28	0.07–0.49
5	0.34	0.23	0.30	0.47	0.39	0.32	0.33	0.31	0.12	0.31	0.29	0.31	0.31	0.45	0.22	0.31	0.12–0.47
6	0.60	0.31	0.50	0.63	0.50	0.77	0.57	0.51	0.73	0.51	0.45	0.72	0.72	0.52	0.57	0.56	0.31–0.77
7	0.71	0.70	0.74	0.59	0.68	0.63	0.66	0.33	0.51	0.73	0.74	0.57	0.57	0.89	0.65	0.63	0.33–0.74
8	0.78	0.57	0.70	0.73	0.62	0.55	0.75	0.57	0.62	0.72	0.58	0.70	0.70	0.64	0.67	0.66	0.55–0.73
9	0.56	0.54	0.56	0.71	0.57	0.57	0.46	0.56	0.67	0.55	0.54	0.59	0.59	0.84	0.59	0.57	0.43–0.71
10	0.46	0.35	0.33	0.57	0.33	0.43	0.46	0.37	0.37	0.41	0.45	0.47	0.47	0.29	0.44	0.42	0.33–0.57
11	0.51	0.33	0.42	0.44	0.23	0.36	0.47	0.39	0.38	0.42	0.60	0.42	0.42	0.59	0.44	0.42	0.23–0.59
12	0.31	0.17	0.17	0.33	0.23	0.16	0.14	0.30	0.17	0.27	0.21	0.32	0.32	0.36	0.25	0.22	0.05–0.33
13	0.57	0.31	0.40	0.63	0.50	0.39	0.47	0.61	0.24	0.51	0.51	0.54	0.54	0.43	0.48	0.47	0.31–0.63
14	0.67	0.66	0.69	0.43	0.54	0.64	0.66	0.35	0.43	0.66	0.68	0.53	0.53	0.58	0.59	0.58	0.35–0.69
15	0.53	0.43	0.53	0.43	0.25	0.48	0.41	0.47	0.21	0.43	0.50	0.42	0.42	0.48	0.40	0.42	0.21–0.50
16	0.52	0.34	0.39	0.45	0.42	0.47	0.52	0.35	0.38	0.50	0.45	0.50	0.50	0.58	0.50	0.44	0.38–0.50
17	0.64	0.64	0.56	0.72	0.57	0.47	0.60	0.28	0.45	0.59	0.63	0.51	0.51	0.63	0.62	0.56	0.45–0.72
18	0.69	0.61	0.65	0.34	0.53	0.55	0.67	0.59	0.70	0.67	0.66	0.34	0.34	0.63	0.63	0.59	0.34–0.73
19	0.66	0.46	0.61	0.59	0.59	0.56	0.61	0.69	0.74	0.63	0.52	0.65	0.65	0.58	0.65	0.61	0.46–0.74
20	0.78	0.65	0.75	0.75	0.70	0.78	0.76	0.73	0.73	0.76	0.74	0.67	0.67	0.72	0.75	0.73	0.65–0.78
21	0.54	0.38	0.43	0.50	0.38	0.37	0.45	0.46	0.47	0.47	0.60	0.53	0.53	0.69	0.47	0.47	0.37–0.60
22	0.55	0.57	0.57	0.18	0.35	0.45	0.58	0.15	0.59	0.57	0.60	0.46	0.46	0.61	0.47	0.47	0.15–0.62
Latent factors																	
Positive																	
2	0.64	0.65	0.69	0.71	0.42	0.57	0.70	0.73	0.60	0.61	0.76	0.39	0.81	0.92	0.58	0.66	0.39–0.92
4	0.45	0.40	0.41	0.27	0.44	0.42	0.41	0.42	0.47	0.46	0.32	0.39	0.51	0.51	0.55	0.42	0.27–0.51
5	0.63	0.61	0.59	0.48	0.63	0.66	0.61	0.50	0.60	0.65	0.67	0.41	0.60	0.68	0.70	0.59	0.41–0.68
9	0.04	0.26	0.30	0.12	0.24	0.25	0.29	0.29	0.09	0.38	0.35	0.28	0.18	0.11	0.19	0.23	0.04–0.38
10	0.32	0.32	0.28	0.17	0.43	0.24	0.27	0.23	0.22	0.39	0.31	0.24	0.10	0.18	0.23	0.26	0.10–0.39
12	0.51	0.59	0.64	0.65	0.35	0.70	0.58	0.45	0.30	0.47	0.61	0.35	0.84	0.69	0.49	0.55	0.30–0.84
16	0.42	0.43	0.40	0.30	0.41	0.31	0.35	0.41	0.37	0.41	0.37	0.11	0.27	0.40	0.31	0.35	0.11–0.43
17	0.21	0.18	0.22	0.09	0.13	0.57	0.24	0.26	0.08	0.24	0.18	0.19	0.20	0.08	0.11	0.21	0.08–0.57
Interpersonal																	
1	0.18	0.34	0.22	0.42	0.25	0.33	0.07	0.31	0.28	0.18	0.22	–0.03	0.38	0.31	0.22	0.25	0.01–0.33
7	0.13	–0.12	0.16	0.09	0.31	0.16	0.22	0.18	–0.07	0.04	–0.10	0.03	–0.10	–0.11	0.19	0.06	0.03–0.24
11	0.68	0.75	0.76	0.83	0.47	0.79	0.78	0.65	0.60	0.77	0.69	0.56	0.70	0.56	0.67	0.68	0.47–0.83
14	0.22	0.07	0.17	0.32	0.45	0.20	0.14	0.36	0.19	0.17	–0.05	0.19	0.14	0.16	0.30	0.19	–0.05–0.45
15	0.56	0.50	0.52	0.58	0.62	0.50	0.56	0.53	0.49	0.61	0.45	0.33	0.52	0.56	0.46	0.52	0.33–0.62
18	0.27	0.28	0.37	0.30	0.53	0.28	0.29	0.27	0.39	0.30	0.36	0.25	0.39	0.37	0.35	0.33	0.25–0.53
21	0.72	0.85	0.76	0.68	0.59	0.86	0.84	0.66	0.62	0.78	0.72	0.71	0.58	0.54	0.75	0.71	0.59–0.86
22	0.39	0.17	0.36	0.45	0.63	0.35	0.29	0.50	0.53	0.38	0.19	0.31	0.23	0.34	0.44	0.37	0.17–0.63
Disorganized																	

3	0.44	0.40	0.64	0.35	0.52	0.31	0.53	0.08	0.26	0.56	0.57	-0.09	0.54	0.51	0.42	0.40	0.08-0.64
6	0.70	0.74	0.70	0.54	0.77	0.62	0.74	0.44	0.44	0.70	0.78	0.05	0.74	0.75	0.65	0.62	0.05-0.78
8	0.04	0.09	0.04	-0.25	0.18	-0.15	0.08	0.06	-0.27	0.09	0.20	0.05	0.36	0.21	-0.02	0.05	0.04-0.27
13	0.36	0.28	0.38	0.10	0.33	-0.20	0.46	-0.25	0.17	0.39	0.33	0.12	0.45	0.44	0.29	0.24	0.09-0.52
19	0.54	0.79	0.59	0.58	0.65	0.42	0.54	0.49	0.40	0.57	0.55	0.07	0.70	0.57	0.49	0.53	0.07-0.79
20	-0.11	-0.02	-0.07	-0.20	-0.08	-0.32	-0.07	-0.38	-0.54	-0.07	-0.10	0.95	0.13	0.17	-0.16	0.05	0.01-0.95

Table 6. Factor loadings for the Raine et al. (1994) model.

Items	US	Spain	NZ	Italy	Australia	Belgium	UK	Tunisia	China	Canada	Greece	Mauritus	Austria	Germany	Total sample	Across samples Mean	Range
Positive																	
2	0.60	0.53	0.54	0.54	0.43	0.47	0.58	0.57	0.49	0.53	0.60	0.63	0.72	0.74	0.55	0.57	0.43-0.74
4	0.60	0.45	0.57	0.61	0.59	0.50	0.52	0.40	0.31	0.53	0.32	0.43	0.73	0.69	0.46	0.52	0.31-0.73
5	0.62	0.56	0.63	0.64	0.68	0.64	0.61	0.58	0.41	0.61	0.64	0.42	0.76	0.78	0.54	0.61	0.41-0.78
7	0.31	0.46	0.29	0.42	0.34	0.31	0.26	0.21	0.37	0.38	0.36	0.52	0.49	0.35	0.23	0.36	0.20-0.52
9	0.54	0.56	0.50	0.58	0.53	0.55	0.48	0.52	0.40	0.59	0.59	0.55	0.51	0.31	0.46	0.51	0.39-0.59
10	0.63	0.53	0.52	0.66	0.54	0.57	0.62	0.51	0.54	0.61	0.64	0.56	0.35	0.32	0.59	0.54	0.51-0.64
12	0.54	0.49	0.50	0.55	0.41	0.50	0.41	0.55	0.38	0.49	0.53	0.41	0.81	0.61	0.49	0.51	0.38-0.81
14	0.22	0.25	0.27	0.18	0.14	0.27	0.28	0.08	0.12	0.29	0.31	0.30	0.06	0.17	0.13	0.21	0.06-0.31
16	0.75	0.59	0.64	0.56	0.62	0.65	0.73	0.59	0.63	0.72	0.70	0.56	0.73	0.70	0.71	0.66	0.56-0.75
17	0.46	0.52	0.45	0.58	0.38	0.47	0.46	0.38	0.34	0.52	0.45	0.50	0.42	0.30	0.36	0.44	0.38-0.58
Interpersonal																	
1	0.74	0.61	0.78	0.60	0.48	0.70	0.66	0.56	0.65	0.67	0.61	0.70	0.67	0.67	0.66	0.65	0.48-0.78
7	0.53	0.35	0.61	0.29	0.59	0.49	0.57	0.28	0.29	0.47	0.48	0.11	0.50	0.60	0.57	0.44	0.11-0.61
9	0.52	0.21	0.29	0.28	0.23	0.23	0.17	0.26	0.47	0.19	0.21	0.15	0.50	0.57	0.31	0.31	0.15-0.57
11	0.79	0.73	0.76	0.88	0.47	0.81	0.87	0.70	0.60	0.79	0.87	0.60	0.84	0.77	0.73	0.75	0.47-0.87
14	0.59	0.52	0.58	0.45	0.67	0.54	0.52	0.46	0.45	0.52	0.48	0.32	0.58	0.52	0.63	0.52	0.32-0.57
15	0.73	0.65	0.73	0.73	0.59	0.72	0.64	0.72	0.40	0.69	0.65	0.53	0.65	0.68	0.59	0.65	0.40-0.73
17	0.35	0.33	0.31	0.28	0.65	0.20	0.32	0.08	0.28	0.25	0.38	0.10	0.36	0.50	0.41	0.31	0.08-0.65
18	0.79	0.71	0.78	0.49	0.80	0.66	0.77	0.70	0.87	0.78	0.77	0.43	0.75	0.73	0.77	0.72	0.43-0.87
21	0.82	0.80	0.77	0.87	0.68	0.84	0.88	0.77	0.71	0.84	0.88	0.73	0.90	0.82	0.79	0.81	0.68-0.90
22	0.69	0.63	0.71	0.41	0.68	0.61	0.68	0.40	0.79	0.71	0.67	0.58	0.69	0.63	0.65	0.64	0.40-0.79
Disorganized																	
3	0.67	0.54	0.61	0.71	0.71	0.60	0.67	0.44	0.55	0.63	0.64	0.62	0.70	0.68	0.64	0.63	0.44-0.71
6	0.77	0.59	0.74	0.71	0.81	0.75	0.80	0.52	0.76	0.72	0.68	0.73	0.83	0.79	0.71	0.73	0.59-0.83
8	0.80	0.63	0.74	0.71	0.66	0.56	0.78	0.57	0.64	0.76	0.66	0.72	0.78	0.79	0.68	0.70	0.57-0.79
13	0.65	0.44	0.52	0.64	0.61	0.39	0.60	0.60	0.26	0.62	0.61	0.56	0.60	0.53	0.55	0.55	0.39-0.62
19	0.79	0.77	0.80	0.68	0.85	0.60	0.79	0.67	0.78	0.79	0.69	0.67	0.87	0.80	0.76	0.76	0.60-0.87
20	0.77	0.67	0.77	0.74	0.65	0.76	0.75	0.70	0.70	0.76	0.76	0.71	0.79	0.85	0.73	0.74	0.65-0.85
Factor correlations																	
F2-F1	0.64	0.04	0.52	0.77	0.56	0.67	0.60	0.60	0.59	0.60	0.55	0.79	0.50	0.42	0.62	0.58	0.04-0.79
F3-F1	0.38	0.05	0.25	0.32	0.22	0.23	0.30	0.27	0.20	0.30	0.26	0.59	0.40	0.21	0.29	0.29	0.05-0.59
F3-F2	0.70	0.04	0.61	0.57	0.47	0.62	0.59	0.68	0.73	0.62	0.66	0.80	0.61	0.67	0.65	0.59	0.04-0.80

Second, examination of the factorial structure underlying the SPQ-B scores indicated that schizotypal traits have a multidimensional, rather than unidimensional, structure. SPQ-B items were grouped, in the present analysis, in a theoretical structure of three first-order factors (i.e., Cognitive-Perceptual, Interpersonal, and Disorganization dimensions) as well as in a bifactor model (three first-order factors plus general factor of schizotypal personality). In fact, this is the first study to show that it is possible to derive a total score for the SPQ-B and to obtain distinct subscores for the three classic schizotypal dimensions. Schizotypal personality is a multifaceted construct phenotypically similar to that found in patients with psychosis (e.g., Liddle, 1987). Just as the manifestation of schizophrenia is heterogeneous – encompassing a broad range of emotional, cognitive, perceptual, social and behavioral functions – schizotypy involves a diverse set of traits. Numerous studies, using the SPQ-B, have obtained evidence of such a three-factor structure for schizotypal personality (Compton et al., 2009a, Fonseca-Pedrero et al., 2011, 2009; Ma et al., 2015, Mata et al., 2005, Ortuño-Sierra et al., 2013, Tran et al., 2015), consistent with the Raine et al. (1994) model. Furthermore, the present results corroborate those found when comparing SPQ scores across samples (e.g., Bora and Arabaci, 2009, Compton et al., 2009b, Fonseca-Pedrero et al., 2016a, Fonseca-Pedrero et al., 2017, Fossati et al., 2003, Raine et al., 1994, Reynolds et al., 2000). Furthermore, this factorial structure is similar to that found in the new measure of schizotypy named the Multidimensional Schizotypy Scale (MSS) (Kwapil et al., 2018).

Third, multigroup CFA showed that the SPQ-B three-factor model had configural, but not strong measurement invariance, across countries. Similar results have been found in prior research using the SPQ and its brief versions, as well as other schizotypy tools (e.g., the short form of the Oxford-Liverpool Inventory of Feelings and Experiences and Chapman's scales of psychosis proneness) (Cicero, 2016, Fonseca-Pedrero et al., 2015, Fonseca-Pedrero et al., 2014a, Kwapil et al., 2012, Ortuño-Sierra et al., 2013). For instance, Ortuño-Sierra et al. (2013), when comparing the factorial equivalence of the SPQ-B between Spanish and Swiss adolescents, found that SPQ-B scores had configural and partial strong invariance across the two samples. In addition, the present results demonstrated that several items showed differential functioning by country. To date, differential item functioning (DIF) for psychosis risk or schizotypy measures has yet to be thoroughly addressed. In cross-cultural research, it is vital to test whether varied groups show differing probabilities of success on (or likelihood of endorsing) an item after matching on the underlying construct (e.g., schizotypy) that the item is intended to measure (Byrne et al., 2009, Zumbo, 2007). DIF is of particular importance in international, comparative, and cross-cultural research particularly in efforts to ensure fairness and equity in testing (Zumbo, 2007). The present findings suggest that some schizotypal traits reflecting emotion, behavior, and cognition may differ across countries, at least those that were included in the present study. In fact, schizotypal traits assessed in different cultures have the potential to provide us with information about cultural variations in social and affective functioning (Cohen et al., 2015). Similar results have been found when psychotic symptoms or psychotic-like experiences are analyzed in samples recruited around the world (Larøi et al., 2014, Nuevo et al., 2012, Woods et al., 2014). The finding of configural measurement equivalence across cultures provides essential evidence of construct validity for the schizotypal dimensions, as well as evidence of the cross-cultural validity of SPQ-B scores; however, examination of DIF by sex, age, and language will be an important next step in future studies.

The results of the present study should be considered in light of the following limitations. First, there is an inherent problem in the use of self-reports as indirect indicators of schizotypal traits. Second, the nature of the sample, composed of a majority of college students, precludes the generalization of the results to other populations of interest. Third, the fact that not all the samples employed the infrequency response to detect those participants who displayed random or pseudo-random patterns of responses may undermine the validity and generalizability of the results found in the present cross-national study. Finally, in the present study, the items of the SPQ-B were extracted from the original full version of the SPQ.

5. Conclusions

We have provided the first comprehensive validation study of the SPQ-B using a large, multinational sample from 14 countries. These results offer new information about the brief assessment of schizotypal traits using the same psychometric tool and analytic procedures to compare results obtained in different countries and linguistic groups. In addition, our results demonstrated that schizotypal personality is composed, at a minimum, of three dimensions (i.e., Cognitive-Perceptual, Interpersonal, and Disorganized), and is perhaps encompassed by a general schizotypal factor. The results derived from this cross-national study have theoretical and clinical implications for diagnostic systems, psychosis models, and cross-national mental health strategies.

Conflict of interest. All the authors have declared that there are no conflicts of interest in relation to this study.

Contributors. E.F.-P. designed the study, coordinated the data collection, contributed to the data analyses, and was lead author of the manuscript. J. O.-S. contributed to the data analyses and manuscript preparation. All the authors contributed to the study design and manuscript preparation. All authors have approved the final manuscript.

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Supplementary material

Brief Assessment of Schizotypal Traits: A Multinational Study

eTable 1. Demographic characteristics of the sample.

Study	Country	Main researcher	<i>n</i>	Sampling/ procedure	Mean age (<i>SD</i>)	Age range	Males <i>n</i> (%)
1	US	Cicero	3,162	College	20 (3.7)	17-55	997 (31.5)
2	US	Kwapil	1,556	College	19.5 (2.9)	17-54	363 (23.3)
3	Spain	Fonseca-Pedrero	1,123	College	20.2 (2)	18-29	224 (19.9)
4	US	Compton	1,190	College	20.9 (4)	16-52	284 (23.9)
5	US	Chmielewski	556	College	-	-	102 (18.3)
6	Mauritius	Raine	1,201	Birth cohort	23.4 (1.2)	21-27	688 (57.3)
7	Italian	Preti	649	College	24.3 (3.5)	19-38	305 (47)
8	Australia	Wuthrich	445	College	22.6 (6.3)	17-53	126 (28.3)
9	US	Cohen	1,458	College	19.3 (2.2)	16-53	531 (36.4)
10	Belgium	Larøi	357	General	25 (10.3)	17-55	110 (38.8)
11	Australia	Badcock	342	General	36.1 (11.6)	17-55	182 (53.2)
12	Belgium	Laloyaux	536	General	24.9 (8.1)	18-55	135 (25.2)
13	Tunisia	Mechri	458	College	20.4 (1.4)	18-29	137 (29.9)
14	New Zealand	Linscott	1,648	College	20.1 (3.1)	17-51	515 (30.3)
15	UK	Barkus	774	General	21.6 (4.4)	17-49	291 (37.6)
16	Australia	Barkus	1,144	College	-	-	326 (28.5)
17	US	Suhr	1,169	College	-	-	299 (27.3)
18	China	Chan	4,907	College	19.7 (1.6)	16-24	2973 (60.6)
19	Canada	Zhang	1,849	College	20.8 (2.9)	18-53	562 (30.4)
20	US	Zhang	1,386	MTurk	31.9 (9.5)	18-55	586 (42.3)
21	Greece	Tsaousis	1,041	General	32.4 (9.9)	18-55	390 (37.5)
22	German	Barron	389	General	32.74 (13.2)	19-66	178 (45.8)
23	UK	Barron	425	College	25.08 (8.7)	16-66	113 (26.6)
24	Austria	Barron	611	General	33.23 (12.7)	19-66	294 (48.1)

eTable2.

Procedure of the study.

<p>Study 1 (D. Cicero).</p> <p>Undergraduates at a large Pacific, public university participated in exchange for partial completion of a course requirement.</p>
<p>Study 2 (T. Kwapil).</p> <p>University of North Carolina at Greensboro received course credit for participating. The questionnaires were completed by all participants in mass screening sessions during five semesters.</p>
<p>Study 3 (E. Fonseca-Pedrero).</p> <p>The Spanish sample was composed of university students enrolled in different courses at three Spanish institutions, the University of Oviedo (Educational Sciences and Psychology), the University of La Rioja (Educational Sciences), and the University of La Laguna (Psychology). Participants received no type of incentive for taking part.</p>
<p>Study 4 (M. Compton).</p> <p>Participants who were enrolled in introductory psychology classes of Georgia State University were invited to volunteer via a recruitment statement posted to an online program used to manage the undergraduate research participation pool. Participating students received course credit, though students were not required to participate in this or any other study.</p>
<p>Study 5 (M. Chmielewski).</p> <p>Participants were undergraduate students who were enrolled in various psychology courses at the University of Iowa.</p>
<p>Study 6 (A. Raine).</p> <p>Participants consisted of a sample of adults in the community in Mauritius undergraduates who received course credit for filling out the SPQ derived from a birth cohort, and were representative of the country as a whole on gender and ethnicity</p>
<p>Study 7 (A. Preti).</p> <p>This study was part of the Cagliari – Psychosis: Investigation on Risk Emergence (CAPIRE). The sample included participants from the first two waves of the CAPIRE study and targeting young adults attending the Cagliari University. These undergraduate samples were enrolled via a snowball procedure. Participation was voluntary and no compensation was given for taking part in the study.</p>
<p>Study 8 (V. Wuthrich).</p> <p>Psychology students at the Macquarie Centre for Cognitive Science, Macquarie University, Sydney (Australia) participated in return for a course credit. All participants completed the computerized Likert version as part of other studies.</p>
<p>Study 9 (A. Cohen).</p> <p>Participants were undergraduate students enrolled at Louisiana State University. Freshmen and sophomore students (N = 8,591) were approached by email to participate in an on-line survey, and offered a chance to win monetary compensation as part of a lottery (10 prizes of \$25US). A five-point Likert scale of the full SPQ was administered in either computerized or standard paper and pencil formats.</p>
<p>Study 10 (F. Larøi).</p> <p>Participants were selected from the general non clinical population.</p>

<p>Study 11 (J. C. Badcock and A Jablensky).</p> <p>Participants consisted of a randomly selected sample of adults from the general community in Perth, Western Australia, taking part in the Western Australian Study of Schizophrenia. Participants were recruited by advertising or telephone screening in the local area. Inclusion criteria included age older than 18 years and fluency in English. Exclusion criteria included either a personal or family history of psychotic illness or a history of substance abuse/dependence, neurological disorder or head injury. Questionnaires were completed either at the study site or at participants' homes.</p>
<p>Study 12 (J. Laloyaux).</p> <p>Participants were selected from general population. The data are from an online study. Any person with a psychiatric disorder was excluded (based on self-report) from the study.</p>
<p>Study 13 (A. Mechri).</p> <p>Participants were Tunisian students from the Faculty of Medicine and the Health Sciences High School of Monastir. Of 800 copies of the SPQ that were distributed, 524 were returned, of which 34 were not completely filled. The participation rate was 61.25%.</p>
<p>Study 14 (R. Linscott).</p> <p>Participants were New Zealand born undergraduates. There were no exclusion criteria related to psychosis, other psychopathology, or substance use. All participants completed a range of questionnaires and tasks, including the SPQ.</p>
<p>Studies 15 and 16 (E. Barkus).</p> <p>Participants were from the University of Wollongong, Australia.</p>
<p>Study 17 (J. Suhr).</p> <p>Participants were unselected undergraduates from Ohio University enrolled in various psychology courses, who completed a large group screening that included many other psychological measures. Participants received course credit for participation.</p>
<p>Study 18 (R. C.J. Chan).</p> <p>Undergraduates of five local universities in Beijing, Guangzhou, and Zhuhai were approached to take part in the current study. They were recruited by the mental health counseling centers of each university to take part in a survey of "everyday worries about others". The survey was conducted in classrooms under the supervision of a counselor from the mental health counseling centers of the universities and research assistants.</p>
<p>Study 19 (L. Zang).</p> <p>The participants completed an online questionnaire. The participants were recruited from the University of British Columbia (UBC) student community through the UBC Psychology human subject participant pool. Students were compensated with course credit for their participation.</p>
<p>Study 20 (L. Zang).</p> <p>Participants were North Americans recruited through the Amazon Mechanical Turk website.</p>
<p>Study 21 (I. Tsaousis).</p> <p>Participants were collected from a community sample as part of the Prefrontally-Mediated Endophenotypes (PreMES) study. Exclusion criteria included a personal history of head trauma, medical, or neurological condition; use of prescribed/recreational drugs; and having a first-degree relatives with a history of a DSM Axis I disorder.</p>

Study 22 and Study 24 (D. Barron and U. Tran).

Participants were recruited from the general population in the course of a larger project on individual differences variables. There were no exclusion criteria.

Study 23 (D. Barron).

Participants were undergraduate students who were enrolled in psychology courses at the University of Westminster.