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Schizotypal personality questionnaire – brief revised (updated): An update of norms, factor structure, and item content in a large non-clinical young adult sample

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Abstract

This study updates and provides evidence for the dimensionality, reliability, and validity of a standard instrument for detection and measurement of schizotypy in non-clinical young adults. Schizotypy represents a set of traits on which both nonclinical and schizophrenia-spectrum populations vary meaningfully. These traits are linked to biological, cognitive, and social dimensions of serious mental illness (SMI), to clinical and subclinical variation in personal and social functioning, and to risk for SMI. Reliable and valid identification of schizotypal traits has important implications for clinical practice and research. Four consecutive independent samples of undergraduates were administered the SPQ-BR ($N=2552$). Confirmatory factor analyses suggested a minor item wording change improved reliability, and this Updated questionnaire was implemented for three-quarters of the sample (SPQ-BRU). A, single-order, nine-factor structure had acceptable psychometric properties. The best fitting second-order structure included four higher-order factors that distinguished Social Anxiety and Interpersonal factors. This differentiation was supported by differential relationships with treatment history. The Disorganized factor had the greatest unique relationship with personal and family treatment history. With few exceptions, factor loadings showed stability across samples. Overall, the higher-order and lower-order factors of schizotypy demonstrated reliability and convergent and discriminant validity; detailed psychometric data are presented in a supplement.

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Conflict of interest

Author CD, LH, and WS declare that they have no conflict of interest.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.psychres.2016.01.053.

Keywords

Serious mental illness; Scale development; Reliability; Validity; Confirmatory factor analysis; Schizophrenia; Psychometrics

1. Introduction

Schizotypy is familiar to most psychologists in the context of Meehl's hypotheses about the etiology of schizophrenia (Meehl, 1962, 1990). Schizotypy is still broadly recognized as a set of traits that vary within normative samples, that are qualitatively similar to some features of neurodevelopmental and schizophrenia spectrum disorders, and that reflect developmental vulnerabilities to those disorders (Lenzenweger, 2010; Lenzenweger, 2011; Everett and Linscott, 2015). Reliable measurement and conceptualization of schizotypy is essential to improving detection of risk for mental illness and understanding the etiology of schizophrenia-spectrum disorders.

Although schizotypy is often thought of as a unitary construct, self-reported schizotypy has not been well-explained by a single dimension (Fonseca-Pedrero et al., 2014). Several different structures for partitioning dimensions of schizotypy have been proposed that differ depending on instrument and version, analytic approach, and purpose for dimensional reduction (Raine and Benishay, 1995; Fonseca-Pedrero et al., 2010b; Fonseca-Pedrero et al., 2014). In general, schizotypy traits include unusual or positive symptom-like experiences, cognitive disorganization, and social and personal affective difficulties including negative symptom-like experiences. At clinical levels of extremity, schizotypal traits are recognized as schizotypal personality disorder. However, they are not exclusive to the schizophrenia spectrum (Dinsdale et al., 2013). At more moderate levels, schizotypy is a source of variance in personal and social functioning (e.g., Fonseca-Pedrero et al., 2010a), a vulnerability or prodromal factor for psychosis (e.g., Horan et al., 2008b), and a stable trait-like feature of schizophrenia (e.g., Lenzenweger, 2011). A broad range of research has demonstrated reliable differences related to psychometrically-defined schizotypy (Sarkin et al., 1998; Dinn et al., 2002; Brown and Cohen, 2010), including differences in clinical presentation, clinical and genetic risk for mental illness, social cognitive abilities, and general functioning (Kaczorowski, 2012; McCleery et al., 2012; Morrison et al., 2013; Fervaha et al., 2014).

The Schizotypal Personality Questionnaire (SPQ; Raine, 1991) is a popular method of measuring both normal variability and abnormal degrees of schizotypy. Although the original 74-item SPQ was originally validated with undergraduates and tested for its ability to discriminate Schizotypal Personality Disorder, the SPQ has evolved as a measure of dimensional schizotypy rather than a diagnostic tool. Subsequent psychometric research shortened the instrument (e.g., Raine and Benishay, 1995) and improved its response format (Wuthrich and Bates, 2005). Recent versions have generally shown good reliability, validity, and long-term stability in people with and without psychosis (Mason, 2015; Moreno-Izco et al., 2015).

Several studies have examined the structure of different versions of the SPQ, although with different item combinations and response formats. Evidence for different dimensional

structures is mixed, but the overall positive, negative, and disorganized distinctions appear to be consistent, as there is substantial evidence for concurrent, predictive, and criterion validity (Stefanis et al., 2004; Compton et al., 2007; Compton et al., 2009; Cohen et al., 2010; Fonseca-Pedrero et al., 2011). The 32-item SPQ-BR (Cohen et al., 2010) is the most recent adult version, substantially shortened with an ordinal response format. The SPQ-BR has a hierarchical factor structure, with three correlated higher-order factors and seven subordinate, lower-order factors (see Fig. 1). It was adapted from the original SPQ (Raine, 1991) in response to psychometric limitations of an earlier shortened version, the 22-item SPQ-B (Raine and Benishay, 1995). Following Raine and Benishay (1995), the three higher-order factors proposed are Cognitive Perceptual (Ideas of Reference/Suspiciousness, Magical Thinking, and Unusual Perceptions), Interpersonal (No Close Friends/Constricted Affect and Social Anxiety), and Disorganized (Eccentric Behavior and Odd Speech). Given the differential nature of social anxiety in the context of schizotypy compared to typical variance in a healthy sample, Social Anxiety was also tested as a separate fourth factor rather than an indicator of Interpersonal schizotypy (Lewandowski et al., 2006; Brown et al., 2008). The developers of the SPQ-BR have demonstrated and replicated the fit and validity of these structures for undergraduate samples (Cohen et al., 2010; Morrison et al., 2013; Callaway et al., 2014).

Given these previous findings, the purposes of the current study include: 1) provide independent replication of the factor structures from Cohen et al. (2010) and Callaway et al. (2014); 2) demonstrate psychometric stability through internal replication in independent samples from the same undergraduate population; 3) recommend and test a minor change to the instrument wording to improve reliability; 4) provide normative data and essential psychometrics; and 5) test relationships of schizotypy to proxy indicators of psychiatric risk. The aim is toward replication and scale development rather than testing alternative theoretical approaches to schizotypy, which is a revitalized and valuable field for which brief and reliable measurement of schizotypy is essential (e.g., Ahmed et al., 2013; Fonseca-Pedrero et al., 2014; Debbané and Mohr, 2015).

The present study utilizes a sample of convenience from a large undergraduate recruitment pool (Davidson, 2014). Following previous findings, the present study will compare the fit of a single “schizotypy” measured trait (e.g., see Broyd et al., 2013) relative to a model that predicts schizotypy is indicated by multiple correlated traits. This study will also examine whether Social Anxiety fits better as an indicator of Interpersonal (negative symptoms) or as a separate correlated factor. We will also assess reliability and discriminant validity of the resulting factors, as well as the extent to which a model of parallel items provides support for the validity of summed scores as indicators of the latent traits. Although external validation variables are limited in the current sample, we will examine relationships between schizotypy with personal and family psychiatric history. Finally, given that the inconsistent pronoun use is confounded with the SPQ factor structure, the present study will test if removing this wording confound improves reliability.

To summarize, the primary foci of this paper are dimensionality, reliability, and validity of the SPQ-BR. For brevity, the changed wording analyses are only summarized here, and details are presented as a supplement. Similarly, given that detailed CFA and normative data

for the SPQ in undergraduates have been reported elsewhere, these intermediate models are summarized and details are presented in a second supplement.

2. Methods

2.1. Participants

Participants for this study were recruited at four different occasions for an online questionnaire including several researchers' measures. Participants were undergraduates recruited through psychology department mass screening (see Table 2). These four independent samples from the same population (undergraduates in introductory psychology courses at a large Midwestern university) are expected to differ only by time (four consecutive semesters) and sampling error. In other words, there was no known reason to expect systematic differences related to the measured traits. Only the first observation for repeat participants was used. Responses included validity-check items. For participating, students received course credit and entry to a large recruitment pool. All procedures were approved by the university Institutional Review Board (IRB#20111011874FB).

2.2. Materials

All participants provided basic demographic information. Starting in the 2012 Spring semester, participants also completed an additional Demographics Questionnaire (see Table 2). Participants were asked if they or any first-degree relative had ever been diagnosed with an Axis I disorder, been prescribed psychotropic medication, or received inpatient psychiatric treatment.

Participants completed the Schizotypal Personality Questionnaire-Brief Revised (SPQ-BR; Cohen et al., 2010; Table 1) in the 2011 Fall semester and a revised version (SPQ-BR "Updated," or SPQ-BRU, Supplement 1) for the remaining three semesters. The SPQ-BR (Cohen et al., 2010) is a 32-item self-report scale on a five-point ordinal response format ("strongly disagree"-"neutral"-"strongly agree") on which higher scores indicate greater schizotypy. The SPQ-BR is reported to have two equivalently good-fitting higher-order factor structures. The first includes three correlated higher-order factors of Interpersonal, Cognitive Perceptual, and Disorganized, which in turn are indicated by seven sub-factors. The Interpersonal higher-order factor includes: no Close Friends (CF), Constricted Affect (CA), and Social Anxiety (SA). The Cognitive Perceptual higher-order factor includes: Ideas of Reference (IR), Suspiciousness (SU), Magical Thinking (MT), and Unusual Perceptions (UP). The Disorganized higher-order factor includes: Eccentric Behavior (EB) and Odd Speech (OS). The second equivalently fitting structure includes Social Anxiety as a fourth higher-order factor not loading on but correlated with the higher-order Interpersonal factor, which includes No Close Friends and Constricted Affect. Further, in Cohen et al. (2010), two sets of subscales are combined: No Close Friends with Constricted Affect and Ideas of Reference with Suspiciousness (SU). In the present study, these factors are treated separately (nine rather than seven total factors). Analyses supporting this decision are included in Supplemental materials.

The SPQ-BRU item wording is changed minimally such that all prompts are phrased in the first-person (“I...”) and none are phrased in the second-person (“You...”).

2.3. Procedures

Participants’ responses were *included* based on three criteria: 1) not missing more than eight (25%) of the SPQ-BR item responses; 2) responding correctly to at least three of four validity check questions (e.g., “If you are paying attention, choose “slightly agree”); and 3) responses did not follow a blatantly arbitrary response set—specifically, not rating all or nearly all items with one rating. Response sets with inter-item standard deviations of 0.03 or higher were included.

2.4. Analytic approach

Robust Maximum Likelihood (MLR) estimation was used for all models. The goodness-of-fit indices employed were: Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA) and its confidence interval, and Standardized Root Mean Square Residual (SRMR). “Good fit” for these indices was considered at CFI = 0.95, RMSEA = 0.05, and SRMR = 0.08. All models were analyzed in Mplus (Version 7; Muthén and Muthén, 1998–2012). Differences in fit between nested models were evaluated using chi-square change (χ^2) tests for the $-2 \times$ scaled difference in the model log-likelihood χ^2 values. Single-order factor analyses assessed the direct fit of items to lower-order factors, which is a prerequisite for assessing higher-order structure. Higher-order factor analyses assessed the adequacy of higher-order factors in predicting the covariance among the lower-order factors. For factors with only two subfactor indicators, loadings onto the higher-order factor were constrained to one to achieve identification.

For single-order factors, we tested the assumption of parallel items: of equal factor loadings and equal residual variances of all items from the same factor. Reliability for each factor was assessed via model-based Omega (Miller, 1995; McDonald, 1999), which is a function of the factor loadings and residual variances.

Most analyses were carried out using the three semesters of similarly-worded SPQ-BRU item responses, excluding the SPQ-BR data from Fall 2011 due to their differently-worded items. The Fall 2011 SPQ-BR data and the subsequent Spring 2012 samples were used for all analyses of the updated wording. This subsequent semester reference sample was chosen to reduce the chance of a time-related cohort effect.

Evaluation of measurement invariance (MI) tested nested models, starting with the least restrictive configural model, which allows all parameters to vary differently (“freed”) across different samples. The best-fitting structural model for the data was used for invariance testing. At each successive step of invariance testing, specific sets of parameters were constrained to be equivalent across samples, and χ^2 tests were used to examine if the constrained model is equivalent, or more precisely, not significantly worse, than the less restrictive model. Single-order MI testing steps proceed: Configural, Metric (loadings), Scalar (intercepts), and Residual (item residual variances). Items whose loadings were invariant at one step were not tested in the proceeding steps (Chen et al., 2005). In MI steps with more than twenty simultaneous hypothesis tests, a moderate correction for multiple

comparisons was applied. For every comparison past the twentieth, alpha was adjusted for a proportionate incremental chance that that comparison would reflect a Type 1 error. For example, in tests with 32 comparisons, such as constraining all item loadings across two samples, $\alpha=0.03125$ (1–32) was applied to interpret each test. In tests with twenty or fewer comparisons, $\alpha=0.05$ (1–20) was applied.

Relationships for schizotypy predicting demographic variables were examined with linear or logistic multiple regression (as appropriate given the outcome type) by regressing the dependent variable on all of the final higher-order latent factors (Muthén, 1984). Logistic regression for binary outcomes utilized Monte Carlo integration (Asparouhov and Muthén, 2007).

3. Results

3.1. Sample description

Participant characteristics are described in Table 2. Supplement 1 provides descriptive normative data. Notably, a substantial portion of undergraduate participants endorsed beliefs and experiences that are often stigmatized as “abnormal,” in spite of their apparent presence in otherwise healthy people (Stefanis et al., 2002; Shevlin et al., 2007). For example, 7.9% endorsed “Agree” or higher for “I often feel that others have it in for me,” 25.1% endorsed “I am an odd, unusual person,” 11.2% endorsed “I often hear a voice speaking my thoughts aloud,” and 17.7% endorsed “Are your thoughts sometimes so strong that you can almost hear them?”.

3.2. Missing data

The number of missing responses per item in the dataset is reported in Supplement 1. Across four samples, 298 of a pool of 2710 responses were excluded: 158 due to blank datasets, 108 due to validity checks, and 32 due to arbitrary response sets.

3.3. SPQ-BR item wording

Details of this analysis are provided in Supplement 2. Briefly, analyses suggest a confound in the original wording (i.e., SPQ-BR) caused by or overlapping with a pronoun difference. Essentially, item responses differed due to first-person (“I...”) vs. second-person (“You...”) pronoun use, with second-person wording primarily in Cognitive-Perceptual items. Changing the wording to all first-person pronouns improved item response psychometrics, as indicated by increased loadings and decreased residual variances.

3.4. SPQ-BRU dimensionality (CFA)

3.4.1. Single-order models—Details are presented in Supplement 1. Briefly, a single-factor model did not fit adequately, i.e., a single factor (such as SPQ Total) does not adequately reproduce the patterns of covariance among the item responses. Separating the previously combined Interpersonal (no Close Friends and Constricted Affect) and Cognitive Perceptual (Ideas of Reference and Suspiciousness) subfactors substantially improved fit. The four-factor model predicted item covariance better than the three-factor model. The

nine-factor model fit better than the three- and four-factor models and was the only model with “good” fit (Fig. 2).

Reliability and model fit were further examined for each of the identified factors. The lower-order factors whose fit was testable had generally adequate goodness-of-fit indices. Omega reliabilities for each of the proposed factors were mostly adequate, ranging from 0.686 for Constricted Affect to 0.878 for Eccentric Behaviors. No scale’s items were tau-equivalent (i.e., they had unequal factor loadings) and thus were not parallel (i.e., also including unequal error variances), indicating summed scores would not adequately represent individual differences in the measured construct. Nonetheless, the authors recognize summed scores are likely to be used, especially in smaller samples, and normative data are presented in Supplement 1.

3.4.2. Higher-order models—The results of the higher-order dimensionality tests are shown in Table 3, and the hypotheses are illustrated in Fig. 1. Tests of fit of the higher-order models vs. the nine-factor baseline model were all significant, indicating that none of the models predicted the covariance among the lower-order factors exactly. A model with only one higher-order factor did not fit the data well, although RMSEA was adequate. The three-factor higher-order model fit better than the one-factor higher-order model, and the four-factor higher-order model fit better than the three-factor higher-order model. Both had acceptable goodness-of-fit indices, with CFI substantially higher than the one-factor higher-order model. Goodness-of-fit indices did not change substantially between three-factor and four-factor higher-order models. The parameters of the final, best-fitting higher-order model are provided in Supplement 1 and illustrated in Fig. 3.

3.5. SPQ-BRU internal replication

Measurement invariance—the extent to which the items related to their traits similarly across three independent samples of the same population—was partially supported. Item comparisons used the adjusted p-value for $32 \times 3 = 96$ comparisons, $p=0.01042$, $\chi^2(1) = 6.5616$. At the structural level, $9 \times 3 = 27$ comparisons were made, so alpha was adjusted to $p=0.03703$, $\chi^2(1)=4.3490$. Configural invariance held: each of the three samples fit adequately to the nine-factor single-order model. Metric invariance held, and all loadings were invariant (at $p < 0.01042$). Scalar invariance held partially. Specifically, four of the 96 compared items’ intercepts (conditional mean given a factor score=0) from the Fall 2012 sample were different from the other two samples: in the Fall 2012 sample, the third Unusual Perceptions item, third Ideas of Reference item, and fourth Odd Speech item had higher intercepts, whereas the first Eccentric Behaviors item had a lower intercept. These differences ranged from 0.10 to 0.15 on a scale of one to five. Overall, residual invariance held for these samples (i.e., fit of the residual model was not different from the final scalar model). However, there was one item residual for which freeing one sample to be different from the others improved model fit ($p<0.01042$): the third Odd Speech item from Spring 2012, which had reduced error (by 0.16) in the Spring 2012 sample compared to the other semesters.

Next, Structural invariance was examined across samples. Factor Variance invariance held: the Factor Variance invariance model was not significantly different from the final Residual invariance model. However, there was one factor for which freeing one sample improved model fit ($p < 0.03703$), a greater variance for the Spring 2013 IR factor, indicating that participants differed in Ideas of Reference to a greater degree (by 0.22) in this sample. Factor Mean invariance held for these samples, i.e., no factor means were different across samples. The three semester samples were overall structurally invariant.

In summary, the overall model was fully invariant except for four (of 96) intercept comparisons, which were each different by less than 3% of the item response range. Model comparisons are presented in Table 4 and 5 display the item parameters of the final invariant model with non-invariant parameters in boldface.

3.6. SPQ-BRU clinical correlates

In the SPQ-BRU sample, participants were asked about their own and their first-degree relatives' psychiatric history. A small portion of participants reported psychiatric treatment, and a slightly larger portion reported a family psychiatric history (see Table 6). The relationships between select demographics and SPQ-BRU higher-order factors were analyzed using logistic regression within structural equation modeling. Personal history of inpatient treatment was examined but is not included because the full-model and regression coefficients were not significant ($R^2 = 0.077$, $p = 0.123$). As shown in Table 6, all four SPQ-BRU higher-order traits independently positively related to personal history of psychiatric diagnosis or psychiatric medication as well as family history of psychiatric medication or inpatient treatment. All four predictors explained a small but significant portion of the variance in psychiatric history ($R^2 = 0.112$ – 0.205). Disorganized consistently had the strongest *unique* positive relationship to psychiatric history, Interpersonal had a small degree of unique positive covariance, Social Anxiety was not related, and Cognitive Perceptual was small-to-moderately *negatively* related (after accounting for covariance with other schizotypy traits).

4. Discussion

Schizotypy includes individual differences between people with no psychiatric problems as well as those with Serious Mental Illness (SMI). It is linked to risk for developing SMI, and it is also related to cognitive differences between healthy individuals that mirror those in SMI. Thus, analog research in people with and without schizotypal characteristics is important for development of research and treatment methods in SMI. The SPQ is commonly used to measure this essential construct of analog SMI research, and reliable and valid measurement is essential.

The present study sought to replicate Cohen et al. (2010), further clarify the factor structure of schizotypy and its constituent characteristics as they apply to responses to the SPQ-BR in a nonclinical sample, and to confirm and improve upon a confound in differential item wording. The data presented also provide practical normative information from a large young adult sample, assessment of internal replication stability, and assessment of the reliability and assumptions underlying the use of summed scores.

To briefly summarize: The nine-factor model had the best fit at a single order, and the four-factor model had the best fit at a higher order, and both had adequate fit indices, replicating Cohen et al. (2010). The instrument had reasonably consistent reliability and stability with some exceptions of very slight intercept differences. Discriminant validity was demonstrated by model fit and moderate correlations among factors. Criterion validity was provided by relationships between greater schizotypy, particularly Disorganized and Cognitive Perceptual, with personal and family psychiatric history. Evidence of the expected wording confound was identified in the originally-worded items, and model fit was improved by changing all items to first-person pronouns in the modified instrument (SPQ-BRU). As is apparent in Fig. 2, the pattern of second-person wording in the SPQ-BR was inextricably tied with the factor structure. The SPQ-BRU's consistent pronoun use improved item psychometrics, specifically increasing loadings and reducing residual variance.

The present responses to the SPQ-BR and SPQ-BRU items indicate a substantial and systematically covarying range of these traits in a non-clinical undergraduate sample. In other words, schizophrenia-like traits are present and vary meaningfully among relatively healthy adults. This supports one end of the hypothesis that schizotypal personality characteristics and experiences exist on a continuum across clinical and non-clinical populations (Lenzenweger, 2006), although the appropriate distribution of this continuum remains a focus of debate (Ahmed et al., 2013; Everett and Linscott, 2015). However, the present results support the conceptualization of multiple related but discriminant trait continua within the domain of schizotypy.

Results suggest schizotypy is well conceptualized as a set of nine constructs that can be summarized by four more general constructs. A single "schizotypy" trait was not supported, and the use of summed scores is not supported by tests of unidimensionality and parallel items.

Independently, all four schizotypy factors were positively related to personal and family psychiatric treatment history. Considering unique covariance, Disorganized consistently had the highest loading and Cognitive Perceptual had negative loadings. This appears inconsistent with predictors of psychosis risk (e.g., Cannon et al., 2008). However, despite recent efforts in early intervention (e.g., Melle et al., 2008), characteristics conferring psychosis risk are not necessarily more likely to motivate treatment utilization (e.g., Srihari et al., 2014). This result could indicate that endorsing Cognitive Perceptual items reflects insight and resiliency (Tait et al., 2003; Lappin et al., 2007). Interpersonal had small and trend-level loadings and Social Anxiety did not load significantly. This suggests that Social Anxiety functions differently from other schizotypy-related constructs in this population. Consequently, this also suggests that although the model fit of three-and four-factor higher order models differ to a small (but significant) degree, considering Social Anxiety independently of Interpersonal schizotypy was justified in this sample.

The SPQ-BRU items were overall mostly stable over three independent samples of the same population, although there was some evidence of instability. Several items from the Cognitive Perceptual and Disorganized sets had different intercepts in the Fall 2012 semester sample. However, four pairs of items across three samples being noted as non-invariant is

relatively small considering 96 binary intercept comparisons were made in a very large sample, and the intercept differences that affected overall model fit were different by less than 3% of the item response range. These differences could indicate Type 1 error, psychometric instability, an unknown cohort effect related to Spring vs. Fall semesters, or sampling variation. Overall, they are very slight difference effects.

The stability results not only indicate potential areas of psychometric instability and targets for scale improvement but also help isolate sources of invariance likely due to manipulation rather than measurement characteristics, for this and future analyses. Researchers may have increased confidence in results of future in-variance results in SPQ-BRU given its psychometric stability across independent samples of the same population. For instance, in the item wording analysis, two items whose parameters changed in SPQ-BRU (OS3 and EB1) were unstable. However, all loadings and other non-invariant item parameters were stable across semesters, suggesting these changes are due to wording change rather than random fluctuations in unstable measurement parameters.

The three-factor and four-factor higher-order structures were replicated in this sample (Raine et al., 1994; Compton et al., 2007; Cohen et al., 2010; Fonseca-Pedrero et al., 2011). It is notable, however, that the higher-order structures did not fit as well as the nine-factor lower-order structure, as assessed by goodness-of-fit indices and chi-square tests. Put simply, this suggests the 32 items measure nine “things,” which is unsurprising because the items were written to capture nine constructs that are theoretically related to schizotypy. Testing and interpreting higher-order structure despite poorer-fit addresses those theoretical relationships and the practicality of parsimony.

The Magical Thinking (MT) subfactor had adequate fit and reliability to its items, its standardized loading on Cognitive Perceptual was small (MT loading=0.39) compared to other sub-factor indicators (ranging 0.60–0.86). The first author has found MT unstable in predicting cognitive, social cognitive, and electro-physiological characteristics in a subsample (Davidson, 2014), its loading has been relatively weak in other factor analyses (Cohen et al., 2010; Callaway et al., 2014), and it may not be normally distributed in college samples, potentially due to floor-effects (Fonseca-Pedrero et al., 2014). This suggests the scale does not adequately measure MT in this population, MT does not fit CFA assumptions, and/or MT functions differently than other indicators of positive symptom-like experiences. This is consistent with literature that assesses MT separately with a large number of items (e.g., Horan et al., 2008a, 2008b).

There are several notable limitations and future directions for this study. A large sample and relatively liberal corrections for multiple comparisons were used. However, measurement stability invariance testing provides a control for observed non-invariance based on the wording manipulation, suggesting improvements are not due to sampling error. The results provide confidence in parameter-level reliability for future research. Non-invariant items may be targets for scale development.

A substantial limitation of this research design is that while these measures may be used to measure treatment response or recovery processes, this study is a cross-sectional design.

Another limitation is that this study was conducted in a large undergraduate sample enrolled in early courses in social sciences with very little variance in age, race/ethnicity, academic achievement, or socio-economic status, limiting generalizability (Henrich et al., 2010). Additionally, the demand biases in assessing schizotypy may be highly context-dependent. Items and scales may function quite differently in clinical populations or during in-person rather than online administration. The present results are directly relevant to research utilizing schizotypy to stratify recruitment from undergraduate pools. Future studies should examine schizotypy in different community samples and in mental illness (e.g., Crump et al., 2013). Finally, although techniques were employed to identify invalid responses, characteristics of non-responders could not be collected, and the possibility of nonrandom dropout and undetected invalid response sets cannot be excluded.

Development and improvement of research techniques in analog samples may improve personalization of treatment for people with SMI by improving the accuracy and breadth of assessment used in treatment planning and monitoring outcomes. Schizotypy research also has important implications for etiological and risk for psychosis research. Future studies should employ more diverse and clinical samples, identify appropriate analog measures, and repeat these measures over time in longitudinal designs, and finally these tools should be applied to analog treatment research.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Fig. 1.
Higher-Order Models for SPQ Lower-order factors: Three and Four-factor Models.

Fig. 2.
Single-Order Models for SPQ-BRU Items.

Better fit than 3 correlated higher-order model $\chi^2(1)=24.03^{**}$, MLR Correction=1.076

Fig. 3.
 SPQ-BRU CFA Summary. Four-factor structure, model fit, and standardized loadings.

Table 1

SPQ-BR original items (Cohen et al., 2010) plus 1st-person (“I”) vs. 2nd-person (“You”) pronoun.

SPQ-BR item	Factor	Sub-factor	I/you
1. Do you sometimes feel that people are talking about you?	CP	IR	You
2. Do you sometimes feel that other people are watching you?	CP	IR	You
3. When shopping, do you get the feeling that other people are taking notice of you?	CP	IR	You
4. I often feel that others have it in for me.	CP	SU	I
5. Do you sometimes get concerned that friends or co-workers are not really loyal or trustworthy?	CP	SU	You
6. Do you often have to keep an eye out to stop people from taking advantage of you?	CP	SU	You
7. Do you feel that you cannot get “close” to people?	IP	CF	You
8. I find it hard to be emotionally close to other people.	IP	CF	I
9. Do you feel that there is no one you are really close to outside of your immediate family, or people you can confide in or talk to about personal problems?	IP	CF	You
10. I tend to keep my feelings to myself.	IP	CA	I
11. I rarely laugh and smile.	IP	CA	I
12. I am not good at expressing my true feelings by the way I talk and look.	IP	CA	I
13. Other people see me as slightly eccentric (odd).	DO	EB	I
14. I am an odd, unusual person.	DO	EB	I
15. I have some eccentric (odd) habits.	DO	EB	I
16. People sometimes comment on my unusual mannerisms and habits.	DO	EB	I
17. Do you often feel nervous when you are in a group of unfamiliar people?	IP or SA	SA	You
18. I get anxious when meeting people for the first time.	IP or SA	SA	I
19. I feel very uncomfortable in social situations involving unfamiliar people.	IP or SA	SA	I
20. I sometimes avoid going to places where there will be many people because I will get anxious.	IP or SA	SA	I
21. Do you believe in telepathy (mind-reading)?	CP	MT	You
22. Do you believe in clairvoyance (psychic forces, fortune telling)?	CP	MT	You
23. Have you had experiences with astrology, seeing the future, UFO’s, ESP, or a sixth sense?	CP	MT	You
24. Have you ever felt that you are communicating with another person telepathically (by mind-reading)?	CP	MT	You
25. I sometimes jump quickly from one topic to another when speaking.	DO	OS	I
26. Do you tend to wander off the topic when having a conversation?	DO	OS	You
27. I often ramble on too much when speaking.	DO	OS	I
28. I sometimes forget what I am trying to say.	DO	OS	I
29. I often hear a voice speaking my thoughts aloud.	CP	UP	I
30. When you look at a person or yourself in a mirror, have you ever seen the face change right before your eyes?	CP	UP	You
31. Are your thoughts sometimes so strong that you can almost hear them?	CP	UP	You
32. Do everyday things seem unusually large or small?	CP	UP	You

Table 2

Demographics by sample semester.

	Fall 2011	Spring 2012	Fall 2012	Spring 2013
<i>N</i> (valid cases)	736	462	615	599
Age [average $\pm$ SD; (range)]	19.0 $\pm$ 1.7 (17–40)	19.2 $\pm$ 2.0 (17–46)	19.0 $\pm$ 1.6 (16–29)	19.5 $\pm$ 2.5 (17–55)
Sex (%female)	63%	60%	63%	62%
Ethnic/racial identity				
– Caucasian (non Hispanic)	86%	88%	84%	87%
– African American	3%	3%	3%	2%
– Asian/pacific islander	4%	3%	7%	3%
– Hispanic/Latino	3%	5%	4%	4%
– Native American	1%	0	1%	1%
– Other	2%	2%	2%	1%
Employment				
– Full time	2%	1%	2%	1%
– Part time	33%	25%	21%	29%
Socio-economic status (self-reported)				
– “Upper class”	6%	9%	7%	10%
– “Middle class”	73%	74%	72%	71%
– “Working class”	12%	15%	17%	15%
– “Lower class”	3%	2%	3%	2%
Residence				
– On campus	65%	74%	68%	68%
– Off campus	30%	25%	31%	31%
ACT score (self-reported)	24.7 $\pm$ 3.9 (15–36)	25.4 $\pm$ 4.0 (14–35)	25.5 $\pm$ 4.0 (12–35)	25.6 $\pm$ 3.9 (15–36)
English as first-language else, age learned English	n/a	96% 7.8 $\pm$ 5.1 (3.5–22)	94% 7.0 $\pm$ 4.6 (1–22)	95% $\pm$ 4.74.4 (1–16)
Mother’s education	n/a			
– Less than high school		4%	4%	3%
– High school graduate		14%	15%	13%
– Some college		20%	22%	19%
– Graduated college		43%	39%	42%
– Some graduate or professional school		4%	3%	5%
– Finished graduate or professional school		16%	15%	16%
Father’s education	n/a			
– Less than high school		3%	3%	3%
– High school graduate		18%	18%	17%
– Some college		20%	18%	17%
– Graduated college		39%	37%	37%
– Some graduate or professional school		5%	4%	3%
– Finished graduate or profes-		15%	19%	20%

	Fall 2011	Spring 2012	Fall 2012	Spring 2013
sional school				

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SPQ-BRU multi-order dimensionality – CFA results the three-factor model fit better than the one-factor higher-order model $\chi^2(2)=516.3, p<0.0005$, and the four-factor fit better than the three-factor higher-order model $\chi^2(1)=24.03, p<0.0005$.

Table 3

Model description	- 2LL	MLR scaling factor	rescaled χ^2 (p-Value) [vs. 9-factor]	DF	RMSEA (CI)	CFI	SRMR
0. 9 Lower-order factors (baseline)	-66,408	1.190	n/a	n/a	0.036 (0.034–0.038)	0.955	0.034
1. 1 Higher-order factor	-66,842	1.223	819.4 (<0.0005)	27	0.047 (0.045–0.049)	0.918	0.065
2. 3 Higher-order factors	-66,622	1.216	398.9 (<0.0005)	25	0.041 (0.039–0.043)	0.937	0.054
3. 4 Higher-order factors (+ social anxiety)	-66,609	1.215	374.8 (<0.0005)	24	0.041 (0.039–0.043)	0.938	0.051

Table 4

Single-order invariance for SPQ-BRU items across three semesters

Model description (all within the nine-factor single-order structure)	-2LL	MLR scaling factor	rescaled χ^2 (<i>p</i> -value; each model vs. previous)	DF	RMSEA (CI)	CFI	SRMR
Saturated	-64,887	1.1139	n/a	n/a	n/a	n/a	n/a
Configural (structure)	-66,136	1.1896	2290.2 (< 0.0005)	1284	0.037 (0.035–0.040)	0.952	0.040
Metric (loadings)	-66,167	1.1977	54.4 (0.186)	46	0.037 (0.034–0.039)	0.951	0.042
Scalar (intercepts)	-66,209	1.2277	85.1 (< 0.0005)	46	0.037 (0.035–0.039)	0.949	0.042
Fall 2012 UP3 freed	-66,205	1.2270	9.1 (0.003)	1	0.037 (0.034–0.039)	0.950	0.042
Fall 2012 IR6 also freed	-66,200	1.2262	9.3 (0.002)	1	0.037 (0.034–0.039)	0.950	0.042
Fall 2012 EB1 also freed	-66,196	1.2254	9.0 (0.003)	1	0.037 (0.034–0.039)	0.950	0.042
Fall 2012 OS4 also freed	-66,192	1.2247	7.6 (0.006)	1	0.037 (0.034–0.039)	0.951	0.042
Strict (residuals)	-66,236	1.1270	54.2 (0.686)	60	0.035 (0.033–0.038)	0.952	0.043
Spring 2012 OS3 freed	-66,231	1.1288	6.7 (0.099)	1	0.035 (0.033–0.038)	0.953	0.043
Structural (factor variances) ^a	-66,238	1.1628	21.3 (0.213)	17	0.035 (0.033–0.037)	0.952	0.046
Spring 2012 IR freed	-66,235	1.1611	6.9 (0.009)	1	0.035 (0.033–0.037)	0.952	0.045
Structural (factor means)	-66,247	1.1750	23.4 (0.177)	18	0.035 (0.033–0.037)	0.952	0.046

IR: Ideas of Reference; EB: Eccentric Behavior; OS: Odd Speech; UP: Unusual Perceptions.

^aFor binary comparisons at the structural invariance level, alpha=0.05.

Table 5

Item parameters in the SPQ-BRU three semester samples, final invariant items model.

Sub-factor	Item #	Spring 2012: unstandardized lower-order item parameters			Fall 2012: unstandardized lower-order item parameters			Spring 2013: unstandardized lower-order item parameters		
		Loading	Intercept	Residual	Loading	Intercept	Residual	Loading	Intercept	Residual
IR	01	0.698 ^a	3.204	0.442	0.698	3.204	0.442	0.698	3.204	0.442
IR	02	0.827	3.096	0.308	0.827	3.096	0.308	0.827	3.096	0.308
IR	03	0.614	2.887	0.621	0.614	3.011	0.538	0.614	2.887	0.621
SU	04	0.581	2.083	0.480	0.581	2.083	0.480	0.581	2.083	0.480
SU	05	0.729	2.774	0.603	0.729	2.774	0.603	0.729	2.774	0.603
SU	06	0.710	2.580	0.648	0.710	2.580	0.648	0.710	2.580	0.648
CF	07	0.972	2.323	0.256	0.972	2.323	0.256	0.972	2.323	0.256
CF	08	1.026	2.460	0.354	1.026	2.460	0.354	1.026	2.460	0.354
CF	09	0.743	2.009	0.665	0.743	2.009	0.665	0.743	2.009	0.665
CA	10	0.825	3.223	0.799	0.825	3.223	0.799	0.825	3.223	0.799
CA	11	0.414	1.461	0.410	0.414	1.461	0.410	0.414	1.461	0.410
CA	12	0.829	2.513	0.676	0.829	2.513	0.676	0.829	2.513	0.676
EB	13	0.972	2.672	0.321	0.972	2.576	0.365	0.972	2.672	0.321
EB	14	1.007	2.597	0.310	1.007	2.597	0.310	1.007	2.597	0.310
EB	15	0.846	3.011	0.573	0.846	3.011	0.573	0.846	3.011	0.573
EB	16	0.815	2.587	0.592	0.815	2.587	0.592	0.815	2.587	0.592
SA	17	1.032	3.153	0.377	1.032	3.153	0.377	1.032	3.153	0.377
SA	18	0.958	3.163	0.409	0.958	3.163	0.409	0.958	3.163	0.409
SA	19	0.955	2.926	0.411	0.955	2.926	0.411	0.955	2.926	0.411
SA	20	0.769	2.379	0.694	0.769	2.379	0.694	0.769	2.379	0.694
MT	21	0.769	1.759	0.222	0.769	1.759	0.222	0.769	1.759	0.222
MT	22	0.798	1.827	0.294	0.798	1.827	0.397	0.798	1.827	0.397
MT	23	0.673	1.648	0.482	0.673	1.648	0.482	0.673	1.648	0.482
MT	24	0.563	1.525	0.334	0.563	1.525	0.334	0.563	1.525	0.334
OS	25	0.910	3.156	0.442	0.910	3.156	0.442	0.910	3.156	0.442
OS	26	0.950	2.984	0.294	0.950	2.984	0.294	0.950	2.984	0.294

Sub-factor	Item #	Spring 2012: unstandardized lower-order item parameters			Fall 2012: unstandardized lower-order item parameters			Spring 2013: unstandardized lower-order item parameters		
		Loading	Intercept	Residual	Loading	Intercept	Residual	Loading	Intercept	Residual
OS	27	0.809	2.935	0.451	0.809	2.935	0.611	0.809	2.935	0.611
OS	28	0.631	3.357	0.699	0.631	3.478	0.627	0.631	3.357	0.699
UP	29	0.748	1.914	0.566	0.748	1.914	0.566	0.748	1.914	0.566
UP	30	0.493	1.529	0.340	0.493	1.529	0.340	0.493	1.529	0.340
UP	31	0.843	2.123	0.554	0.843	2.272	0.728	0.843	2.123	0.554
UP	32	0.621	1.777	0.440	0.621	1.777	0.440	0.621	1.777	0.440

IR: Ideas of Reference; SU: Suspiciousness; CF: No Close Friends; CA: Constricted Affect; EB: Eccentric Behavior; SA: Social Anxiety; MT: Magical Thinking; OS: Odd Speech; UP: Unusual Perceptions.

^aNon-invariant parameters are bold.

Table 6

Logistic regression: personal and family psychiatric history on Schizotypy factors.

Dependent variable (% prevalence)	SPQ-BRU factor predictor	Single-predictor logistic regression (one latent trait as predictor)			Full logistic regression model (all four latent traits as predictors)			
		Odds ratio ^a	Co-efficient	p-Value	R ² (p-Value)	Odds ratio	Co-efficient	p-Value
Diagnosed with axis I disorder (9.0%)	Cognitive-Perceptual	3.122	0.289	<0.0005	0.205 (<0.0005)	0.312	-0.258	0.036
	Interpersonal	1.986	0.280	<0.0005		1.506	0.156	0.052
	Disorganized	3.723	0.411	<0.0005		5.766	0.529	<0.0005
Ever prescribed psychotropic medication (7.4%)	Social anxiety	1.529	0.234	<0.0005		1.013	0.006	0.925
	Cognitive-Perceptual	2.513	0.239	<0.0005	0.204 (0.002)	0.231	-0.325	0.013
	Interpersonal	1.757	0.233	<0.0005		1.474	0.148	0.083
Family history of psychotropic medications (17.7%)	Disorganized	3.250	0.376	<0.0005		6.749	0.577	<0.0005
	Social anxiety	1.403	0.189	0.001		0.957	-0.022	0.758
	Cognitive-Perceptual	1.947	0.175	<0.0005	0.140 (0.001)	0.305	-0.274	0.007
Family history of inpatient treatment (15.6%)	Interpersonal	1.442	0.154	<0.0005		1.279	0.098	0.151
	Disorganized	2.420	0.292	<0.0005		4.971	0.504	<0.0005
	Social anxiety	1.218	0.111	0.005		0.909	-0.050	0.345
	Cognitive-Perceptual	2.078	0.191	<0.0005	0.112 (0.003)	0.370	-0.233	0.022
	Interpersonal	1.519	0.202	<0.0005		1.468	0.155	0.020
	Disorganized	2.345	0.281	<0.0005		3.504	0.400	<0.0005
	Social anxiety	1.302	0.148	<0.0005		0.960	-0.022	0.703

^aSchizotypy trait factors in this model are fully Z-scored (factor mean=0, variance=1), and thus an odds ratio (OR) represents the odds of the dependent variable given a one standard deviation change in the schizotypal trait, and the logistic regression coefficients represent the change in log odds of the dependent variable for a one unit increase in the predictor (standardized, so loading=loading*SD(theta)/SD(Y))