The dimensional structure of short forms of the Wisconsin Schizotypy Scales

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Abstract:

The Wisconsin Schizotypy Scales (WSS) are widely used for assessing schizotypy. Confirmatory factor analysis (CFA) indicates that a two-factor structure, positive and negative schizotypy, underlies these scales. Recently developed 15-item short forms of the WSS demonstrated good reliability and validity. This study examined the factor structure underlying the short-form WSS. Consistent with the original scales, CFA on three large samples (n = 6137, 2171, and 2292, respectively) indicated that a two-factor model with positive and negative dimensions provided better fit than a generic schizotypy model for the short-form WSS. The short-form dimensions correlated highly with the original scale dimensions and displayed good stability across 10 weeks. Preliminary construct validity was demonstrated through associations with interview and questionnaire measures of psychopathology, functioning, and personality comparable to those found with the original WSS. This is the first study examining the dimensional structure of the short WSS and the validity of these dimensions. The findings support the multidimensional nature of schizotypy and the appropriateness of dimensions derived from the short-form WSS.

Keywords: Schizotypy | Wisconsin Schizotypy Scales | Schizophrenia | Psychosis proneness

Article:

Introduction

Current research conceptualizes schizotypy as a multidimensional phenotype that encompasses clinical and subclinical manifestations of the schizophrenia spectrum (Lenzenweger, 2010 and Kwapil and Barrantes-Vidal, 2014). Ample evidence supports significant overlap between schizotypy and schizophrenia across behavioral and neurobiological domains, suggesting that the identification of schizotypic individuals should facilitate the detection of etiological risk and protective factors for schizophrenia-spectrum disorders (for a review see Ettinger et al., 2014). It also allows for the examination of etiological factors relatively untainted by confounds accompanying full-blown schizophrenia, such as hospitalization, medication, and stigma. Since their development by the Chapmans and colleagues, the Wisconsin Schizotypy Scales (WSS, also known as the Chapman Scales of Psychosis Proneness)—including the Perceptual Aberration (Chapman et al., 1978), Magical Ideation (Eckblad and Chapman, 1983), Physical Anhedonia (Chapman et al., 1976), and Revised Social Anhedonia (Eckblad et al., 1982)

Scales—have been widely employed in the study of schizotypy. Cross-sectional and longitudinal investigations provided evidence for the reliability and validity of the WSS (e.g., Gooding et al., 2005, Kwapil et al., 2008 and Kwapil et al., 2013).

Schizotypy, and by extension schizophrenia, are conceptualized as multidimensional constructs (Raine et al., 1994, Vollema and van den Bosch, 1995 and Stefanis et al., 2004), with positive and negative symptom dimensions the most consistently replicated factors. Using confirmatory factor analysis (CFA) with 6137 young adults, Kwapil et al. (2008) found evidence for a two-factor structure with positive and negative factors underlying the original WSS. In addition, they reported that, as hypothesized, the schizotypy dimensions were differentially associated with symptoms and impairment. Positive schizotypy was associated with psychotic-like experiences, substance abuse, mood disorders, and mental health treatment; negative schizotypy was associated with negative and schizoid symptoms and decreased likelihood of intimate relationships. Both dimensions were related to schizotypal and paranoid symptoms and poorer functioning. Kwapil et al. (2013) reported that both dimensions predicted schizophrenia-spectrum disorders using data from the 10-year follow-up study conducted by Chapman et al. (1994).

Despite the demonstrated validity of the WSS, the combined length of the scales (166 items) can be problematic; therefore, Winterstein et al. (2011) created 15-item short forms for each of the four WSS. They chose items based upon content analysis and psychometric properties using classical test theory, item response theory, and differential item functioning. Winterstein et al. (2011) reported good internal consistency for the short-form scales as well as preliminary evidence for validity. Gross et al. (2012) investigated the reliability and validity of the short-form WSS using interview ratings of psychotic-like and schizophrenia-spectrum symptoms and questionnaire measures of personality and social impairment. Despite the drastic reduction in items, the short scales demonstrated good reliability, correlated highly with the original scales, and exhibited hypothesized associations with measures of psychopathology, personality, and impairment. Fonseca-Pedrero et al. (2014) reported that the brief versions of the Perceptual Aberration and Magical Ideation Scales had good psychometric properties and loaded on a single underlying factor. However, they did not examine the properties of the anhedonia scales.

The present study extends the work of Winterstein et al. (2011), Fonseca-Pedrero et al. (2014), and Gross et al. (2012) by examining the factor structure underlying the short WSS in three large samples. This is the first study examining the dimensional structure of the short WSS and the validity of these dimensions. It was hypothesized that the two-factor structure reported by Kwapil et al. (2008) for the original scales will be replicated in the shortened scales. Assuming that the structure is supported, we hypothesized that the short-form dimensions would exhibit good temporal stability and comparable associations with measures of schizotypic symptoms, impairment, personality, and social functioning as reported in Kwapil et al. (2008).

Method

Participants

WSS data were obtained from three large, independent samples of undergraduates. The first two samples completed the original WSS. We then derived the short WSS scores and dimensions from the original scales, allowing us to compare performance, factor structure, and the correlates of these factors between the original and short scales. The first sample included 6137 students (76% female) with a mean age of 19.4 (SD = 3.7). This sample was used by Kwapil et al. (2008) to examine the factor structure of the original schizotypy scales and by Winterstein et al. (2011) to derive the short forms. Therefore, a second sample of 2171 participants (76% female) with a mean age of 19.6 (SD = 3.3) from Kwapil et al. (2012) was used in the CFAs to provide an independent comparison of the findings from the original sample. The third sample was collected specifically for the present study to provide an independent sample that completed only the short WSS. It contained 2292 participants (76% female) with a mean age of 19.5 (SD = 2.8). Note that the three groups did not differ significantly on age or sex composition.

To examine the temporal stability of the schizotypy dimension scores, a subset of 106 participants from sample 1 volunteered to complete the schizotypy scales on two occasions about 10 weeks apart (sample 1a). In terms of demographics and WSS scores, this subset was comparable to the original sample. To examine construct validity of the short forms, a subset of 780 participants from sample 1 completed personality and social adjustment questionnaires (sample 1b). Likewise, this subset was comparable to the original sample. An overlapping subset of 430 participants from sample 1 was administered structured diagnostic interviews (sample 1c). This subset displayed similar demographics but slightly higher WSS scores than the original sample. Note that samples 1b and 1c were examined in Kwapil et al. (2008) and Gross et al. (2012).

Materials and procedures

The first two samples completed the original WSS (which were used to compute short WSS scores), whereas participants in the third sample only completed the short WSS. The original scales take about 25 min to complete, whereas the short forms take about 10 min. All participants completed a 13-item infrequency measure (Chapman and Chapman, 1983) to screen for invalid responders. The rate of omitted subjects ranged from 6.3% to 9.3% across the three samples. The Perceptual Aberration Scale measures psychotic-like perceptual and bodily experiences, the Magical Ideation Scale assesses beliefs in invalid causality, the Revised Social Anhedonia Scale taps asociality and diminished pleasure from social situations, and the Physical Anhedonia Scale assesses deficits in sensory and aesthetic pleasure.

Sample 1b (n = 780) completed the NEO-PI-R (Costa and McCrae, 1992), a self-report measure of the Five-Factor Model of personality, as well as the Social Adjustment Scale (Weissman, 1999), a self-report measure of social functioning in school, leisure, and family contexts. Sample 1c (n = 430) completed portions of the Structured Clinical Interview for DSM-IV (First et al., 1995) assessing mood episodes and substance use disorders. Quantitative ratings of substance use and impairment were coded using the rating system described in Kwapil (1996). The International Personality Disorders Examination (World Health Organization, 1995) was used to provide diagnoses and dimensional ratings of schizophrenia-spectrum personality disorders. The Wisconsin Manual for Assessing Psychotic-like Experiences (Chapman and Chapman, 1980) was used to assess seven classes of clinical and subclinical psychotic symptoms. The Negative

Symptom Manual (Kwapil and Dickerson, 2001) assesses six classes of clinical and subclinical negative symptoms of schizophrenia. The Global Assessment of Functioning Scale (GAF; American Psychiatric Association, 2000) assesses overall functioning. The diagnostic interviews were conducted by a licensed psychologist and advanced graduate students who were unaware of participants' WSS scores. Participants provided informed consent and received credit for their participation. The study was approved by the UNCG Institutional Review Board.

Results

Descriptive statistics for the short WSS in the first two samples are reported in Gross et al. (2012) and descriptives for the third sample are reported in Table 1. These values were comparable across the three samples, and the short scales demonstrated good reliability and high correlations with their original scale counterparts.

	M	SD	Range	Skew (SE)	Kurtosis (SE)	Alpha	Binary alpha
Magical Ideation	3.55	2.93	0–15	0.86 (.05)	0.30 (.10)	.75	.93
Perceptual Aberration	1.29	2.12	0–15	2.50 (.05)	7.70 (.10)	.79	.86
Social Anhedonia	2.46	2.64	0–15	1.54 (.05)	2.52 (.10)	.77	.89
Physical Anhedonia	2.35	2.17	0–14	1.25 (.05)	1.75 (.10)	.65	.82

Table 1. Descriptive statistics for the Shortened Wisconsin Schizotypy Scales in sample 3 (n = 2292).

Confirmatory factor analyses

CFAs were conducted to examine the factor structure underlying the shortened scales in each of the samples. Sample size and number of participants per observable variable were more than sufficient (Bentler and Chou, 1987) and well above the 200 participants minimum recommended by Barrett (2007). The WSS items have a binary response format so they were treated as categorical indicators in the models. Note that the specification of categorical item-level observed variables precludes the use of many traditional fit statistics (e.g., GFI or RMSEA). Model fit was assessed using the Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), and Sample-Size Adjusted BIC; smaller values indicate better fit (Kline, 2011). Unlike other fit indices, AIC and BIC adjust for model complexity by penalizing more complex models. All analyses were computed using Mplus 7 (Muthén and Muthén, 2010) with maximum likelihood estimation with robust standard errors (MLR), which is recommended for use with categorical indicators (e.g., Finney and DiStefano, 2013).

Consistent with Kwapil et al. (2008), three models were tested. In each model, latent factors were estimated for each of the four scales from the 15 dichotomous items (specified as categorical variables). The latent factors for each of the scales were then used to estimate higher-order schizotypy latent factors. The first (default) model did not differentiate an underlying factor structure for schizotypy, but rather just included a generic schizotypy factor. The second model included a positive schizotypy factor with loadings from Perceptual Aberration and Magical Ideation, and a negative schizotypy factor with loadings from Revised Social Anhedonia and Physical Anhedonia. The positive and negative schizotypy factors were allowed to correlate

in this and the subsequent model. The final model allowed the Revised Social Anhedonia factor to load on both of the schizotypy factors, consistent with previous findings (Lewandowski et al., 2006, Brown et al., 2008 and Kwapil et al., 2008). As seen in Table 2, the final model provided the best fit for the data in all three samples. Fig. 1 provides the item and factor loadings from each of the three samples for the best fitting model.

	Sample 1 ($n = 6137$)			Sample 2 ($n = 2171$)			Sample 3 ($n = 2292$)		
	AIC	BIC	Adj. BIC	AIC	BIC	Adj. BIC	AIC	BIC	Adj. BIC
Unidimensional	245,632.4	246,439.0	246,057.7	88,664.8	89,346.8	88,965.5	101,482.9	102,171.3	101,790.1
Two-factor[a]	245,223.7	246,037.1	245,652.6	88,545.7	89,233.3	88,848.9	101,411.5	102,105.7	101,721.3
Two-factor[b]	245,056.7	245,876.8	245,489.0	88,438.3	89,131.7	88,744.1	101,343.8	102,043.7	101,656.1

Table 2. Confirmatory factor analyses using the schizotypy items.

AIC = Akaike Information Criteria, BIC = Bayesian Information Criteria.

a. Positive schizotypy factor (loadings from the Perceptual Aberration and Magical Ideation Scales); negative schizotypy factor (loadings from the Revised Social Anhedonia and Physical Anhedonia Scales).

b.

c. Positive schizotypy factor (loadings from the Perceptual Aberration, Magical Ideation and Revised Social Anhedonia Scales); negative schizotypy factor (loadings from the Revised Social Anhedonia and Physical Anhedonia Scales).

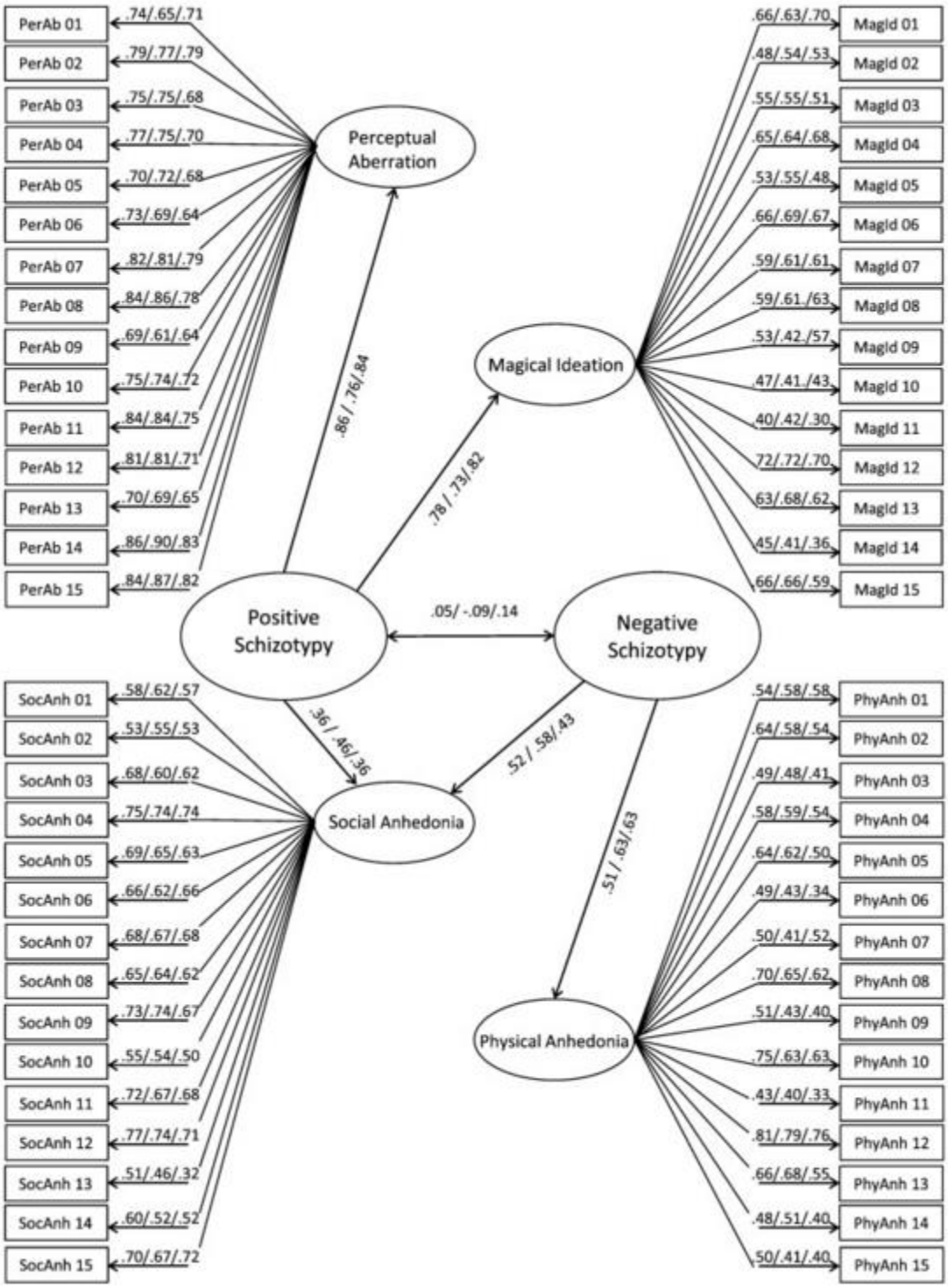

Fig. 1. Confirmatory factor analysis two-factor solution showing standardized coefficients from three samples (n = 6137/n = 2171/n = 2292).

Computation of factor scores

Positive and negative schizotypy dimensional scores were computed for each participant based upon the factor weights derived from the final CFA. Researchers wanting to compute the factor scores for the schizotypy dimensions may find item-level categorical CFA impractical. A more practical alternative method for computing the factor scores comes from loadings derived from principal components analysis of the short-scale scores from sample 1. The positive schizotypy factor can be computed as: (Perceptual Aberration * .234) + (Magical Ideation * .187) + (Physical Anhedonia * −.047) + (Social Anhedonia * .051) − .89. The negative schizotypy factor score can be computed as: (Perceptual Aberration * .018) + (Magical Ideation * − .015) + (Physical Anhedonia * .279) + (Social Anhedonia * .244) − .999. Note that the CFA and principal components derived dimensions correlated highly: .92 for the positive dimension and .94 for the negative dimension.

Correlation of dimension scores from the original and shortened scales

Correlations were computed in the first two samples to examine the comparability of the respective schizotypy dimensions based upon the original and short scales. The positive schizotypy dimension scores from the original and short scales correlated .93 and the negative schizotypy dimension scores correlated .88 in both samples, $p < .001$. Thus, the dimensions derived from the original and short scales appeared consistent.

Temporal stability of schizotypy dimension scores

The schizotypy dimensions showed good test–retest reliability over a 10-week interval (M = 10.4, SD = 1.0, range = 8.6–12.3 weeks) in sample 1a. The intraclass correlation was .84 for the short-scale positive schizotypy and .78 for the short-scale negative schizotypy dimensions ($p < .001$ for both correlations). These values were comparable to the test–retest reliability of the schizotypy dimensional scores computed from the original scales (.81 for positive and .82 for negative schizotypy). The stability of the dimensional scores for the short scales was good in terms of overall magnitude, magnitude relative to the internal consistency reliability of the component short scales, and magnitude of the stability of the dimensional scores from the original scales.

Validity of the schizotypy dimensions

To assess the validity of the schizotypy dimensions, a series of simultaneous linear and binary logistic regressions was computed that examined the prediction of interview measures of psychopathology and questionnaire measures of personality and social adjustment. The positive and negative schizotypy factor scores were entered simultaneously to examine the relative contribution of each factor. The standardized regression coefficient (β), semi-partial r2, and effect size f2 were reported for each predictor. Following Cohen (1992), f2 values above .15 are medium effects and above .35 are large effect sizes. Binary logistic regressions were computed for dichotomous criteria with the odds-ratios and 95% confidence intervals reported. Maximum likelihood estimation and bootstrapped standard errors (with 2000 samples) were employed. Alpha level was set at .001 for all of the regression analyses to minimize Type I error and reduce the likelihood of reporting statistically significant but inconsequential findings.

Table 3 presents the associations of the positive and negative schizotypy factors with interview measures of psychopathology. The significance and magnitude of the findings mirror the results for the dimensions derived from the original WSS reported by Kwapil et al. (2008). Both dimensions were associated with poorer overall adjustment and schizotypal and paranoid symptoms. The positive dimension was uniquely associated with ratings of psychotic-like experiences and substance abuse, whereas the negative dimension was uniquely associated with negative and schizoid symptoms. Table 4 presents the binary logistic regressions examining the associations of the schizotypy dimensions with interviews of mood episodes, mental health treatment, and family psychopathology. Positive, but not negative, schizotypy was associated with history of major depressive episodes and mental health treatment.

	(*df* = 1,427)					
	Positive schizotypy			Negative schizotypy		
Criterion	β	Δr^2	f^2	β	Δr^2	f^2
Global Adjustment Scale	− .351	.123*	**.15**	− .231	.053*	.06
Psychotic-like experiences	.532	.283*	***.40***	.046	.002	.00
NSM – total score	.069	.005	.01	.488	.238*	**.31**
Schizotypal symptoms	.413	.170*	**.21**	.159	.025*	.03
Schizoid symptoms	.090	.008	.01	.419	.175*	**.21**
Paranoid symptoms	.197	.038*	.04	.171	.029*	.03
Alcohol impairment	.209	.043*	.05	− .037	.001	.00
Drug impairment	.334	.111*	.13	-.051	.002	.00

Table 3. Linear regressions of the interview measures of psychopathology in sample 1b (n = 430).

Medium effect sizes in bold, large effect sizes in bold and italics.
*p < .001.

	Positive schizotypy		Negative schizotypy	
Criterion	OR	95% CI	OR	95% CI
Steady relationship	1.14	.90–1.45	.78	.63–.97
Major depressive episode	1.73*	1.38–2.17	.94	.73–1.22
Manic episode	3.77	1.69–8.45	1.56	.63–3.87
Psychiatric treatment				
Hospitalization	2.16	1.33–3.53	1.35	.76–2.37
Outpatient	1.64*	1.32–2.04	.88	.68–1.13
Medication	1.70*	1.31–2.20	1.11	.83–1.49
Any treatment	1.74*	1.40–2.16	.93	.73–1.19
1st or 2nd degree relative				
With psychosis	1.29	.87–1.93	1.01	.64–1.59
With nonpsychotic illness	1.32	1.08–1.60	.93	.77–1.12

Table 4. Logistic regressions of interview measures of psychopathology and treatment in sample 1b (n = 430).
*$p < .001$.

Table 5 presents linear regressions for the Social Adjustment Scale and the NEO-PI-R domain scores. Both schizotypy dimensions were associated with overall ratings of social impairment. Positive schizotypy was associated with social impairment in school and family settings, whereas negative schizotypy was associated with impairment in leisure and family settings. Positive schizotypy was associated with increased neuroticism and decreased agreeableness and conscientiousness. Negative schizotypy was associated with low extraversion and decreased agreeableness. Both positive and negative schizotypy were associated with openness to experience; however, consistent with Kwapil et al. (2008) and Gross et al. (2014) the associations were in contrasting directions.

	Step 1 (*df* = 1,777)					
	Positive schizotypy			Negative schizotypy		
Criterion	β	Δr^2	f^2	β	Δr^2	f^2
Social adjustment scale						
Total	.235	.054*	.07	.224	.049*	.06
Student	.223	.049*	.05	.028	.001	.00
Leisure	.109	.012	.01	.274	.074*	.08
Family	.225	.050*	.05	.136	.018*	.02
NEO-PI-R						
Neuroticism	.309	.094*	.10	.042	.002	.00
Extraversion	− .090	.008	.01	− .479	.225*	**.30**
Openness to Experience	.277	.075*	.09	− .319	.100*	.12
Agreeableness	− .157	.024*	.03	− .246	.059*	.07
Conscientiousness	− .212	.044*	.05	.001	.000	.00

Table 5. Linear regressions of questionnaire measures of personality and adjustment in sample 1c (n = 780).

Medium effect sizes in bold.
*p < .001.

Discussion

The construct of schizotypy affords a unique opportunity to investigate neurodevelopmental and psychosocial factors underlying schizophrenia. Further, it provides a rich model for conceptualizing psychosis as a dynamic continuum ranging from subclinical manifestations, to schizophrenia-spectrum personality disorders, to schizophrenia. Phenomelogical, genetic, cognitive, and neurobiological evidence for putative overlap between schizotypy and schizophrenia supports the dimensional conceptualization of these constructs and suggests that the schizotypy continuum provides the unique opportunity to elucidate etiological risk and protective factors for schizophrenic psychopathology (Ettinger et al., 2014). Psychometric assessments have been extensively employed in the measurement of schizotypy because they are noninvasive, inexpensive to administer, and useful in conjunction with other measures of risk. The Chapmans' original WSS have been widely used, and numerous cross-sectional and longitudinal studies support their validity. Furthermore, recent studies consistently demonstrate that a two-factor structure underlies the scales. The identification of this factor structure is advantageous because it maps onto current conceptual models of schizotypy and allows researchers to work with two dimension scores rather than scores from multiple scales.

The present study employed a series of CFA models to examine the factor structure of the short WSS in three large samples. The validity of the factor structure was then examined in two subsamples. The study indicated that: a) a comparable factor structure underlies the original and short WSS; b) the schizotypy dimensions derived from the short WSS correlate highly with the original WSS dimensions; c) the dimensions have good temporal stability; d) the short-form dimensions demonstrate construct validity based upon associations with psychopathology, functioning, and personality; and e) the validity of the short dimensions is consistent with findings from the original WSS. These findings are essential given that researchers who employ the brief scales will do so with the expectation that they are measuring the same constructs as the original scales.

The conceptualization and measurement of schizotypy and schizophrenia as multidimensional appear essential for advancing our understanding of these constructs. Many studies demonstrate that the positive and negative symptom dimensions of schizotypy and schizophrenia are associated with distinct patterns of clinical, affective, and cognitive impairment (e.g., Andreasen et al., 1990, Kwapil et al., 2008 and Barrantes-Vidal et al., 2010). The present findings indicated that positive and negative schizotypy are associated with differential patterns of schizophrenic-like symptoms, with positive schizotypy most strongly associated with psychotic-like and schizotypal symptoms, and negative schizotypy most strongly associated with ratings of negative and schizoid symptoms. Furthermore, the positive dimension is associated with affective dysregulation, including elevated rates of mood disorders (e.g., Myin-Germeys and van Os, 2007 and Barrantes-Vidal et al., 2009), whereas the negative dimension is associated with diminished positive affect (e.g., Horan, et al., 2006). It appears likely that these phenotypic differences between the dimensions represent different etiological pathways.

Nevertheless, researchers often treat schizotypy and schizophrenia as homogenous constructs, rather than considering their multidimensional structure, resulting in both conceptual and empirical problems. Frequently, studies compare an unspecified group of patients with schizophrenia with a non-schizophrenic control group on psychophysiological, cognitive, or treatment-response measures, despite the fact that different dimensions may have markedly different associations with these outcome measures. The results of this study support careful specification and measurement as essential for parsing apart the etiological, phenomenological, and clinical heterogeneity of schizophrenia and schizotypy. The present study focused on positive and negative schizotypy; however, this is not meant to imply that only two factors underlie schizotypy or that they are fully captured by these questionnaires. Positive and negative symptom dimensions are the most widely replicated for schizotypy and schizophrenia; however, there is ample evidence supporting additional factors (e.g., Claridge et al., 1996 and Stefanis et al., 2004). An important challenge will be to clarify the number and nature of these dimensions, as well as to build measures that accurately capture this multidimensional structure.

The present findings, along with the findings of Gross et al. (2012), indicate that the short WSS offers a promising battery for assessing schizotypy in nonclinical young adults. The availability of shortened forms of the measures that produce a coherent factor structure should prove advantageous for researchers—especially those who found the length of the original scales problematic. However, continued validation of the WSS short forms and the dimensions is needed. Specifically, studies should examine the psychometric properties and validity of the

scales in non-student participants, including both community and clinically ascertained samples. Likewise, the factor structure should be examined in diverse groups. For example, Kwapil et al. (2012) demonstrated that the factors derived from the original scales were comparable in Spanish and American samples. Studies should also examine the associations of the dimensions with psychophysiological, cognitive, and biobehavioral assessments, and longitudinal research is needed to examine the extent to which the short dimensions identify individuals at risk for transitioning into schizophrenia-spectrum disorders.

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Contributors

Georgina M. Gross, MS, contributed to the design and analyses, and was lead author of the manuscript. Paul J. Silvia, PhD contributed to the analyses and writing of the manuscript. Neus Barrantes-Vidal, PhD, contributed to the writing of the manuscript and study design. Thomas R. Kwapil, PhD, designed the study and contributed to the data analyses and writing of the manuscript.

Conflict of interest

None of the authors had a conflict of interest.

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