The multidimensional schizotypy scale-brief: Scale development and psychometric properties

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Abstract:

This article reports on the development and psychometric properties of a brief version of the Multidimensional Schizotypy Scale (MSS-B). The MSS-B contains 38 items that assess positive, negative, and disorganized schizotypy. The scale was derived from the full-length Multidimensional Schizotypy Scale, and the positive, negative, and disorganized subscales were designed to provide the same content coverage as the original subscales. Scale development involved a derivation sample (n = 6265) and a separate cross-validation sample (n = 1000), both drawn from four universities and Amazon Mechanical Turk. The MSS-B was derived using classical test theory, item response theory, and differential item functioning. The three subscales exhibited high internal-consistency reliability, good item- and model-fit, good test information functions, and expected patterns of intercorrelations and associations with neuroticism, sex, and race/ethnicity. This pattern of findings was almost identical between the derivation and cross-validation samples. Furthermore, the pattern of findings was closely comparable for MSS-B subscales and the full-length MSS subscales. The MSS-B appears to offer a promising brief measure for assessing schizotypy.

Keywords: Assessment | Schizotypal | Schizophrenia-spectrum | Psychosis | Scale development

Article:

1. Introduction

1.1. Schizotypy and Schizophrenia

Researchers and clinicians dating back to Bleuler (1950) and Kraepelin (1919) recognized that schizophrenic psychopathology is not limited to severe psychotic episodes, but also includes milder clinical and subclinical presentations (Kwapil and Barrantes-Vidal, 2012). Schizotypy is defined as the phenotypic manifestation of an underlying vulnerability for schizophrenia-spectrum psychopathology that is expressed across a broad range from subclinical expression to

the prodrome to schizophrenia-spectrum personality disorders to full-blown psychosis. It offers a useful and unifying construct for conceptualizing this continuum of clinical and subclinical manifestations (Kwapil and Barrantes-Vidal, 2015, Scientific Software International, Inc., 2015, Lenzenweger, 2010). Schizotypy, and by extension schizophrenia, is multidimensional, with positive, negative, and disorganized dimensions (e.g., American Psychiatric Association, 2013; Kwapil and Barrantes-Vidal, 2015; Tandon et al., 2009; Vollema and van den Bosch, 1995). The *positive* or psychotic-like symptom dimension involves disruptions in content of thought (ranging from odd beliefs to delusions), perceptual oddities (including illusions and hallucinations), and paranoia. The *negative* or deficit dimension involves diminished functioning such as alogia, anergia, avolition, anhedonia, flattened affect, and disinterest in others and the world. The *disorganization* dimension is characterized by disruptions in the ability to organize and express thoughts and behavior (ranging from mild disturbances to formal thought disorder and grossly disorganized actions).

1.2. Assessment of Schizotypy

A number of questionnaire measures of schizotypy have been developed dating back to the 1970s (see reviews by Chapman et al., 1995; Kwapil and Chun, 2015, Scientific Software International, Inc., 2015, Mason, 2015, Scientific Software International, Inc., 2015, Mason et al., 1997). These measures offer the advantages of being relatively inexpensive, brief and non-invasive to administer, and allow for the assessment of large numbers of participants from clinical and nonclinical samples. Cross-sectional and longitudinal studies employing these measures have enhanced our understanding of schizotypy and the development of schizophrenia-spectrum disorders (e.g., Barrantes-Vidal et al., 2013; Blanchard et al., 2011; Chapman et al., 1994; Gooding et al., 2005; Raine, 1991). However, currently available measures tend to suffer from a number of limitations, including lack of a clear conceptual framework (i.e., not developed with a clear, current theoretical model of schizotypy), unclear factor structure (e.g., Gross et al., 2014) and psychometric shortcomings, such as outdated measurement methodology and item bias. Further, existing scales contain wording that is at times outdated or problematic. For example, items on the SPQ switch between first-person statements (“I prefer to keep to myself”) and second-person questions (“Do you believe in telepathy?”). The WSS item “I have noticed sounds on my records that are not there at other times” is most likely no longer relevant to adolescent and young adult participants. Likewise, an item such as “The first winter snowfall has often looked pretty to me” (WSS) is problematic for creating a measure with cross-cultural validity.

Kwapil et al. (2017b) recently developed the Multidimensional Schizotypy Scale (MSS) to assess current multidimensional formulations of schizotypy. The MSS built upon the strengths of previous psychometric measures of schizotypy and was specifically designed to address limitations of currently available schizotypy questionnaires. The scale contains 77 true-false items that assess positive, negative, and disorganized schizotypy. The MSS was developed following procedures recommended by DeVellis (2012) including: (a) development of comprehensive trait specifications for the three schizotypy dimensions, (b) generation of a large pool of candidate items based on these specifications, (c) review of the items by expert and non-expert reviewers, (d) repeated administrations of the candidate items to large and diverse samples from multiple sources – interspersed with evaluation, modification, and dropping of items, (e)

selection of final items based on content validity, classical test theory, item response theory, and differential item functioning, and (f) evaluation of the psychometric properties of the items and subscales in a large independent sample of participants.

Findings from the derivation (n = 6265) and cross-validation (n = 1000) samples indicated that the MSS subscales have good to excellent internal consistency reliability, high item discrimination, and minimal differential item functioning for sex and ethnicity. Furthermore, Kwapil et al. (2017a) replicated the psychometric properties in a large, independent sample (n = 1430), and demonstrated support for the construct validity of the MSS positive, negative, and disorganized subscales.

Although schizotypy questionnaires have been widely used, their length may prove prohibitive for many studies. Thus, short forms have recently been produced for many of the commonly used schizotypy measures. For example, the 72-item Schizotypal Personality Questionnaire (SPQ; Raine, 1991) was shortened to a 22-item version (SPQ-B; Raine and Benishay, 1995) and the 104-item Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE; Mason et al., 1995) was shortened to a 43-item version (O-LIFE-B; Mason et al., 2005). The 166-item Wisconsin Schizotypy Scales (WSS), comprised of 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, were shortened to 60 items (WSS-B; Winterstein et al., 2011b). However, the time-savings of abbreviated forms of popular measures must be weighed against potential loss of reliability, content coverage, and subscale inclusion. For example, the coefficient alpha reliabilities of the four original O-LIFE subscales range from .77 to .89 (Mason et al., 1995), whereas the reliabilities of the brief subscales range from .63 to .80 (Mason et al., 2005). The original SPQ contained nine subscales and three factor scores, whereas the brief form only contained the three factor scores without the subscales.

1.3. Goals of the present study

The present study reports on the development and psychometric properties of a brief form of the MSS. The brief form (MSS-B) was developed following the same procedures as the original scale and was designed to overcome many of the limitations of current schizotypy measures. In addition, it adhered to the recommendations by Smith et al. (2000) for short scale development. The goal was to develop a brief version of the MSS that (a) covered the full range of content for the three schizotypy dimensions described in the trait specification and assessed by the original MSS, (b) included items from the MSS with superior item-subscale correlations, high discrimination values, and good fit to the IRT model, and (c) did not exhibit marked differential item functioning for sex or ethnicity. Furthermore, it was expected that coefficient alpha values for the MSS-B subscales would exhibit only minimally lower values than the original subscales (as predicted by the Spearman-Brown formula). The goal was to develop brief subscales for positive, negative, and disorganized schizotypy that contained approximately 10 to 15 items each.

2. Methods

2.1. Participants

The MSS-B was derived and cross-validated using the same large samples that were used to develop and cross-validate the full-length MSS (Kwapil et al., 2017b). The candidate schizotypy items were administered to 8750 participants at four universities and on Amazon Mechanical Turk (MTurk) as part of twelve administrations over a two-year period. Note that many available scales were developed using relatively small or homogenous samples. The inclusion of MTurk and college student samples from multiple sites increased the age range and diversity of our sample. Supplemental Table 1 presents information regarding each of the administrations. Participants were dropped if they had elevated scores on measures of invalid responding or failed to complete at least half the items. Note that as expected, the MTurk participants (M = 34.7 years, SD = 10.1) were older on average than the college student participants (M = 19.7 years, SD = 3.5; $t(6259) = 81.5$, $p < .001$). Participants 60 years of age or older were not retained given that (a) schizotypy studies primarily focus on younger participants at or near the age of greatest risk for developing schizophrenia-spectrum disorders, (b) we aimed to avoid age-related cognitive disruptions in deriving the subscales (that might especially impact the disorganization subscale), and (c) we only had 176 subjects (2% of total sample) age 60 years or older. The scale-derivation sample included 6265 subjects and the cross-validation sample included 1000 participants who were randomly selected from the final seven administrations (and were not included in the derivation analyses). Table 1 presents the demographic characteristics of the derivation and cross-validation samples.

Table 1. Demographic Characteristics of the Derivation and Cross-Validation Samples.

	Derivation Sample (n = 6265)	**Cross-Validation Sample (n = 1000)**
Sex	1975 male, 4290 female	500 male, 500 female
Age in years: Mean (SD)	26.4 (10.4)	26.7 (10.2)
Age in years: range	18–59	18–59
Ethnicity/Race		
Caucasian	4429 (71%)	695 (70%)
Black/African American	763 (12%)	114 (11%)
Hispanic/Latino	371 (6%)	63 (6%)
Asian/Pacific Islander	434 (7%)	88 (9%)
Native American	42 (1%)	4 (<1%)
Other	225 (4%)	36 (4%)
English as first language	5890 (94%)	931 (93%)

2.2. Materials

2.2.1. Trait specification and item generation

Development of the MSS began with the preparation of detailed trait specifications describing positive, negative, and disorganized schizotypy. These descriptions guided the creation of approximately 300 candidate true-false items (including items from other scales in original or modified form). True-false (rather than Likert scale) item response format was selected because it is consistent with previous measures of schizotypy such as the SPQ, O-LIFE, and WSS, and to avoid potential over-endorsement of deviant experiences because of a tendency to select responses in the middle of a Likert scale. Eight experts and six non-experts reviewed the items

for content and grammar. The first two administrations included 81 positive, 79 negative, and 86 disorganized schizotypy items. The item pool was reduced to 53 positive, 53 negative, and 49 disorganized schizotypy items for the third administration. The remaining nine administrations included 42 positive, 39 negative, and 37 disorganized schizotypy items.

2.2.2. Test battery

The candidate schizotypy items were administered with the 13-item Infrequency Scale (Chapman and Chapman, 1983), the Attentive Responding Scale (ARS; Maniaci and Rogge, 2014), which contains infrequency (6 items) and inconsistency (6 item pairs) subscales, and the NEO-FFI-3 neuroticism subscale (McCrae and Costa, 2010). In addition, the Social Desirability Scale (Crowne and Marlowe, 1960) was given during the first three administrations. Participants were excluded from the analyses if they had scores of 3 or above on the Infrequency Scale or the ARS total, or 4 or above on the ARS variable responding index. Neuroticism and social desirability were measured to examine the associations of the schizotypy items with these constructs. The Social Desirability Scale was discontinued after the third administration (n = 2174) given that social desirability was not significantly positively correlated with any of the retained schizotypy items.

2.3. Procedures

The project received IRB approval at each of the four participating universities. Participants completed the online survey using Qualtrics software. University students received course credit and MTurk participants received $1.00 for taking part in the study. The survey began with the informed consent form and the demographic items. The schizotypy, infrequency, and ARS items (along with the social desirability items on the first three administrations) were intermixed and organized in six blocks presented in random order. The neuroticism items were administered at the end of the assessment (they were not intermixed with the other items because they had a different response format).

2.3.1. MSS-B item selection

The full-scale MSS items and the brief version MSS-B items were selected based on classical test theory, item response theory, and differential item functioning statistics, along with content validity. A total of 26 positive, 26 negative, and 25 disorganized schizotypy items were retained for the final MSS full-length subscales from the pool of 119 schizotypy items in survey 3. The items for the MSS-B positive, negative, and disorganized schizotypy subscales were selected from the initially derived full-length MSS subscales based on classical test theory, item response theory, differential item functioning statistics, and content validity. Efforts were made to ensure content validity by selecting items for the MSS-B subscales that covered the full range of the constructs described in the trait specifications and comprising the full-length MSS subscales. In terms of classical test theory, preference was given to items with low endorsement frequencies (.05–.35), high item-scale correlations with the items for that schizotypy dimension, and relatively lower correlations with the two other schizotypy dimensions.

Given that questionnaire and interview measures of negative schizotypy are often inappropriately saturated with neuroticism and depression (see Barrantes-Vidal et al., 2013; Gross et al., 2014), preference was given to negative schizotypy items with low correlations with neuroticism. Given that distress and affective dysregulation are presumed to be part of positive and disorganized schizotypy, we were less restrictive about the associations of positive and disorganized schizotypy items with neuroticism. However, we gave preference to positive and disorganized schizotypy items with medium correlations with neuroticism, and when deciding among items tapping similar content, gave preference whenever possible to items with lower correlations with neuroticism. Furthermore, we ensured that items correlated higher with their own domain than with neuroticism.

Items with low endorsement frequency were selected given the relative rarity of schizotypic experiences in the general population and to maximize discrimination at the high end of the scale. Regarding the item response theory statistics, preference was given to items with high discrimination. Given the selection of items with low endorsement frequency, it was expected that the subscales would provide maximal information at the high levels of the trait and that items would have difficulty values in the range of .5–2.5. Items with markedly elevated differential item functioning for sex or ethnicity were eliminated from the final scale. The cross-validation sample was subsequently used to assess the subscales' psychometric properties after the final item selection. Note that a two-parameter logistic (2PL) IRT model was used for scale development as it provided superior model fit to the 1PL and 3PL models. Further, the c parameters generated from the 3PL models were low (ranging from .00 to .05), which suggests that the 2PL model is appropriate and that item endorsements are reflective of differences on the underlying trait of schizotypy (as opposed to other sources of variability).

3. Results

3.1. Selection of MSS-B items for the three dimensions

3.1.1. Item statistics

The MSS-B contains 13 positive, 13 negative, and 12 disorganized schizotypy items (see Supplemental Table 3), all of which were drawn from the original MSS. Six of these items were taken directly from other scales (three from the Magical Ideation, and one each from the Perceptual Aberration, Revised Social Anhedonia, and Physical Anhedonia Scales) and four were modified from other scales (two from the Cognitive Slippage Scale (Miers and Raulin, 1987), and one each from the Revised Social Anhedonia Scale and the Schizotypal Personality Questionnaire). The remaining 28 items were original items written during the scale development process described above for the full-length MSS. The average reading grade level of the items was 8.7, based on five indices (Readable, 2017). This was comparable with the 8.2 reading grade level for the full-scale MSS (Kwapil et al., 2017b).

Supplemental Table 4 presents the classical test theory, item response theory, and differential item functioning statistics for the final items selected for the three subscales computed in the cross-validation sample. Two-parameter logistic (2PL) IRT models, generated using IRTPRO Version 3 (Scientific Software International Inc., 2015) produced discrimination and difficulty

parameters, item response curves, and DIF (X^2) statistics for sex and ethnicity. IRTPRO uses maximum likelihood estimation for item parameter estimation and parameter estimates for all models are always in the logistic metric. All of the items had high correlations with their respective subscales and high discrimination, and none of the items exhibited statistically significant differential item functioning for sex. One positive schizotypy item had significant differential item functioning for ethnicity (with lower difficulty for White participants). In addition, we examined item-level fit statistics. IRTPRO computes the trace line diagnostic statistic S - $\times^2$ suggested by Orlando and Thissen (2000). None of the positive, negative, or disorganized items showed misfit at the $p < .001$ level suggesting that for all items the trace lines have been fitted sufficiently well. This indicates that the model-expected proportions responding 0 and 1 match the observed data. Because these statistics assume perfect fit to the 2PL model, these results suggest excellent item-fit for the MSS-B items.

Consistent with our goal of selecting negative schizotypy items with low correlations with neuroticism, in the derivation sample the average point-biserial correlation of the 13 MSS-B negative schizotypy items with neuroticism total score was .11, whereas the average point-biserial correlation of the MSS-B negative schizotypy items with the negative schizotypy subscale total was .50. Consistent with our goal of selecting positive and disorganized schizotypy items with medium correlations with neuroticism, in the derivation sample the average point-biserial correlation of the 13 MSS-B positive schizotypy items with neuroticism total score was .19, whereas the average point-biserial correlation of the MSS-B positive schizotypy items with the positive schizotypy subscale total was .51. Likewise, in the derivation sample the average point-biserial correlation of the 12 MSS-B disorganized schizotypy items with neuroticism total score was .36, whereas the average point-biserial correlation of the MSS-B disorganized schizotypy items with the disorganized schizotypy subscale total was .66.

3.1.2. Subscale statistics

The MSS-B positive, negative, and disorganized subscale scores are computed as the total number of items answered in the schizotypic direction. We recommend the use of separate subscale scores as opposed to one total score for the measure, based upon the ample evidence that schizotypy is a multidimensional construct. Table 2 presents descriptive statistics from the derivation and cross-validation samples for the final versions of the three subscales. The psychometric properties were closely comparable in the two samples. The subscales were positively skewed, consistent with the item selection strategy. All three subscales demonstrated good internal consistency reliability based on Cronbach's alpha and binary alpha (Hancock and Mueller, 2001) in both samples. We also reported the predicted reliability for each subscale based upon the reliability for the full-length subscales using the Spearman-Brown Prophecy Formula. The estimated and actual coefficient alpha values are closely comparable, suggesting that the MSS-B retained items of comparable quality from the full-length MSS. Exploratory factor analyses with geomin rotation computed on both the derivation and cross-validation samples indicated that each subscale was unidimensional, consistent with the subscales in the full-length MSS.

Table 2. Descriptive Statistics, Reliability, and Correlations of the Schizotypy Subscales in the Derivation (n = 6265) and Cross-Validation (n = 1000) Samples.

Subscale	Items	Sample	Mean (SD)	Skew (SE)	Kurtosis (SE)	Alpha	Binary	SBEA
Positive Schizotypy	13	Derivation	1.85 (2.34)	1.74 (.03)	3.18 (.06)	.80	.81	.80
		Cross-Validation	1.93 (2.34)	1.60 (.08)	2.67 (.16)	.78	.78	.80
Negative Schizotypy	13	Derivation	1.76 (2.35)	1.79 (.03)	3.16 (.06)	.80	.78	.79
		Cross-Validation	1.86 (2.47)	1.62 (.08)	2.20 (.16)	.81	.79	.80
Disorganized Schizotypy	12	Derivation	1.82 (2.89)	1.88 (.03)	2.78 (.06)	.90	.91	.88
		Cross-Validation	1.73 (2.85)	1.94 (.08)	3.00 (.16)	.89	.91	.88

Alpha = Coefficient alpha reliability; Binary = binary alpha reliability; SBEA = Spearman Brown Estimated Alpha.

Table 3. Correlations of the Schizotypy Subscales in the Derivation (n = 6265) and Cross-Validation (n = 1000) Samples.

Subscale	Positive Schizotypy	Negative Schizotypy	Disorganized Schizotypy	Sex	Neuroticism
Positive Schizotypy		.17*	**.43***	-.00	**.34***
Negative Schizotypy	.13*		**.32***	-.12*	.20*
Disorganized Schizotypy	**.39***	**.32***		-.01	***.53****
Sex	.04	-.13*	-.00		.15*
Neuroticism	**.30***	.20*	***.51****	.18*	

*p < .001.

Results for the Derivation sample are listed above the diagonal and for the cross validation sample are listed below the diagonal.

Positive correlations with sex indicate higher scores in women.

Medium effect sizes are in bold, large effect sizes in bold and italic.

Table 3 presents the intercorrelations of the MSS-B schizotypy subscales, as well as correlations with neuroticism and sex in the two samples. Alpha was set at .001 for these analyses given the large sample size, and effect sizes are noted following Cohen (1992). The pattern of correlations was invariant across the samples and was closely comparable with the findings from the full-length subscales (Kwapil et al., 2017b). Positive and negative schizotypy were modestly correlated, whereas disorganized schizotypy had moderate positive correlations with the other two dimensions. Each of the subscales of the MSS-B had correlations of .95 or higher with their corresponding subscale from the full-length MSS. However, as Smith et al. (2000) noted, these correlations should be interpreted conservatively because the same responses are included in the short and long forms. As expected, positive and disorganized schizotypy were unassociated with sex. However, consistent with the common finding of greater negative symptoms in men than in women (e.g., Tandon et al., 2009), men scored slightly higher than women on the negative schizotypy subscale. Neuroticism had a modest correlation with negative schizotypy, medium correlation with positive schizotypy, and a large correlation with disorganized schizotypy. ANOVAs were computed comparing the racial/ethnic groups on the three subscale scores. None of the analyses were statistically significant: positive schizotypy, $F(5994) = 1.68$, partial eta-squared = .008; negative schizotypy, $F(5994) = 3.55$, partial eta-squared = .018; disorganized

schizotypy, $F(5994) = 1.23$, partial eta squared = .006 (small effect sizes for all three analyses). The item response theory test information curves for the three schizotypy subscales indicate that, as intended, maximum test information (greatest discrimination) and minimal error occurred at high trait levels (see Fig. 1).

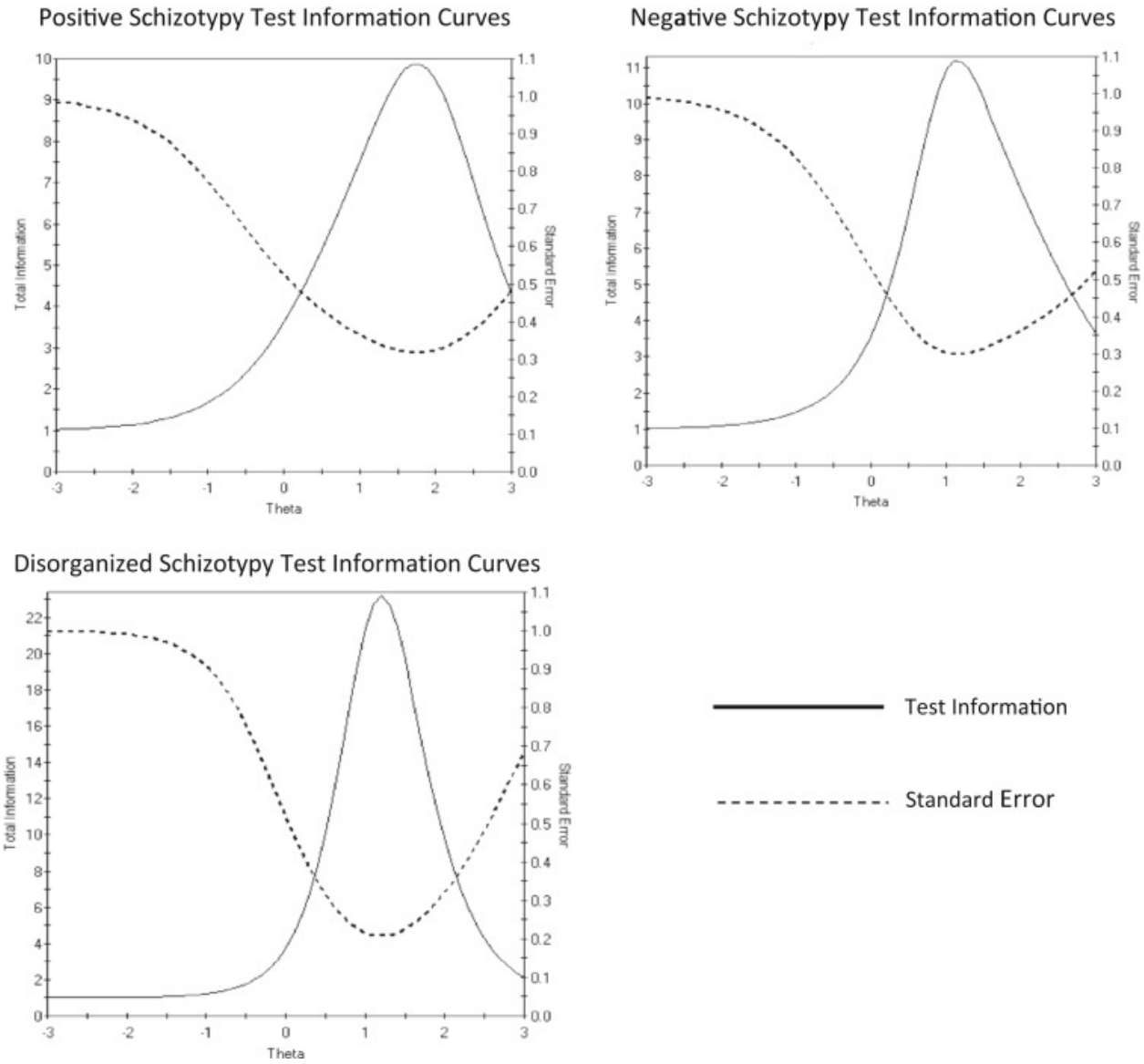

Figure 1. Test Information Curves for the MSS-B Positive, Negative, and Disorganized Schizotypy Subscales. Note: The test information curve (also commonly referred to as the test information function) represents the quality and number of test items across the range of the underlying trait (schizotypy, represented on the x axis). The curve is representative of the reliability of the set of items, as the contribution of each item to test-score variability depends on how highly it correlates with the other items. The desired shape of the curve varies depending on the purpose of the scale. For our purposes, higher information was desired at higher levels of schizotypy, as it is presumed to be relatively rare in the general population and the purpose of the MSS-B is to be maximally discriminating at the high end of the trait. An undesirable curve would show low information (and high standard error) either at the desired level of theta, or across the entire trait (Hambleton and Swaminathan, 1985).

4. Discussion

Questionnaire measures of schizotypy have provided useful tools for screening and assessing large numbers of non-clinically ascertained participants, as well as clinical patients. However, the assessment of schizotypy seems to be at somewhat of an impasse as currently available measures suffer from a number of limitations including lack of a clear conceptual framework, outdated wording, unclear factor structure, and psychometric shortcomings. Specifically, many of these measures do not map onto current multidimensional conceptualizations of schizotypy. For example, some measures assess schizotypy as a unidimensional construct. Furthermore, scales that assess schizotypy multidimensionally often differ in the number and the content of the factors. In some cases, scales that purport to measure the same factor sometimes appear to be measuring different constructs altogether (Gross et al., 2014). Many of the available measures suffer from psychometric limitations – in part because they were developed prior to the advent of modern measurement tools such as item response theory and differential item functioning, which can improve upon psychometric properties over and above classical test theory (Hambleton et al., 2000). Evaluation of these scales with item response theory and differential item functioning reveal that some items suffer from low discrimination and high item bias for sex and ethnicity (e.g., Winterstein et al., 2011a). In addition, some of the available scales employ wording that appears outdated or culturally biased. Finally, many available scales were developed using relatively small or homogenous samples. The MSS was developed to address many of these limitations in that it is based upon current multidimensional models of schizotypy (that mirror current models of schizophrenia) and employed multiple measurement models in its derivation. Preliminary psychometric properties suggest it is a promising measure of schizotypy. The 77-item MSS is comparable in length to the SPQ (72 items) and shorter than the O-LIFE (104 items) and the WSS (166 items). However, development of a brief version of the scale with comparable psychometric properties offers researchers greater flexibility, especially when facing time/feasibility constraints.

The preliminary psychometric findings for the MSS-B from the large, diverse, multisite derivation and cross-validation samples appear promising. Four areas are notable: (a) care was taken to ensure that the content coverage was comparable in the MSS and MSS-B; (b) the subscales exhibit high internal consistency reliability, good test information functions, and expected patterns of intercorrelations and associations with neuroticism, sex, and race/ethnicity; (c) the pattern of findings is almost identical between the derivation and cross-validation samples, and (d) the pattern of findings is closely comparable for the MSS-B and the full-length MSS subscales. For example, the magnitude of correlations is basically the same for the MSS and MSS-B in both samples. As expected, positive and disorganized schizotypy were unassociated with sex in both scales and samples, whereas negative schizotypy is higher (modestly) in men in every analysis.

As designed, the negative schizotypy subscale was minimally correlated with neuroticism (consistent with findings for the MSS). The MSS and MSS-B disorganized schizotypy subscales exhibited the strongest associations with neuroticism, suggesting that disorganized characteristics may be especially distressing for participants. The NEO-FFI does not include facets of neuroticism. Future studies should administer the full length measure of neuroticism to determine which facets are associated with disorganized schizotypy. Finally, the reliabilities of the MSS-B subscales show no shrinkage in the cross-validation sample relative to the derivation sample, and minimal reduction in the short relative to the full-length subscales. Obviously, the

data for both the brief and original MSS come from the same samples, but the results thus far suggest that the MSS-B performs comparably to its full-length counterpart and that the MSS-B subscales perform consistently across samples. Future studies should examine the properties of the MSS-B in large, diverse, independent samples.

The MSS and MSS-B were derived and cross-validated in a sample aged 18–59 years old. Note that schizotypy questionnaires are typically used with older adolescent and young-adult samples, given that this is often when schizotypic signs first appear and are the start of the period of greatest risk for developing schizophrenia-spectrum disorders. We suggest that researchers should use caution in administering the MSS-B with people outside of the reported age range until psychometric properties are established for these ages.

The MSS and MSS-B subscales did not differ among racial/ethnic groups, in contrast to findings for previous scales that Caucasians tend to score lower on measures of schizotypy than non-Caucasian groups (e.g., Chmielewski et al., 1995). Given that studies suggest that previous measures of schizotypy contain items with marked DIF for race/ethnicity (e.g., Winterstein et al., 2011b), we endeavored to select items with minimal DIF for race/ethnicity, as well as sex. The elimination of biased items is crucial for determining whether group differences on a scale represent genuine group differences, as opposed to artifactual findings resulting from biased items. We suggest that the inclusion of the measurement of DIF and the elimination of high DIF items for race/ethnicity represent strengths of the MSS-B. Furthermore, the fact that we did not find significant racial/ethnic group differences suggests that previous findings using existing scales may have resulted from the inclusion of biased items.

Mason (2015) differentiated between clinical and personality approaches to the operationalization and measurement of schizotypy with the former deriving from Meehl's (1962) model, and the later arising from Claridge and colleagues' [e.g., Claridge (1997)] work. Given that we view schizotypy as a multidimensional continuum of the expression of the underlying vulnerability for schizophrenia-spectrum psychopathology, the MSS-B would follow more closely to the personality rather than the clinical approach. However, in contrast to Mason, we make no claims that schizotypy is a dimension of normal personality, which implies that most people fall in the middle ranges and that pathological expressions accrue at either extreme. We expect that schizotypy is relatively rare in the general population, that most people will score at the low end of the MSS-B, and that pathological expressions will be associated with elevated scores on the MSS-B (not scores on either extreme). Note that we do not suggest the use of arbitrary cut-points to "identify schizotypy" (e.g., > 1.96 SD above the mean), which Mason links to the clinical approach. The Chapmans (e.g, Chapman et al., 1994) employed this strategy in their landmark work merely as a means of maximizing group differences, which had the unfortunate outcome of such cut-points being reified as the demarcation of schizotypy in subsequent research. Unless taxometric studies or other methods empirically identify a meaningful cut-point, we recommend the use of continuous scores for both the MSS and MSS-B.

Having provided initial demonstration of the psychometric properties of the MSS-B, the next step will be to assess the construct validity of the subscales as measures of positive, negative, and disorganized schizotypy. We believe that this research strategy should include comparison with other psychometric schizotypy measures, interview and laboratory studies to examine

associations with schizophrenic-like symptoms and impairment (including cross-sectional and longitudinal studies), examination of daily life correlates using ambulatory assessment, and administration of the scale to schizophrenia-spectrum patients and their relatives. Note that the MSS and MSS-B are intended as research instruments and they are not intended for clinical assessment and treatment. Given that our focus was on providing brief assessments of the three schizotypy dimensions, we do not recommend examination of facets underlying the three dimensions. Finally, consistent with our multidimensional approach, we do not recommend computation of a total schizotypy score, but rather use of the three subscale scores.

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Supplemental Table 1. Summary of Candidate Schizotypy Item Administrations

Admin-istration	Survey Version[a]	Date	Sample[b]	Total *n*	Dropped missing	Dropped infrequency	Dropped > age 59	Usable *n*	% female	Age M (SD)
1	1	Spring 2015	UNCG	166	18	24	0	124	62.1	19.4 (1.8)
2	1	Fall 2015	UNCG/YSU	953	79	61	0	813	71.6	19.7 (4.2)
3	2	Spring 2016	UNCG/YSU	1055	88	124	0	843	68.4	20.5 (4.2)
4	3	May 2016	MTurk	391	28	37	21	305	56.7	35.9 (9.8)
5	3	June 2016	MTurk	1296	71	105	61	1059	63.9	34.4 (10.5)
6	3	Fall 2016	UNCG	724	27	89	0	608	75.2	18.9 (2.3)
7	3	Fall 2016	YSU	641	15	90	0	536	70.8	20.0 (3.8)
8	3	Fall 2016	TTU	409	15	80	0	314	57.4	19.5 (4.2)
9	3	Fall 2016	UIUC	915	21	128	0	766	68.3	19.2 (1.5)
10	3	October 2016	MTurk	761	0	71	33	657	60.6	35.2 (9.1)
11	3	October 2016	MTurk	723	0	80	27	616	59.4	34.7 (10.0)
12	3	November 2016	MTurk	716	0	58	34	624	64.3	34.4 (10.0)
Total				8750	362	947	176	7265	65.9	26.4 (10.4)

[a]survey 1: 81 positive schizotypy items, 79 negative schizotypy items, 86 disorganized schizotypy items, NEO-FFI, Social Desirability Scale, Infrequency Scale, Attentive Responding Scale

survey 2: 53 positive schizotypy items, 53 negative schizotypy items, 49 disorganized schizotypy items, NEO-FFI, Social Desirability Scale, Infrequency Scale, Attentive Responding Scale

survey 3: 42 positive schizotypy items, 39 negative schizotypy items, 37 disorganized schizotypy items, NEO-FFI, Infrequency Scale, Attentive Responding Scale

[b]sample: UNCG = University of North Carolina at Greensboro, YSU = Youngstown State University, TTU = Tennessee Tech University, UIUC = University of Illinois at Urbana-Champaign, MTurk = Amazon Mechanical Turk

Supplemental Table 2. Number of Participants by Decade of Life in the Derivation and Cross-Validation Samples

	Derivation Sample (*n* = 6265)		Cross-Validation Sample (*n* = 1000)	
Age Range	***n***	**%**	***n***	**%**
18-19	2459	39.2	373	37.3
20-29	1952	31.2	303	30.3
30-39	1018	16.2	182	18.2
40-49	505	8.1	101	10.1
50-59	326	5.2	41	4.1

Supplemental Table 3. The Multidimensional Schizotypy Scale-Brief

The following items inquire about a broad range of attitudes, experiences, and beliefs that people have. Please answer each item in the way that best describes you. Please note that there are no right or wrong answers – just answer in the way that is most like you.

Note that the label column refers to the subscale (P = positive, N = negative, D = disorganized schizotpy). The key column indicates the response which is in the schizotypic direction. Items answered in the keyed direction are scored "1", items answered in the non-keyed direction are score "0".

Item	label	key	
1	N01	T	Throughout my life I have noticed that I rarely feel strong positive or negative emotions.
2	P01	T	I have sometimes felt that strangers were reading my mind.
3	D01	T	My thoughts and behaviors are almost always disorganized.
4	N02	F	In general, it is important for me to have close relationships with other people.
5	P02	T	I often think that I hear people talking only to discover that there was no one there.
6	D02	T	Most of the time I find it is very difficult to get my thoughts in order.
7	N03	T	I have always preferred to be disconnected from the world.
8	P03	T	I have felt that there were messages for me in the way things were arranged, like furniture in a room.
9	D03	T	I often have difficulty following what someone is saying to me.
10	N04	F	If given the choice, I would much rather be with another person than alone.
11	P04	T	I believe that dreams have magical properties.
12	D04	T	I often feel so mixed up that I have difficulty functioning.
13	N05	T	Throughout my life, very few things have been exciting or interesting to me.
14	P05	T	I sometimes wonder if there is a small group of people who can control everyone else's behavior.
15	D05	T	My thoughts are so hazy and unclear that I wish that I could just reach up and put them into place.
16	N06	T	Having close friends is not as important as people say.
17	P06	T	I have had the momentary feeling that someone's place has been taken by a look-alike.
18	D06	T	My thoughts and behaviors feel random and unfocused.
19	N07	T	Generally I do not have many thoughts or emotions.
20	P07	T	There are times when it feels like someone is touching me when no one is actually there.
21	D07	T	No matter how hard I try, I can't organize my thoughts.
22	N08	T	Throughout my life, I have had little interest in dating or being in a romantic relationship.
23	P08	T	I have had experiences with seeing the future, ESP or a sixth sense.
24	D08	T	I find that I am very often confused about what is going on around me.
25	N09	F	Most of the time I feel a desire to be connected with other people.
26	P09	T	I often worry that other people are out to get me.
27	D09	T	People find my conversations to be confusing or hard to follow.
28	N10	T	There are just not many things that I have ever really enjoyed doing.
29	P10	T	Some people can make me aware of them just by thinking about me.
30	D10	T	My thoughts are almost always hard to follow.
31	N11	T	I generally am not interested in being emotionally close with others.
32	P11	T	I believe that there are secret signs in the world if you just know how to look for them.

33	D11	T	I often have difficulty organizing what I am supposed to be doing.
34	N12	T	My emotions have almost always seemed flat regardless of what is going on around me.
35	P12	T	I often worry that someone or something is controlling my behavior.
36	D12	T	I have trouble following conversations with others.
37	N13	F	Spending time with close friends and family is important to me.
38	P13	T	At times I have wondered if my body was really my own.

Supplemental Table 4. Item-level Statistics from the Cross-Validation Sample for the MSS Positive Schizotypy Subscale

		Classical Test Theory Point-biserial correlations				Item Response Theory		Differential Item Functioning	
Item	P	Positive Schizotypy	Negative Schizotypy	Disorganized Schizotypy	Neuroticism	Discrim-ination	Difficulty	X^2 Sex	X^2 Ethnic
Positive Schizotypy Subscale									
I believe that dreams have magical properties.	.33	.62	.01	.16	.13	1.81	0.61	3.8	0.0
Some people can make me aware of them just by thinking about me.	.14	.58	.04	.13	.07	1.88	1.47	3.1	0.0
I have had the momentary feeling that someone's place has been taken by a look-alike.	.07	.45	.05	.15	.10	1.71	2.18	0.1	0.1
I have sometimes felt that strangers were reading my mind.	.10	.55	.06	.23	.17	2.00	1.67	5.9	0.0
I have felt that there were messages for me in the way things were arranged, like furniture in a room.	.07	.49	.05	.12	.06	2.07	1.96	1.4	3.4
I believe that there are secret signs in the world if you just know how to look for them.	.37	.61	.05	.16	.13	1.71	0.49	1.2	0.1
I sometimes wonder if there is a small group of people who can control everyone else's behavior.	.09	.51	.09	.19	.13	1.79	1.86	4.6	1.0
I often worry that other people are out to get me.	.13	.49	.20	.44	.39	1.35	1.79	1.5	0.3
I often think that I hear people talking only to discover that there was no one there.	.11	.47	.10	.28	.22	1.39	1.95	0.2	2.0
At times I have wondered if my body was really my own.	.09	.51	.10	.29	.22	1.74	1.89	0.3	0.0
There are times when it feels like someone is touching me when no one is actually there.	.13	.57	.09	.27	.19	1.76	1.56	0.0	2.0
I have had experiences with seeing the future, ESP or a sixth sense.	.23	.52	.04	.10	.09	1.23	1.25	0.0	11.7*
I often worry that someone or something is controlling my behavior.	.06	.52	.07	.29	.21	2.27	1.93	1.8	0.4
Negative Schizotypy Subscale									
Throughout my life I have noticed that I rarely feel strong positive or negative emotions.	.16	.13	.51	.16	.04	1.27	1.70	2.2	0.9
My emotions have almost always seemed flat regardless of what is going on around me.	.17	.09	.58	.20	.07	1.66	1.36	9.6	3.1
Generally I do not have many thoughts or emotions.	.05	.08	.31	.08	.01	1.00	3.36	1.9	3.2

Throughout my life, very few things have been exciting or interesting to me.	.11	.12	.54	.34	.26	1.55	1.84	2.8	3.1
I have always preferred to be disconnected from the world.	.18	.16	.63	.31	.20	2.07	1.20	1.0	4.9
Having close friends is not as important as people say.	.13	.09	.55	.11	.08	1.78	1.60	3.8	1.1
In general, it is important for me to have close relationships with other people.	.16	.02	.64	.10	.07	2.28	1.24	0.1	0.0
If given the choice, I would much rather be with another person than alone.	.22	.00	.52	.06	.05	1.36	1.25	4.7	1.2
Most of the time I feel a desire to be connected with other people.	.21	.00	.65	.12	.10	2.30	1.03	0.1	0.0
Throughout my life, I have had little interest in dating or being in a romantic relationship.	.10	.06	.45	.16	.09	1.29	2.14	0.0	0.7
I generally am not interested in being emotionally close with others.	.19	.05	.72	.20	.11	3.43	1.00	0.0	0.2
There are just not many things that I have ever really enjoyed doing.	.13	.15	.52	.40	.30	1.45	1.77	0.2	1.8
Spending time with close friends and family is important to me.	.05	.04	.44	.10	.04	1.97	2.22	1.8	0.3
Disorganized Schizotypy Subscale									
Most of the time I find it is very difficult to get my thoughts in order.	.20	.28	.17	.74	.39	3.16	0.96	0.0	1.2
No matter how hard I try, I can't organize my thoughts.	.10	.21	.16	.63	.35	2.42	1.58	0.4	0.1
My thoughts are so hazy and unclear that I wish that I could just reach up and put them into place.	.15	.33	.19	.67	.36	2.52	1.24	0.0	2.3
My thoughts are almost always hard to follow.	.15	.28	.23	.73	.33	3.08	1.19	0.6	0.1
I find that I am very often confused about what is going on around me.	.14	.33	.21	.62	.36	2.04	1.43	0.4	0.1
People find my conversations to be confusing or hard to follow.	.13	.18	.31	.59	.25	1.79	1.54	1.8	0.6
I have trouble following conversations with others.	.10	.21	.32	.67	.29	2.71	1.52	0.6	0.1
My thoughts and behaviors are almost always disorganized.	.14	.26	.22	.77	.37	4.14	1.18	0.6	2.1
My thoughts and behaviors feel random and unfocused.	.15	.32	.24	.75	.38	3.50	1.18	0.0	0.0
I often have difficulty organizing what I am supposed to be doing.	.22	.26	.13	.71	.39	2.93	0.92	0.1	0.5

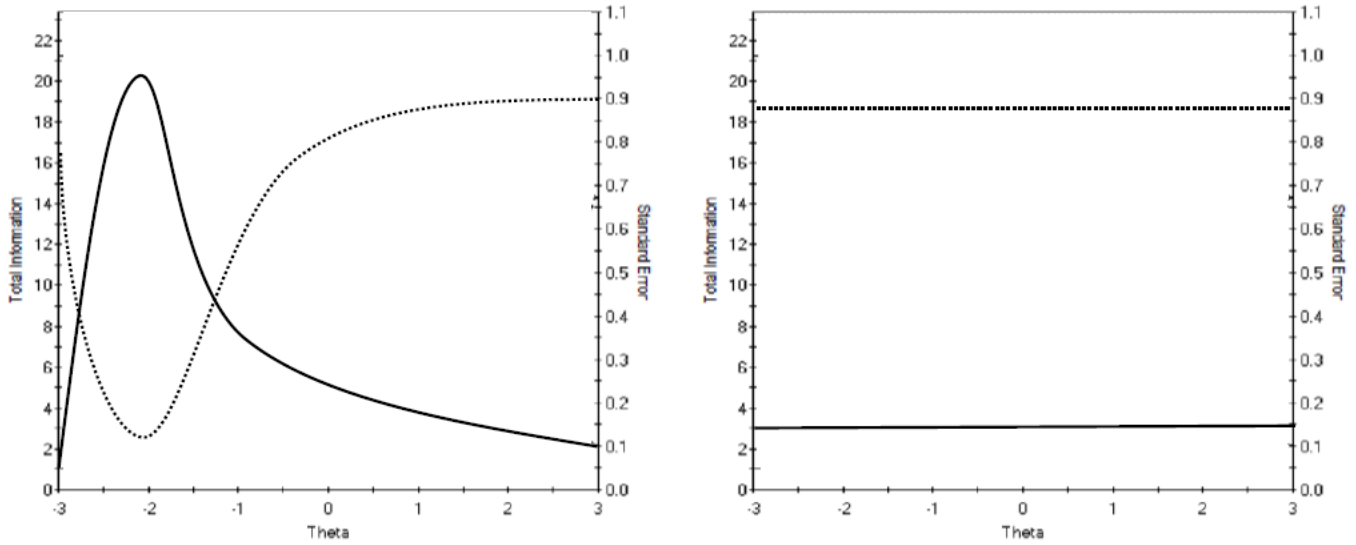
I often feel so mixed up that I have difficulty functioning.	.14	.27	.22	.67	.39	2.46	1.34	0.9	0.3
I often have difficulty following what someone is saying to me.	.11	.27	.28	.62	.27	2.17	1.57	1.0	0.5

Differential Functioning Analyses: *****p* < .001

Supplemental Table 5. Comparison of MTurk and College Student Samples on the Three Schizotypy Subscales

	MTurk Sample (*n* = 475)		College Sample (*n* = 525)			
Schizotypy Subscale	**Mean**	**SD**	**Mean**	**SD**	***t*-test**	**Cohen's *d***
Positive Schizotypy	1.82	2.26	2.03	2.40	$t = 1.44$, ns	.09
Negative Schizotypy	2.19	2.82	1.55	2.06	$t = 4.16$, $p < .001$	.26
Disorganized Schizotypy	1.64	2.90	1.81	2.80	$t = 0.95$, ns	.06

Supplemental Figure 1. Hypothetical Test Information Curves Representing Poor Outcome for the MSS-B Subscales



Test Information

Standard Error

The two hypothetical test information curves represent what poor outcomes would look like for our subscales. The curve on the left shows a test that is maximally discriminating at the low end of the trait, but has relatively poor discrimination at the high end of the trait (the opposite of what we aimed for with the MSS-B). The second curve shows a test that poorly discriminates across the entire range of theta. These hypothetical curves are in contrast to the actual curves reported in Figure 1 of the article.