Associations between cognitive biases and domains of schizotypy in a non-clinical sample

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ABSTRACT

Schizotypy is a non-clinical manifestation of the same underlying biological factors that give rise to psychotic disorders (Claridge and Beech, 1995). Research on normative populations scoring high on schizotypy is valuable because it may help elucidate the predisposition to schizophrenia (Jahshan and Sergi, 2007) and because performance is not confounded by issues present in schizophrenia samples. In the current study, a Confirmatory Factor Analysis was conducted using several comprehensive measures of schizotypy. As expected and replicating prior research, a four-factor model of schizotypy emerged including a positive, a negative, a cognitive disorganization, and an impulsive nonconformity factor. We also evaluated how each factor related to distinct cognitive biases. In support of hypotheses, increased self-certainty, decreased theory of mind, and decreased source memory were associated with higher scores on the positive factor; decreased theory of mind was associated with higher scores on the negative factor; and increased self-certainty was associated with greater impulsive nonconformity. Unexpectedly, decreased self-certainty and increased theory of mind were associated with greater cognitive disorganization, and decreased source memory was associated with greater impulsive nonconformity. These findings offer new insights by highlighting cognitive biases that may be risk factors for psychosis.

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1. Introduction

Psychotic symptoms are considered to be distributed along a continuum with subclinical psychotic experiences referred to as schizotypy (Claridge and Beech, 1995). Examining schizotypal traits in non-clinical populations may help elucidate factors related to the predisposition to schizophrenia (Gooding et al., 2005). Additionally, these investigations are valuable because performance is not confounded by issues often present in schizophrenia samples, such as long-term antipsychotic medication usage, social isolation, and recurrent hospitalizations (Jahshan and Sergi, 2007).

1.1. Latent structure of schizotypy

Schizotypy is a multidimensional construct (Mason and Claridge, 2006). Attempts have been made to establish the structure of schizotypy via scale and item analysis on a number of self-report scales; however, these analyses have failed to present a unified picture of schizotypy seemingly because some measures failed to capture the comprehensive nature of the construct (Mason and Claridge, 2006). When measures tapping into all components of the DSM-IV-TR diagnosis of Schizotypal Personality Disorder are included, four factors emerge (Mason, 1995). The positive factor includes ideas of reference, magical thinking, unusual perceptual experiences, and paranoid ideation. The negative factor includes social anhedonia, lack of close friends, and constricted affect. The cognitive disorganization factor includes a mixture of cognitive disorganization and social anxiety, and the impulsive nonconformity factor includes asocial and disinhibited behavior (Mason, 1995).

The impulsive nonconformity component of schizotypy warrants further comment. Researchers argue that a three-factor solution of schizotypy, including positive, negative, and cognitive disorganization, may be too restrictive given what we know about symptomatic and biological overlap between psychosis and affective disorders, such as bipolar disorder (Berrettini, 2003). According to the unitary view of psychosis, a broader concept of psychosis proneness including asocial and disinhibited characteristics might reflect the clinical reality more accurately (Mason and Claridge, 2006). Thus, including scales that tap into this component is in keeping with this evidence.

An important issue in the multidimensional assessment of schizotypy is whether measures used in factor analyses comprehensively define each latent domain of schizotypy. To accurately reflect the components of schizotypy, researchers should include measures that define several important features of each factor.

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1.2. The role of cognitive biases

Mounting evidence demonstrates that specific cognitive biases pose as risk factors for the transition from subclinical psychotic experiences to clinically significant psychotic disorders (Beck et al., 2009). Research has found that remediating faulty information processing (using CBT) in individuals at high risk for developing psychosis reduced the likelihood of progression to psychosis and of being prescribed antipsychotic medication (Morrison et al., 2004, 2007). These results highlight that targeting cognitive biases prior to the onset of full-blown psychosis may lead to delayed onset or improved prognosis.

Although cognitive biases ostensibly play a role in the development of psychosis, few cognitive biases have been examined across the psychosis spectrum. Additionally, studies that explored cognitive mechanisms in schizotypy rarely considered whether sub-domains of schizotypy were associated with each bias. The current study extends prior literature by exploring relationships between cognitive biases (e.g., self-certainty, knowledge corruption, theory of mind, and source memory) and sub-domains of schizotypy.

1.2.1. Self-certainty

The Beck Cognitive Insight Scale assesses whether individuals with psychosis can critically examine their beliefs (Beck et al., 2004). Factor analyses revealed two factors: self-reflectiveness and self-certainty (Beck et al., 2004; Warman et al., 2007). Self-reflectiveness is the ability to acknowledge fallibility in one's interpretations of experiences. Self-certainty is over-confidence in beliefs and unwillingness to consider feedback.

Authors posit that self-reflectiveness may be a state characteristic, while self-certainty may be a trait characteristic (Bora et al., 2007; Warman et al., 2007). Bora et al. (2007) found that changes in acute symptom recovery were not associated with changes in overall cognitive insight or self-certainty, but were associated with improvements in self-reflectiveness in patients with delusions. These findings suggest that overconfidence (self-certainty) spans both the presence and absence of delusions in chronic and early disease process, suggesting that this thinking style may represent a vulnerability factor for psychosis (Buchy et al., 2009). Because self-certainty appears to be trait-based rather than state-based, the current study will only utilize this index.

One study has explored the relationship between self-certainty and delusion proneness, a component of positive schizotypy, in a non-clinical sample. Warman and Martin (2006) found that greater self-certainty was associated with higher delusion proneness. Relatedly, other researchers have found that individuals who fail to take alternative, conflicting information into account when making a decision (Sellen et al., 2005) and individuals who have less mental flexibility (Tsakanikos and Reed, 2005) have higher scores on the impulsive non-conformity factor. Though the relationship between self-certainty and the impulsive nonconformity factor has not been empirically tested, the aforementioned research suggests that there may be an association.

1.2.2. Knowledge corruption

Knowledge corruption, a term coined by Moritz et al. (2005), refers to increased errors in decision-making coupled with overconfidence in those errors. Healthy individuals and patients with schizophrenia both make mistakes; however, patients display a liberal acceptance bias not found in healthy controls that allows for higher inclusion of faulty information into one's memory (Moritz et al., 2006). While healthy individuals generally have comparatively low confidence in their errors (Moritz et al., 2006), schizophrenia subjects tend to put more trust in incorrect memory information (Moritz et al., 2005). Thus, although inadequate information may dissuade a healthy individual from making strong inferences, it may not be enough to dissuade individuals with schizophrenia from making high-confidence judgments (Moritz et al., 2006).

Moritz et al. (2005) posit that knowledge corruption represents a potential mechanism for the emergence of delusions, given that this framework of corrupted beliefs may not provide an adequate basis for reality assessment. A tarnished information system may make navigating the external world more challenging because it offers an incorrect context from which to interpret information. While researchers have suggested that knowledge corruption might lead to the development of delusions (Moritz et al., 2005), no researchers have explored relationships between knowledge corruption and factors of schizotypy.

1.2.3. Theory of mind

Theory of mind is the ability to attribute mental states to oneself or others (Langdon, 2003). Theory of mind allows individuals to explain and predict behavior (Sprong et al., 2007) and facilitates engagement in adaptive and appropriate social behaviors (Corcoran, 2001).

Studies examining the relationship between schizotypy and theory of mind have mixed findings, seemingly because schizotypy is multifaceted. Thus, studies that divide schizotypy by specific clusters of traits are quite useful (for review, see Gooding and Pflum, 2011). Some studies support that higher ratings of positive schizotypy (Meyer and Shean, 2006; Pickup, 2006), negative schizotypy (Monestes et al., 2008), and cognitive disorganization (Brown and Cohen, 2010) are associated with worse theory of mind. However, other researchers failed to find these associations (Jahshan and Sergi, 2007; Fernyhough et al., 2008).

Many of these studies could be critiqued for their methodological limitations, such as the utilization of theory of mind measures that do not range in difficulty and, thus, reach ceiling effects, or tasks that may not be appropriate for use with this population (Gooding and Pflum, 2011). Given the mixed evidence in the theory of mind literature, research is needed to clarify the relationship between theory of mind abilities and domains of schizotypy.

1.2.4. Source memory

Source memory is the ability to distinguish between internally generated information and externally derived information (Vinogradov et al., 1997). While the schizophrenia literature demonstrates the presence of source memory deficits and associations with symptomatology, such evidence is scarce in the schizotypy literature.

Researchers have observed more source memory errors in adults reporting greater positive features of schizotypy (Allen et al., 2006; Asai and Tanno, 2008). Researchers have also found that adolescents who made more source memory errors endorsed more hallucination items on the Schizotypal Personality Questionnaire and were genetically at high-risk for developing psychosis (Debbane et al., 2009). These studies provide evidence that worse source memory is associated with greater positive schizotypy experiences.

However, it is important to consider that many of these studies included small sample sizes and measures that did not adequately represent all domains of schizotypy. The current study extends the literature by exploring potential associations between source memory abilities and all components of schizotypy defined continuously.

1.3. The current study

The current study extends on prior research by utilizing a number of measures that tap into subcomponents of each factor and by considering schizotypal characteristics on a continuum. We aim to replicate the four-factor solution of schizotypy via Confirmatory Factor Analysis using several measures that we believed comprehensively capture all four factors and to examine relationships between cognitive biases and factors of schizotypy.

1.3.1. Hypotheses

Given the aforementioned literature, we hypothesize that we will replicate a four-factor model of schizotypy that includes the positive,

negative, cognitive disorganization, and impulsive nonconformity factors. We also hypothesize that increased self-certainty will be associated with greater positive and impulsive nonconformity schizotypy; increased knowledge corruption will be associated with greater positive schizotypy; diminished theory of mind will be associated with greater positive, negative, and cognitive disorganization schizotypy; and decreased source memory will be associated with greater positive schizotypy.

2. Methods

2.1. Participants

Participants included 420 undergraduates recruited from the University of Miami (see Table 2). The mean age was 19.18 years (S.D. = 2.73) and the majority of subjects were female (62.9%, N = 264). Forty six percent of participants identified as Caucasian, 22.6% as Hispanic, 16.2% as Other, 11.2% as Asian Americans, and 4.5% as African American. Participants were awarded credit for their participation.

2.2. Procedures

The Institutional Review Board of the University of Miami approved this study. A trained research assistant administered the questionnaires to approximately 10 participants at a time in a quiet room. Participants completed the paper-and-pencil questionnaires at their own pace.

2.3. Instruments

2.3.1. Magical Ideation Scale (MIS; Eckblad and Chapman, 1983)

This measure consists of 30 true-false items inquiring about physically impossible/illogical or magical belief structures embedded in participant's interpretations of personal experiences (e.g., "I sometimes have a feeling of gaining or losing energy when people look at me or touch me."). A higher score indicates more pronounced magical thinking. In the current study, the MIS had good internal consistency (Cronbach's $\alpha = 0.82$).

2.3.2. Schizotypal Personality Questionnaire – Brief Form (SPQ-B; Raine and Banishay, 1995)

This 22-item Yes/No questionnaire consists of the Cognitive-Perceptual (e.g., "Do you believe in telepathy?"), Interpersonal (e.g., "People find me aloof and distant."), and Disorganization (e.g., "I sometimes forget what I am trying to say.") subscales with higher scores indicating more difficulties. In the current study, the SPQ-B had acceptable internal consistencies (SPQ_Pos Cronbach's $\alpha = 0.64$, SPQ_Neg Cronbach's $\alpha = 0.78$, SPQ_Disorg Cronbach's $\alpha = 0.79$).

2.3.3. Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE; Mason et al., 1995)

This 104-item Yes/No measure assesses schizotypal traits on four scales: Unusual Experiences (e.g., "I have felt that I have special, almost magical powers."), Introvertive Anhedonia (e.g., "There are just not many things that I have ever really enjoyed."), Cognitive Disorganization (e.g., "I am easily distracted when I read or talk to someone."), and Impulsive Nonconformity (e.g., "Do you often overindulge in alcohol and food."). Higher scores indicate greater difficulty. In the current study, the O-LIFE subscales had adequate internal consistencies (OLIFE_UE Cronbach's $\alpha = 0.86$; OLIFE_IA Cronbach's $\alpha = 0.76$; OLIFE_CD Cronbach's $\alpha = 0.86$; OLIFE_IN Cronbach's $\alpha = 0.70$).

2.3.4. Borderline Symptom List: Short Version Additional Scale (BSL-23; Bohus et al., 2007)

This 11-item scale assesses dysfunctional impulsive behaviors, which have been found to appear across a number of personality disorder diagnoses and schizotypy. This scale was included as an indicator of the impulsive nonconformity factor to provide richness and comprehensiveness to a domain otherwise derived from the O-LIFE impulsive nonconformity factor, which was originally defined, in part, by Chapman's Hypomania Scale (Eckblad and Chapman, 1986) and Claridge's Borderline Personality Scale (Claridge and Broks, 1984). Participants are asked to report the extent to which 11 behaviors (e.g., "During the last week I had outbreaks of uncontrolled anger or physically attacked others.") were performed over the last 7 days. Participants rate each item on a Likert scale from 0 (not at all) to 4 (daily or more often). In the current study, the internal reliability for this scale was acceptable (Cronbach's $\alpha = 0.61$) for research purposes (Cortina, 1993).

2.3.5. Cognitive Insight: Beck Cognitive Insight Scale (BCIS; Beck et al., 2004)

This 15-item self-report instrument measures how individuals evaluate their own judgments, and it includes two indices, one of which is the self-certainty index (BCIS_SC). Participants rate how much they agree with each statement (e.g., "My interpretations of my experiences are definitely right.") on a Likert scale from 0 (do not agree at all) to 3 (agree completely). Higher scores indicate more self-certainty. The internal reliability for the BCIS_SC was 0.63, which is comparable to Beck et al.'s (2004) reliability.

2.3.6. Reading the Mind in the Eyes Task-Revised (Baron-Cohen et al., 2001)

This task includes 36 photographs of the eye regions of anonymous individuals reflecting a wide range of mental states and four response options for each photograph. Higher scores reflect better theory of mind. In the current study, the internal reliability was adequate (Cronbach's $\alpha = 0.78$).

The Reading the Mind in the Eyes Task has received praise because of its sensitivity to reveal subtle impairments in mentalizing and because of its large number of items, which provides a bigger window to reveal individual differences in ability and decreases the risk of ceiling effects (Baron-Cohen et al., 2001). Another strength is its inclusion of complex mental states, making the task more difficult and increasing the likelihood of obtaining a wider range of performance.

2.3.7. Source Memory Task (adapted from Vinogradov et al., 1997)

This task contains two phases, separated by a 30 minute delay, to assess the participant's ability to identify the source of given information. During the study phase, participants are presented with a list of 20 sentences with 10 blank spaces; participants are asked to read each sentence and to "make up a word" for each blank. During the testing phase, the experimenter presents a "test list" to the participant that contains 30 word pairs: 10 word pairs where the target word was generated by the experimenter, 10 word pairs where the target word was generated by the research participant, and 10 new word pairs. Participants are asked whether the target word was "written on the page," "made up by the subject," or "brand new" and are asked how confident they are for each of their responses. Reponses are scored by the subject's correct classification of the word pair as "self-generated," "other-generated," or "new." In the current study, internal reliability was high (Cronbach's $\alpha = 0.86$). It is important to mention that although this task is typically administered to patients with schizophrenia, we found our sample to be sufficiently challenged, as was evidenced by a mean hit rate of 76% and accuracy ranging from 27% to 100% across our sample.

2.3.8. Knowledge Corruption Index (Moritz et al., 2005)

This index measures the degree to which false information intrudes into someone's knowledge system. Response specifications are as described in the preceding paragraph. The knowledge corruption index is calculated by computing the percentage of very

Table 1
Correlation matrix for schizotypy and cognitive bias indicators.

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. SM	1												
2. BCI_SC	−0.09	1											
3. MIS	−0.07	0.11*	1										
4. BSL	−0.11*	0.08	0.22**	1									
5. SPQ_Neg	0.06	0.01	0.19**	0.08	1								
6. SPQ_Pos	−0.04	0.15**	0.62**	0.19**	0.31**	1							
7. SPQ_Disorg	−0.01	0.03	0.38**	0.27**	0.45**	0.44**	1						
8. OLIFE_UE	−0.07	0.08	0.72**	0.17**	0.32**	0.72**	0.45**	1					
9. OLIFE_CD	0.08	−0.09	0.37**	0.26**	0.55**	0.48**	0.57**	0.50**	1				
10. OLIFE_IA	−0.05	0.02	0.14**	0.06	0.59**	0.13**	0.25**	0.14**	0.32**	1			
11. OLIFE_IN	−0.10*	0.16**	0.37**	0.51**	0.18**	0.36**	0.43**	0.41**	0.38**	0.17**	1		
12. TOM	0.19**	−0.11	−0.19**	0.09	0.01	0.01	−0.01	−0.03	0.07	−0.16**	0.04	1	
13. KC	−0.54**	0.15**	0.08	0.05	0.03	0.06	0.03	0.02	−0.02	0.11*	−0.19**	1

Note. SM, Source Memory Task; BCI_SC, Beck Cognitive Insight Scale Self-Certainty Subscale; MIS, Magical Ideation Scale; BSL, Borderline Symptom List Additional Scale; SPQ_Neg, Schizotypal Personality Disorder Negative Scale; SPQ_Pos, Schizotypal Personality Disorder Positive Scale; SPQ_Disorg, Schizotypal Personality Disorder Disorganized Scale; OLIFE_UE, Oxford Liverpool Inventory of Feelings and Experiences_Unusual Experiences Scale; OLIFE_CD, Oxford Liverpool Inventory of Feelings and Experiences_Cognitive Disorganization Scale; OLIFE_IA, Oxford Liverpool Inventory of Feelings and Experiences_Introvertive Anhedonia Scale; OLIFE_IN, Oxford Liverpool Inventory of Feelings and Experiences_Impulsive Noncomformity Scale; TOM, Reading the Mind with the Eyes Task Score; KC, Knowledge Corruption Index. All data were collected at one time point.

confident responses (i.e., rated a 5) that are errors (Moritz et al., 2005, 2006). In other words, the numerator represents the number of incorrect, very confident responses, and the denominator represents the total number of very confident responses. If participants made no very confident responses, the knowledge corruption index was set at 0. No psychometric properties have been published for this task.

3. Results

All variables were checked for outliers and normality, and no variables had to be transformed. The correlation matrix for all primary variables is presented in Table 1. Means, standard deviations and ranges were obtained for indicators of schizotypy and cognitive biases (see Table 3). Structural Equation Modeling (SEM) with the M*plus* statistical program (v6, Muthén and Muthén, 2007) was used to test primary and exploratory hypotheses.

To estimate the model parameters with missing data, we used full information maximum likelihood (FIML). The maximum likelihood method was employed to estimate path coefficients, loadings, and standard errors for significance tests (two-tailed, $\alpha = 0.05$). Several indices recommended by Hu and Bentler (1999) were followed to evaluate model fit, including ≥ 0.95 for the comparative fit index (CFI), ≤ 0.06 for the root-mean-square error of approximation (RMSEA), and ≤ 0.08 for the Standardized Root Mean Squared Residual (SRMR).

3.1. Descriptive statistics

When examining relationships between demographic variables and primary variables, we found that gender was significantly associated with the impulsive nonconformity factor ($z = -2.54$, $p = 0.01$): Males had more impulsive nonconformity than females. Caucasians had less negative schizotypy than African Americans ($z = 2.6$, $p = 0.01$) and those who identified as Other ($z = 2.04$, $p = 0.04$).

Although there were some significant relationships between demographic variables and dependent variables, we did not control for these associations. There are no theoretical reasons to expect associations between cognitive biases and domains of schizotypy to differ as a function of age, gender, or ethnicity, and controlling for these associations would significantly diminish our power, degrees of freedom, and the overall model fit. It is important to note that the inclusion of these covariates in our final model did not change the significance of any individual paths.

3.2. Measurement model

Before testing our entire model, we tested an *a priori* measurement model of schizotypy based on prior literature (Mason et al., 1995), which included positive, negative, cognitive disorganization, and impulsive nonconformity factors. The latent variable model specified the OLIFE_UE, SPQ_Pos, and MIS as indicators of positive schizotypy, the OLIFE_IA and SPQ_Neg as indicators of negative

Table 2
Means and standard deviations for demographic variables.

	Mean (S.D.)	Frequency (percent)
Gender		
Male		156 (37.1%)
Female		264 (62.9%)
Age	19.18 (2.73)	
Ethnicity		
Caucasian		191 (45.5%)
Hispanic		95 (22.6%)
African American		19 (4.5%)
Asian American		47 (11.2%)
Other		68 (16.2%)

Note. S.D. = standard deviation.

Table 3
Means, standard deviations and ranges for schizotypy indicators and cognitive biases.

	M	S.D.	Range
O-LIFE			
Unusual experiences	8.85	5.97	0–28
Introvertive anhedonia	5.59	3.84	0–22
Cognitive disorganization	9.48	5.55	0–24
Impulsive nonconformity	7.96	3.67	0–21
SPQ-B			
Positive	2.69	2.12	0–8
Negative	2.98	2.39	0–8
Disorganized	2.06	1.81	0–6
MIS	6.08	4.7	0–24
BSL-23	1.5	2.41	0–18
Self-certainty	7.43	3.00	0–17
Theory of mind	23.58	4.53	6–32
Source memory	22.92	3.76	8–30
Knowledge corruption	0.11	0.12	0–0.67

schizotypy, the OLIFE_CD and SPQ_Disorg as indicators of cognitive disorganization, and the OLIFE_IN and BSL as indicators of impulsive nonconformity. We found that the SPQ_NEG indicator had a small negative residual (-0.08); therefore, consistent with consensus, this residual was fixed to zero for subsequent analyses. The measurement model of a four-factor solution of schizotypy fit the data well (χ^2 (22) = 47.32, $p = 0.001$; Comparative Fit Index (CFI) = 0.98; root mean squared error of approximation (RMSEA) = 0.05; standardized root mean squared residual (SRMR) = 0.03). All standardized loadings from the indicators to each domain of schizotypy were significant and greater than 0.5. Standardized loadings are presented in Fig. 1.

Latent domains of schizotypy were all significantly positively associated with each other. Positive schizotypy was associated with negative schizotypy ($z = 4.12$, $p < 0.001$), cognitive disorganization ($z = 16.65$, $p < 0.001$), and impulsive nonconformity ($z = 8.88$, $p < 0.001$). Negative schizotypy was associated with cognitive disorganization ($z = 6.65$, $p < 0.001$) and impulsive nonconformity ($z = 1.42$, $p = 0.001$). Cognitive disorganization was associated with impulsive nonconformity ($z = 8.51$, $p < 0.001$).

3.3. Structural model

After establishing acceptable measurement model fit and loadings of indicators on the latent domains of schizotypy, the latent variables were used in the SEM model specification and evaluation. Because knowledge corruption and source memory were derived from the same measure, their residuals were correlated. The SEM analyses were conducted in five steps.

The hypothesized model incorporated the measurement model of schizotypy factors presented previously. Proposed modification indices that significantly improved the model were added step-wise. The final model fit the data well (χ^2 (47) = 121.87, $p < 0.001$; Comparative Fit Index (CFI) = 0.96, root mean squared error of approximation (RMSEA) = 0.06; standardized root mean squared residual (SRMR) = 0.04). Standardized coefficients are presented in Fig. 2.

Higher self-certainty ($z = 2.9$, $p = 0.004$), lower theory of mind ($z = -2.33$, $p = 0.02$), and lower source memory ($z = -2.06$, $p = 0.04$) were associated with greater positive schizotypy. Higher self-certainty ($z = 2.51$, $p = 0.01$) was associated with greater negative schizotypy. Lower self-certainty ($z = -3.19$, $p = 0.001$) and greater ToM ($z = 2.21$, $p = 0.03$) were associated with greater cognitive disorganization schizotypy. Higher self-certainty ($z = 3.17$, $p = 0.002$) and lower source memory ($z = -2.65$, $p = 0.008$) were associated with greater impulsive nonconformity schizotypy. See Table 4 for unstandardized path coefficients, standard errors, and z-values for direct effects.
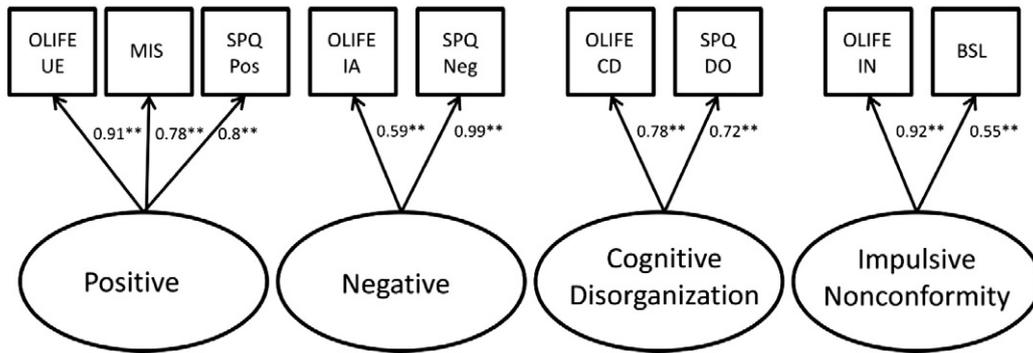
Fig. 1. Measurement model for latent domains of schizotypy. Indicators include OLIFE_UE, MIS, SPQ_Pos, OLIFE_IA, SPQ_Neg, OLIFE_CD, SPQ_Disorg, OLIFE_IN and BSL. Standardized loadings are shown *p<0.05, **p<0.001.

4. Discussion

Our measurement model of schizotypy was consistent with our hypotheses and prior research and yielded a four-factor solution including positive, negative, cognitive disorganization and impulsive nonconformity factors. We think this four-factor solution captures the schizotypy construct well given our inclusion of measures that tap into numerous components of each latent factor. It is important that future research on psychosis proneness utilizes measures that assess the full range of characteristics underlying the multidimensional construct schizotypy.

The current study is notable for identifying associations between information processing biases and domains of schizotypy. Consistent with hypotheses, we found that higher self-certainty, lower theory of mind, and lower source memory were associated with higher ratings on the positive factor of schizotypy. The current research is the first to examine whether high self-certainty is associated with positive schizotypy, including, but not limited to, delusion proneness. According to Beck et al. (2009), beliefs may become delusional when they are held with high confidence and when they are impermeable to doubt. It is

possible that high certainty may not allow corrective feedback to be incorporated into one's belief system, and thus, might lead to unusual rationalizations or incorrect interpretations.

Prior research yielded a significant association between decreased theory of mind and magical ideation (Meyer and Shean, 2006). The current study is notable because our operationalization of positive schizotypy encompasses magical ideation as well as other subcomponents of positive schizotypy. Thus, we can conclude that impairments in theory of mind might impact the development of a number of experiences underlying positive schizotypy. Impairments in theory of mind reflect difficulties with overriding the automatic salience of first-person evidence and with representing multiple simultaneous and possibly contradictory views of reality (Langdon, 2003, 2005). Plausibly, these difficulties may promote the acceptance of thoughts that are improbable (Langdon et al., 2010) and may lead one to make incorrect inferences about the intention of others (e.g., viewing neutral interchanges as hostile or negatively valenced).

The current study supports prior research (Allen et al., 2006; Asai and Tanno, 2008) indicating that deficits in the ability to discriminate the source of information are associated with greater positive
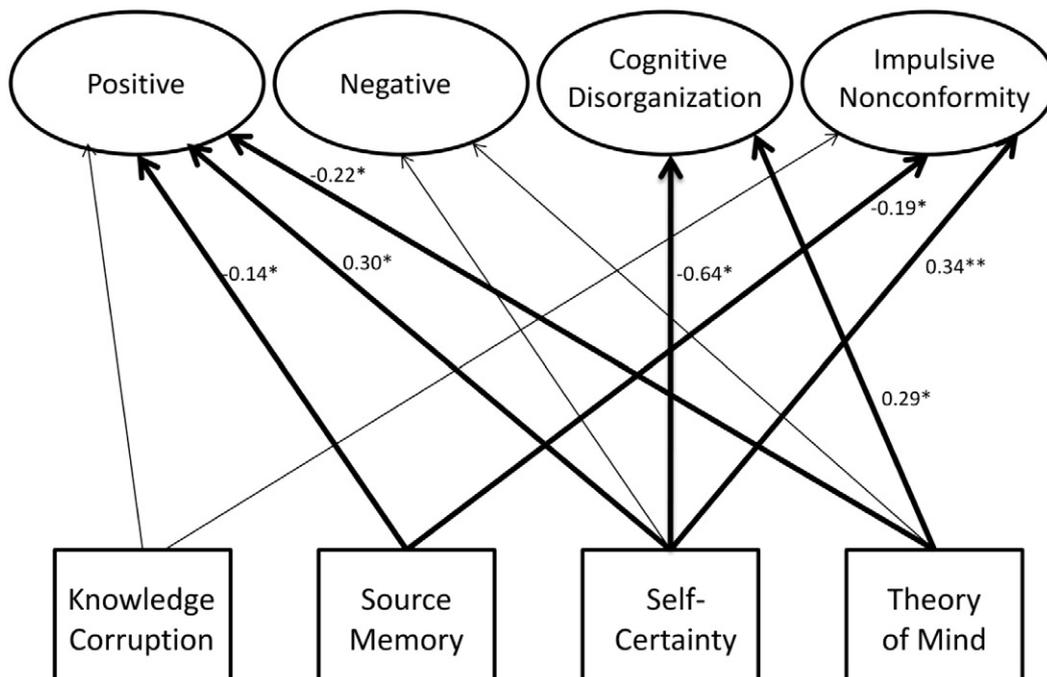

Fig. 2. Structural model of knowledge corruption, source memory, self-certainty and theory of mind predicting domains of schizotypy. Significant paths (bold lines) are shown with standardized coefficients *p<0.05, **p<0.001.

Table 4
Structural model unstandardized path coefficients, standard errors and z-values for direct effects.

	Coefficient	SE	z
Positive on			
Self-certainty	0.17	0.06	2.9**
Knowledge corruption	0.00	0.001	−0.24
Theory of mind	−0.18	0.08	−2.33*
Source memory	−0.10	0.05	−2.06*
Negative on			
Self-certainty	0.38	0.15	2.51*
Theory of mind	−0.28	0.16	−1.73
Cognitive Disorganization on			
Self-certainty	−0.44	0.14	−3.19**
Theory of mind	0.30	0.14	2.21*
Impulsive Nonconformity on			
Self-certainty	0.31	0.10	3.17*
Knowledge corruption	0.004	0.002	1.89
Source memory	−0.21	0.08	−2.65*

$*p < 0.05$, $**p < 0.01$.
SE = standard errors.

schizotypy. Thus, this cognitive mechanism might present vulnerability for the development of positive subclinical symptom experiences, such as believing that one's thoughts belong to another.

Consistent with hypotheses, higher self-certainty was associated with greater impulsive nonconformity. Thus, an unwillingness to consider alternatives prior to arriving at conclusions was associated with impulsive, asocial behaviors and poorer self-control. Perhaps high confidence in one's thoughts makes one react in an impulsive manner, given that little attention is given to evaluating competing information.

Several study hypotheses were not supported. Contrary to expectations, higher knowledge corruption was not associated with greater positive schizotypy. Because this hypothesis was derived from the schizophrenia literature, a corrupted knowledge system may be necessary to maintain fixed false beliefs (delusions), but not to *consider* unusual beliefs. Closer inspection of items tapping into positive schizotypy reveals wording that is less absolute and less confident. For example, positive schizotypy items include phrases such as "had a passing thought" and "got a momentary feeling." Thus, perhaps only experiences that cross the clinical threshold into delusions, which are fixed, rely on a corrupted knowledge system.

Also contrary to hypotheses, we found no association between theory of mind and negative schizotypy. We examined this association in an attempt to clarify previously mixed findings (Jahshan and Sergi, 2007; Fernyhough et al., 2008; Monestes et al., 2008).

Unexpectedly, we found that higher self-certainty was associated with greater negative schizotypy. It is possible that greater confidence in one's interpretations of experiences may make social interactions less rewarding and/or interesting because others' feedback is not incorporated into a holistic understanding of experiences. Because this was not an *a priori* hypothesis, results need to be replicated to confirm this finding.

Interestingly, we found that greater theory of mind was associated with greater cognitive disorganization. This finding is in the *opposite* direction than anticipated. The research used to derive our hypothesis (Brown and Cohen, 2010) found that specific types of mistakes during a theory of mind task (i.e., more negative ratings of faces) were associated with greater cognitive disorganization. Thus, specific types of mistakes made during a theory of mind task and overall performance on a theory of mind task differentially relate to the cognitive disorganization factor of schizotypy.

A third unpredicted finding emerged: Lower self-certainty was associated with greater cognitive disorganization. This relationship is established in the social anxiety literature whereby individuals with greater social anxiety demonstrate lower self-certainty (Krain et al., 2008). However, this finding is inconsistent with schizophrenia

research that demonstrates higher self-certainty as associated with greater cognitive disorganization (Lysaker et al., 2010). Our unusual findings regarding the cognitive disorganization factor may reflect the fact that one of our indicators of cognitive disorganization has been found to load heavily onto measures of neuroticism (Kendler and Hewitt, 1992). Thus, to better understand these associations, future researchers might separate cognitive disorganization measures into items that tap into social anxiety/neuroticism and items that tap into attentional and cognitive difficulties.

We also discovered an unexpected finding regarding impulsive nonconformity. Specifically, lower source memory was associated with greater impulsive nonconformity. It seems that difficulty differentiating the origins of information contributes to an overall fallible and confused memory system. Because the content and appraisal of one's memory are important for the ongoing regulation and modulation of one's behavior (Finn et al., 1999), false memory information may result in poorly planned or abrupt behavioral consequences. This explanation is speculative; thus, further research is needed to confirm this finding.

Findings involving the impulsive nonconformity factor should be considered in the context we presented earlier: Our choice of scales reflects our support for a unitary theory of psychosis, which maintains the inclusion of such features in the characterization of a comprehensive schizotypy. Additionally, we note that findings regarding impulsive nonconformity warrant further attention given that research shows that elevations on measures of impulsivity and asociality are related to delinquent behaviors and increased substance abuse (Labouvie and McGee, 1986), indicating risk factors for possible additional psychological difficulties.

When comparing zero-order correlations between indicators of schizotypy and cognitive biases (see Table 1) and Structural Equation Model path analyses (see Table 4), interesting findings emerged. Specifically, while our path model revealed significant associations between a latent variable (e.g. positive schizotypy) and a cognitive bias (e.g. self certainty), when examining the zero-order correlations between all indicators of a latent variable (e.g. MIS, SPQ_Pos, OLIFE_UE for positive schizotypy) and cognitive biases (e.g. self certainty), not all indicators were significantly associated with that cognitive bias. This is possibly due to the fact that indicator containing random or systematic measurement error, whereas latent variables, or hypothetical statistical constructs, are freer from measurement error. Thus, it seems that a truer representation of the relationships between the domains of schizotypy and cognitive biases is derived from the model we describe using Structural Equation Modeling (Bollen, 1989, p 11).

Finally, we note some interesting results regarding demographic variables and domains of schizotypy. We found that males endorsed more impulsive nonconformity characteristics than females. These findings are consistent with prior research documenting that men show increased impulsive nonconformity (Fonseca-Pedrero et al., 2008) when compared to females. We also found that Caucasians had less negative schizotypy than African Americans and those who identified as "Other". Although compelling, these results should be interpreted with caution because of the small sample size of our African American group ($N = 19$) and because of difficulties with interpretation due to the heterogeneity of participants who identified as "Other".

4.1. Limitations and future directions

The current study is not without limitations. Data were cross-sectional; thus, we cannot assume causality in associations between cognitive biases and domains of schizotypy. Future research should examine these characteristics longitudinally to observe whether changes in cognitive biases are associated with changes in schizotypy and/or the emergence of clinically significant psychosis.

Some of the internal reliabilities for study indicators were lower than generally preferred (i.e., SPQ_POS Cronbach's $\alpha = 0.64$; BSL

Cronbach's $\alpha = 0.61$, BCIS_SC Cronbach's $\alpha = 0.63$), although some researchers view reliabilities as low as 0.6 as appropriate for research purposes (Cortina, 1993). Also, our sample is from an expensive, private university; thus, results may not be generalizable to older individuals and those in other socioeconomic brackets.

It is important to note that the theory of mind task we used, the RMET, assesses only the social-perceptive component of this complex construct. Therefore, our findings regarding theory of mind are limited as we did not include an assessment of the social-cognitive component, which would have allowed for a more comprehensive evaluation of theory of mind. Further, we should note that the inclusion of the revised Social Anhedonia Scale would have strengthened our assessment of the social component of negative schizotypy, given that one of the measures we used, the O-LIFE Introvertive Anhedonia Scale, includes only a few questions that map onto this domain.

Though the SPQ-Brief was included in the battery of questionnaires, this measure warrants caution when used in isolation. Some researchers have found the internal reliability scores for two of the subscales (positive and cognitive disorganization) to be inadequate, and there has been some debate regarding the factor model of the measure (Compton et al., 2007, 2009). However, we think these shortcomings are tempered by the inclusion of numerous other well-validated and reliable instruments, such as the MIS and the O-LIFE (Eckblad and Chapman, 1983; Mason et al., 1995). Future suture studies might avoid the limitations presented here by utilizing the full-length SPQ (Compton et al., 2007).

4.2. Conclusions

In summary, findings from this study suggest that cognitive biases, including self-certainty, theory of mind and source memory, are differentially associated with components of schizotypy.

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