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A cognitive bias against disconfirmatory evidence (BADE) is associated with schizotypy

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Abstract

A bias against disconfirmatory evidence (BADE) has been observed in schizophrenia, and in the present study we evaluated whether this extends to a nonclinical sample scoring high on a schizotypy scale. Thirty-seven high and 32 low schizotypy healthy participants were sequentially presented with three sentences that increasingly disambiguated the true content of a delusion-neutral scenario and were asked to rate the plausibility of four interpretations for this scenario. Relative to low schizotypy participants, high schizotypy participants continued to endorse their initial beliefs, even in the face of evidence that disconfirmed these beliefs. This result provides support for the "schizophrenia spectrum" account of psychosis.
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1. Introduction

Schizotypy refers to psychotic-like traits that are qualitatively similar, but quantitatively much less severe, than the psychotic symptoms found in schizophrenia and schizotypal personality disorder (Strauss, 1969; van Os et al., 2000, 1999; Verdoux and van Os, 2002). Unlike schizophrenia and schizotypal personality disorder, schizotypy is nonclinical and is an aspect of normal individual variation (Claridge and Beech, 1995; Johns and van Os, 2001). Schizophrenia, schizotypal personality disorder and schizotypy are characterized by similar psychopathology, including cognitive–perceptual aberrations, interpersonal deficits, and cognitive disorganization (Siever et al., 2002; Stefanis et al., 2002), and this continuity forms the basis of the fully dimensional view of the schizophrenia spectrum (Claridge and Beech, 1995, Fig. 9.1).

Some examples of cognitive biases that have been associated with schizophrenia include a *jumping to conclusions* bias (Garety et al., 1991), an *attributional bias* (Bentall et al., 1994), problems with *theory of mind* (Frith, 1994), and *knowledge corruption* (Moritz et al., 2004). In agreement with the fully dimensional account of the schizophrenia spectrum (Claridge and Beech, 1995), many of these biases have also been demonstrated in healthy people displaying schizotypy (Gray and Snowden, 2005; Langdon and Coltheart, 1999; Laws and Bhatt, 2005; Sellen et al., 2005).

In recent work using delusion-neutral test materials, we have demonstrated a bias against disconfirmatory evidence (BADE) in the absence of a bias against

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confirmatory evidence (BACE) in people with schizophrenia (Moritz and Woodward, 2006; Woodward et al., 2006a,b, submitted for publication). In some of these studies, the BADE was increased for patients currently experiencing delusions (Woodward et al., 2006a,b). The purpose of the current investigation was to assess whether a nonclinical sample with high scores on measures of schizotypy would also demonstrate a BADE. Thus, as for the schizophrenia studies, we predicted that people with high schizotypy would show a BADE, but not a BACE. This study design has a methodological advantage over our past patient-based studies, as confounding variables such as lengthy psychoactive medication use, generalized intellectual deficits, knowledge of diagnostic status, stigmatization, and the effects of institutionalization do not affect interpretation of the results.

2. Methods

2.1. Participants

535 undergraduate students were screened for schizotypal traits with the Schizotypy Personality Questionnaire (SPQ; Raine, 1991). Participants with SPQ scores greater than the 90th percentile (*high schizotypy*), and less than the 10th percentile (*low schizotypy*), were invited to participate in the second session in exchange for course credits or a small remuneration. Of the 103 subjects contacted, 75 agreed to participate. The final sample consisted of 37 high schizotypy and 32 low schizotypy individuals, as data were lost for six participants due to technical difficulties.

All participants reported an absence of previous severe head trauma and mental disorder (as measured by an administered medical questionnaire) and gave written informed consent in accordance with the Simon Fraser University Research Ethics Board.

2.2. Measures

The SPQ is a 74-item yes–no self-report inventory consisting of nine subscales modeled after the 9 criteria of DSM-III-R schizotypal personality disorder (Raine et al., 1994). The Quick Test (Ammons and Ammons, 1962) and the North American Adult Reading Test (NAART; Blair and Spreen, 1989) served as estimates of intelligence.

The BADE test employed here was based on previous versions of this test, and the details regarding administration are available elsewhere (Woodward et al., 2006a,b). The current version consisted of 30 written delusion-neutral scenarios. The plausibility of four interpretations was rated for each scenario. Each scenario had one *true* interpretation, two *lure* interpretations, and one *absurd* interpretation. The true interpretation appeared implausible initially but became more reasonable as additional information was revealed. The lure interpretations appeared plausible initially but became implausible as additional information was revealed, and consisted of one "emotional" lure interpretation, and a "neutral" lure interpretation (examples below). The absurd interpretation was designed to be implausible at all stages. Disconfirmatory and confirmatory evidence were introduced by three successive sentences (e.g., "Jenny can't fall asleep"; "Jenny can't wait until it is finally morning"; and "Jenny wonders how many presents she will find under the tree"). After presentation of each sentence, participants were invited to update ratings previously assigned to each of the four interpretations, based on all evidence. The four interpretations for this scenario are as follows: "Jenny is nervous about her exam the next day" (neutral lure); "Jenny is worried about her ill mother" (emotional lure); "Jenny loves her bed" (absurd); and "Jenny is excited about Christmas morning" (true).

The BADE scenarios were presented via Microsoft Internet Explorer 6.0. A 1–10 rating scale with a scroll bar was positioned beneath each interpretation, with nominal ratings "poor", "possible", "good", and "excellent" positioned underneath the following rating scale numbers: 0, 3.5, 6.5, and 9.5, respectively. Ratings were entered via mouse click. One practice trial was administered to allow participants to become familiar with the rating scale and scroll bar. Test duration was approximately 20 min.

Measures directly indexing integration of confirmatory and disconfirmatory evidence were computed as change scores from the initial rating, as increasing evidence is accrued. For each interpretation (emotional and neutral lure, absurd, and true), three BADE and one BACE measures were obtained. The three BADE measures were computed as the *decrease* in plausibility ratings from sentence #1 to the average of sentences #2 and #3, for emotional and neutral lure interpretations, and for absurd interpretations. The BACE measure was computed for the true interpretations, as the *increase* in plausibility ratings from sentence #1 to the average of sentences #2 and #3.

3. Results

High and low schizotypy participants did not differ on verbal IQ (as assessed by Quick Test, $t(67) = -0.36$, $p = 0.72$, and NAART, $t(67) = -0.66$, $p = 0.14$), or

Table 1
Sociodemographic characteristics of the samples

	High schizotypy (n=37)	Low schizotypy (n=32)
Age	19.11 (1.83)	19.67 (2.28)
Gender	23 F, 14 M	20 F, 12 M
Education	13.32 (.47)	13.76 (0.79)
Quick	36 (7.21)	36 (5.58)
NAART	32 (10.77)	30 (9.55)

gender, $\chi^2(1)=3.17$, $p=0.08$, or age, $t(67)=1.15$, $p=0.26$. They showed a minor but significant difference on education, $t(67)=2.90$, $p<0.01$. The slight sampling difference in education is due to a greater number of 1st year students in the high schizotypy group relative to the low schizotypy group. However, the difference was small, and entering education as a covariate in the analyses reported below did not affect the results, so this is not discussed further. Means for demographic variables are listed in Table 1.

All results are reported as between-groups t-tests for three BADE measures and one BACE measure. The t-tests were tested at 0.05 one-tailed, under the hypothesis that high schizotypy participants would show an increased BADE. These analyses resulted in a significant high schizotypy BADE for emotional lures, $t(67)=2.06$, $p<0.05$, and neutral lures, $t(67)=1.84$, $p<0.05$, with the group difference for the absurd items bordering on significance, $t(67)=1.66$, $p=0.06$. Importantly, there was no group difference detectable for true items, $t(67)=0.44$, $p=0.66$, confirming that the BADE is not attributable to a difficulty integrating any type of information. Mean BADE and BACE values are listed in Fig. 1.

All BADE and BACE measures were correlated with the SPQ subscales (ideas of reference, excessive social anxiety, odd beliefs or magical thinking, unusual perceptual experiences, odd or eccentric behavior, no close friends, odd speech, constricted affect, and suspiciousness) using Pearson's correlation coefficients, two-tailed. Considering the BADE measures for emotional and neutral lures, respectively, significant correlations were observed with ideas of reference, $r(67)=-0.24$, $p<0.05$; $r(67)=-0.23$, $p=0.05$, and with excessive social anxiety, $r(67)=-.29$, $p<0.05$; $r(67)=-0.27$, $p<0.05$. All other correlations were nonsignificant (all ps>0.06).

4. Discussion

In the present study we observed a bias against disconfirmatory evidence (BADE) in individuals scoring high on a schizotypy scale, but not a bias against confirmatory evidence (BACE). The BADE was revealed through an unwillingness to downwardly adjust plausibility ratings to reflect recently encountered disconfirmatory evidence. Interpretation of the BADE finding was supported by the observation that on these same scenarios, relative to the low schizotypy group, participants displaying high schizotypy were not compromised in their ability to integrate confirmatory information into their ratings. This combination of findings suggests that a BADE is linked to schizotypal traits, and that this is not due to a more general integration deficit, or difference in intelligence.

One limitation of the present study was that the group comparisons do not directly suggest that delusional ideation is associated with a BADE in schizotypy because we did not select participants on the basis of delusional ideation scores, but instead used total SPQ score. As such our sample does not represent extreme ends on a continuum of delusional ideation scores. Thus, splitting the samples by delusional ideation instead of total score may have produced greater group differences on the BADE measure. However, correlational analyses suggested an association between BADE and the referential aspect of delusional ideation and social anxiety. Future studies may examine relations between BADE/BACE and specific symptoms/symptom profiles by selecting (nonclinical) participants on the basis of

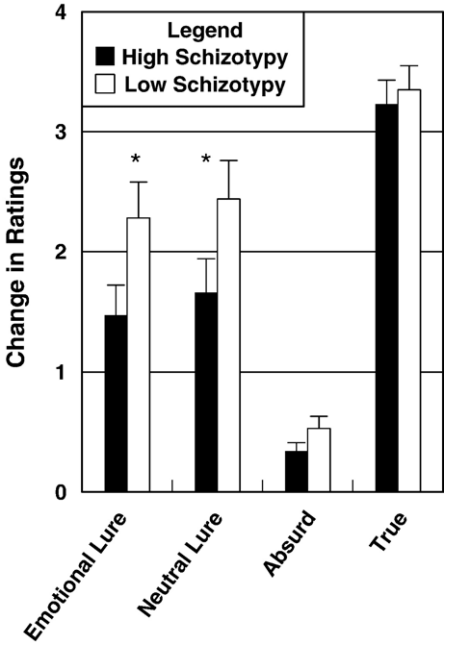

Fig. 1. Mean rating decreases (for lure and absurd interpretations; BADE) or increases (for true interpretations; BACE), presented as a function of group (bars are standard errors). *$p<0.05$, high vs. low schizotypy.

delusional ideation scores from the SPQ or other schizotypy scales.

These data support the fully dimensional model of the schizophrenia spectrum, which predicts unifying cognitive biases. The implication of these findings is that in their strongest forms, these cognitive biases may combine to contribute to the formation of the delusional aspects of psychosis. Future studies may investigate which combinations (if any) of such cognitive biases may serve as clear prodromal features of schizophrenia, and whether they could be used to predict first episodes of psychosis, or relapses.

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Contributors: The first author assisted in conceptualizing the study, managed the study, collected the data, carried out the preliminary data analysis, prepared the first draft of the manuscript in partial fulfillment of an honour's thesis at Simon Fraser University, and collaborated in the writing of the final version of the manuscript. The second author assisted in conceptualizing the study, designed the BADE task, carried out the final data analysis, and wrote the final version of the manuscript. The third author provided laboratory space and resources for data collection, assisted in conceptualizing the study, and collaborated in the writing of the final version of the manuscript. All authors contributed to and have approved the final manuscript.

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