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Specificity of emotion-related effects on attentional processing in schizotypy

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Abstract

Objectives—In the schizophrenia spectrum, cognitive functions such as perception, language, and attention have been shown to be adversely influenced by negative affect. The present study addressed three issues of specificity and one issue of mechanism regarding affect-related attentional disruption in schizotypy: (1) Is attentional disturbance from negative affective stimuli specific to positive (PS) but not negative schizotypy (NS)? (2) Do positive affective stimuli also foster attentional disturbance? (3) Are anxiety and depression differentially related to PS and NS? (4) Whatever the degree of specificity in these relationships, does anxiety mediate the relationship between schizotypy and attentional disturbance?

Methods—Nonpatient participants (*N*=162) provided responses on scales of schizotypy, anxiety, and depression and performed an emotional Stroop task, judging the ink color of positive, neutral, and negative words.

Results—PS but not NS was associated with poorer attentional performance. This attentional disturbance was specific to negative words. PS was associated with anxiety and depression, whereas NS was associated only with depression. Finally, anxiety and depression did not fully mediate the relationship between PS and attentional interference related to negative affective stimuli.

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Conflict of interest

All authors declare that they have no conflict of interest.

Contributors

All authors were involved in data collection. Aprajita Mohanty designed the study, conducted literature searches and statistical analyses, and was the primary author of the manuscript. Gregory Miller and Wendy Heller contributed to writing it and provided laboratory resources, funding, and oversight. Nancy Koven was also involved in designing the study. All authors contributed to and have approved the final manuscript.

Conclusions—Findings of attentional disturbance in the presence of negative affective stimuli, particularly in positive schizotypy, have substantial theoretical implications. They provide a path by which the interplay of cognitive and affective phenomena could lead to the formation, maintenance, and exacerbation of positive symptoms, including delusions and hallucinations. Findings from this study also underscore the importance of examining the differential contribution of comorbid anxiety and depression to cognitive and affective function in the schizophrenia spectrum.

Keywords

Schizotypy; Positive schizotypy; Emotional Stroop; Anxiety; Depression

1. Introduction

Cognitive functions such as perception and language are adversely influenced by negative affect in the schizophrenia spectrum (Asarnow et al., 1978; Burbridge and Barch, 2002; Docherty et al., 1994a, b; Kerns and Berenbaum, 2000). The interaction between cognitive and emotional function provides a possible mechanism for the formation and exacerbation of positive symptoms of schizophrenia (Bentall et al., 2001; Freeman et al., 2002; Garety et al., 2007). A critical aspect of cognitive function that is well established as impaired in schizophrenia-spectrum samples is selective attention (Braver et al., 1999; Lubow and Gewirtz, 1995). However, the disruption of attention by negative affective distractors and its relation to positive and negative symptoms has received much less systematic study.

Using a selective attention paradigm in which emotional valence and arousal properties of distractors were manipulated, the present study examined three aspects of the relationship between positive and negative schizotypy dimensions and attention. Studies using the emotional Stroop task in schizophrenia-spectrum samples have demonstrated that paranoid symptoms are associated with interference from threat-related words (Bentall and Kaney, 1989; Epstein et al., 1999; Fear et al., 1996; Leafhead et al., 1996). However, these studies did not examine two important issues. First, they did not examine whether the emotional interference is a broad effect associated with positive and negative dimensions of the schizophrenia spectrum or a narrower effect specific to the positive dimension. Second, research examining the effect of emotion on cognition in the schizophrenia spectrum has utilized only negative stimuli, confounding valence and arousal, which are often distinguished as aspects of emotion. In the present study, the differential relationship of positive and negative schizotypy with attentional interference from emotional stimuli was examined. By using three sets of stimuli (positive, neutral, and negative), the present study was able to distinguish valence and arousal as conceptually orthogonal dimensions (Bradley and Lang, 1998) and examine whether the emotional stimulus induced attentional disturbance in schizotypy is a broad effect of emotion or specific to negative emotion.

A third uncertainty in the available literature is the diagnostic specificity of the emotional interference effects. Thus, distinct from the emotional nature of the immediate task and its relationship to positive and negative symptoms, anxiety and depression may have an important impact on cognitive and affective function in the schizophrenia spectrum. Studies focusing on such relationships have typically relied solely on depression scales or combined depression and anxiety indices (Norman et al., 1998). Very few studies have systematically examined the relationship of dimensions of anxiety and depression to dimensions of schizotypy or schizophrenia (e.g., Lewandowski et al., 2006), and none has systematically explored potentially distinct relationships involving different aspects of anxiety or depression. This is important because psychometrically discernable constructs of anxious apprehension, anxious arousal, and anhedonic depression (Nitschke et al., 2001) differ in the cognitive and neural mechanisms that implement them (Engels et al., 2007; Heller and Nitschke, 1998; Nitschke et

al., 1999, 2000) and hence are likely to have different behavioral, personality, and clinical implications for specific aspects of schizotypy and schizophrenia. Thus, as a third goal, the present study examined the relationship between dimensions of schizotypy and dimensions of anxiety and depression.

Finally, because similar attentional biases toward threat-related stimuli are seen in anxiety and schizophrenia-spectrum samples (Bentall and Kaney, 1989; Bentall et al., 1995; Blackwood et al., 2001; Fear et al., 1996; Green et al., 2001; Williams et al., 1996), it has been hypothesized that attentional disturbance in schizotypy and schizophrenia is largely a function of high levels of anxiety associated with them. For example, a study showed that, although anxiety and schizotypy scores independently accounted for variance in attentional dysfunction in a selective attention task, the contribution of anxiety was greater (Braunstein-Bercovitz, 2000; Braunstein-Bercovitz et al., 2002). However, the proposed mediating role of anxiety has not been tested systematically using a formal mediating variable analysis. Thus, the present study examined whether different dimensions of anxiety (anxious apprehension, anxious arousal, trait anxiety, and anxiety sensitivity) mediate the relationship between dimensional schizotypy and attentional interference.

2. Method

2.1. Participants

One-hundred and sixty-two (92 female) unselected, right-handed, native-English-speaking psychology undergraduate students (Mean/SD age=18/.73 years) participated in the study for course credit. Participants were screened to ensure that they were not color-blind and gave informed consent prior to participation approved by the campus IRB.

2.2. Questionnaires

The Chapman scales for psychosis proneness (Chapman et al., 1976, 1978; Eckblad and Chapman, 1983) were used to measure positive schizotypy with the perceptual aberration (PerAb) and magical ideation (MagId) subscales and negative schizotypy with the physical anhedonia (PhyAn) and social anhedonia (SocAn) subscales (see Chmielewski et al., 1995, for normative data, and Edell, 1995, for reliability and validity data on the Chapman scales, which have similar reliabilities). Since PerAb and MagId scales share up to half of their variance (here correlating .662, $p<.001$), select many of the same subjects, and possibly identify the same syndrome (Eckblad and Chapman, 1983), a positive-schizotypy index was computed as the sum of PerAb and MagId *z* scores. Similarly, PhyAn and SocAn ($r=.464$, $p<.001$) were combined by summing PhyAn and SocAn z scores (see Barrantes-Vidal et al., 2003, for similar combination). The positive and negative schizotypy composite scores provide essentially orthogonal measures ($r=.14$, n.s.; see Table 2). In addition to schizotypy measures, the present study utilized measures of anxiety, depression, and substance use listed in Table 1.

2.3. Stimuli and task

The emotional Stroop interference task consisted of four blocks of positive or negative affective words alternating with eight blocks of neutral words. Stimuli were blocked on emotional valence due to greater ecological validity and evidence from pilot studies and published evidence indicating more robust behavioral effects for blocked than intermixed trials (Compton et al., 2000; Dalgleish, 1995; Holle et al., 1997). Each block consisted of 16 trials with one trial occurring every 2000 ms. Stimulus presentation and collection of response times (RT) were controlled by STIM software from James Long Co. A trial began with the presentation of a word for 1500 ms, followed by a fixation cross for 500 ms. The word was presented in one of four ink colors (red, yellow, green, and blue), with each color occurring equally often with each word type (positive, neutral, and negative). Trials were pseudorandomized such that

no more than two trials featuring the same color appeared in a row. Using two button boxes (one for the left and other for the right hand), participants were asked to ignore the meaning and respond with the ink color of the words as quickly and accurately as possible. The mapping of the four colors to the first and second fingers of each hand was counterbalanced in order to control for possible laterality-related effects in reaction time. The first and third blocks presented were neutral words, with positive and negative blocks presented either second or fourth (a four-block pattern that was repeated for the total of 16 blocks) and with valence order counterbalanced across participants. Words were carefully selected on the basis of established norms for valence, arousal, and frequency of usage in the English language (Bradley and Lang, 1998) as well as for number of letters (three to eight). Of the 256 words, 64 were positive (e.g., birthday, ecstasy, laughter), 64 were negative (e.g., suicide, war, victim), and two sets of 64 were neutral (e.g., hydrant, moment, carpet). The positive and negative words did not differ in arousal ratings, frequency ($p<.05$). The two sets of neutral words did not differ from each other ($p<.05$) but differed intentionally from the positive and negative words in valence and arousal ratings ($p<.05$).

2.4. Procedure

After providing informed consent, participants completed the questionnaires in group sessions and the emotional interference task in individual half-hour computer sessions. The delay between questionnaire and individual lab sessions ranged from two to eight weeks. In the computer session, participants were seated 115 cm from the computer monitor at eye level in a semi-darkened room and instructed to identify the ink color of each word while ignoring the word's meaning. Participants were given 24 practice trials prior to the experimental task. The principal measures during this task were emotional interference for positive (positive-word RT minus neutral-word RT) and negative (negative-word RT minus neutral-word RT) words. From the full *N* of 162 participants, RT data were unavailable for two participants, and questionnaire data were unavailable from one participant.

3. Results

The mean scores obtained by the participants on the four scales of psychosis proneness, PerAb (M=4.98, SD=5.57), MagId (M = 8.05, SD = 5.40), PhyAn (M = 10.41, SD=6.19), and SocAn (M=6.78, SD=5.07), were similar to each other in range and distribution and similar to scores obtained in a very large undergraduate sample (Chmielewski et al., 1995). The emotion interference manipulation was successful: emotional words were associated with delayed responses, with both positive words and negative words reliably showing interference (positive interference mean=9 ms, SD=42 ms, $t(159)=2.63$, $p=.009$; negative interference mean=19 ms, SD=49 ms, $t(159)=4.84$, $p<.001$). Table 2 presents zero-order correlations between the self-report measures and RT interference.

Table 3 presents the results of seven sets of hierarchical regressions conducted with schizotypy measures as predictors and RT interference, anxiety, or depression as dependent variables (DV). In each set of regressions, positive schizotypy was entered alone as a predictor, then negative schizotypy was entered alone, and finally both positive and negative schizotypy were entered together (full model). Of primary interest was the increment in variance accounted for (ΔR^2) when each was added second, as a means of evaluating the unique variance each contributed.

Centrally relevant to the goals of the study, higher positive but not negative schizotypy scores were associated with greater negative-word interference (p =.007). Examination of positive schizotypy and attentional interference suggested a nonlinear relationship. Dividing the sample into quartiles of positive schizotypy score, Fig. 1 illustrates a monotonic relationship between positive schizotypy and negative-word interference, with the greatest interference for the

highest-scoring group, $F(3, 156)=2.72$, $p<.05$. This group showed more negative-word interference than the other three groups, which did not differ, as confirmed by a Newman–Keuls test ($p<.05$). Parallel examination of the other combinations of positive vs. negative schizotypy and positive vs. negative stimuli showed no such relationship. Education, gender, and substance abuse were not associated with negative-word interference and did not mediate the relationship between positive schizotypy and negative-word interference (all *p*s nonsignificant).

Table 3 shows that positive schizotypy was also uniquely associated with measures of anxiety and depression. Only for depression did negative schizotypy, added second, also provide unique variance. To evaluate a possible mediating role of anxiety in the relationship between positive schizotypy and interference for negative words, the regression procedure of Baron and Kenny (1986) was followed. The procedure requires, first, that the independent variable, IV (positive schizotypy) correlate with the DV (negative-word interference; $p<.01$ in Table 2). Second, the potential mediator (anxiety or depression) must correlate with the IV. As Table 3 and Fig. 2 show, all potential mediators correlated significantly with positive schizotypy scores. Third, the mediator should predict the DV even when the variance associated with the IV is removed. Anxious apprehension and anxiety sensitivity met this criterion. Finally, for complete mediation, the correlation of IV and DV, with mediator variance removed, should not differ from zero. Fig. 2 shows that the relationship of positive schizotypy to negative-word interference remained significant even when the variance associated with anxious apprehension or anxiety sensitivity was removed. Thus, none of the anxiety or depression measures completely mediated the relationship between positive schizotypy and attentional interference for negative words. Anxious apprehension and anxiety sensitivity met three of the four requirements and thus partially mediated the relationship.

4. Discussion

The present study addressed three issues of specificity and one issue of mechanism regarding attentional disturbance in schizotypy: (1) Given that negative affect fosters positive symptoms, is attentional disturbance associated with negative affective stimuli specific to positive schizotypy or also associated with negative schizotypy? (2) Given that negative affect fosters cognitive disturbance, do positive affective stimuli also foster cognitive disturbance? (3) Are anxiety and depression differentially associated with positive and negative schizotypy? (4) Whatever the degree of specificity in these relationships, does anxiety mediate the relationship between schizotypy and attentional disturbance?

Negative-word interference was predicted by positive but not negative schizotypy indicating that it is specific to positive schizotypy. The relationship between positive schizotypy and negative-word interference, though monotonic and significant in linear regressions, was skewed, carried by high scores on positive schizotypy. Thus, this relationship is likely to be evident only with large samples or toward the clinically significant end of this dimension. It is notable that the 37 ms negative-word interference for the high positive-schizotypy group is in line with 30–40 ms reported by Matthews and Harley (1996) for similar words in clinical groups (e.g., PTSD), so the present sample adequately represented clinical levels of severity with respect to this phenomenon.

The second issue was whether this attentional interference from negative affective stimuli would extend to positive stimuli. Results found no evidence that positive stimuli foster attentional interference. The zero-order correlations in Table 2 show that positive-word interference was unrelated to all other variables. With the largest correlation of .04 and a substantial sample size, lack of statistical power is not a plausible explanation for this null result. Thus, present results strongly indicate that only negatively valenced stimuli contribute

to attentional interference in schizotypy. Furthermore, supplementary tests indicated that attentional interference was not due to an overall effect of arousal: analyses examining the relationship of positive and negative schizotypy to emotional arousal ([positive RT plus negative RT] minus [2*neutral RT]) were not significant.

Several factors could account for the increased attentional disturbance related to negative affective stimuli in schizotypy. This relationship could be mediated by heightened responsivity to stressors in the schizophrenia spectrum as evidenced by personality (Berenbaum and Fujita, 1994), neuroendocrine (Breier et al., 1991; Walker et al., 1996), psychophysiological (Fernandes and Miller, 1995; Kring, 1999; Kring and Neale, 1996; Nuechterlein and Subotnik, 1998; Simons et al., 1993), and experience-sampling (Myin-Germeys et al., 2000, 2001) studies. Similar affect processing abnormalities noted in nonpatients with elevated positive-schizotypy scores (Fernandes and Miller, 1995) may account for the cognitive impairment related to negative affective stimuli seen in the present study and elsewhere (Kerns and Berenbaum, 2000). Increased attentional disturbance related to negative affective stimuli in schizotypy may also be related to deficits in executive function. For example, a recent neuroimaging study reported that nonpatients high in positive schizotypy showed poorer recruitment of cognitive control mechanisms implemented in dorsolateral prefrontal cortex in the presence of negative distractors (Mohanty et al., 2005). In addition, positive schizotypy was associated with abnormal activity in ventral striatal and limbic areas (nucleus accumbens, hippocampus, and amygdala) that constitute a circuit believed to play a crucial role in the interaction and integration of cognitive and affective processes. Dysfunction in any component of this circuit has been hypothesized to contribute to cognitive/affective dysfunction commonly seen in schizophrenia (Grace and Moore, 1998).

The present finding that attentional function is compromised in the presence of negative affective stimuli, even in nonpatients, has substantial theoretical implications. It provides a path by which the interplay of cognitive and affective phenomena could lead to the formation, maintenance, and exacerbation of positive symptoms, including delusions and hallucinations (Freeman et al., 2002; Garety et al., 2001). Disturbance in contextual processing due to an attentional bias toward negative stimuli may play an important role in the development and maintenance of delusional conviction, loosening of associations, and flight of ideas. Present findings also support the prediction that attentional impairment due to negative affect accounts for affect-related disruptions in other cognitive processes in schizotypy and schizophrenia. For example, reasoning errors in schizophrenia have been shown to be a product of inappropriate discrimination between relevant and irrelevant data, a deficit that is accentuated in the context of negative stimuli (Mujica-Parodi et al., 2000).

The third issue motivating the present study was an examination of the relationship between dimensions of anxiety, depression, and schizotypy. Positive schizotypy was associated with measures of anxious apprehension, anxious arousal, trait anxiety, anxiety sensitivity, and depression. In contrast, negative schizotypy was associated only with depression. This pattern of results is particularly important because of extensive evidence indicating that components of anxiety and depression differ in cognitive and neural mechanisms (Engels et al., 2007; Keller et al., 2000; Nitschke et al., 1999, 2000). Thus, cognitive processes distinguishing anxious apprehension and anxious arousal may have different implications for how symptoms of psychosis manifest and respond to treatment (Garety et al., 2001). Anxious arousal may play an important role in triggering psychotic symptom onset and exacerbation. For example, it has been reported that vulnerable individuals experience a period characterized by sympathetic nervous system hyperarousal prior to an active phase of schizophrenia and psychotic symptom exacerbation (Hazlett et al., 1997; Nuechterlein and Dawson, 1984; Nuechterlein and Subotnik, 1998). Similarly, anxious arousal, panic attacks, and psychostimulants have been reported to trigger symptom onset and exacerbation of psychotic symptoms (Allen and Argus, 1968;

Janowsky et al., 1973; Sandberg and Siris, 1987). Depression during the acute phase of schizophrenia may be associated with a favorable course and outcome (Vaillant, 1964), whereas depression during the residual phase is associated with worse prognosis (Johnson, 1988). Finally, anxious apprehension shares features (e.g., attentional bias to threat), themes (e.g., anticipation of danger), and maintenance factors (e.g., safety behaviors) with certain positive symptoms such as persecutory delusions (Freeman and Garety, 2003), which might contribute to the association of negative affect-induced cognitive disturbance with positive symptoms.

Finally, the present study investigated whether anxiety mediates the relationship between positive schizotypy and attentional interference. Although Braunstein-Bercovitz (2000) reported that anxiety accounts for greater variance in attentional disruption in high schizotypy scorers than do schizotypy measures, the role of anxiety as a mediator was not tested. Present results showed that although anxious apprehension and anxiety sensitivity partially mediated the relationship between positive schizotypy and attentional interference, none of the anxiety or depression measures fully mediated the relationship. These findings are consistent with an fMRI study showing that abnormal brain activity in response to negative affective stimuli in a positive-schizotypy sample is not fully mediated by anxiety (Mohanty et al., 2005).

Berenbaum (1995) suggested that the intricate relationship between emotion and cognition seen in individuals with schizophrenia or with vulnerability to it is as noteworthy as the relationship between emotion and cognition in individuals with emotional disorders. Present findings demonstrate the impact of affective factors on attentional function in the schizophrenia spectrum and highlight the importance of examining the role of cognitive/affective interactions in the development and maintenance of symptoms in schizophrenia.

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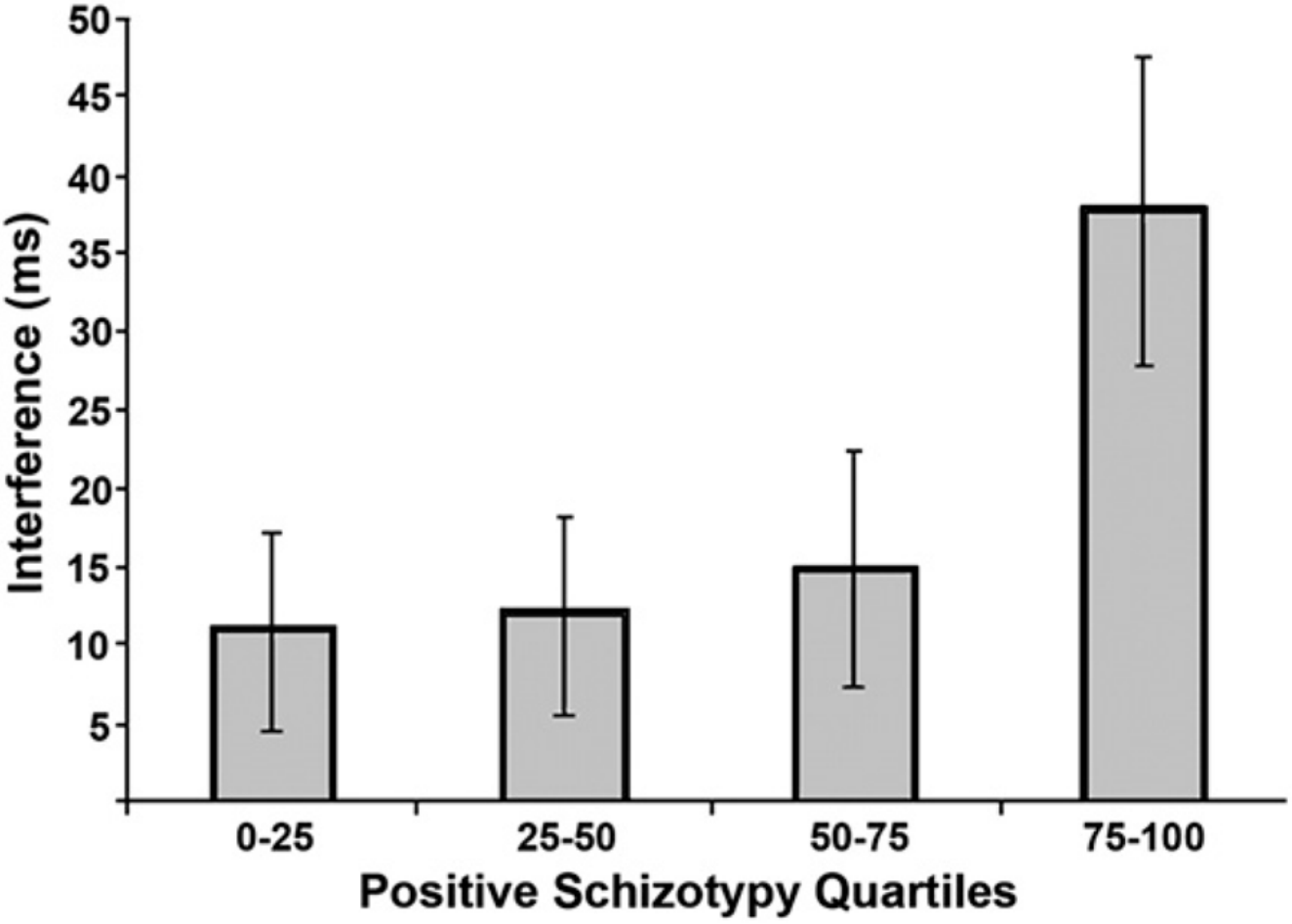

Fig. 1.
Nonlinear relationship between positive schizotypy (*x*-axis, subjects grouped by quartile) and negative-word interference (*y*-axis, negative-word RT minus neutral-word RT).

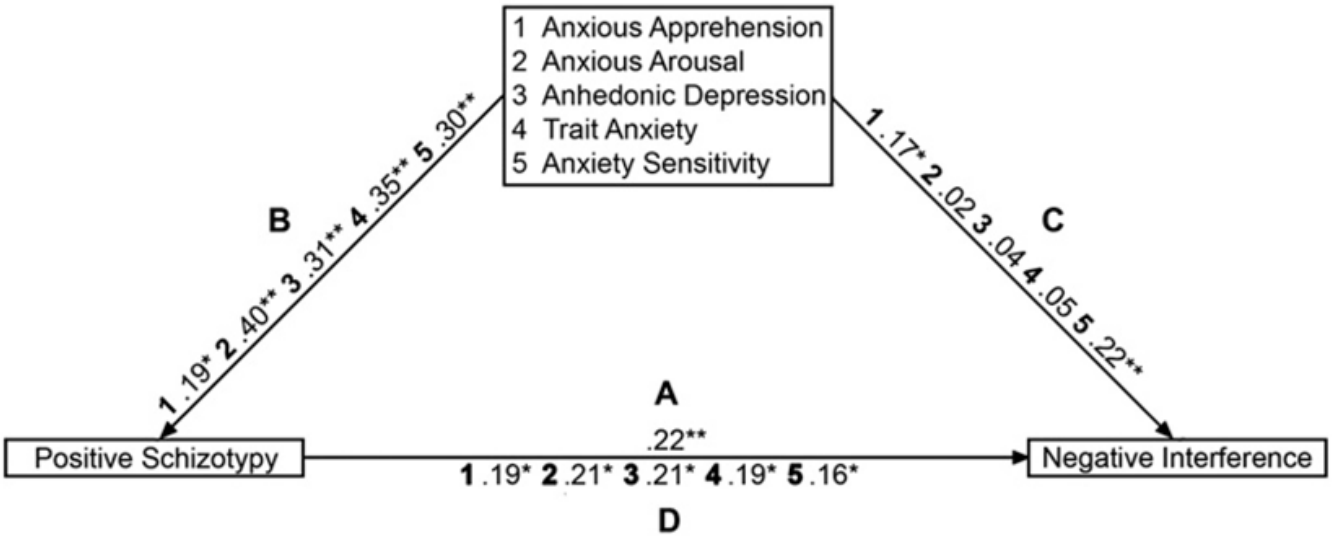

Fig. 2.

Results of analyses conducted to evaluate a possible mediating role for anxiety in the relationship between positive schizotypy (IV) and interference for negative words (DV). The numbers in bold correspond to the potential mediators depicted in the center box. The remaining numbers depict β values as measures of the magnitude of the various relationships: A, between IV and DV; B, between potential mediator and IV; C, between mediator and DV, with variance associated with the IV removed; and D, between IV and DV, with mediator variance removed.

Table 1

Questionnaire measures of anxiety, depression, and substance use

Questionnaire	Acronym	Citation	Measure
Penn State Worry Questionnaire	PSWQ	(Meyer et al., 1990; Molina and Borkovec, 1994)	Cognitive (worry-related) aspects of anxiety (Anxious apprehension)
Mood and Anxiety Symptom Questionnaire (Anxious Arousal subscale)	MASQ-AR	(Watson et al., 1995)	Acute and somatic aspects of anxiety
Mood and Anxiety Symptom Questionnaire (Anhedonic depression subscale)	MASQ-AD	(Nitschke et al., 2001; Watson et al., 1995)	Depression
State-Trait Anxiety Inventory	STAI-TA	(Spielberger et al., 1983)	Trait-anxiety symptoms
Anxiety Sensitivity Index	ASI	(Peterson and Reiss, 1992; Peterson and Heilbronner, 1987; Maller and Reiss, 1992)	Fear of anxiety-related sensations
Alcohol Use Disorders Identification Test	AUDIT	(Saunders et al., 1993)	Alcohol consumption, drinking behaviour, and related problems
Drug Abuse Screening Test-Short Form	DAST-10	(Skinner, 1982)	Substance-use (other than alcohol and tobacco) related problems

Table 2

Correlations between schizotypy, RT interference, and anxiety and depression measures

	NS	PI	NI	AP	AR	AD	TA	AS
PS	0.14	−0.08	0.22**	0.19*	0.39**	0.31**	0.35**	0.30**
NS		−0.01	0.09	0.06	0.13	0.27**	0.13	0.03
PI			0.04	0.04	−0.04	−0.04	0.03	0.00
NI				0.20*	0.11	0.10	0.12	0.26**
AP					0.40**	0.36**	0.67**	0.55**
AR						0.57**	0.45**	0.47**
AD							0.55**	0.36**
TA								0.52**

Note. PS = positive schizotypy; NS = negative schizotypy; PI = interference for positive words (positive-word RT minus neutral-word RT); NI = interference for negative words (negative-word RT minus neutral-word RT); AP = anxious apprehension; AR = anxious arousal; AD = anhedonic depression; TA = trait anxiety; AS = anxiety sensitivity;

* $p<.05$,

** $p<.01$ (2-tailed; $N=162$ except for one missing score for each anxiety and depression questionnaire measure and two missing scores for the RT measures).

Table 3

Positive and negative schizotypy predicting RT interference, anxiety, and depression

DV	Predictors	R^2	ΔR^2	*F* or *t*	*p*
PI	Full model	.006		.468	.627
	PS added second		.006	−.959	.339
	NS added second		.000	−.004	.997
NI	Full model	.054		4.449	.013
	PS added second		.050	2.728	.007
	NS added second		.004	.828	.409
AP	Full model	.038		3.084	.049
	PS added second		.035	2.380	.018
	NS added second		.001	.375	.708
AR	Full model	.162		15.250	.000
	PS added second		.144	5.209	.000
	NS added second		.006	1.063	.289
AD	Full model	.149		13.836	.000
	PS added second		.074	3.701	.000
	NS added second		.054	3.165	.002
TA	Full model	.131		11.871	.000
	PS added second		.114	4.555	.000
	NS added second		.006	1.030	.305
AS	Full model	.088		7.626	.001
	PS added second		.087	3.889	.000
	NS added second		.000	−.202	.840

Note. DV = dependent variable; PS = positive schizotypy (perceptual aberration and magical ideation); NS = negative schizotypy (physical and social anhedonia); PI = interference for positive words; NI = interference for negative words; AP = anxious apprehension; AR = anxious arousal; AD = anhedonic depression; TA = trait anxiety; AS = anxiety sensitivity. Numerator degrees of freedom=2 for full model and 1 for testing PS or NS when added second. Denominator degrees of freedom were 157 in analyses involving RT and 158 in analyses involving anxiety or depression measures.