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Facial emotion recognition in schizotypy: The role of accuracy and social cognitive bias

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Abstract

Facial emotion recognition deficits have been widely investigated in individuals with schizophrenia; however, it remains unclear whether these deficits reflect a trait-like vulnerability to schizophrenia pathology present in individuals at risk for the disorder. Although some studies have investigated emotion recognition in this population, findings have been mixed. The current study uses a well-validated emotion recognition task, a relatively large sample, and examines the relationship between emotion recognition, symptoms, and overall life quality. Eighty-nine individuals with psychometrically defined schizotypy and 27 controls completed the Schizotypal Personality Questionnaire, Penn Emotion Recognition Test, and a brief version of Lehman's Quality of Life Interview. In addition to labeling facial emotions, participants rated the valence of faces using a Likert rating scale. Individuals with schizotypy were significantly less accurate than controls when labeling emotional faces, particularly neutral faces. Within the schizotypy sample, both disorganization symptoms and lower quality of life were associated with a bias toward perceiving facial expressions as more negative. Our results support previous research suggesting that poor emotion recognition is associated with vulnerability to psychosis. Although emotion recognition appears unrelated to symptoms, it probably operates by means of different processes in those with particular types of symptoms. (*JINS*, 2010, *16*, 474–483.)

Key words: Schizophrenia, Vulnerability, PERT, SPQ, Quality of life, Social perception

INTRODUCTION

Social cognition refers to the way people think about themselves and others (Penn, Sanna, Roberts, 2008) and includes skills such as social perception, interpretation, and processing (Penn, Corrigan, Bentall, Racenstein, & Newman, 1997). Deficits in these domains reflect an important feature of schizophrenia pathology. Specifically, the ability to correctly perceive emotion from facial expressions is an important aspect of social cognition with which patients with schizophrenia have particular difficulty (Dougherty, Bartlett, & Izard, 1974; Gur et al., 2003; Kerr & Neale, 1993). Emotion recognition deficits reflect a stable feature occurring in all phases of illness (Addington & Addington, 1998; Kucharska-Pietura, David, Masiak, & Phillips, 2005; Wölwer, Streit, Polzer, & Gaebel, 1996), and are related to impairments in social functioning (Addington & Addington, 2006; Hooker & Park, 2002; Mueser, et al., 1996). Moreover, these deficits are generally resistant to antipsychotic treatment (Herbener, Hill, Marvin, & Sweeney, 2005). Despite accumulating knowledge about emotion recognition processes in schizophrenia, many questions about their nature remain.

Some have proposed that facial emotion recognition deficits may reflect a vulnerability factor for schizophrenia pathology (Kee et al., 2004; Leppänen et al., 2008; Pinkham et al., 2007; Williams, Henry, & Green, 2007). This is an important issue as increasing resources are marshaled toward clarifying endophenotypic and other markers for early identification and possible intervention (e.g., COGS studies; Calkins et al., 2007). The evidence for emotion recognition deficits as a vulnerability factor is somewhat mixed. For example, emotion recognition deficits are present at all phases of illness including symptom remission (Wölwer et al., 1996) and remain stable over time (Addington, Saeedi, & Addington, 2006). However, studies examining emotion recognition in individuals at elevated risk for the disorder have found equivocal support. For example, one study examining emotion recognition in siblings of patients with schizophrenia did not find that siblings were impaired overall relative to controls, although they exhibited similar error patterns as

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patients with schizophrenia (Leppänen et al., 2008). Another study using a clinical high risk group of individuals showing some early symptoms of psychosis found that these individuals were impaired in facial affect recognition relative to controls (Addington, Penn, Woods, Addington, & Perkins, 2008).

Studies using psychometrically identified schizotypy samples have also yielded mixed findings. For example, Poreh, Whitman, Weber, & Ross (1994) found that individuals with schizotypy were significantly worse than controls when identifying facial emotions, and Williams et al. (2007) found that severity of schizotypy traits correlated with worse emotion recognition, especially positive emotions. However, at least three other studies have failed to find that psychometrically identified individuals at risk for schizophrenia are less accurate than normal individuals at recognizing facial emotions (Jahshan & Sergi, 2007; Toomey & Schuldberg, 1995; Toomey, Seidman, Lyons, Faraone, & Tsuang, 1999). This is somewhat surprising given the host of more basic neurocognitive (Barrantes-Vidal et al., 2002; Bergida & Lenzenweger, 2006), psychophysiological (Gooding, Miller, & Dwapil, 2000; Kimble et al., 2000; O'Driscol, Lenzenweger, & Holzman, 1998), metabolic (Buchsbaum et al., 2002; Mohanty et al., 2005), and other markers of the illness that have been found in this group. Therefore, it is not yet clear whether emotion recognition deficits reflect a trait-like vulnerability to schizophrenia.

One reason for the inconsistency of the relationship between schizotypy traits and emotion recognition across prior studies is inconsistency in how schizotypy is defined (e.g., social anhedonia, total schizotypy, positive schizotypy). It is possible that only certain dimensions of schizotypy traits are associated with emotion recognition ability. In support of this, Wout, Aleman, Kessels, Laroi, & Kahn (2004) found that only positive (not negative or disorganized) schizotypy traits were related to specific types of errors, those involved in labeling angry expressions as happy. Conversely, Williams et al. (2007) found that negative, but not positive or disorganized schizotypy traits were associated with worse emotion recognition performance, especially with negative facial expressions. While these studies are far from conclusive, the possibility is raised that specific schizotypal traits may be preferentially related to emotion recognition deficits. In further support of this idea, Larøi, D'Argembeau and colleagues (2007) found that it was only the negative dimension of schizotypy that was not associated with their measure, the Self Face Recognition Questionnaire, a task encompassing self and other face recognition. Therefore, schizotypy dimensions may be important for understanding facial emotion identification as well as general face recognition. In light of the fact that few prior studies have included individuals with the full spectrum of positive, negative and disorganized schizotypy traits when examining emotion recognition, this knowledge gap is an important one to address.

Another consideration is the type of facial emotion stimuli used, as there is considerable variability in stimuli and response formats across prior studies, and most use highly restricted stimuli. In the case of the Facial Emotion Identification Test (FEIT; Kerr & Neale, 1993), one of the most widely used emotion recognition task in schizophrenia research, the pictures are black and white photographs of mostly Caucasian actors, and all posed expressions. The pictures also do not control for intensity of facial expressions. Prior research has highlighted the importance of ethnicity in facial expressions (Brekke, Nakagami, Kee, & Green, 2005), and at least one previous study has offered evidence that posed facial emotions may be detected differently than genuine expressions (Davis & Gibson, 2000). These tests also may be sensitive enough to reveal large differences between schizophrenia patients and controls but insensitive to the potentially more subtle impairments characteristic of individuals with schizotypy.

A final consideration is that prior studies assume that emotion recognition deficits reflect a skills deficit in being able to accurately recognize facial emotions in others. There is some evidence in patients with schizophrenia, particularly those with pronounced disorganization symptoms, that their deficit reflects a systematic bias. For example, research from Kohler et al. (2003) suggests that patients show a negative bias for ambiguous or nonemotional faces. Cohen, Nienow, and colleagues (2009) have also shown that certain patients, those with disorganized symptoms, tend to evaluate others' faces inaccurately as being "angry." This "angry" attribution bias was also associated with poorer social functioning. Moreover, delusion-prone individuals have shown an attentional bias for angry expressions in that they take longer to process these faces (Green et al., 2001). Overall, these findings raise the possibility that, at least for some individuals with schizotypy, emotion recognition deficits actually reflect a systematic bias in perceiving others' emotions as opposed to a skills deficit for emotions more generally. It would be particularly important to determine the degree to which these negativistic biases impair functioning, similar as has been shown in patients with schizophrenia.

The present project examined emotion recognition with diverse stimuli in a group of psychometrically identified schizotypes with a broad range of positive, negative and disorganized traits and a comparison control group. We examined accuracy and reaction times on the emotion recognition task as well as subjective appraisals of the affective tone of the stimuli. These variables were compared between control and the schizotypy groups, and then examined across positive, negative and disorganized symptoms. Finally, we examined the relationship between these variables and quality of life to evaluate their "real world" effects.

METHODS

Participants

In line with many previous studies on schizotypy, we used a psychometric-based extreme groups design. Using this design, individuals with schizotypy are compared with those without it. The rationale of this design for schizotypy research

is based on the notion that schizotypy is a categorically distinct, not a dimensional construct. In support of this design, research suggests that there is a distinct subset of individuals (around 10% of the general population) who are at elevated risk for developing the disorder (Gooding, Tallent, & Matts, 2005; Korfine & Lenzenweger, 1995; Kwapil, 1998; Lenzenweger & Korfine, 1992; Meehl, 1962, 1990; Tyrka et al., 1995). Much research identifies those at risk based on the subtle neurocognitive and behavioral aberrations (Gooding, Kwapil, & Tallent, 1999; Lenzenweger et al., 1991; Lenzenweger & Korfine, 1994; O'Driscoll et al., 1998; Park, Holzman, & Lenzenweger, 1995) using a psychometric high risk paradigm (see Lenzenweger, 1994, for an overview).

Links to an online questionnaire were sent to 8993 freshman and sophomore undergraduates at Louisiana State University as part of a larger study on schizotypy (Cohen & Hong, in press; Cohen, Inglesias et al., 2009). Those who completed the questionnaire were entered into a lottery of ten possible $25 prizes. 1775 students responded resulting in 1395 complete profiles. The questionnaire consisted of a consent form, demographic questions, and the Schizotypal Personality Questionnaire (SPQ; Raine, 1991). Those subjects with positive, negative, or disorganized scores in the 95th percentile (based on gender and ethnicity norms) were invited to participate further in the laboratory phase of the study. Of these individuals, 17 were recruited based on high positive scores, 32 based on high negative scores, and 26 were recruited based on high disorganization scores. Some individuals were recruited based on high scores on more than one factor including two with both high disorganization and negative scores, eight with high disorganization and positive scores, two with high negative and positive scores, and finally two participants had high scores on all three factors. We also identified individuals with scores below gender and ethnicity means on the SPQ subscales whom we recruited as a control group. There were no other exclusionary criteria. The final sample included 89 participants in the schizotypy group and 27 participants in the control group. The participants recruited for the laboratory phase of the study completed a variety of questionnaires and laboratory measures, and the entire study lasted approximately 2 hours. These participants received $20 cash compensation and the possibility of extra credit toward psychology courses. The reader is referred to other manuscripts reporting on this sample that contain neurocognitive and other data not published here (Cohen, Iglesias et al., 2009; Cohen & Minor, 2009; Cohen & Davis, 2009). This study was approved by the LSU Human Subject Review Board and all subjects offered informed consent before completing the surveys.

Measures

Schizotypal Personality Questionnaire (SPQ)

The SPQ is a 74-item, self report questionnaire that assesses a broad range of schizotypal personality disorder symptomatology (DSM IV-TR; Raine, 1991). We modified the response format to improve sensitivity by using a five-point Likert scale ranging from −2 (strongly disagree) to 2 (strongly agree). Likert scale versions have been shown to be highly correlated with the traditional format (range of r's = .88–.94), and show superior internal reliability (Wuthrich & Bates, 2005). Given research demonstrating that schizotypy measured by the SPQ may be composed of three factors (Chen, Hsiao, & Lin, 1997; Raine et al., 1994; Reynolds, Raine, Mellingen, Venables, & Mednick, 2000), we used dimensional scores reflecting positive (cognitive-perceptual), negative (interpersonal), and disorganized schizotypy as well as total SPQ scores for each participant. The positive factor is composed of original four SPQ subscales: ideas of reference, odd beliefs/magical thinking, unusual perceptual experiences, and paranoid ideation; the negative factor is composed of four subscales: social anxiety, no close friends, constricted affect, paranoid ideation; and the disorganized factor is composed of the two remaining subscales: odd behavior and odd speech. Some research has shown that negative schizotypy tends to be more pronounced in males and positive traits are more pronounced in females (Fonseca-Pedrero, Lemos-Giráldez, Muñiz, García-Cueto, & Campos-Álvarez, 2008; Miller, & Burns, 1995; Venables & Bailes, 1994). Therefore, individual scores were transformed to z-scores computed based on gender and ethnicity means of the larger sample (n = 1395) to control for these variables.

Lehman's Quality of Life Brief Interview (OoL-I)

Quality of life was assessed with the QoL-I, a self-report questionnaire that includes items assessing an individual's subjective perception of his/her quality of life as well as objective items assessing activities and social supports (Lehman, 1995). This measure has previously been used in research involving psychiatric populations (Anderson, McNeil, & Reddon, 2002; Heider et al., 2007; Wasserman, Sorensen, Delucchi, Masson, & Hall, 2006) and has shown good psychometric properties (Lehman, 1996). The brief version includes 78 items, and the amount of administration time was not feasible for our research purposes. We used the even briefer version (Bellack, Bennett, Gearon, Brown, & Yang, 2006; Cohen & Davis, 2009; Cohen & Hong, in press), which includes 33 items, allowing for computation of seven scales in both the objective and subjective domains: home concerns, daily activities, family relationships, social relationships, financial concerns, legal concerns, health concerns, and global life quality. For the current study, we used summary scores in both the objective and subjective domains. Increasing scores reflect improved quality of life.

Penn Emotion Recognition Test (PERT)

Emotion recognition was measured using the 40-item PERT (Gur et al., 2002; Kohler et al., 2003). The items include both high and low intensity angry, fearful, happy, sad, and neutral faces. These faces represent a diversity of ethnicity and age and include both posed and evoked expressions. The

task presents each face one at a time and participants are asked to choose which emotion is being expressed from a list of six choices (happy, sad, disgust, fear, anger, no emotion). In addition to accuracy, we also measured reaction times when categorizing the faces and subjective valence ratings of facial expressions to examine potential biases. Participants made valence ratings using the Semantic Affective Moniker (Lang, Bradley, & Cuthbert, 2005), an analogue scale ranging from 1 (good mood) to 9 (bad mood).

Analyses

Analyses were conducted in several steps. To begin, we compare demographic and clinical variables between the schizotypy and control groups. Next, given that previous research has shown that males and females exhibit differences on emotion recognition tasks (Derntl et al., 2009), especially research pertaining to schizophrenia and schizotypy (Gruzelier, 1994; Weiss et al., 2007), we compare males and females on each PERT variable. We then compare the schizotypy and control groups on PERT accuracy, reaction time, and valence ratings.

Next, we conducted three separate 2 (group) × 5 (emotion) mixed factorial analyses of variance (ANOVAs) with repeated measures of emotion. In all analyses, the Greenhouse Geisser procedure was used for correction of data violating the assumption of sphericity. The next set of analyses was performed only within the schizotypy group. First, we examine the relationship between emotion recognition performance and schizotypy symptoms. Spearman's correlations were computed examining the relationship between the three schizotypy factors (positive, negative, and disorganized) and the three emotion recognition variables (accuracy, reaction times, and valence ratings). The final set of analyses was also restricted to the schizotypy group. We, again, computed Spearman's correlations to examine the relationship between the emotion recognition variables and both subjective and objective quality of life.

RESULTS

Demographics

Demographic and clinical information for both the control and schizotypy groups is presented in Table 1. Groups were similar in terms of age, gender, and ethnicity. The schizotypy group showed significantly higher scores on all clinical variables and lower quality of life. Other than age (skew > 1.5), all variables were normally distributed unless otherwise noted, (all skew scores < 1.5). To correct for skew, age was analyzed using nonparametric statistics.

PERT Accuracy

First, males and females performed similarly on the PERT, ($t(114) = .36$, *n.s.*). Comparing the schizotypy and control groups, there was a significant main effect for emotion ($F(2.93) = 74.73$; $p < .01$). Bonferroni-corrected *post hoc* tests showed that happy was recognized most often (M = 95.60%; SD = 0.60%), followed by sad and neutral (M = 74.0%; SD = 1.80% and 63.69%; SD = 2.65%), and anger and fear were recognized least often (M = 59.05%; SD = 1.61% and 57.33%; SD = 1.67%). There was also a main effect for group ($F(1) = 8.81$; $p < .01$); the schizotypy group (M = 68.4% correct; SD = 0.11%) performed worse than the control group (M = 75.0% correct; SD = 0.19%). A significant interaction was also found ($F(2.93) = 6.56$; $p <$. 01). *Post hoc* analysis revealed that the control group was more accurate when identifying neutral faces than the schizotypy group $t(114) = 4.15$; $p < .01$. Mean accuracy scores for across different emotions are presented in Figure 1. Groups were not significantly different on any other emotion (all t's < 0.93, *n.s.*).

Further *post hoc* analyses were conducted examining the high *versus* low intensity expressions. Groups were similar on the high intensity facial expressions ($t(114) = .71$, *n.s.*), however the control group (M = 69.68%) was more accurate than

Table 1. Means and standard deviations ($M(SD)$) for demographic and clinical variables for schizotypy and control groups

	Schizotypy (n = 89)	Controls (n = 27)	t	p
% male	30.30	48.10		
% Caucasian	87.60	77.80		
Age	19.19 (1.39)	19.81 (3.25)	1092.50[2]	.45
SPQ total	1.41 (0.58)	−1.94 (0.35)	−36.83*	.00
SPQ positive	1.14 (0.92)	−1.75 (0.35)	−24.46*	.00
SPQ negative	1.28 (1.02)	−1.43 (0.34)	−21.40*	.00
SPQ disorganization	1.27 (0.79)	−1.64 (0.51)	−22.58*	.00
QOL subjective[1]	30.41 (6.41)	39.96 (4.94)	7.01 (113)*	.00
QOL objective[1]	−3.93 (5.65)	2.04 (3.97)	6.08 (57.51)*	.00

*$p < .01$.
[1]n = 26 controls.
[2]Mann Whitney U test.
SPQ = Schizotypal Personality Questionnaire; QOL = Lehman's Brief Quality of Life Interview.

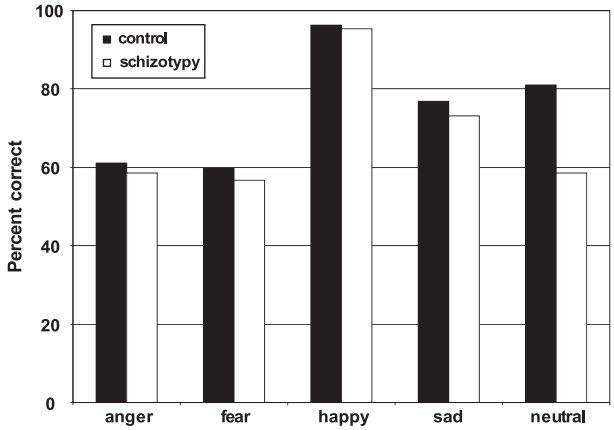

Fig. 1. Penn Emotion Recognition Test mean accuracy scores for the control and schizotypy groups.

the schizotypy group ($M = 65.03\%$) on the low intensity expressions at a trend toward significance ($t(114) = 1.70$; $p < .10$).

Post hoc tests were performed to examine the types of errors participants made. Because groups differed only when labeling neutral faces, we looked only within this category to examine errors. For this analysis we included only those participants who made errors labeling neutral faces (18 control, 81 schizotypy). We computed the percentage of total neutral errors mislabeled as each different emotion category (i.e., neutral as anger errors). Because these data were not normally distributed, we conducted nonparametric, Mann-Whitney tests to examine whether the schizotypy and control groups differed in the types of errors made. The schizotypy group labeled significantly more neutral faces as disgust ($U = 512.50$; $p < .05$). All other tests were nonsignificant.

PERT Reaction Time

Males and females were similar in terms of reaction times ($t(114) = 0.86$, *n.s.*). Comparing schizotypy and control groups, a main effect for emotion was again found ($F(3.17) = 59.19$; $p < .01$). Bonferroni-corrected *post hoc* analysis showed that happy faces had the quickest reaction times ($M = 33078.32$; $SD = 10867.53$), followed by sad and neutral faces which were not different from each other ($M = 0480.00$; $SD = 17713.33$ and $M = 46755.23$; $SD = 21700.40$). Fear was detected next quickest ($M = 58494.68$; $SD = 28392.12$), and angry faces showed the longest reaction times ($M = 68401.12$; $SD = 28376.71$). There was no difference in reaction times between groups ($F(1) = 1.90$, *n.s.*), and no interaction was found ($F(3.17) = 0.24$, *n.s.*).

PERT Valence Ratings

Males and females were similar in their ratings of the faces ($t(114) = .31$, *n.s.*). Comparing the schizotypy and control groups, there was a main effect for emotion ($F(2.37) = 526.83$; $p < .01$). Bonferroni corrected *post hoc* tests showed that happy faces were rated most positively ($M = 2.53$; $SD = 0.97$) followed by neutral faces ($M = 5.52$; $SD = 0.52$), then fear ($M = 6.41$; $SD = 0.69$) and anger ($M = 6.98$; $SD = 0.73$), sad faces were rated most negative ($M = 7.16$; $SD = 0.68$), but not significantly different from anger. There was no main effect for group ($F(1) = 0.90$, *n.s.*) and no interaction ($F(2.37) = 1.61$, *n.s.*).

The Relationship Between Schizotypy Symptoms and Emotion Recognition

Spearman's correlations between PERT accuracy, reaction time, valence ratings, and SPQ factors are presented in Table 2. Accuracy was not significantly correlated with any SPQ factor. Valence was significantly positively correlated with SPQ disorganization factor scores such that higher disorganization scores were associated with more negative ratings of faces ($r = -0.31$). Reaction time was significantly negatively correlated with SPQ negative factor scores in that SPQ negative factor scores were associated with quicker labeling of facial emotions ($r = -0.27$).

The Relationship between Emotion Recognition and Quality of Life

Spearman's correlations between PERT variables and quality of life are presented in Table 3. Subjective quality of life was positively correlated with valence ratings of the faces; more negative ratings of faces were associated with lower quality of life ratings. Finally, as a last note, PERT accuracy, reaction times, and valence were not related, suggesting that associations between these variables would not account for the observed correlations. All other correlations were also nonsignificant.

DISCUSSION

As predicted, the current study revealed impaired facial emotion recognition abilities in individuals with schizotypy. While some previous studies on individuals with schizotypy have not found this, we believe our study addresses some critical limitations of prior research. We used a large schizotypy group with a broad range of symptomology, a more sensitive emotion recognition task including more culturally

Table 2. Spearman's correlations between SPQ factors and PERT variables

	SPQ positive	SPQ negative	SPQ disorganization
SPQ positive	—		
SPQ negative	−.29*	—	
SPQ disorganization	.11	−.36*	—
PERT accuracy	−.02	.11	−.14
PERT RT	−.13	−.27*	.00
PERT valence	.16	−.08	.31*

*$p < .01$.
RT = reaction time; SPQ = Schizotypal Personality Questionnaire; PERT = Penn Emotion Recognition Test.

Table 3. Spearman's correlations between PERT variables and quality of life

	PERT accuracy	PERT RT	PERT valence	QOL objective	QOL subjective
PERT accuracy	—				
PERT RT	−.16	—			
PERT valence	.08	.12	—		
QOL objective	−.18	.09	−.02	—	
QOL subjective	−.13	.18	−.27*	.36*	—

*$p < .01$.
RT = reaction time; QOL = Lehman's Brief Quality of Life Interview; PERT = Penn Emotion Recognition Test.

representative stimuli, and examined subjective ratings in addition to facial emotion identification accuracy scores. The present data offer some evidence that emotion recognition deficits may reflect an important vulnerability marker for schizophrenia-spectrum pathology. These deficits were present in the schizotypy group as a whole, and accuracy recognizing emotions was unrelated to any specific schizotypy trait. Deficits were not associated with particular schizotypy traits nor can they be attributed to the effects of severe mental illness such as medication or hospitalization.

Although much previous research has pointed to negative expressions as being the source of errors in schizophrenia patients (Bediou et al., 2005; Dougherty et al., 1974; Kohler et al., 2003; Kucharska-Pietura et al., 2005; Leppänen et al., 2006; Muzekari & Bates, 1977; Premkumar et al., 2008) and their relatives (Leppänen et al., 2008), our results suggest that it is only with the neutral expressions that schizotypy differ from controls. Overall performance was poorest with negative expressions in both groups, supporting prior evidence that labeling negative as opposed to positive emotions is a more difficult task (Johnston et al., 2001). Our findings are, however, consistent with prior studies in individuals with schizophrenia that have shown patients have a tendency to label nonemotional faces as expressing an emotion, usually negative (Kohler et al., 2003). This could be interpreted in multiple ways. First, Quirk and colleagues (2007) has suggested that ambiguity brings out differences between individuals with schizotypy and normal participants. This is further supported in our findings of a trend for the schizotypy group to do worse on low intensity expressions than controls. Reading either a low intensity or neutral face could be considered a more ambiguous task than reading a pure facial expression of a basic emotion. Second, individuals with schizotypy may exhibit some type of cognitive or perceptual bias making them more likely to see emotion in a face even when it is not there. In support of this idea, fMRI studies of schizophrenia patients have shown different patterns of brain activation in response to facial emotion tasks (Fakra et al., 2008; Phillips et al., 1999; Taylor, Liberzon, Decker, & Koeppe, 2002; Taylor, Phan, Britton, & Liberzon, 2005). Perceptual abnormalities may be present that alter individuals' interpretations of faces (Gooding, Luh, & Tallent, 2001; Gooding & Tallent, 2002). In addition, social cognitive biases also alter how individuals interpret social information (Bentall et al., 2001; Penn et al., 1997; Pinkham et al., 2003), and may be important for understanding emotion recognition (Dougherty et al., 1974; Smári, Stefánsson, & Thorgilsson, 1994; Tsoi et al., 2008). Although these factors have been researched in schizophrenia patients, they have yet to be demonstrated in individuals with schizotypy. In our study, the schizotypy group did not rate the neutral faces as being more or less negative than controls, nor did they take longer to decide which emotion was expressed. However, perceptual anomalies and biases may be present to different degrees in different subtypes (as suggested below), and do not necessarily alter processing speed in a systematic manner. If labeling a neutral face is thought of as a more ambiguous situation, this is where biases would operate. When patterns of neutral misattributions were examined, the schizotypy group tended to identify more neutral expressions as being disgusted than the control group. This suggests that a particular bias may be toward perceiving ambiguous or neutral faces as disgust. It is unclear why there would be a bias toward perceiving disgust rather than any other negative or threatening emotion, and this is something that should be investigated with further research.

The schizotypy and control groups did not differ in reaction times when identifying facial emotions, nor was reaction time associated with accuracy within the schizotypy group. This might suggest that individuals with schizotypy were not aware of their mistakes. An important goal for future research would be to examine the relationship between perceived performance and actual performance. However, considering the significant findings for reaction time in this study—their positive association with negative schizotypy symptoms, allows us to speculate about this issue at least within those individual exhibiting high negative symptoms. First, this relationship is surprising given the host of neurocognitive limitations present in these individuals (Diforio et al., 2000; Kendler, 1991; Neumann & Walker, 2003). Our results suggest that individuals with high levels of negative symptoms, although they are not more or less accurate at identifying emotions, are more efficient. This is not to say they quickly arrive at the wrong answer; overall accuracy for the schizotypy group approached 70%. However, this might suggest that for some reason these individuals are not as invested in the task. Difficulty identifying emotions might be met by further effort and attention in those with low negative symptoms while not in those with high negative symptoms. This could possibly be because negative symptoms

are associated with a schizoidal avoidance of social stimuli and interactions (Kwapil, Barrantes-Vidal, & Silva, 2008).

While schizotypy as a group did not show a systematic valence rating bias, disorganization symptoms were related to subjective perception of emotional faces as being more negative. This is consistent with what has been observed more generally for patients with schizophrenia – that patients with disorganization tend to report seeing faces as being angry (Cohen, Nienow et al., 2009). This raises two important issues for future research to consider. First, combining schizotypy into one group potentially obscures differences between those with different symptom presentations. Second, previous studies that have not examined the full range of schizotypy may produce results that apply to only a particular subtype and not to schizotypy as a whole. Given that disorganized schizotypy traits are often not assessed in schizotypy studies (e.g., those using the Chapman scales [Chapman, Chapman, Kwapil, 1995)], it would be critical to use instruments that assess a full range of schizotypal traits.

One of the more general concerns of this study was whether or not facial emotion recognition ability was related to general quality of life. Our results suggest that while individuals with schizotypy may be less accurate at recognizing emotions, this is unrelated to quality of life. Rather, their subjective appraisals of the valence of emotional faces are related to self-reported quality of life. It is those individuals who see more negative faces that also say their quality of life is lower. Perceiving others' emotions as negative could have an impact on social enjoyment, or believing that one's life is not enjoyable (perhaps due to symptoms) may lead individuals to see the social world as more negative. Biased interpretation of emotional faces may be a factor that leads to social misunderstandings such as misinterpretation of others' intentions, failure to comprehend social situations, and trouble learning how to react to and express emotions. It may also affect the development of social schema that accurately predict others' behavior. This could offer explanations for why many individuals with schizotypy report less enjoyment in social situations (Horan, Brown, & Blanchard, 2007) and may be less accurate in interpreting social cues (Kendler et al., 1996; Meehl, 1990).

This study has some limitations. First, participants in our sample were mostly Caucasian. Research in schizophrenia patients has shown that participants from other ethnic groups may not perform as well as Caucasians on measures of emotion perception (Habel et al., 2005). Although, at least in some studies, this may be due to the use of mostly Caucasian stimuli (Pinkham et al., 2008), examining emotion recognition across ethnic groups would be essential for future research.

Another important consideration not addressed in the current study is the effect of depression on facial affect recognition. There is research to suggest that individuals who are depressed are poor at recognizing facial expressions of emotion (Feinberg, Rifkin, Schaffer, & Walker, 1986; Langenecker et al., 2005). Given that depression is quite common in schizotypy (Gooding et al., 2005; Lewandowski et al., 2006), examining the effects of and/or controlling for depressive symptomotology is an important avenue for future research in this area. As depression has been shown to be associated with errors on neutral and low intensity facial expressions (Csukly, Czobor, Szily, Takács, & Simon, 2009), this is an especially salient limitation of the current study. Furthermore, depression (Angermeyer, Holzinger, Matschinger, & Stenger-Wenzke, 2002; Goldney, Fisher, Wilson, & Cheok, 2000; Pyne et al., 1997) and subclinical depressive symptoms (da Silva Lima, & de Almeida Fleck, 2007; Goldney, Fisher, Dal Grande, & Taylor, 2004) are related to quality of life. This is also important in individuals with schizophrenia (Huppert, Weiss, Lim Pratt, & Smith, 2001; Reine, Lançon, Tucci, Sapin, & Auquier, 2003). Therefore, controlling for depressive symptoms may be important when considering quality of life as well.

While the PERT is an improvement over other existing facial emotional stimuli and shows promise as a more sensitive measure of emotion recognition, especially in individuals less impaired than patients with schizophrenia, it still does not approximate the manner in which facial expressions of emotion are experienced in daily life. Using dynamic rather than static emotional expressions may reveal further emotional processing abnormalities (Archer et al., 1994). Emotional expressions are also often accompanied by a variety of body movements and contextual cues which are used to interpret emotion. The use of stimuli that more closely resemble faces encountered outside of the laboratory would increase external validity of future studies.

In summary, our results support previous research suggesting that poor emotion recognition is associated with vulnerability to psychosis (Kee et al., 2004; Williams et al., 2007) rather than a state-related effect of psychotic symptoms. Emotion recognition appears to be impaired in all individuals at risk for schizophrenia as it is unrelated to symptoms. However, it appears to operate by means of different processes in those with particular types of symptoms. This study suggests that these processes do affect functioning even in those individuals who are relatively unimpaired globally. Further research is needed to delineate the relationships between emotion recognition processes, symptoms, and social functioning.

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