Progress in Neuro-Psychopharmacology & Biological Psychiatry 34 (2010) 393–400

Contents lists available at ScienceDirect

Progress in Neuro-Psychopharmacology & Biological Psychiatry

journal homepage: www.elsevier.com/locate/pnp

Facial emotion perception in Chinese patients with schizophrenia and non-psychotic first-degree relatives

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ARTICLE INFO

Article history:
Received 15 June 2009
Received in revised form 19 November 2009
Accepted 8 January 2010
Available online 15 January 2010

Keywords:
Chinese
Facial emotion perception
First-degree relatives
Schizophrenia

ABSTRACT

Although there is a consensus that patients with schizophrenia have certain deficits in perceiving and expressing facial emotions, previous studies of facial emotion perception in schizophrenia do not present consistent results. The objective of this study was to explore facial emotion perception deficits in Chinese patients with schizophrenia and their non-psychotic first-degree relatives. Sixty-nine patients with schizophrenia, 56 of their first-degree relatives (33 parents and 23 siblings), and 92 healthy controls (67 younger healthy controls matched to the patients and siblings, and 25 older healthy controls matched to the parents) completed a set of facial emotion perception tasks, including facial emotion discrimination, identification, intensity, valence, and corresponding face identification tasks. The results demonstrated that patients with schizophrenia performed significantly worse than their siblings and younger healthy controls in accuracy in a variety of facial emotion perception tasks, whereas the siblings of the patients performed as well as the corresponding younger healthy controls in all of the facial emotion perception tasks. Patients with schizophrenia also showed significantly reduced speed than younger healthy controls, while siblings of patients did not demonstrate significant differences with both patients and younger healthy controls in speed. Meanwhile, we also found that parents of the schizophrenia patients performed significantly worse than the corresponding older healthy controls in accuracy in terms of facial emotion identification, valence, and the composite index of the facial discrimination, identification, intensity and valence tasks. Moreover, no significant differences were found between the parents of patients and older healthy controls in speed after controlling the years of education and IQ. Taken together, the results suggest that facial emotion perception deficits may serve as potential endophenotypes for schizophrenia.

1. Introduction

Emotion perception deficit is a core impairment of patients with schizophrenia. Many studies have found this deficit to be a crucial predictor of social functioning or social competency (Hooker and Park, 2002; Kohler et al., 2003; Leventhal et al., 1987; Mandal et al., 1998; Mueser et al., 1996; Sachs et al., 2004). Social functioning abnormality is, in turn, one of the strongest predictors of schizophrenia (Davidson et al., 1999). A one-year follow-up study found a significant relationship between impaired facial emotion perception among schizophrenia patients and functional outcome (Kee et al., 2003), and in the past few decades increasing numbers of researchers have found that patients with schizophrenia demonstrated deficits in facial emotion perception (Addington and Addington, 1998; Baudouin et al., 2002; Borod et al., 1993; Dougherty et al., 1974; Feinberg et al., 1986; Kerr and Neale, 1993; Kohler et al., 2000; Kosmidis et al., 2007; Muzekari and Bates, 1977; Salem et al., 1996; Walker et al., 1984). Follow-up studies have also found that patients with schizophrenia performed worse than healthy controls in emotion perception after two weeks (Lewis and Garver, 1995) and over four weeks (Gaebel and Wolwer, 1992), which implied stable impairment in emotion perception in these patients.

However, the relationship between the clinical symptoms of patients and their facial emotion perception performance appears to

Abbreviations: AIMS, Abnormal Involuntary Movements Scale; BARS, Barnes' Akathisia Rating Scale; CPZ, chlorpromazine; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, fourth edition; FEDT, Facial Emotion Discrimination Test; FEIT, Facial Emotion Identification Test; FEIDT, Facial Emotion Intensity Differentiation Test; FEVT, Facial Emotion Valence Test; HC, healthy controls; IQ, intelligence quotient; PANSS, Positive and Negative Syndrome Scale; SANS, Scale for the Assessment of Negative Symptoms; SPD, schizotypal personality disorder; SZ, schizophrenia; TFR, Test of Facial Recognition; VAPT, videotape affect perception test; WAIS-R, Wechsler Adult Intelligence Scale — Revised.

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doi:10.1016/j.pnpbp.2010.01.007

be rather more complicated, and the findings are mixed. Mandal et al. (1999) and Martin et al. (2005) found that patients with schizophrenia who exhibited negative symptoms performed worse in facial emotion perception tests, but that positive symptoms were not found to be correlated with emotion recognition (Martin et al., 2005). Silver et al. (2002) found positive symptoms to be negatively correlated with the ability to identify happy faces, and that the ability to discriminate happy faces was positively correlated with the SANS total score. van't Wout et al. (2007) found no significant correlations between the positive, negative, or general psychopathology subscales of the PANSS and errors in automatic facial affect processing. Similarly, Lewis and Garver (1995) did not find significant correlations between facial affect recognition scores and positive or negative symptoms as measured by PANSS, either at the baseline or at a two-week re-test.

More recently, researchers have begun to use the high-risk approach to investigate emotion processing in patients with schizophrenia. Generally speaking, non-psychotic relatives of patients with schizophrenia, persons with schizotypal personality traits and people with prodromes are considered to be the high-risk groups for developing schizophrenia (Phillips and Seidman, 2008).

Similar to the findings in schizophrenia, schizotypy traits were also described as a 3-factor model: positive (e.g., magical ideation, perceptual aberration), negative (e.g., physical anhedonia, social anhedonia), and disorganized (e.g., disorganized speech and behavior) symptom constellations (Kerns, 2006). Waldeck and Miller (2000) found that schizotypal personality disorder (SPD) performed as well as healthy controls in emotion recognition test, however, SPD demonstrated significantly lower scores in the identification of joy and surprise. Shean et al. (2007) found that healthy undergraduates demonstrated more facial affect perception impairments if they got higher score in schizotypy. The authors also concluded that deficits in perceiving and responding to expressions of affect might contribute to development of schizotypal traits. Through screening from 843 non-clinical participants with Schizotypal Personality Questionnaire, researchers identified high schizotypy group (the upper 15%) and low schizotypy group (the lower 15%), Williams et al. (2007) found that negative aspects of schizotypy was significantly associated with reduced facial affect discrimination and facial affect recognition accuracy, especially with the identification of negative emotions. With the same participants as Williams et al. (2007), Henry et al. (2009) found that the highly schizotypal participants presented difficulties in the amplification of emotion expressive behavior. van't Wout et al. (2004) did not find significant differences between the high and low schizotypy groups in the behavioral emotional processing tasks, while they found that the high schizotypal participants presented longer reaction times to the neutral words in the affective word-priming task. Persons with schizotypy also presented some deficits in emotional experience. In the study of (Kerns, 2005), they found that positive schizotypy individuals reported greater attention to emotions but less emotional clarity than controls, they also concluded that positive schizotypy was associated with the processing of emotional information. Berenbaum et al. (2006) explored the correlations of emotional awareness and different dimensions of SPD. The results indicated negative affect, attention to emotion, and clarity of emotion that were associated with dimensions of SPD, and there were clear evidence of different dimensions of SPD being differentially associated with different aspects of emotion. Individuals with disorganized schizotypy reported increased emotionality on self-report, however, they may have difficulties in understanding and organizing them. Meanwhile, the individuals with negative schizotypy presented deficits in identifying the experienced emotion and processing of emotion besides the deficits of emotional expression (Kerns, 2006). Moreover, individuals with negative schizotypy also reported experiencing reduced intensity of emotions (Kerns, 2006; Ferguson and Katkin, 1996). Horan et al. (2006) explored the relations between social anhedonia and schizotypy, the results revealed that individuals with social anhedonia reported higher perceived stress and trait negative affectivity compared with controls. In the emotional expression, several studies found that individuals with schizotypy, especially those with negative schizotypal characteristics, demonstrated alexithymia with reduced capacity to emotional expression (van't Wout et al., 2004; Gooding et al., 2002).

With Bonn Scale for the Assessment of Basic Symptoms, Hambrecht et al. (2002) found that a quarter of individuals diagnosed to be in the psychosis prodromes reported subjective complaints of having difficulties in discrimination of different emotions. More evidence about the emotion perception is needed about the persons in the prodrome to psychosis.

Relatively, more studies explored the emotion perception in non-psychotic relatives of patients with schizophrenia. This was also called endophenotype approach, through this way, researchers tried to study the genetic basis of schizophrenia (Gottesman and Gould, 2003; Greenwood et al., 2007). Several criteria are required for the endophenotype. First, the endophenotype should be associated with the illness; second, it should be heritable; third, it should be state independent; fourth, it should be cosegregated within families, it means unaffected relatives will be at a higher rate than the general population (Gottesman and Gould, 2003). It has been posited that unaffected first-degree relatives are at a higher risk of developing schizophrenia if facial emotion perception deficits are indeed markers of schizophrenia (Gottesman, 1991), and it is thus important to explore whether facial emotion perception deficits are potential markers.

Unaffected biological relatives of individuals with schizophrenia have previously been shown to exhibit some deficits in facial emotion perception. McCown et al. (1988) found that the parents of schizophrenics performed significantly worse than the parents of medical surgery patients in affect recognition tests. Gur et al. (2007) focused on the speed, and similarly found that unaffected relatives exhibited deficits in accuracy in emotion intensity discrimination tests, and concluded that emotion-processing accuracy had a moderate to strong genetic influence on the variation in performance between individuals. Leppänen et al. (2008) also showed that the unaffected siblings of schizophrenia patients had impaired recognition of negative facial expressions compared with positive facial expressions. However, Toomey et al. (1999) did not find significant group differences in performance in face identification and facial emotion identification tasks in a sample of 21 non-psychotic first-degree relatives (6 parents, 12 siblings, and 3 offspring) of schizophrenia patients and 19 healthy controls. Bölte and Poustka (2003) similarly demonstrated that the first-degree relatives of schizophrenics did not perform significantly worse than healthy controls in facial emotion identification task, and concluded that emotion perception might not be a potential marker of schizophrenia. Kee et al. (2004) administered three specific tasks of facial perception processing — the facial emotion identification test (FEIT), voice emotion identification test (VEIT), and videotape affect perception test (VAPT) — to 58 patients with schizophrenia, 51 non-psychotic biological siblings, and 49 healthy controls, and found no significant differences in performance among the groups for any of the tasks. However, when a composite index (comprising the mean standardized scores of the FEIT, VEIT, and VAPT) was calculated, the siblings were shown to perform significantly worse than the healthy controls but significantly better than the schizophrenia patients.

The results of these studies demonstrate that it is impossible to come to a consistent conclusion as to whether non-psychotic first-degree relatives of schizophrenia patients demonstrate deficits in facial emotion perception. The inconsistency may in part be due to the inclusion of only one relative group in the studies, either the siblings of the patients, the parents of the patients, or a mix of parents, siblings, and offspring. The differentiation of the various subgroups within the first-degree group might result in a more precise answer.

Cultural and ethnical factors may also influence facial emotion perception. Recent studies have shown that cultures differ in both expressed emotion and emotion perception (Ekman et al., 1987), and that there are cultural differences in the judgment of emotion intensity and affect recognition (Matsumoto and Ekman, 1989;

Matsumoto, 1999). Brekke et al. (2005) found that emotion recognition in schizophrenics was influenced by ethnicity, and specifically that Latinos and African-Americans scored lower in emotion perception than Caucasians. These cross-ethnic differences remained significant even after controlling for other variables, such as neurocognition and level of clinical symptoms. Habel et al. (2000) reported that patients with schizophrenia performed significantly worse than healthy controls in U.S., German, and Indian cultures. However, few studies have focused on non-Caucasian samples, and the universality of the emotion deficit in schizophrenia in non-Western cultures has rarely been examined.

The purpose of this study was to explore facial emotion perception deficits in patients with schizophrenia and their non-psychotic first-degree relatives using a comprehensive suite of facial emotion perception tasks. In particular, we explored whether the performance of the siblings and parents of schizophrenia patients was impaired compared with corresponding healthy controls. We also explored whether the finding of deficits in the perceptual identification among persons of Western European ancestry could be generalized to persons of Chinese ancestry. We have two hypotheses: First, patients with schizophrenia may present worse performances than their siblings, while their siblings performed worse than healthy controls. Parents of patients might also show worse performance than corresponding healthy controls in facial emotion perception tasks. Second, facial emotion deficits found in Western European ancestry could also be generalized to persons of Chinese ancestry.

2. Experimental procedures

2.1. Participants

Sixty-nine patients who fulfilled the diagnostic criteria of the DSM-IV (APA, 1994) for schizophrenia based on diagnostic interviewing (using the Structured Clinical Interview for DSM-IV and medical record reviews) were recruited from the Mental Health Centre of Shantou University. Patients with a history of neurological illness and alcohol or drug dependence (according to clinical records, information from clinicians, and interviews with the patients) were excluded. Clinical symptoms were rated using the Positive and Negative Symptom Scale (PANSS) (Kay et al., 1987). Researchers have found that atypical antipsychotics may reduce extrapyramidal side effects and lower the incidence of tardive dyskinesia in schizophrenia (Arvanitis et al., 1997; Beasley et al., 1999; Tran et al., 1997). However, there were still some patients in the sample who were being medicated with typical antipsychotics. To assess the presence of intolerable extrapyramidal side effects in these patients, we used the Abnormal Involuntary Movement Scale (AIMS) (Guy, 1976) and Barnes' Akathisia Rating Scale (BARS) (Barnes, 1989).

Fifty-six first-degree relatives (33 parents and 23 siblings) of the schizophrenia patients were recruited to the study. The participants were screened by psychiatrists with two year or more experiences for the presence of psychiatric illnesses, but no such illnesses were found.

Ninety-two healthy controls were recruited through the local advertisements and the internet forum of the local community, including 67 younger healthy controls for comparison with the patients and the siblings of the patients and 25 older healthy controls for comparison with the parents of the patients. They were paid for the participation. A semi-structured interview was conducted by a trained research assistant to ascertain that none of the healthy controls had any family history of psychiatric illness or suffered from a neurological illness or alcohol or drug dependence.

Intellectual quotient (Arvanitis et al., 1997) was estimated by the short form (information, arithmetic, similarity, and digit span) of the Chinese version of the Wechsler Adult Intelligence Scale — Revised (WAIS-R) (Gong, 1992). The demographic and clinical variables of the participants are shown in Table 1. The study was approved by the ethics committees of the Mental Health Centre of Shantou University and the Institute of Psychology, and written informed consent was obtained from each of the participants. All experiments were conducted in accordance with the Declaration of Helsinki.

2.2. Measures

The materials used in the tests comprised black and white still photographs depicting six basic emotions (happiness, surprise, sadness, fear, disgust, and anger) (Ekman and Friesen, 1976; Lyons et al., 1998). The photographs were presented on a liquid crystal display (LCD, 17″, resolution rate of 1280 × 800, brush rate of 60 Hz) within a square, white area, with response items listed under each expression. Each photograph was presented for 15 s.

The Facial Emotion Discrimination Test (FEDT) consisted of 21 photographs. The participants were shown two photographs at the same time and were instructed to report whether the two photographs represented the same or different types of emotion.

The Facial Emotion Identification Test (FEIT) consisted of 36 photographs, 6 for each emotion. In this test, the participants were asked to choose the emotion that best described the photograph.

The Facial Emotion Intensity Differentiation Test (FEIDT) consisted of 24 photographs. Each photographs included two faces with the same person and emotion, but in different intensities. The participants were instructed to select the more intense expression in sets of photographs that contained a balance of the six emotions.

The Facial Emotion Valence Test (FEVT) consisted of 24 photographs, with 8 photographs each for positive emotions (happiness and surprise), negative emotions (sadness, fear, disgust, and anger), and neutral emotions. The participants were instructed to judge which type of emotion (positive, negative, or neutral) the photographs showed.

A composite facial emotion perception index was computed based on the four facial emotion perception tasks, in accordance with the method of Kee et al. (2004), by summing the *Z* scores of the FEDT, FEIT, FEIDT, and FEVT.

A Test of Facial Recognition was designed to capture facial recognition in a method analogous to that of the Benton Test of Facial Recognition (TFR) (Benton et al., 1978). The photographs in the test showed non-emotional human faces, and were chosen from the images in Ekman and Friesen (1976). In the first part of the test, the subjects were presented a target photo of a person, and were instructed to choose which of six photos shown below the target face the same as it was. In the second part, the participants were asked to identify which three of six photos were the same person as the target face.

2.3. Procedures

The participants were given a general introduction to the study and the opportunity to ask questions. All of the participants gave informed consent before testing began. They completed the IQ subscales first, and then the FEDT, FEIT, FEIDT, FEVT, and TFR. The tests took between 40 min and 1 h to complete, depending on the individual participant. Generally speaking, the schizophrenia patients spent more time on the tests. The tests for the schizophrenia patients were conducted in a quiet room of the hospital. Some of the healthy controls were also tested at the hospital, and some were tested in our laboratory. After the tests, the schizophrenia patients were interviewed and rated using the PANSS, AIMS, and BARS.

2.4. Data analysis

Accuracy was the main concern of the present study, accuracy referred to the correct hit responses. Speed was also included in the study, it focused on the correct responses. To calculate the composite index of facial emotion perception, the scores for each task were transformed to *Z* scores and added together to generate a single index. A

Table 1
Demographic and clinical data of patients with schizophrenia, siblings and parents of patients and corresponding HC.

	SZ ($N=69$)	Sib ($N=23$)	Younger HC ($N=67$)	F	p	Parents ($N=33$)	Older HC ($N=25$)	F	p
Male:Female	47:22	12:11	45:22			15:18	10:15		
Means (SD)									
Age (years)	26.59 (6.74)	30.09 (8.09)	26.00 (6.02)	3.32	.039	52.24 (5.67)	52.04 (3.54)	0.03	0.876
Education (years)	10.73 (2.74)	10.87 (3.92)	10.87 (2.70)	0.05	.955	8.17 (5.08)	11.12 (2.40)	7.21	0.010
IQ	94.75 (17.64)	100.17 (18.09)	99.22 (16.40)	1.49	.355	97 (17.85)	103.6 (14.54)	2.27	0.137
Age of onset (years)	21.51 (5.80)								
Duration of illness (years)	4.80 (4.70)								
Medication (chlorpromazine equivalence, mg/day)	666.35 (446.69)								
Positive and Negative Syndrome Scale									
Positive symptoms	18.48 (6.09)								
Negative symptoms	16.88 (5.52)								
General psychopathology	32.47 (7.18)								
Abnormal Involuntary Movements Scale	0.60 (1.58)								
Barnes' Akathisia Rating Scale	1.09 (2.13)								

Note: SZ = schizophrenia; sib = siblings of schizophrenia; HC = healthy controls.

MANCOVA was used to analyze the group differences in facial emotion perception. The method of Bonferroni was used for correction for multiple testing. The effect sizes of the group comparisons were calculated in terms of Cohen's d (Cohen, 1988). Partial correlation analysis was also conducted to explore the relationships between the clinical variables and facial emotion perception performance of the schizophrenia patients, controlling for age and years of education.

3. Results

As the first-degree relatives included both the relatively younger siblings and the older parents of the patients, two control groups were used to match these two relatives groups. The siblings of the patients were significantly older than the patients and the younger healthy controls [$F(2,158)=3.34, p<0.05$], but the differences in the number of years of education and IQ among the three groups were not significant. Age was thus controlled as a covariate in the subsequent analysis (Table 2). The parents of the patients had significantly fewer years of education than the older healthy controls [$F(1,61)=10.30$, $p<0.01$], and the IQ of the older healthy controls was marginally significantly higher than that of the parents of the patients. The difference in age between the two groups was not significant. Years of education and IQ were thus controlled in the subsequent analyses (Table 3).

The performances of the patients, their siblings, and the younger healthy controls in the facial emotion perception tests were analyzed first. The MANCOVA indicated that the three groups differed significantly in accuracy in the four facial emotion perception tasks and the TFR (Table 2). For the FEDT, the group effect was significant [$F(2,155)=3.63$, $p<0.05$], with the younger healthy controls performing significantly better than the schizophrenic group ($p<0.05$), although the performance of the siblings of the patients was not significantly different from that of either the younger healthy controls ($p>0.05$) or the patients ($p>0.05$). For the FEIT, FEIDT, FEVT, and TFR, the group effects were all significant [$F(2,155)=13.79$, $p<0.001$; $F(2,155)=10.16$, $p<0.001$; $F(2,155)=10.22$, $p<0.001$; $F(2,155)=8.23$, $p<0.001$, respectively], and post-hoc tests revealed that both the younger healthy controls and the siblings of the patients performed significantly better than the patients, whereas the younger healthy controls performed as well as the siblings of the patients in all of the tasks ($p>0.05$). The results also indicated that patients with schizophrenia performed slower than the younger healthy controls in all the facial emotion perception tests, and slower than their siblings only in the TFR test. No significant differences were seen between the siblings of patients and younger healthy controls in the speed. The MANCOVA that compared the parents of the patients and the older healthy controls demonstrated that the older healthy controls performed significantly better than the parents of patients in the FEIT, FEVT, and a trend of significance in TFR [$F(1,55)=5.11$, $p=0.029$; $F(1,54)=9.55$, $p=0.004$; $F(1,61)=3.08$, $p=0.086$, respectively], although there were no significant differences between the two groups for the FEDT and FEIDT [$F(1,61)=0.67$, $p=0.418$; $F(1,54)=0.74$, $p=0.395$, respectively]. For the speed, no significant differences were found between the parents of patients and older healthy controls (Table 3).

In terms of the composite index, the group effects in the accuracy and speed among the patients, their siblings, and the younger healthy controls were significant [$F(2,155)=20.84$, $p<0.001$; $F(2,155)=11.28$,

Table 2
Facial emotion perception performances among schizophrenia, first-degree relatives, and HC.

		SZ			Sib			Younger HC			F	p	Cohen's d		
		N	M	SD	N	M	SD	N	M	SD			SZ vs. younger HC	SZ vs. Sib	Sib vs. younger HC
FEDT	Accuracy	69	69.09	11.80	23	72.26	9.38	67	73.56	7.38	3.63	0.029	−0.45	−0.28	−0.16
	Speed (s)		4.71	2.05		4.44	1.57		3.61	1.42	5.25	0.002	−0.63	−0.14	−0.58
FEIT	Accuracy	69	53.54	15.46	23	66.39	13.17	67	64.30	11.32	13.79	0.0005	−0.79	−0.86	0.18
	Speed (s)		4.55	2.03		4.07	1.43		3.46	1.25	5.33	0.001	−0.65	−0.26	−0.48
FEIDT	Accuracy	69	66.30	11.34	23	72.91	6.81	67	73.51	8.82	10.16	0.0005	−0.71	−0.64	−0.07
	Speed(s)		4.63	2.28		4.01	1.44		2.99	1.22	10.40	0.0005	−0.90	−0.30	−0.81
FEVT	Accuracy	69	68.66	18.07	23	78.56	14.87	67	80.78	14.12	10.22	0.0005	−0.69	−0.57	−0.15
	Speed (s)		3.46	1.53		3.10	1.12		2.58	1.11	6.51	0.001	−0.66	−0.25	−0.47
CI	Accuracy	69	−1.38	2.90	23	1.02	2.33	67	1.20	1.94	20.84	0.0005	−1.04	−0.87	−0.09
	Speed		1.30	3.67		.28	2.73		−1.43	2.01	11.28	0.0005	−0.93	−0.30	−0.78
TFR	Accuracy	69	90.85	14.82	23	97.97	3.50	67	97.47	4.52	8.23	0.0001	−0.60	−0.55	0.12
	Speed (s)		8.72	2.37		7.14	2.23		6.89	1.75	10.15	0.0005	−0.88	−0.68	−0.13

Note: SZ = schizophrenia patients; HC = healthy controls; Sib = siblings of the schizophrenia patients; FEDT = Facial Emotion Discrimination Test; FEIT = Facial Emotion Identification Test; FEIDT = Facial Emotion Intensity Differentiation Test; FEVT = Facial Emotion Valence Test; CI = composite index, Z score, the negative values are worse for the accuracy, while better for the speed; TFR = Test of Facial Recognition.

Table 3
Facial emotion perception performances between parents of patients and corresponding older HC.

		Parents			Older HC			*F*	*p*	Cohen's *d* Parents vs. older HC
		N	*M*	*SD*	*N*	*M*	*SD*			
FEDT	Accuracy	33	69.55	10.24	25	70.95	9.95	0.67	0.418	−0.14
	Speed (s)		4.30	1.42		3.68	1.11	2.81	0.100	−0.49
FEIT	Accuracy	27	52.04	10.65	25	58.80	9.87	5.11	0.029	−0.66
	Speed (s)		4.82	2.00		4.04	1.12	2.56	0.117	−0.49
FEIDT	Accuracy	26	68.98	10.73	25	70.14	8.55	0.74	0.395	−0.12
	Speed (s)		5.14	1.94		4.43	1.20	0.38	0.541	−0.45
FEVT	Accuracy	26	70.58	16.47	25	83.61	8.54	9.25	0.004	−0.99
	Speed (s)		3.94	1.44		3.32	1.14	0.83	0.367	−0.49
CI	Accuracy	23	−0.91	3.11	25	1.14	1.96	6.95	0.012	−0.80
	Speed (s)		0.83	3.78		−0.97	2.45	2.20	0.146	−0.58
TFR	Accuracy	33	89.23	10.09	25	94.87	7.38	3.08	0.086	−0.63
	Speed (s)		9.31	2.43		9.12	1.94	0.027	0.871	−0.09

Note: HC = healthy controls; FEDT = Facial Emotion Discrimination Test; FEIT = Facial Emotion Identification Test; FEIDT = Facial Emotion Intensity Differentiation Test; FEVT = Facial Emotion Valence Test; CI = composite index; TFR = Test of Facial Recognition.

$p<0.001$, respectively]. The schizophrenia group performed significantly worse than their siblings ($p<0.001$) and the younger healthy controls ($p<0.001$), whereas the siblings of the patients performed as well as the younger healthy controls ($p>0.05$). Furthermore, the schizophrenia group performed significantly slower than the younger healthy controls, differences between patients and their siblings, siblings of patients and younger healthy controls, were not found significant. As to the accuracy, the effect sizes for the four facial emotion tasks and the TFR between the siblings of the patients and the younger healthy controls were all negligible (Cohen, 1988), ranging from −0.16 to 0.18 (Table 2), and the effect size for the composite index was also negligible (Cohen's $d=-0.09$). Fig. 1 shows the facial emotion perception and TFR profiles of the patients with schizophrenia, their siblings, and the younger healthy controls (all of the scores in the figure are *Z*-transformed and age is controlled). The figure demonstrated that the schizophrenia patients performed the worst in all of the tasks, and that the siblings of the schizophrenia patients performed as well as the younger healthy controls and better than the schizophrenia patients. For the speed, the effect sizes between the two groups were different, they were large for the FEIDT, moderate to large for the FEDT and CI, small for the FEIT and EFVT, while negligible for the TFR (Table 3).

The group effect on accuracy between the parents of the patients and the older healthy controls for the composite index was also significant [$F(1,45)=6.95$, $p=0.012$], with the older healthy controls performing significantly better than the parents of the patients. The effect sizes of the accuracy were large for the FEVT and the composite index, moderate to large for the FEIT and TFR, and small for the FEDT and FEIDT. Fig. 2 shows the facial emotion perception and TFR profiles of the parents of the patients and the older healthy controls (all of the scores in the figure are *Z*-transformed, and years of education and IQ are controlled). The figure shows that the parents of the patients performed worse than the older healthy controls in all of the tests. For

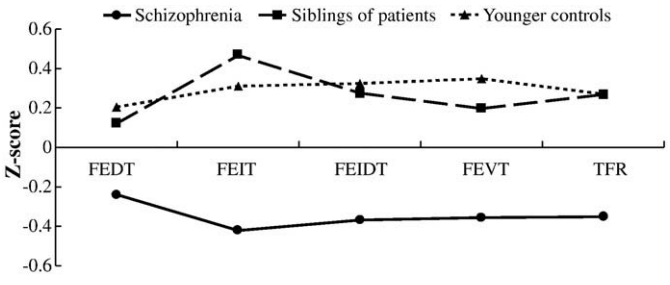

Fig. 1. Facial emotion perception profiles (accuracy) among patients with schizophrenia, their siblings, and younger controls.

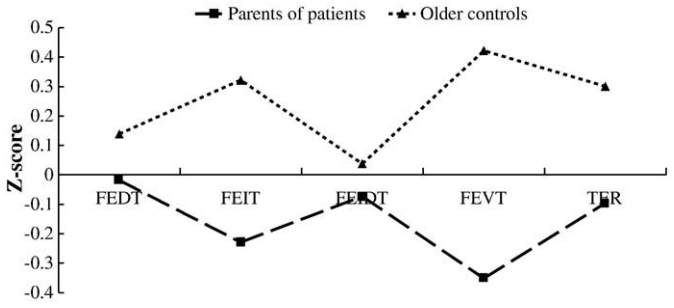

Fig. 2. Facial emotion perception profiles (accuracy) between parents of patients and older controls.

the speed, there was no significant differences between the two groups [$F(1,45)=2.20$, $p=0.146$]. The effect sizes of the speed between the two groups were moderate to large for the CI, small for FEDT, FEIT, FEIDT, FEVT, and negligible for the TFR.

The correlations between the clinical variable scores and facial emotion perception accuracy scores were calculated for the schizophrenia patients. The preliminary results showed that medication dose was significantly negatively correlated with the FEDT ($r=-0.284$, $p<0.05$) and composite index of emotion perception ($r=-0.255$, $p<0.05$), but other clinical variable scores, including duration of illness, side effects, and clinical symptoms, were not significantly correlated with facial emotion perception performance. When we controlled the medication effect, we found no significant correlations between the clinical variable scores and the facial emotion perception scores (Table 4).

4. Discussion

The results demonstrated that patients with schizophrenia performed significantly worse than their siblings and the corresponding younger healthy controls in the FEIT, FEIDT, FEVT, TFR, and the composite index, and also performed significantly worse than the younger healthy controls in the FEDT. Moreover, patients with schizophrenia also demonstrated significantly reduced speed than the younger healthy controls in all the tests. The siblings of the patients performed as well as the younger healthy controls in all of the facial emotion perception tasks, and also in the composite index and TFR, in both accuracy and speed. Parents of the patients performed significantly worse than older healthy controls in the FEIT, FEVT and the composite index in accuracy. Parents of patients did not show deficits in the speed, after controlling the years of education and IQ. After controlling medication dose, no significant correlations were found between facial emotion perception performances and the clinical variable scores in patients with schizophrenia.

In the present study, we found that patients with schizophrenia demonstrated deficits in both facial emotion perception and the facial identity tasks, which were consistent with the two recently meta-analyses (Chan et al., 2009; Kohler et al., 2009). Previous study suggested some variations such as subject characteristics, experimental tasks and control tasks that might cause the inconsistencies across different studies (Edwards et al., 2002). In our study, a series of facial emotion perception tasks as well as a control task about facial identity has been used, therefore we could explore the facial emotion perception in patients with schizophrenia relatively comprehensively. However, due to the lack of a detailed description of the subtype of patients, we could only provide the performances of the overall patients.

The results of this study are interesting. Among the previous studies that have explored the facial emotion perception of first-degree relatives, Toomey et al. (1999) and Bölte and Poustka (2003) did not find significant differences between the relatives and the healthy controls. However, in accordance with McCown et al. (1988) and Gur et al. (2007), who reported that relatives performed significantly worse than healthy

Table 4
Correlation coefficients between clinical variables and accuracy of facial emotion perception tasks.

	Duration	PANSS-P	PANSS-N	PANSS-G	AIMS	BARS
FEDT	0.174	−0.175	−0.045	0.015	−0.047	−0.007
FEIT	0.154	−0.211	−0.044	−0.026	0.106	−0.133
FEIDT	−0.083	0.025	−0.221	−0.159	0.159	0.173
FEVT	0.179	−0.188	−0.006	0.027	0.091	−0.062
CI	0.175	−0.220	−0.100	−0.040	0.119	−0.034
TFR	0.153	−0.225	−0.144	−0.160	−0.078	−0.174

Note: CI = composite index; Duration = duration of illness; AIMS, Abnormal Involuntary Movement Scale; BARS, Barnes' Akathisia Rating Scale; PANSS-P, Positive and Negative Symptom Scale — Positive Symptom Scale; PANSS-N, Positive and Negative Symptom Scale — Negative Symptom Scale; PANSS-G = Positive and Negative Symptom Scale — Generally Symptom Scale; FEDT = Facial Emotion Discrimination Test; FEIT = Facial Emotion Identification Test; FEIDT = Facial Emotion Intensity Differentiation Test; FEVT = Facial Emotion Valence Test; CI = composite index; TFR = Test of Facial Recognition.

controls in facial emotion perception tasks from the accuracy and speed respectively, we found that the parents of the patients performed significantly worse than their corresponding older healthy controls in both accuracy and speed. We also found that the siblings of the patients performed as well as the corresponding younger healthy controls in both accuracy and speed, which was consistent with the findings of Kee et al. (2004). Of the two genetically related groups explored in the study — the siblings of the patients and the parents of the patients — the parents appeared to be more impaired than the siblings. Shared environment may have influenced the results to some degree. However, as the parents of the patients were older than both the patients and their siblings, they were unlikely to have shared more of an environment with the patients than the siblings, and thus the greater impairment found among the parents may not be attributable to the shared environment.

To compare the results with those of previous studies, effect sizes were calculated and used as an index. Of the studies that have adopted non-siblings as the relative group, the effect size of the group difference was small in the studies of McCown et al. (1988) and Toomey et al. (1999) (0.19 and 0.24, respectively) but large (−1.05) in the study of Bölte and Poustka (2003). Although the effect size was large in the study of Gur et al. (2007), the relatives were first- and fourth-degree relatives, and they focused on the reaction time. In the present study, the effect size between the parents of the patients and the older healthy controls for the composite index was fairly large for the accuracy (−0.80) and moderate to large for speed (−0.58), and fell between the effect sizes in the aforementioned studies. Although Leppänen et al. (2008) concluded that deficits in the processing of negative facial expressions may represent a heritable endophenotype of schizophrenia, the effect sizes between the unaffected siblings of schizophrenia patients and healthy controls in their study were small to medium (0.37 for positive hits-false alarms and −0.37 for negative hits-false alarms). Kee et al. (2004) reported a small effect size for the group difference between the siblings of schizophrenia patients and healthy controls (−0.31), and the corresponding effect size in this study was also very small (−0.09).

We adopted a more comprehensive suite of facial emotion perception tasks to detect the observed deficits, in contrast to the single index used in most previous studies. This approach may be more sensitive in detecting subtle deficits in emotion perception in non-psychotic first-degree relatives of schizophrenics. The two groups of genetic relatives of the schizophrenia patients demonstrated different trends of facial emotion perception compared with the corresponding healthy controls, which indicates that we must pay more attention to the differing roles of different genetically related groups in endophenotype studies of psychiatric illness. Previous studies have found that schizophrenia occurs higher in biological relatives of patients with schizophrenia than in the general population, the prevalence of schizophrenia is about 1% in the general population while as high as 6%–13% in first-degree relatives (Vollema et al., 2001; Kremen et al., 1998; Cornblatt et al., 1999). Phillips and Seidman (2008) pointed that only a subgroup of biological relatives of patients might carry susceptibility genes. By identifying the genetic determinants of biological markers known to represent the subclinical pathologic abnormalities of a disease, researchers may find the candidate genes that affect the actual manifestations of that disease (Gottesman and Gould, 2003; Greenwood et al., 2007). The present results suggested that parents and siblings of schizophrenia patients might play different roles in the genetic basis of schizophrenia, age difference might be an important reason. Further studies are needed to explore the different roles. Moreover, Phillips and Seidman (2008) concluded that first-degree relatives of schizophrenia patients demonstrated greater abnormality when the tasks involve more subtle expressions and complex social interactions. Further studies that adopt subtle expressions and other modalities (for example, emotional prosody and posture) could give us more precise information on facial emotion perception in first-degree relatives.

This study focused on non-Caucasian samples, and found that patients with schizophrenia in Chinese culture also demonstrated deficits in facial emotion perception. Chan et al. (2008) also got similar findings. They recruited 43 patients with schizophrenia in remission from an outpatient clinic in Hong Kong, and found that patients with schizophrenia suffered from deficits of certain aspects of facial emotion recognition. In the two direct cross-ethnic comparison studies (Habel et al., 2000; Brekke et al., 2005), the results confirmed the culture differences in facial emotion perception among different ethnic patients, but both showed patients with schizophrenia demonstrated deficits in facial emotion perception, although Caucasian patients might suffer relatively less impairments. The present study verifies the universality of emotion perception deficits in schizophrenia, and suggests that the findings on facial emotion perception abnormalities can also be generalized to persons of Chinese ancestry. Up to date, no studies compared facial emotion perception performances in first-degree relatives of patients among different cultures. Therefore it is still unclear whether different cultures have the same biological influences to the facial emotion perception.

The study has some limitations. The sample sizes for the groups of relatives were relatively small, which may have influenced the power of the tests to detect differences between the relative groups and the control groups. The healthy controls were tested in different settings, which may have small influences on the results. Although we controlled the demographic differences between control groups and patients/relatives, it might still have some possible influences on the results. Moreover, many previous studies have found that non-paranoid schizophrenics performed worse than paranoid schizophrenics in facial emotion perception tasks (Chan et al., 2008; Kline et al., 1992; Phillips et al., 1999; Weniger et al., 2004), but we did not have information on the particular schizophrenia subgroups to which the patients belonged to determine whether this was linked to the facial emotion perception of their relatives.

These limitations notwithstanding, the chief merit of this study are the findings that the deficits in the perceptual identification of emotion among schizophrenia patients of Western European ancestry can be generalized to schizophrenia patients of Chinese ancestry, and facial emotion perception deficits may serve as potential endophenotypes for schizophrenia. As the next step, studies that employ larger sample sizes should be conducted to further explore the heritability of facial emotion perception in schizophrenia.

Acknowledgements

This study was supported partially by the Project-Oriented Hundred Talents Programme (O7CX031003), the Knowledge Innovation Project of the Chinese Academy of Sciences (KSCX2-YW-R-131), and the National Basic Research Programme (973 Programme No.

2007CB512302 and 2007CB512305). These funding bodies had no further role in the study design; in the collection, analysis, and interpretation of the data; in the writing of the manuscript; or in the decision to submit the paper for publication.

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