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Facial expression and face orientation processing in schizophrenia

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ABSTRACT

Schizophrenia patients exhibit deficits in recognition and identification of facial emotional expressions, but it is unclear whether these deficits result from abnormal affective processing or an impaired ability to process complex visual stimuli such as faces. Participants comprised 16 outpatients with schizophrenia and 22 matched healthy control subjects who performed two computerized visual matching tasks (facial emotional expression and orientation). Accuracy and reaction time were recorded. Clinical symptoms were assessed in the patients using the Brief Psychiatric Rating Scale (BPRS), Scale for the Assessment of Positive Symptoms (SAPS), and Scale for the Assessment of Negative Symptoms (SANS). Social functioning as measured by the Zigler social competence scale was indexed in all participants. Patients with schizophrenia were less accurate than control participants on both facial emotion and orientation matching tasks, but there was no diagnosis-by-task interaction. Clinical symptoms of the patients were associated with deficits on emotion and orientation matching tasks. Worse social functioning was correlated with facial emotion matching errors across both groups. Patients with schizophrenia show general deficits in processing of faces, which is in turn associated with worse symptoms and reduced social functioning.

1. Introduction

Past research indicates that both vocal and facial emotion recognition is impaired in schizophrenia (Walker et al., 1984; Feinberg et al., 1986; Borod et al., 1993; Archer et al., 1994; Mandal et al., 1998; Edwards et al., 2001; Baudouin et al., 2002; Hooker and Park, 2002), and that this deficit is likely to be a trait-like feature of the illness (Kline et al., 1992; Schneider et al., 1995; Salem et al., 1996; Poole et al., 2000; Exner et al., 2004; Addington, et al., 2008). Schizophrenia patients (SZ) perform worse than healthy control subjects (CO) on tasks that require emotion identification or discrimination (Walker et al., 1980; Salem et al., 1996), but such deficits may stem from a generalized deficit in face processing. Indeed, evidence suggests that there is no specific deficit in emotion perception in schizophrenia (Kerr and Neale, 1993) but that they may have generalized deficits in processing of faces (Salem et al., 1996) and face processing deficits may be related to cognitive deficits in schizophrenia (Schneider et al., 1995; Bryson et al., 1997; Addington and Addington, 1998; Kohler et al., 2000).

The relationships among symptom severity, emotion processing, and face processing have been investigated but are not clearly understood. Some studies have found a relationship between increased positive symptoms and deficits in face processing (Schneider et al., 1995; Kohler et al., 2000; Baudouin et al., 2002; Martin et al., 2005); other studies have found a relationship between negative symptoms and deficits in face processing (Mueser et al., 1996; Kohler et al., 2000; Suslow et al., 2003b), and yet other studies have found no relationship between symptoms and face processing (Muzekari and Bates, 1977; Borod et al., 1993; Salem et al., 1996). Nevertheless, accurate processing of socially relevant stimuli such as faces seems to have important implications for social functioning in schizophrenia (Hooker and Park, 2002; Suslow et al., 2003a; Kim et al., 2005).

The goal of the present study was to extend previous findings of facial processing deficits of schizophrenia in relation to social functions using two simple matching tasks with no language or memory demands, which may introduce additional cognitive load. We hypothesize that SZ subjects will be impaired on both the emotion matching task and the orientation matching task compared with CO subjects. We further examined reaction time performance on these tasks in order to gauge whether or not there was additional cognitive loading.

2. Methods

2.1. Participants

Twenty-two healthy control participants (CO) (12 females) were recruited via advertisements. They were screened for history of psychiatric illness, head injury, epilepsy, and drug use. Sixteen (5 females) individuals who met the DSM-IV criteria (American Psychiatric Association, 2000) for schizophrenia or schizoaffective disorder (13 schizophrenia, 3 schizoaffective) were recruited from an outpatient clinic. All schizophrenic and schizoaffective subjects (SZ) were chronically ill (mean years of illness = 13.4, S.D. = 7.4). Exclusion criteria for SZ were multiple diagnoses, head injury,

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Table 1
Demographic information.

	Control subjects ($n=22$)	Schizophrenic subjects ($n=16$)
Education (years)	13.2 (1.9)[a]	12.8 (2.0)
Age	34.5 (11.2)	38.8 (10.2)
Full scale I.Q.[b]	95.4 (14.5)	100.0 (14.0)
BPRS	N/A	24.9 (13.6)
SANS	N/A	28.8 (18.6)
SAPS	N/A	25.9 (22.1)
SPQ	16.5 (8.0)	N/A
Global handedness score[c]	80.3 (35.7)	58.3 (56.7)
CPZ equivalent[d]	N/A	283.9 (98.3)
Illness duration	N/A	13.4 (7.4)
Zigler score[e]	5.0 (1.9)	2.2 (1.1)

[a] Mean (standard deviation).
[b] Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999).
[c] Global Handedness Questionnaire (Ransil and Schachter, 1994).
[d] Chlorpromazine dose equivalent (in milligrams per day; Woods, 2003).
[e] Zigler Score of Social Functioning (Zigler and Levine, 1981).

epilepsy, or current drug abuse. All SZ subjects were taking atypical antipsychotic drugs (risperidone, olanzapine or clozapine). Demographic information is presented in Table 1. All participants gave written informed consent as approved by the Vanderbilt University Institutional Review Board and were paid.

There were no group differences in age ($F(1,36)=1.41$, $P=$ n.s.), education ($F(1,36)=0.41$, $P=$ n.s.), estimated full-scale IQ ($F(1,34)=0.92$, $P=$ n.s.) and handedness measured by the Global Handedness Questionnaire ($F(1,36)=1.96$, $P=$ n.s.). IQ data were missing from two CO subjects, but since the education level was matched, it is unlikely that the two groups differed in general cognitive ability.

2.2. Materials and procedure

All tasks were performed on an iMac computer (screen size 28.75×21.25 cm). Subjects were seated 40 cm from the screen. Face stimuli were selected from the Karolinska Directed Emotional Faces (KDEF, Lundqvist et al., 1998), which provides standardized face stimuli for emotional expressions as well as orientation of faces. Calvo and Lundqvist (2008) conducted a study investigating valences and accuracy of identification using the KDEF stimuli. This study showed that happy faces were identified more accurately than other faces. However, fearful faces were identified less accurately than other faces. Please see www.psychonomic.org/archive for norms for each face and expression regarding identification accuracy, errors, and reaction times. Emotions used in the present study were neutral, happy, sad, fearful, and angry. All subjects had normal or corrected-to-normal vision. All subjects were given detailed instructions before beginning the experiment and were given practice trials.

2.2.1. Emotion matching

Subjects were asked to look at a fixation dot at the center of the screen. When they were ready to begin a trial, they clicked on the fixation dot with the mouse. The screen displayed a target face directly above the fixation dot and three different face stimuli below the fixation dot (see Fig. 1). Subjects were instructed to select one of the three response faces below the fixation point that best matched the target in its emotional expression. The identity of the target face differed from the identities of the response faces. Thus, on any given trial, there were faces of four different people on the screen. There were 20 trials.

2.2.2. Facial orientation matching

The procedure was identical to the one described above for the emotion-matching task, but in this case subjects were instructed to select one of the three response face stimuli that best matched the orientation of the target face above the fixation dot (see Fig. 2). There were 20 trials.

The order of task presentation was counterbalanced across subjects. For both matching tasks, accuracy and reaction times (RT) were recorded.

2.2.3. Clinical symptoms

The Brief Psychiatric Rating Scale (BPRS; Overall and Gorhman, 1962), the Scale for the Assessment of Positive Symptoms (SAPS; Andreasen, 1984), and the Scale for the Assessment of Negative Symptoms (SANS; Andreasen, 1984) were used to assess symptoms.

2.2.4. Schizotypal personality in CO subjects

We used the Schizotypal Personality Questionnaire (SPQ) (Raine, 1991), a self-report questionnaire based on the DSM Axis II criteria for schizotypal personality disorder.

2.2.5. Social functioning

The Zigler social competence scale (Zigler and Levine, 1981) was used to estimate social functioning in all participants, using demographic information including age, employment, marital status and education.

2.3. Data analysis

Repeated measures analysis of variance (ANOVA) was used to compare the two groups on % correct responses and response times. Fisher's PLSD was used for the post-hoc analysis. Correlations were computed using the Pearson product-moment correlation. Cohen's *d* was used to calculate effect sizes.

3. Results

3.1. Accuracy

There was a main effect of diagnosis ($F(1,36)=10.10$; $P=0.003$, $r=0.89$). CO subjects (Mean = 92.50%; S.D. = 8.46) performed better overall than SZ subjects (Mean = 81.41%; S.D. = 20.25). A main effect for task was also found ($F(1,36)=8.82$; $P=0.005$, $r=0.84$). Subjects

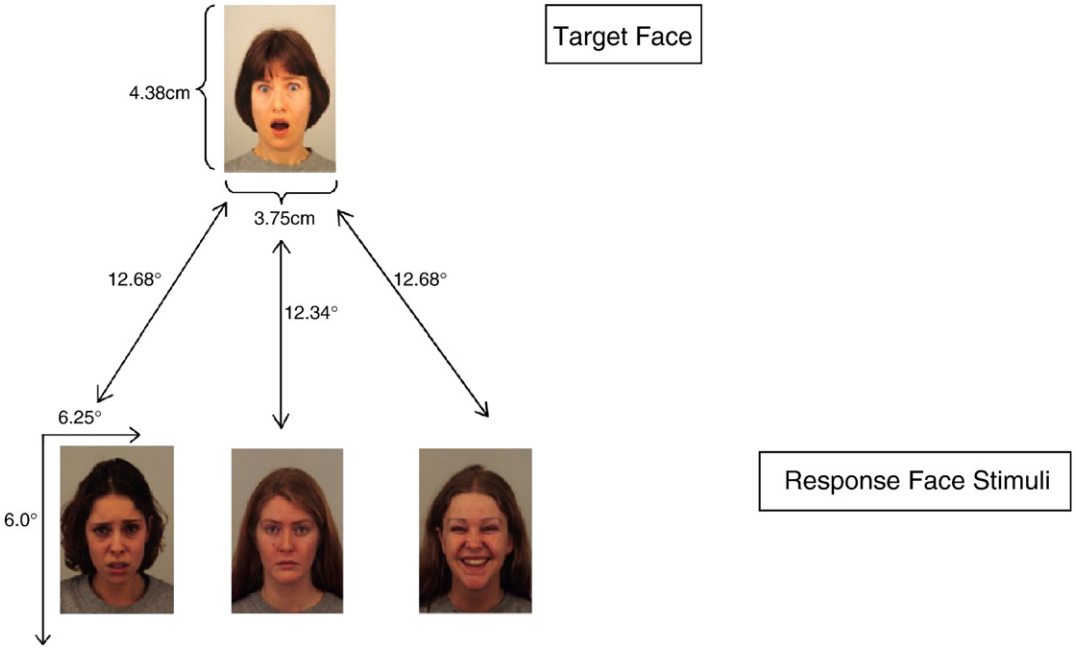

Fig. 1. Face emotion matching task.

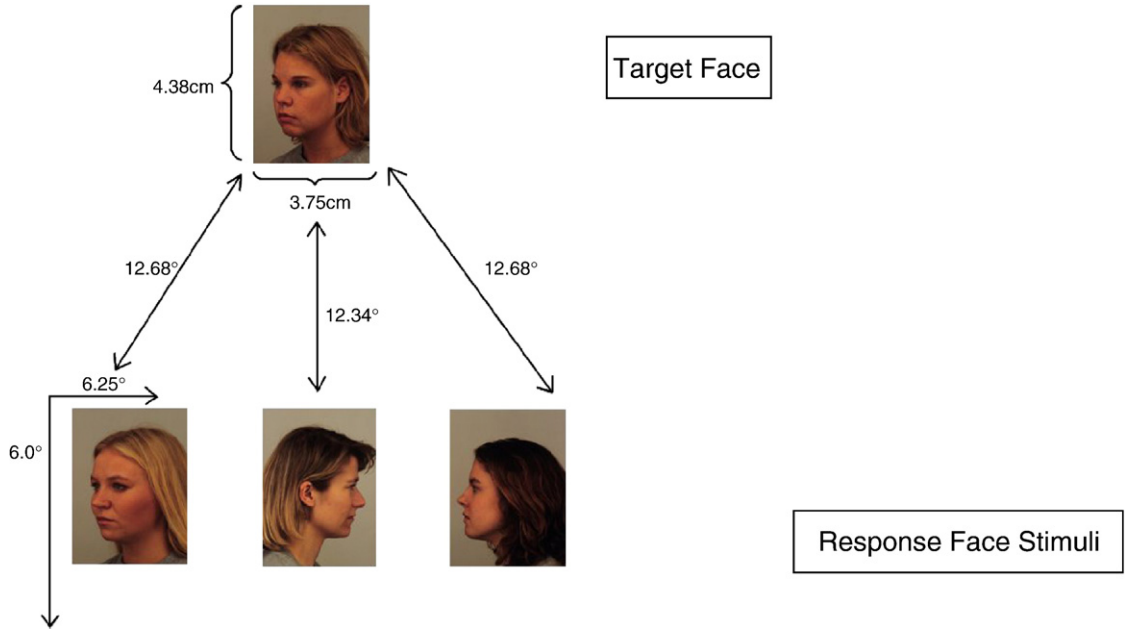

Fig. 2. Face orientation matching.

performed better on the facial orientation task (Mean = 92.50%; S.D. = 18.45) than on the emotion matching task (Mean = 83.16%; S.D. = 10.16). There was no significant interaction (see Fig. 3).

Given the uneven ratio of male to females in the study, it is important to address potential sex differences. A multifactorial ANOVA with diagnosis and sex as independent variables was conducted on the accuracy of the performance on the two face tasks. There was no main effect of diagnosis or sex. There was no diagnosis-by-sex interaction.

3.2. Reaction time

There was no main effect of diagnosis ($F(1,36) = 0.22$; P = n.s.), but there was a main effect of task type ($F(1,36) = 20.09$; $P < 0.0001$, $r = 0.99$). Subjects were faster on the face-orientation task (Mean = 4723 ms; S.D. = 3516) than on the emotion matching task (Mean = 7153 ms; S.D. = 2326). There was a trend towards a group-by-task interaction ($F(1,36) = 4.03$, $P < 0.06$, $r = 0.49$). However, post-hoc analyses showed no significant differences in reaction time between groups on either the facial orientation matching task or the emotion matching task (see Fig. 4).

3.3. Relationships with social functioning and symptomatology

There was a significant group difference on the Zigler score of social functioning ($F(1,36) = 26.59$, $P < 0.0001$), with the CO subjects scoring higher than the SZ subjects. Across both groups, the Zigler score was positively correlated with the performance on the emotion matching task ($r = 0.38$; $P = 0.02$). Interestingly, there was also a trend for a significant correlation between the Zigler score of social functioning and performance on the face-orientation task ($r = 0.31$, $P = 0.06$) suggesting that better performance on face processing in general may be related to better social functioning.

In the SZ group, BPRS ratings were negatively correlated with performance on the emotion matching task ($r = -0.57$, $P = 0.02$), suggesting that SZ subjects with ia high level of symptoms were less accurate on the emotion matching task. There was a significant negative correlation between positive symptoms (SAPS) and accuracy on the emotion matching task ($r = -0.54$, $P = 0.04$). There were no significant correlations with negative symptoms and task performance. Illness duration was negatively correlated with performance on the face-orientation task ($r = -0.68$, $P = 0.07$) and positively correlated

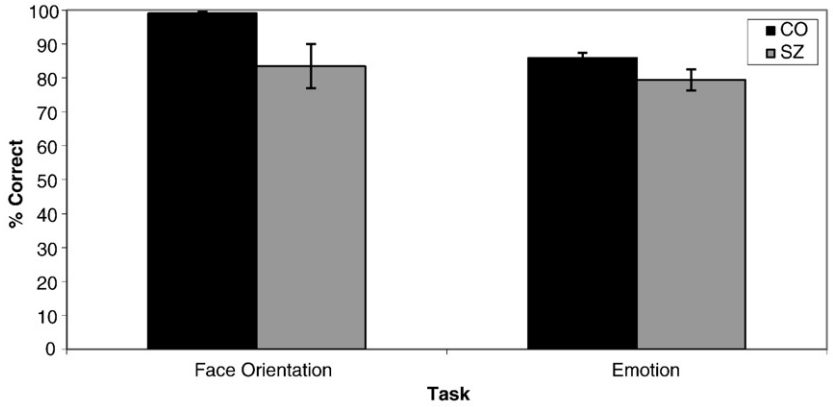

Fig. 3. Accuracy on the matching tasks. Mean percent correct (S.E.).

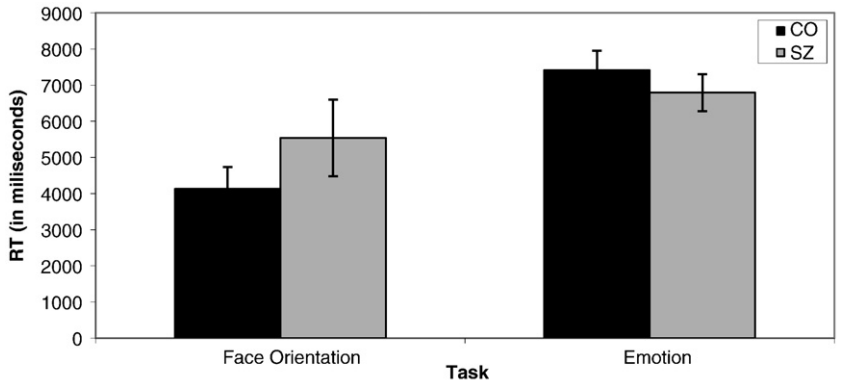

Fig. 4. Response times of matching tasks. RT in milliseconds (S.E.).

with RT on the same task ($r = 0.74$, $P = 0.04$). Daily medication dose (as measured by the CPZ equivalent) was positively correlated with performance on the face-orientation task ($r = 0.53$, $P = 0.05$) and negatively correlated with reaction time on the same task ($r = -0.60$, $P = 0.02$). These findings suggest that symptom management is related to the ability to process facial stimuli. In other words, those patients with better face processing ability tend to have fewer symptoms.

4. Discussion

This study aimed to investigate face processing in SZ subjects while controlling for additional cognitive demands. Face processing was impaired in SZ subjects whether they were asked to match emotion or orientation. Therefore, any studies of facial emotion processing should account for the fact that SZ subjects have deficits in face processing and that facial emotion processing deficits may not indicate a specific problem of emotion processing. It is interesting to note that most studies of SZ subjects report slower RT than CO subjects (see Gale and Holzman, 2000), but there was no overall RT difference between SZ and CO subjects in our study, and both groups were faster on matching orientation than emotion.

Our results suggest that positive symptoms, as indicated by SAPS and to some extent BPRS scores, are related to poorer performance on emotion matching that in turn may be related to a facial processing deficit in general. In line with this finding, Pinkham et al. (2008) found that patients with paranoid schizophrenia showed decreased neural activation in the right amygdala, fusiform face area, and left ventrolateral prefrontal cortex as compared with controls during a face processing task. These findings are interesting in that core features of negative symptoms are affective, and one would therefore hypothesize a relationship between negative symptoms and facial emotion processing deficits. However, several studies have reported associations between positive symptoms and emotional processing deficits (Schneider et al., 1995; Kohler et al., 2000; Baudouin et al., 2002; Martin et al., 2005). It is possible that this relationship depends on whether the tasks used are specifically affective in nature or are contaminated by general problems in face processing.

Our study also underscores the relationship between social functioning and the ability to process facial stimuli. There was a positive correlation between the Zigler score of social functioning and the ability to correctly process emotional faces across both groups. This is similar to the findings reported by Hooker and Park (2002) who showed that affect recognition performance was related to social functioning.

There are several limitations to our study. The sample size is small so we were not able to examine the symptom-face processing relationship comprehensively. Secondly, it is yet to be determined if deficits in face processing are due to a larger overarching perceptual and cognitive deficit. Faces are after all, a class of complex visual stimuli. However, a study on biological motion perception in SZ patients (Kim et al., 2005) indicates that SZ patients may be selectively impaired in processing socially relevant stimuli such as faces and bodies compared with non-biological objects.

Taken together our findings indicate that SZ have deficits in face processing in general, replicating Salem et al.'s results (1996) and that face processing deficits may have significant and detrimental social information processing consequences for the patients.

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