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Face-related visual search deficits in first-episode schizophrenia

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ABSTRACT

Schizophrenia is considered a complex illness with multiple cognitive dysfunctions, including a deficit in visual processing. However, whether the deficiency of visual processing in schizophrenia is general across stimuli or stimulus-specific remains the subject of debate. In the current study, eighteen first-episode schizophrenic patients and eighteen healthy controls participated in three visual search tasks in which they were asked to search a specific target of a triangle, face identity or facial affect. The results showed that, compared to healthy controls, the accuracies for face identity and facial affect searches were significantly lower in schizophrenic patients, while the performance of the triangle search was the same. Furthermore, the accuracy of the facial affect search was negatively correlated to negative symptoms in schizophrenia. These results revealed a face-related deficit in schizophrenia and suggest that visual processing deficits in schizophrenia were stimuli-specific.

1. Introduction

Schizophrenia has long been characterized by multiple cognitive dysfunctions, including attention, memory, and executive function (Fioravanti et al., 2005). Recently, more attention is being paid to social cognition in schizophrenia (Green and Leitman, 2008). As a core perception in social cognition, facial perception in schizophrenia has also been the subject of recent research (Green et al., 2015). Facial affect perception, which is considered crucial in social interaction, is found to be impaired in schizophrenic patients; such a deficit could be a specific cognitive marker for schizophrenia (Schoeman et al., 2009). However, for general face processing, the evidence is not consistent. For example, using a matching task, Martin et al. (2005) found a lower accuracy of face recognition in schizophrenic patients, which indicated a deficit in face identity processing. However, such a deficit was also found when using a house as the stimulus (Butler et al., 2008). More importantly, the face inversion effect was found to be normal in schizophrenic patients, indicating a normal holistic processing of the face stimulus (Butler et al., 2008). In eye tracking studies, some evidence showed that the scan path of schizophrenia was restricted when viewing the stimuli containing social information, including emotional and neutral faces (Loughland et al., 2002a, 2002b; Nikolaides et al., 2016). However, another study found that the abnormal scanning patterns of schizophrenic patients were not stimulus-specific, indicating a general impairment of the eye movement pattern (Benson et al., 2012). Thus, Bortolon et al. (2015) proposed that the face perception deficit was not a specific marker for schizophrenia and might result from deficits in earlier visual processing stages.

Although evidence showed that both the face and other perceptions were impaired in schizophrenia, it should be noted that numerous neurophysiological studies found abnormalities in anatomical structures and functional activities related to face processing. For example, magnetic resonance imaging (MRI) studies showed that the gray matter volume of the fusiform gyrus was much smaller in schizophrenic patients than in healthy controls (Lee et al., 2002; Onitsuka et al., 2006). This area, which was termed the fusiform face area (FFA), was found to be crucial in face identification and recognition (Kanwisher et al., 1997; Kanwisher and Yovel, 2006). Importantly, the neural response to face stimuli in this area was also found to be weaker in schizophrenic patients than in healthy controls (Quintana et al., 2003). Similarly, event-

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related potential (ERP) studies showed a weaker N170 response to the face stimulus in schizophrenic patients (Onitsuka et al., 2006). Because N170 is considered a face-sensitive component in ERPs (Bentin et al., 1996; Rossion et al., 1999) and has a close relationship to FFA activity (Rossion et al., 2003), the weak N170 response revealed an impaired face processing in schizophrenic patients. Interestingly, although the face inversion effect was found to be normal in schizophrenic patients behaviorally, it was absent in the patients for N170 (Tsunoda et al., 2012). Taken together, existing neurophysiological evidence suggests that schizophrenia may cause physiological changes related to face processing. Furthermore, these studies did not report related changes in lower visual cortex or earlier electrophysiological potentials, suggesting that face-related changes may not be a consequence of early visual processing deficits.

To determine whether the deficit in face processing is related to the deficit in early visual processing, we examined both kinds of processing with the same experimental design. We adopted a visual search task, but not a match-to-sample task, which is usually used to examine the face recognition. The match-to-sample task may contain a mnemonic component that was general across stimuli and shown to be impaired in schizophrenia (Lett et al., 2014). Comparatively, the visual search task is more concentrated on the detection and identification of the stimuli. Only first-episode schizophrenic patients were included to avoid the confounding factors of cumulative antipsychotic medication and illness chronicity.

2. Methods

2.1. Participants

Eighteen patients with first-episode schizophrenia (SZ, 9 females, mean age 25.9 ± 5.9 years old) and eighteen age- and gender-matched healthy control participants (HC, 9 females, mean age 25.5 ± 6.4 years old) participated in this study. All participants reported normal or corrected-to-normal vision. Each patient was diagnosed with schizophrenia according to DSM-IV (Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition). None of the patients had a history of any severe medical or neurological disorder. All the patients had been diagnosed with schizophrenia for the first time and received psychiatric treatment no longer than one year before participating the study. Psychiatric symptoms were assessed by a trained psychiatrist or psychologist based on the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987). The Personal and Social Performance scale (PSP) was administered to assess subjects' social functioning; this has been shown to be an acceptable, quick and valid measure (Morosini et al., 2000). The basic demographic and descriptive characteristics of the study participants are shown in Table 1.

The healthy volunteers had no history of any major psychiatric disorders, major physical illnesses, or use of any medication known to affect the central nervous system. The exclusion criteria for both groups also included neurological illness, traumatic brain injury, substance use or addiction. This study was approved by the Institutional Review Board of Guangzhou Brain Hospital. All participants were paid for their participation and provided their informed consent.

2.2. Stimuli and procedures

Subjects sat quietly in a dimly lit room. The visual stimuli were presented on a Dell 19-in. LCD monitor with a spatial resolution of 1024×768 (23.8°× 17.9°visual angle) and a refresh rate of 60 Hz. Subjects viewed the stimuli from a distance of 85 cm. Each participant completed three visual search experiments (Fig. 1). Throughout the experiments, subjects were asked to fixate on a small white cross presented at the center of the monitor.

Table 1
Clinical and demographic characteristics of the patients and healthy controls.

	Patients (n = 18)	Healthy Controls (n = 18)	*t*
Gender (male/ female)	9/ 9	9/ 9	–
Age	25.9 (5.9)	25.5 (6.4)	0.2
Education (years)	12.2 (3.3)	12.0 (2.6)	0.2
Handedness (right/ left)	18/ 0	18/ 0	–
Duration of illness (months)	13.7 (9.6)	–	–
Duration of treatment (days)	58.4 (89.5)	–	–
Antipsychotics drug use (mg)[a]	588.4 (293.7)		
PANSS total	58.9 (8.8)	31.7 (1.2)	13.0*
PANSS positive symptoms	15.1 (3.9)	7.0 (0.0)	8.9*
PANSS negative symptoms	12.2 (3.4)	7.3 (0.5)	6.2*
PANSS general symptoms	31.6 (5.3)	17.4 (1.0)	11.1*
PSP	58.9 (12.1)	89.1 (2.4)	−10.4*

The values in the brackets are standard deviations (SD).
[a] equivalent to Chlorpromazine dosage.
* $p < 0.001$.

2.2.1. Experiment 1

In this experiment, subjects were instructed to search a target triangle among two or four items. The stimuli were hollow regular triangles. The length of each side was 2.47° and 1.38° for the outer side and inner side, respectively. The triangle pointed to one of four directions: upward, downward, left, or right. The target was the triangle that pointed downward, while the others were the distractors. Each trial began with a fixation of a random period within 1000–2000 ms. Subsequently, two or four triangles were presented for 600 ms at two or four possible positions in the visual field. The center of each triangle was 2.47°away from the fixation point. In half of the trials, a target triangle was presented. In the other trials, the target was absent. Subjects were asked to press one of two keys to indicate if there was a target ("n" for present, "m" for absent) as quickly and accurately as possible. Each subject completed six blocks of the experiment. Each block contained 40 trials. The order of the four trials (2 or 4 items × target present or absent) was counterbalanced in each block.

2.2.2. Experiment 2

The task was a search for a specific face identity. Sixty-four faces (thirty-two females) with a neutral expression were selected from the Chinese Facial Affective Picture System (CFAPS) (Gong et al., 2011). The outer parts (hair, ears, and face contour) were excluded and the brightness and RMS contrast were matched via Photoshop. Finally, each face picture extended 1.93°×2.10°. The procedure was very similar to the task of the triangle search. Before each block, one of the faces was presented to the subjects as the target. The rest of them were thus the distractors. Each trial began with the fixation. Then, two or four faces were presented for 600 ms among the four possible positions. Subjects were asked to indicate if the target was presented.

2.2.3. Experiment 3

In this experiment, subjects were asked to search for a happy face among the distractors of neutral faces. Thirty-two happy faces (sixteen females, see Supplemental Materials) were selected from CFAPS, in addition to the sixty-four neutral faces used in Exp2. The targets were the happy faces, while the distractors were the neutral faces. The procedure was similar to Exp1 and Exp2. Subjects were asked to indicate if there was a happy face in each trial. However, it should be noted that no target face was presented in the beginning of the experiment. Instead, the instruction on the screen was "If there's a happy face, press the left button. Otherwise, press the right button." Furthermore, we carefully explained the instruction to the subjects and asked them to practice a few trials to ensure that they fully understood the task.