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Visual self-recognition in patients with schizophrenia

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Abstract

Self-processing is associated with distinct patterns of behavior and neural activity in healthy individuals. Self-monitoring deficits have been reported in schizophrenia in auditory and tactile modalities but it is unknown whether they generalize to all sensory domains. We investigated self-face recognition in patients with schizophrenia, using a visual search paradigm with three types of targets: objects, famous faces and self-faces. Schizophrenic patients showed increased reaction time (RT) for detecting targets overall compared to normal controls but they showed faster RT for self-face compared with the Famous-face condition. For healthy controls, there was no difference between Self- and Famous-face conditions. Thus, visual search for self-face is more efficient than for famous faces and self-face recognition is spared in schizophrenia. These findings suggest that impaired self-processing in schizophrenia may be task-dependent rather than ubiquitous.

Keywords: Schizophrenia; Self-recognition; Self-face; Visual search; Social cognition

1. Introduction

Self-related information enjoys privileged access to our conscious awareness (e.g., "Cocktail party phenomenon"). Past research suggests that self-processing is associated with distinct patterns of behavior and neural activations (Keenan et al., 1999, 2000a, 2001; Platek et al., 2004, 2006; Tong and Nakayama, 1999; Turk et al., 2003; Uddin et al., 2005).

Schizophrenia has been associated with deficits in self-processing. Frith and Done (1988) proposed that a breakdown in the awareness of self-generated actions may result in symptoms of schizophrenia (e.g., auditory hallucination and delusions). Evidence from voice recognition studies supports this theory. Schizophrenic patients have difficulties differentiating their own from other voices and as result, they tend to misidentify their own voices as alien (Allen et al., 2004; McGuire et al., 1995). Impaired self-processing in schizophrenia extends to other domains. Schizophrenic patients have difficulties in discriminating self-generated tactile sensations from those generated by others (Blakemore et al., 2000). In addition, they may experience altered perception of their own bodies (Daprati et al., 1997; Traub and Orbach, 1964).

While there is accumulating evidence for altered self-information processing in schizophrenia from auditory and tactile modalities, surprisingly little is known about their visual self-recognition. Self-face is a very compelling stimulus; people process their own faces more

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efficiently than other faces (Keenan et al., 1999, 2000a; Tong and Nakayama, 1999). For example, RT for detecting self-face is faster than that for stranger faces (Tong and Nakayama, 1999). Furthermore, there may be a specialized neural network for self-face processing (Keenan et al., 2000a,b; Platek et al., 2006; Sugiura et al., 2005). Altered self-face processing in schizotypal individuals has been reported (Platek and Gallup, 2002; Platek et al., 2003). In these studies, healthy individuals showed a right hemisphere advantage for self-face processing but such asymmetry was absent in schizotypal individuals.

The present study investigated visual self-recognition in schizophrenia with a visual search paradigm. Since past research suggests that self-processing is impaired in schizophrenia, we hypothesized that visual self-recognition would be impaired. To control for the fact that self-faces are more familiar than stranger faces, we included famous faces. To control for the fact that faces are more complex than other stimuli, we included objects.

2. Methods

2.1. Participants

Twenty schizophrenic outpatients (11 women; SZ; 14 paranoid subtypes) were recruited from the Outpatient Clinic of Seoul National University Hospital, Korea. All patients met the criteria for schizophrenia of the Diagnostic and Statistical Manual of Mental Disorders-4th edition (DSM-IV) (American Psychiatric Association, 1991) based on the Structured Clinical Interview for DSM-IV (SCID) (First et al., 1997). Nineteen healthy controls (9 women; CO) were recruited through advertisements from the local community. Exclusion criteria for all participants were (1) current substance use, (2) brain injury, (3) neurological disorder and (4) mental retardation. In addition, CO were excluded if they had (1) past or present DSM-IV Axis I or Axis II disorder, or (2) a family history of psychotic illness. The Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987) was used to assess symptoms in SZ. All patients were taking atypical antipsychotic drugs (clozapine, risperidone, quetiapine, amisulpride or olanzapine) at the time of testing. All participants gave written informed consent after a complete description of the procedure was provided and were paid. The Institutional Review Board of Seoul National University Medical College approved the study protocol and consent procedure. See Table 1 for detailed demographic information.

Table 1
Demographic information

	CO (N=19)	SZ (N=21)		
Age	26.4 (2.6)	25.5 (5.1)	$t_{36}=-.8$	NS
Education (years)	15.3 (1.6)	14.2 (1.5)	$t_{36}=2.1$	$p<.05$
SES for participants	3.1 (.6)	2.8 (.4)	$t_{34}=-1.26$	NS
SES for parents	2.9 (.5)	3.0 (.6)	$t_{34}=.28$	NS
Handedness (R/L/B)	19/0/0	17/3/1	($\chi^2=2.1$)	NS
Gender (M/F)	10/9	10/11	($\chi^2=.22$)	NS
Age of onset	21.9 (5.3)	NA		
PANSS total	27.1 (6.0)	NA		
PANSS positive	14.6 (4.9)	NA		
PANSS negative	12.9 (3.9)	NA		

Values are given as mean (SD).
SES (social Economic Status).

2.2. Apparatus

A Macintosh G4 with a 17-inch CRT monitor (Flatron, LG Inc.) was used to present the tasks. Participants were tested individually in a quiet room with normal interior lightning. The unrestricted viewing distance to the monitor was about 50 cm.

2.3. Visual search paradigm

In the visual search task, participants were instructed to detect a target among distractors as quickly and accurately as possible. There were three conditions: Self-face, Famous-face and Object conditions. In all conditions, the stimulus set size varied from 2 to 8 (set 2, 4, and 8). In the Self-face condition, the self-face of each participant was the target to be detected among distractor face images. In the Famous-face condition, the face of a famous actor or actress was the target. In the Self-face and Famous-face conditions, the gender of all images matched the gender of the participant. For example, for female participants, a set of five female faces were used as distractor faces and an image of a famous actress was used as the target in the Famous-face condition. In the Object condition, an image of a ribbon was the target and images of a butterfly were distractors.

2.3.1. Stimuli

There were three types of face images: self-face, famous face, and unfamiliar stranger face. For object stimuli, an image of a ribbon and an image of a butterfly were used. All face images were of Korean women and men. Those faces were presented without hair, facial hair, or any other obvious visual cues against a uniform

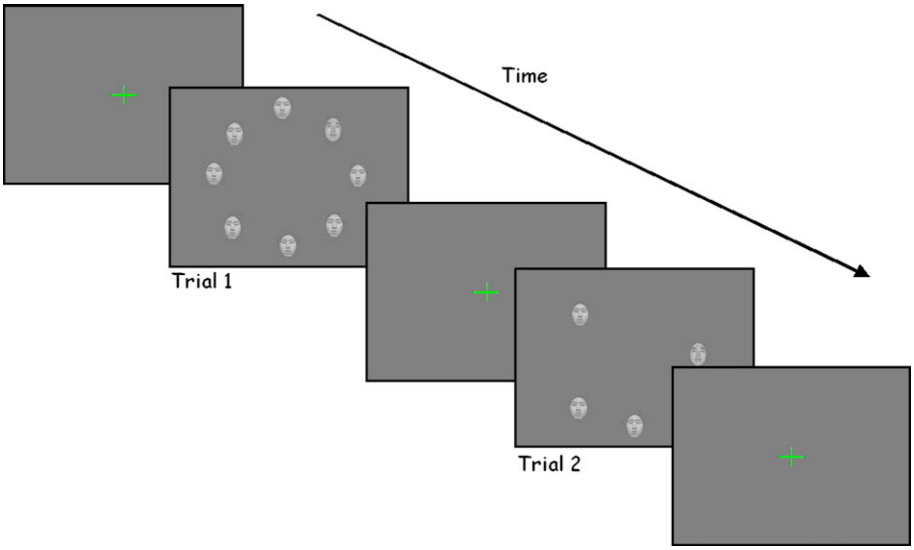

Fig. 1. A schematic diagram of a visual search task. At the beginning of each trial, participants initiated each trial by pressing a space bar when a central fixation point appeared. A fixation point was followed by an array and participants were asked to search for a target (e.g., a front-view image of self) among distractors. An array of stimuli was presented until participants made a response. As soon as they made a response, a fixation point appeared on the screen, indicating that they can proceed to the next trial.

gray background. For self-face, the front-view images of each participant were taken during a separate session prior to the experiment with a digital camera. Face images then were stored with 256 gray-level and cropped so that faces were matched for size and placement within a fixed window size. The famous faces were front-view images of a Korean actor and a Korean actress. The unfamiliar stranger faces consisted of front-view images of six Korean women and six Korean men taken from volunteers at Seoul National and Vanderbilt Universities. The stimulus size was 79×120 pixels.

Table 2
Accuracy(% correct) and RT (ms) for the visual search task

Condition	Set size	Trial type	Accuracy		RT	
			CO	SZ	CO	SZ
Object	Set 2	Target-present	98.5 (2)	98.1 (3.5)	661.8 (139.6)	901.2 (229.9)
		Target-absent	98.9 (2.0)	99.6 (1.0)	705.4 (134.7)	974.3 (332.9)
	Set 4	Target-present	98.7 (2.3)	98.1 (2.7)	648.2 (142.5)	902.2 (273.1)
		Target-absent	99.8 (.7)	99.0 (1.6)	758.6 (163.9)	1125.8 (414.9)
	Set 8	Target-present	97.2 (4.1)	97.8 (3.1)	756.2 (147.4)	1021.9 (291.8)
		Target-absent	99.8 (.8)	99.4 (1.4)	956.9 (219.0)	1327.2 (619.5)
Famous-face	Set 2	Target-present	98.3 (2.9)	97.5 (3.1)	837.7 (160.3)	1044.0 (275.9)
		Target-absent	99.3 (1.8)	99.3 (1.4)	910.8 (164.7)	1207.3 (277.5)
	Set 4	Target-present	98.1 (2.7)	98.8 (2.8)	845.0 (161.7)	1071.3 (277.5)
		Target-absent	100 (0)	99.3 (1.8)	1137.2 (184.6)	1425.1 (475.8)
	Set 8	Target-present	94.1 (6.3)	95.0 (7.3)	1237.9 (301.7)	1505.2 (527.4)
		Target-absent	99.8 (.8)	99.3 (1.4)	1671.7 (272.9)	1946.5 (679.1)
Self-face	Set 2	Target-present	98.7 (2.0)	98.8 (1.9)	877.5 (236.5)	1213.7 (467.3)
		Target-absent	99.6 (1.0)	99.6 (1.0)	896.2 (147.6)	1139.8 (323.3)
	Set 4	Target-present	98.3 (2.8)	98.1 (3.0)	865.3 (183.6)	1357.7 (374.4)
		Target-absent	99.6 (1.6)	99.6 (1.5)	1147.5 (168.5)	1357.7 (374.1)
	Set 8	Target-present	95.5 (5.1)	95.7 (5.2)	1248.6 (239.8)	1463.4 (371.9)
		Target-absent	99.8 (.7)	99.6 (1.0)	1748.5 (323.5)	1847.4 (546.2)

Values are given as mean (SD).

2.3.2. Procedure

The order of three conditions of was counterbalanced across participants. Before participants started each condition, they were shown a target (i.e., self face for Self-face condition, famous face for Famous-face condition, and a ribbon for Object condition) and were instructed to search for the target among distractors as accurately and quickly as possible by pressing yes/no buttons using their index/middle fingers of the dominant hand. A target was present on 50% of the trials. There were 6 practice trials and 180 test trials for each condition.

Participants initiated each trial by pressing a space bar when a central fixation point appeared. Then a stimulus set was presented on the screen and remained on until participants responded by pressing a key. Stimuli were randomly assigned to one of eight possible locations, which formed a circle around the fixation point subtending a visual angle of 8°×8°. All set sizes within trial types occurred with equal frequency and were randomly ordered within a given condition. Participants rested between conditions and each condition took approximately 15 min to complete. See Fig. 1 for further information. Reaction time (RT; ms) and accuracy were recorded. Responses with RT<100 ms were categorized as errors. In addition, the search slope and the slope of RT with respect to the set size were computed for each condition to examine the efficiency of visual search.

3. Results

Repeated-measures ANOVA was performed on RT, search slope, and accuracy, separately, with diagnosis as a between-group variable, and condition (object, famous face, and self face), set size (i.e., set size 2, 4 and 8) and trial type (i.e., target present and target absent) as within-group variables.

Repeated measures ANOVA on RT showed significant main effects of group ($F(1,36)=8.80$, $p<.01$), set size ($F(2,72)=244.70$, $p<.0001$), trial type ($F(1,36)=99.33$, $p<.0001$) and condition ($F(2,72)=87.50$, $p<.0001$) (see Table 2). SZ were slower than CO. Both groups showed longer RT on target-absent trials and with larger set sizes. Both groups were also slower in Self-face and Famous-face condition compared to Object condition. The significant interaction between set size and condition ($F(4,144)=51.29$, $p<.0001$) showed that both groups showed increased RT for target detection as the set size increased, especially with self-face and famous-faces compared with object targets. Significant interaction of condition-by-trial type ($F(2,72)=9.56$, $p<.0001$) showed that both groups were slower in target-absent trials in Famous-face and Self-face conditions compared to Object condition.

Two three-way interactions showed that the search pattern of SZ was different from that of CO. Significant interaction of set size-by-condition-by-group ($F(4,144)= 2.76$, $p=.03$) showed that in the Self-face condition, the set size effect on RT was smaller in SZ than in CO compared to other conditions. In addition, the group difference in RT became smaller in target-absent trials of Self-face condition (condition-by-trial type-by-group interaction, $F(2,72)=4.50$, $p=.01$), due to relatively faster RT of SZ in the Self-face condition compared to other conditions.

Repeated-measures ANOVA on search slope were conducted to examine efficiency of the visual search (see Fig. 2). The main effect of trial type ($F(1,36)=56.62$, $p<.0001$) and the main effect of condition ($F(2,72)=66.10$, $p<.0001$) were significant. Both groups showed smaller search slope in the target-present compared with the target-absent trials, and smaller

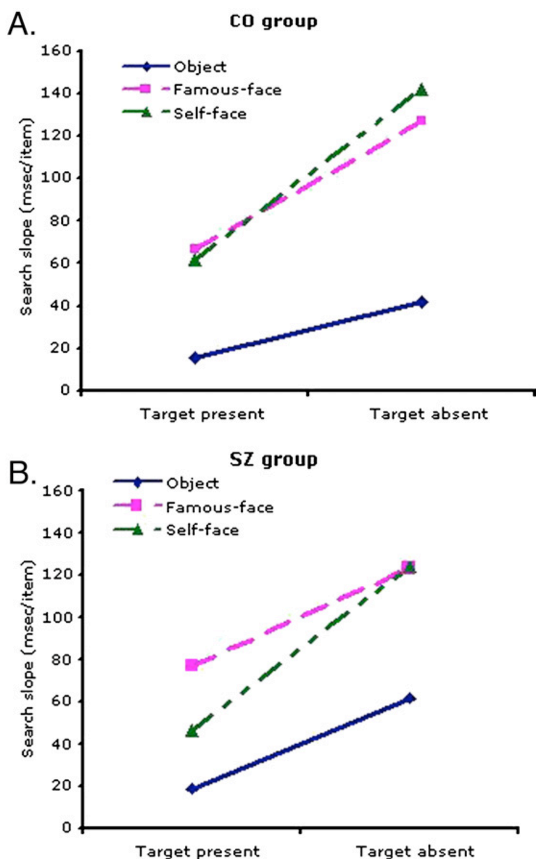

Fig. 2. Mean search slope of healthy controls (CO, A) and patients with schizophrenia groups (SZ, B).

search slope in the Object condition compared with the Self-face and Famous-face conditions. Significant interaction of trial type-by-condition ($F(2,72)=10.81$, $p<.0001$) showed that in both groups difference between the search slopes for the target-present and target-absent trials was increased in Self-face condition compared to Famous-face and Object conditions, due to faster search in the target-present trials of the Self-face condition. Significant interaction of group-by-condition was also significant ($F(2,72)=3.98$, $p<.05$). Group difference became larger in the Self-face condition compared to Object and Famous-face conditions due to reduced search slope of SZ in the Self-face condition (Self condition, $t_{36}=2.03$, $p<.05$, $d=.37$; Famous condition, $t_{36}=-.25$, NS; Object condition, $t_{36}=-.99$, NS). Although post hoc analyses did not reveal significant group difference in the Self-face condition after the Bonferroni correction, the effect size indicates a moderate effect for the Self condition.

Both SZ and CO scored greater than 94% correct in all conditions (Table 2). The main effects of set size ($F(2,72)=12.39$, $p<.001$) and trial type ($F(1,36)=36.26$, $p<.001$) were significant. A significant interaction of set size-by-trial type ($F(2,72)=14.76$, $p<.001$) showed that both groups were less accurate on target-present trials as the set size increased. In addition, both groups showed much less accurate on target-present trials in the Famous-face and Self-face conditions, compared with the Object condition (trial type-by-condition interaction,($F(2,72)=5.36$, $p<.01$). Significant interaction of set size-by-condition ($F(4,144)=3.83$, $p<.01$) showed that the effect of increasing the set size on accuracy was larger in the Self-face and Famous-face conditions compared with the Object condition.

4. Discussion

This study examined visual self-recognition of self in schizophrenia using a visual search paradigm. Overall, SZ showed slower RT in target detection. All subjects showed slower RT as the set size increased and on target-absent trials. More importantly, we did not find evidence for impaired visual self-recognition in schizophrenia.

Previous studies have reported impaired self-processing in SZ in auditory and tactile domains (e.g., Allen et al., 2004; Blakemore et al., 2000; Johns et al., 2001). Moreover, visual self-recognition in schizotypal individuals was found to be abnormal (Platek and Gallup, 2002; Platek et al., 2003). However, we found no compelling evidence for impaired visual self-recognition in schizophrenia. Thus even if SZ have difficulties processing auditory or tactile self-information, self-processing in the visual domain seems intact. Irani et al. (2006) also recently reported that SZ were able to recognize self-face and familiar face as well as control subjects when asked to judge the familiarity of the faces. These findings suggest that impaired self-recognition in SZ may not be present in all modalities.

One's own face is a highly familiar, over-learned object, so it is possible that any advantage of processing self-face over other objects may result from its familiarity, not from its special role. It has also been shown that processing one's own face is not different from processing highly familiar faces on a behavioral level in healthy individuals (e.g., Kircher et al., 2001). To control for familiarity on visual search, we included the Famous-face condition. SZ and CO showed similar search behaviors in the Famous-face condition, suggesting that familiarity of the stimulus has a similar effect on both groups. Thus, the search behavior of SZ in the Self-face condition cannot be solely explained by a potential familiarity effect. CO did not process their own faces differentially from familiar, over-learned famous faces, which is consistent with previous studies. However, when the self-face was the target, the cost of increasing the number of distractors (i.e., slower RT with larger set size), was reduced in SZ, but not in CO. These results suggest that searching one's own face may be different from searching famous face in SZ, but not in CO but this is a very subtle effect.

It is unclear why SZ process self-face differently compared to CO, despite the fact that both groups process famous faces in a similar way. One possible explanation for this altered self-face processing is that SZ in the current study may be hypersensitive to the self-related cues. Majority of SZ in this study were paranoid (14 out of 20 patients). Paranoid schizophrenia SZ may be more accurate (i.e., more sensitive) to facial emotions than non-paranoid SZ and CO (Davis and Gibson, 2000). Paranoid SZ may also have biases towards selecting self-related information from the environment when encountering ambiguous stimuli (Blackwood et al., 2004; Blackwood et al., 2001). Future studies are necessary to investigate the mechanism of self-processing in schizophrenia in relation to clinical symptoms with larger sample size.

In summary, we did not find a significant evidence for impaired visual self-recognition in schizophrenia. But while our main results suggest that self-face processing may not be impaired in schizophrenia, there may be subtle alterations in how they process their own faces. Considering the possibility of a specialized neural network for self-recognition (Keenan et al., 2000b; Platek et al., 2004, 2006), further studies using the brain imaging method may provide us with the underlying neural mechanism of self-recognition in schizophrenia.

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