

Research Article

Different Perceptual Mechanism of Categorizing Emotional Faces in Depression and Schizophrenia

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Abstract

Background: Emotional stimuli affect basic and cognitive operations, such as perception, attention and memory and changes in emotional perception are associated with various mental disorders. Changes in emotional perception are associated with various mental disorders, such as major depressive disorder (MDD) and schizophrenia (SCZ). However, the differences in emotional cognition and their mechanisms among different mental disorders are still unclear. Objective: Different from negative expression processing preferences (attention, memory, etc.), categorizing positive facial expressions are much faster than emotion neutral and negative facial expressions, i.e., positive face classification advantage (PFCA). The present experiment directly investigated the difference in categorizing emotional faces between patients with MDD and SCZ. Main ideas: In healthy controls, happy faces were classified faster than sad faces (i.e., positive face classification advantage, PFCA). Although the ability of expression classification in both MDD and SCZ patients was reduced, the processing patterns of the two groups were different. The PFCA in patients with MDD was similar to that in normal controls. On the contrary, the PFCA was absent in patients with SCZ due to the need to invest more attention resources in classifying a face as happy emotion, suggesting that patients with SCZ have greater obstacles in processing positive facial expressions. Conclusion: The patterns of categorizing emotional faces was different between SCZ and MDD patients, which has important clinical significance for the differential diagnosis of the two diseases and the cognitive evaluation during treatment.

Keywords

Major Depressive Disorder, Schizophrenia, Facial Expression, Positive Face Classification Advantage, Face Perception

1. Introduction

Emotion plays a central role in human decision-making and adaptation. Dysfunction of the emotion regulation system is associated with behavioral problems, including aggressive, addictive and risk-taking behaviors, as well as anxiety and depression [3]. Emotional stimuli affect basic and cognitive

operations, such as perception, attention and memory and changes in emotional perception are associated with various mental disorders [2, 3, 10, 21].

As one of the most serious mental disorders, the face expression processing of patients with schizophrenia (SCZ) is

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the core part of their social cognitive dysfunction. For the face expression recognition disorder in SCZ, the general defect hypothesis was proposed for face or expression processing [5, 20]. Behavioral studies have shown that patients with SCZ have dysfunction in face perception, recognizing facial identity information (i.e. age, gender, etc.) and distinguishing familiar and unfamiliar faces [5, 20, 24]. Different from the symptoms of SCZ, such as absurd thinking and strange behavior, MDD is mainly manifested as low mood, lack of interest, lack of motivation and other symptoms and related to the processing of social stimuli such as facial expressions. The defects in emotion recognition may be the main reason for the negative emotional state and social interaction of individuals [8, 22]. Patients with MDD' preference for emotional information processing may be related to their emotional disorder. Using face matching task, the early studies found that compared with the healthy control group, the correct matching of sad and interested/happy facial expressions was significantly reduced in patients with MDD [17].

To date, although the conclusions are not entirely consistent, an increasing number of studies have directly compared the emotional processing between MDD and SCZ patients [7, 12, 19, 23]. Recently, Wang et al. (2020) compared the emotion-behavior correspondence between MDD and SCZ patients, and found that the correspondence between self-reported likes and behaviors of patients with SCZ was low no matter whether they were ideal or unpopular images, while the emotion-behavior correspondence induced by bad images in patients with MDD was low under the condition of direct stimulus presentation and representation. Under ideal conditions, the defect of emotion-behavior coupling only appears in the presence of a stimulus. This result showed that there are both common and unique patterns of emotional behavior decoupling in MDD and SCZ patients [23]. Moreover, Kramer et al. (2024) investigate the influence of visual contextual information on emotion recognition of ambiguous facial expressions in depression and schizophrenia spectrum disorders and found increased susceptibility to anger-suggesting cues in schizophrenia and to fear-suggesting cues in depression [12].

Interestingly, different from negative expression processing preferences (attention, memory, etc.), studies have shown that categorizing positive facial expressions are much faster than emotion neutral and negative facial expressions (such as sadness, anger, disgust), i.e., positive face classification advantage (PFCA) [13-15]. It is worth noting that this simple selective classification task of PFCA actually reflects a unique mechanism independent of facial expression recognition and memory, that is, face classification is based on visual information similar to all "facial action patterns", regardless of the faces that are generating them, and the facial expression classification process also includes expression attribute extraction [13]. Our recent work showed that, compared with the PFCA in healthy control group, the classification of emotional faces in patients with SCZ was overall slower with lower

accuracy, but there was no obvious PFCA [14, 25]. There have been extensive reports on emotion recognition disorder in MDD, but it mainly focuses on attention, recognition, recognition and other related processes. Our recent study investigated PFCA phenomenon in MDD and found that MDD patients showed PCA similar to the control group [26]. To date, however, there was no direct comparison of facial expression categorization between patients with MDD and SCZ. Therefore, the present study aims to assess the ability of MDD and SCZ patients to accurately categorize facial expressions of emotion, such as happiness and sadness, independent of facial expression recognition and memory.

Hypothesis: Compared to the healthy controls, patients with MDD and SCZ could exhibit varying degrees of PFCA. As mentioned before [26], MDD patients could show PCA similar to the control group, whereas SCZ patients could reveal PFCA reduction.

2. Method

2.1. Participants

Three groups of participants were recruited in the present study with 32 for each, schizophrenic (SCZ; 15 females; 34.6 ± 12.2 y) and depressive patients (MDD; 16 females; 35.2 ± 11.8 y) diagnosed according to DSM-V (Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition) from the 904th Hospital and healthy control participants (15 females; 34.9 ± 12.5 y) from community. The demographic data such as age, gender and the education level were matched among three participant groups ($p > 0.1$).

Duration of illness for each SCZ patient was 8.5 ± 6.1 years, without a history of severe medical disorder or severe neurological disorder, which took the antipsychotic medication of Chlorpromazine equivalent according to medical advice. The Positive and Negative Syndrome Scale (PANSS) showed significant group differences of the scores of positive, negative and general symptoms (13.3, 12.4 and 26.8 for in the SCZ and 7.5, 7.1 and 16.9 in the normal control group, respectively; both p -values < 0.001).

All patients with MDD were single episode and have never been treated, with no co-morbid diagnoses (e.g., anxiety disorder, bipolar disorder, or drug abuse) and no history of suicide attempts. The scores of the 17-item Hamilton Rating Scale for Depression (HRSD-17) were 23.1 and 2.6 for patients with MDD and normal controls, respectively, $p < 0.0001$.

The healthy controls did not take any medication that affects the nervous system, with no history of any major psychiatric disorders or major physical illnesses. This study was approved by the Ethical Committee of the 904th Hospital of PLA and all participants signed the informed consent to participate.

2.2. Stimuli

By changing the distance among facial features and/or the shape of the facial features, we conducted 20 different schematic face models for each face category (Figure 1). There were two blocks (a short break between two blocks) of 120 trials each with 40 neutral, 40 happy, and 40 sad faces. All stimuli were presented randomly at the center of a monitor, with a visual angle of $7.27^\circ \times 6.06^\circ$ [14].

2.3. Procedure

The participants seated in a dimly lit and sound-attenuated cabin and were asked to category happy and sad faces by pressing correspondingly labeled buttons on the keyboard as quickly and correctly as possible, ignoring neutral faces. The labels of the response buttons were counterbalanced across the participants. Each stimulus was presented for 300 ms with an inter-trial interval ranging randomly between 800 ms and 1200 ms post response onset. The participants completed one practice sequence of 30 stimuli, which were not used in the main experiment.

2.4. Data Analysis

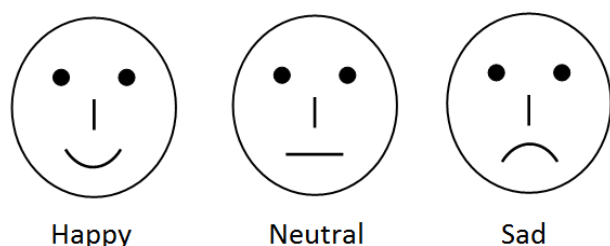


Figure 1. Schematic stimuli used in the present study.

The performance data (RTs and accuracy rates) were analyzed using a two-way analysis of variance (ANOVA) with Expression (happy, sad) as within-subject factors and Group

(controls, MDD and SCZ patients). Degrees of freedom were corrected whenever necessary using the Greenhouse–Geisser epsilon correction factor.

3. Results

Accuracy rates: Across experimental conditions, controls (96.6%) showed higher accuracy rates than SCZ (85.4%) and MDD (89.2%) patients ($F(1, 93) = 8.8$, $p < 0.01$, partial $\eta^2 = 0.198$), with no significant difference for the latter two groups ($p = 0.056$). Neither the main effect of Expression [$F(1, 93) = 1.98$, $p = 0.115$, partial $\eta^2 = 0.101$] nor the two-way interaction of Expression * Group [$F(2, 93) < 1$] reached significant level.

Reaction time: Figure 2 showed the RTs and PFCA size (i.e., $RT_{Sad} - RT_{Happy}$) of classification of emotional faces in controls, MDD and SCZ patients, respectively. The main effect of Group was overall significant, $F(1, 93) = 51.58$, $p < 0.001$, partial $\eta^2 = 0.526$, showing the patients exhibited slowly response speed (877 ms and 781 ms for MDD and SCZ patients, respectively; $p = 0.255$) than controls (667 ms; both p -values < 0.01). The main effect of Expression was significant, $F(1, 93) = 74.74$, $p < 0.001$, partial $\eta^2 = 0.446$, showing that the happy faces were categorized by expressions more quickly (743 ms) than sad (807 ms) face, i.e., PFCA (positive face classification advantage). The two-way interaction of Expression * Group was also significant, $F(2, 93) = 17.04$, $p < 0.001$, partial $\eta^2 = 0.268$, and further post-hoc analysis showed that the PFCA was evident for MDD ($RT_{Sad} - RT_{Happy}$: 90 ms; $p < 0.01$) and controls (82 ms; $p < 0.01$) but not for patients with SCZ (21 ms; $p = 0.822$). Actually, the PFCA size was similar between MDD and controls ($p = 0.881$). Moreover, for happy face, the controls exhibited quickly response speed (626 ms) than did patients with MDD (736 ms; $p < 0.001$), the latter was faster than patients with SCZ (866 ms; $p < 0.001$); for sad faces, although the controls exhibited quickly response speed (708 ms) than did patients with MDD (826 ms; $p < 0.001$), the response speed in patients with SCZ (887 ms) did not significantly differ for patients with MDD ($p = 0.087$), respectively.

Table 1. The behavioral performance of classification of emotional faces in controls, MDD and SCZ patients, respectively.

		Controls	SCZ	MDD
RTs (ms)	Happy faces	626	866	736
	Sad faces	708	887	826
	PFCA size	82	11	90
Accuracy (%)	Happy faces	98.0	87.5	89.9
	Sad faces	95.2	85.4	88.3

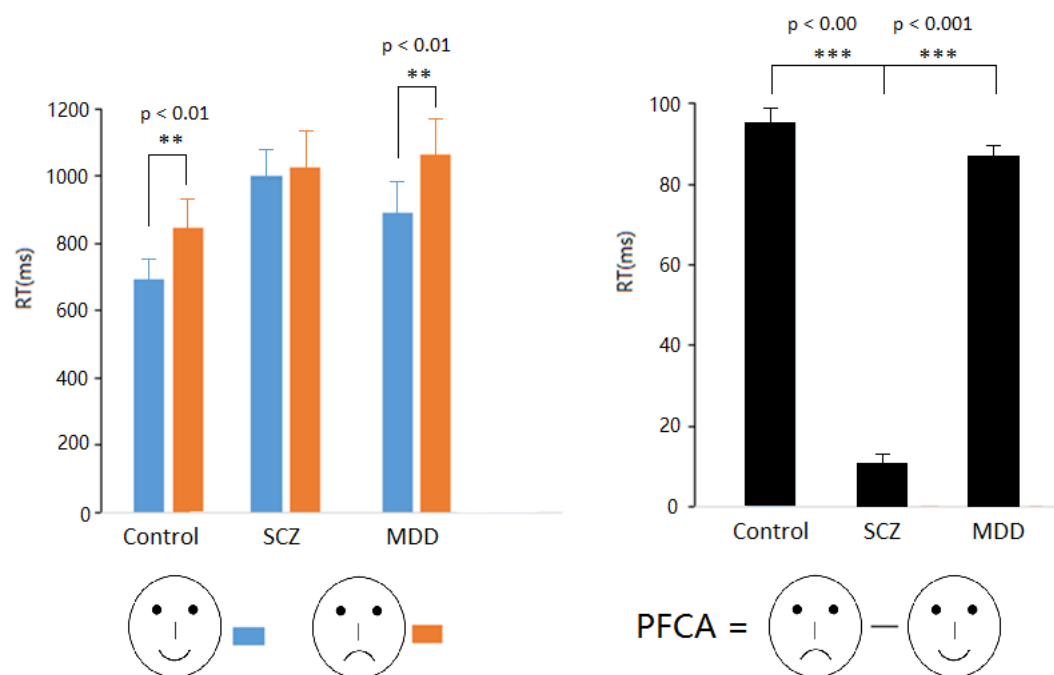


Figure 2. The RTs and PFCA size (RT_{sad} minus RT_{happy} with error bars of SE) of classification of emotional faces in controls, MDD and SCZ patients, respectively.

4. Discussion

To our knowledge very few studies have compared directly facial classification by expressions between MDD and SCZ patients. Based on the analysis of the reaction times (RTs), in line with the previous studies [14], we found that in healthy controls, happy faces were classified faster than sad faces (i.e., PFCA). Although the two groups of patients generally showed the disorder of expression classification with slow reaction speed and low accuracy, the PFCA effect of patients with SCZ disappeared, indicating that there was a significant positive expression explicit classification processing disorder, while the patients with MDD had a similar reaction pattern of expression classification as the healthy control group (compared with the control group, there was no group difference in PFCA effect).

Previous evidence has shown that patients with SCZ have serious obstacles in face emotion recognition [1, 16, 20]. In the present study, interestingly, although overall the classification of emotional faces in patients with SCZ was dysfunction, the PFCA was absent, suggesting a significant expression processing disorder. Further analysis showed that the group differences of happy expressions were more significant than that of sad expressions, indicating that the disappearance of PFCA in patients with SCZ was mainly caused by the slower classification of happy faces, rather than the faster response to sad faces. That is, patients with SCZ need to invest more attention resources in classifying a face as happy emotion, indicating that patients with SCZ have greater ob-

stacles in processing positive facial expressions. However, previous studies have shown that the recognition of positive emotional expressions in patients with SCZ is similar to that of normal people, but there is damage to the recognition of negative emotional expressions, that is, negative emotional specificity dysfunction [4, 7, 18-19]. For example, Mioni et al. (2018) asked patients with SCZ to classify happy, sad and neutral facial expression pictures, and found that the classification of negative emotions was related to the cognitive and clinical symptoms of patients with SCZ, suggesting that patients with SCZ had different channels for recognition and processing of positive and negative emotional facial expressions [18]. In fact, the negative emotion specific impairment of patients with SCZ is mainly based on the recognition and memory process of facial expression. The PFCA phenomenon in this study reflects the simple classification processing of facial expression which is different from recognition and memory, and the top-down processing based on experience which is mainly based on the common feature attribute template [13-15]. This may be the main reason why the results of this study are different from those of previous studies.

Using the task of simple expression classification, although the cognitive ability of facial expression classification decreased (slower response speed and lower accuracy), the response pattern of expression classification in depression was similar to that in healthy controls, with no negative cognitive tendency in the process of facial expression. Similar to the results of this study, Karparova et al. (2005) found that the overall sensitivity of patients with MDD to emotion related stimuli decreased, and there would be general damage in decoding facial expressions, regardless of the type of emotion

[9]. Therefore, the increased reaction time and / or error rate of facial expression classification in patients with MDD may reflect the more common perceptual motor deficits in facial expression processing. Actually, brain regions related to emotion processing could be different among affective disorders. For example, there was evidence that schizophrenic patients showed decreased emotion recognition abilities and less frontal cortex usage compared with bipolar patients using the parietal lobe to compensate for facial emotion recognition [7].

Before reaching a conclusion, we need to reiterate several limitation points. First of all, this study mainly explored the expression categorization of patients with schizophrenia and depression. In the future research, we will expand the research participants, especially based on the characteristics of bipolar disorder, and systematically investigate the characteristics and mechanism of expression processing of schizophrenia, depression and bipolar disorder, and establish objective indicators for effective differentiation, differential diagnosis and cognitive evaluation. In addition, due to various influencing factors of mental illness (such as gender, age and disease sub-type), we will expand the sample size in future research, pay attention to the characteristics of disease classification, stage and comorbidity, and systematically explore the influence and mechanism of various factors. Finally, the present MDD patients were a first-episode patient who did not take medication, while SCZ patients took the antipsychotic medication of Chlorpromazine equivalent according to medical advice. Therefore, the first-episode SCZ patients without taking medicine will be explored in the future and it is also necessary to investigate the influence of antipsychotic medication on the emotional processing.

In addition, the positive expression categorization advantage holds significant implications for social behavior and personality. For example, a strong PFCA could reflect high emotional intelligence, including the ability to recognize, understand, and regulate one's own and others' emotions [11]. The ability to categorize and express positive emotions effectively can aid in conflict resolution by promoting empathy, understanding, and constructive dialogue among group members [6]. Moreover, examining how the positive expression categorization advantage varies across different cultures can also provide insights into cultural norms and socialization practices that influence emotional expression and social behavior. Therefore, future research should continue to explore these implications across diverse cultural contexts and social behavior and personality to gain a more comprehensive understanding of how positive expressions influence our social lives.

In sum, the present study directly investigated the difference of categorizing emotional faces between patients with MDD and SCZ. Patients with SCZ have significant explicit classification processing disorder, i.e., the absence of PFCA, which is due to the need to invest more attention resources in classifying a face as happy emotion, suggesting that patients

with SCZ have greater obstacles in processing positive facial expressions. On the contrary, although their expression classification was delayed, the PFCA in patients with MDD was similar to that in healthy controls, suggesting that the reduced expression classification may be due to the common perceptual motor deficits in patients with MDD. The different patterns of categorizing emotional faces has important clinical significance for the differential diagnosis of the two diseases and the cognitive evaluation during treatment.

Article Highlights

- 1) Investigating categorizing emotional faces between MDD and SCZ patients.
- 2) The emotion classification in patients with MDD was similar to that in normal controls.
- 3) There was the dysfunction of emotion classification in patients with SCZ.

Abbreviations

MDD	Major Depressive Disorder
PFCA	Positive Face Classification Advantage
SCZ	Schizophrenia

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Data Availability Statement

The data that support the findings of this study are available from the 904th Hospital, but restrictions apply to the availability of these data, which were used under licence for the current study and so are not publicly available. The data are, however, available from the authors upon reasonable request and with the permission of the 904th Hospital.

Conflicts of Interest

The authors declare no conflicts of interest.

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