Schizophrenia Research 134 (2012) 95–100

Contents lists available at ScienceDirect

Schizophrenia Research

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

Distinct facial processing in schizophrenia and schizoaffective disorders

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ARTICLE INFO

Article history:
Received 6 May 2011
Received in revised form 27 July 2011
Accepted 1 August 2011
Available online 24 August 2011

Keywords:
Face
Schizophrenic
Visual
Cognitive
Mood disorder

ABSTRACT

Although schizophrenia and schizoaffective disorders have both similar and differing clinical features, it is not well understood whether similar or differing pathophysiological processes mediate patients' cognitive functions. Using psychophysical methods, this study compared the performances of schizophrenia (SZ) patients, patients with schizoaffective disorder (SA), and a healthy control group in two face-related cognitive tasks: emotion discrimination, which tested perception of facial affect, and identity discrimination, which tested perception of non-affective facial features. Compared to healthy controls, SZ patients, but not SA patients, exhibited deficient performance in both fear and happiness discrimination, as well as identity discrimination. SZ patients, but not SA patients, also showed impaired performance in a theory-of-mind task for which emotional expressions are identified based upon the eye regions of face images. This pattern of results suggests distinct processing of face information in schizophrenia and schizoaffective disorders.

1. Introduction

Schizophrenia (SZ) and schizoaffective disorder (SA) are two diagnoses within the psychotic disorder spectrum. It has been long debated whether similar or differing pathophysiological processes underlie schizophrenia and schizoaffective disorder, and more broadly, whether these diagnoses represent a single disorder or two distinct disorders. Evidence supporting the notion of a single disorder emerges from both electrophysiological and cognitive studies, where similar deficits in some aspects of cortical response and cognitive performance were found in both patient groups (Fiszdon et al., 2007; Hooper et al., 2010; Mathalon et al., 2010). On the other hand, these and other studies also found differential deficits in other aspects of electrophysiological and cognitive responses between patients with SZ and with SA, supporting the notion of two distinct disorders (Stip et al., 1999; Mathalon et al., 2010). It appears that some pathophysiological and cognitive mechanisms overlap in the two disorders while others do not. Thus, identifying the pathophysiological and cognitive processes that distinguish schizophrenia and schizoaffective patients may provide new insights into the relationship between the two psychotic diagnoses.

At the phenomenological level, schizoaffective disorder is associated with prominent mood abnormalities (mania and/or depression) whereas schizophrenia is not. An interesting but poorly explored question is whether the differing clinical abnormalities in these two disorders are related to their cognitive ability to process affective vs. non-affective information. Previous studies have found that the processing of facial emotional stimuli is impaired in schizophrenia (Walker et al., 1984; Heimberg et al., 1992; Green et al., 2009; Norton et al., 2009). Because these studies combined patients with SA and SZ into a single group, the findings allow no inference about whether and how clinical abnormalities and impairments in the processing of external emotion information may be related in each of the psychotic disorders.

In this context, comparative studies in the facial processing domain may provide empirical opportunities for distinguishing the cognitive processes involved in schizophrenia and schizoaffective disorder. Using psychophysical methods, this study examined facial emotion discrimination in patients with SZ or SA. This study also included a facial identity discrimination task as a non-emotion comparison and the Eyes Test as a measure of Theory of Mind (Baron-Cohen et al., 2001). To establish the relevance to differing clinical variations between the two diagnoses, the perceptual responses to affective and non-affective facial signals were compared with symptom scales (PANSS) (Kay et al., 1987).

2. Methods

2.1. Subjects

The sample included schizophrenia (SZ) patients, patients with schizoaffective disorder (SA), and healthy controls (HC). The inclusion criteria for subjects were that they: 1) be between 18–65 years old, 2) have no history of drug or alcohol abuse in the six months prior to

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0920-9964/$ – see front matter
doi:10.1016/j.schres.2011.08.001

participation, 3) have no neurological problems such as seizure, stroke or major head injury, and 4) have an IQ>70.

Patients were recruited from McLean Hospital as well as the Greater Boston area. They were diagnosed using the SCID-IV (First et al., 2002b) by independent clinicians who were blind to the purposes of the study, and using all available medical records. Patients with SA had a chronic psychotic illness but were not in an acute mood episode at the time of participating in this study. The strategy of avoiding confounds of acute mood states allowed this study to focus on the trait-related abnormalities which are more closely linked to the underlying pathophysiology of the disorder. The clinical assessment of these patients is summarized in Table 1.

Healthy controls were recruited by posting advertisements in the local community. They were screened for exclusion of psychiatric illness using the SCID (NP version) (First et al., 2002a).

The verbal component of the WAIS-R (Wechsler, 1981) was administered to all subjects as a measure of general intelligence. This sample represents a group of subjects who participated in two previous studies with this research group (Chen et al., 2009; Norton et al., 2009). Demographic information of the sample is presented in Table 2.

2.2. Procedure

The procedure included the administration of two psychophysical tasks — emotion discrimination (Norton et al., 2009) and identity discrimination (Chen et al., 2009) — and of one standardized cognitive task known as the Eyes Test (Baron-Cohen et al., 2001).

2.3. Emotion discrimination

The targets were face images generated from the NimStim Face Stimulus Set (Tottenham et al., 2009). The images contained various intensities of happy or fearful expressions, ranging from a neutral expression to a highly emotive one. The variation of emotion intensity was achieved by morphing between a facial image with a highly emotive expression (extreme happiness or extreme fearfulness) and one with a neutral expression. Morphing was done using FantaMorphPro 1.0 (2007) (Abrosoft Co.). Images were cropped to minimize the presence of hair and other non-face information. The extent to which an image contained information from the emotionally salient face (i.e. 100% emotional) was considered the emotional signal strength.

The task was to indicate which of two sequentially presented face images, one with a specific emotional intensity and the other with a neutral expression, was either happier or more fearful (Fig. 1A). The time interval between two presentations was 500 ms. The critical measure was the just noticeable difference (JND) between the emotional and neutral faces at which subjects performed at the criterion of 80% correct. This JND can be extracted from a psychometric function of the percent-correct scores, and is defined as the perceptual discrimination threshold (Chen et al., 2005). The order in which the neutral and emotive images were presented was randomized. A two-alternative-forced-choice procedure was utilized to eliminate subjective bias in participants' responses. The presentation of the face images was blocked such that a given session contained only one type of emotion (e.g. happiness). In each testing session, eight trials were repeated for each of the six emotion intensity levels (0, 6, 12, 24, 48, or 100%). There were four testing sessions in total: two identities (male and female) × two emotions (fear and happiness), which were presented in quasi-random order among subjects. The data derived from all emotional intensity conditions including 0% were used for threshold calculations. The 0% emotion intensity data were not used for accuracy analyses, since this condition compares two identical images, and is invalid as an accuracy measure. Accuracy was analyzed using mixed-model 3 (group: SA, SZ and HC) × 5 (emotion intensity level: 6, 12, 24, 48 and 100%) ANOVA. Separate ANOVAs were used for the two emotion conditions — one for fear discrimination and one for happiness discrimination. Thresholds were analyzed first using ANOVAs and further using Student's *t*-tests.

Table 1
Comparison of clinical characteristics between schizophrenia and schizoaffective groups.

	SZ (n = 19)	SA (n = 15)
Positive Symptom Subscale Scores[a]	15.3 (5.8)	16.2 (7.1)
Negative Symptom Subscale Scores[a*]	19.3 (8.4)	13.0 (4.9)
General Psychopathology Scores[a]	31.8 (7.9)	29.9 (5.7)
Illness duration (year)	18.1 (10.8)	15.3 (10.3)
Antipsychotic dose (mg)[b]	563.5 (339.6)	546.3 (372.3)
Proportion taking antidepressants (%)	42.1	60.0

*Two groups differ significantly ($p<0.05$).
[a] Based upon the PANSS scale (Kay et al., 1987).
[b] Calculated from chlorpromazine equivalent (Woods, 2003).

Table 2
Summary of demographic information of the sample.

Group	Sex (M—male, F—female)	Age (year)	Verbal IQ*	Education (year)
Schizophrenia (n = 19)	M = 11 F = 8	42.6 (9.4)	93.9 (10.9)	12.6 (2.3)
Schizoaffective (n = 15)	M = 7 F = 8	38.9 (10.9)	103.4 (12.9)	15.3 (2.5)
Healthy control (n = 30)	M = 13 F = 17	41.0 (14.4)	110.4 (9.0)	14.1 (3.0)

*Groups differ significantly ($p<0.001$).

2.4. Identity discrimination

The targets were face images with neutral expressions, either the original images of two individuals or images morphed between them (Fig. 1B). Morphing for identity discrimination was done using the software program *Morph (Version 1.0)* (1992) San Diego, CA: Gryphon Software.

The task was to determine which of two simultaneously presented face images was identical to a face image presented immediately prior. Each trial contained two presentations. The first presentation contained a single face image, while the second contained two face images side by side: one of which was identical to that of the first presentation, the other differing from it by varying degrees. The time interval between two presentations was 500 ms. During the testing session, sixteen trials were used for each of the five facial identity difference levels (5, 10, 20, 40, or 100%) and were distributed in a random order. The critical measure for identity discrimination was the just noticeable difference (JND) between the two comparison face images at which performance reached the criterion of 80% correct, which was extracted from the same psychometric function used in emotion discrimination. Accuracy was analyzed using mixed-model 3 (group: SA, SZ and HC) × 5 (facial difference level: 5, 10, 20, 40 and 100%) ANOVA. Perceptual thresholds of the groups were analyzed using Student's *t*-tests.

2.5. Eyes Test

This is a widely used cognitive task which measures a person's capacity to discriminate the mental states of others, or Theory of Mind, based on expressions in the eye region of the face (Baron-Cohen et al., 2001). The targets were 36 images of actors' and actress's eyes depicting different types of emotions. The task was to view each of the serially presented images and select for each image which of four accompanying words best described the emotion that was being conveyed. Performance was measured by the proportion of the correct