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Happy facial expression processing with different social interaction cues: An fMRI study of individuals with schizotypal personality traits

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ABSTRACT

In daily life facial expressions change rapidly and the direction of change provides important clues about social interaction. The aim of conducting this study was to elucidate the dynamic happy facial expression processing with different social interaction cues in individuals with (n = 14) and without (n = 14) schizotypal personality disorder (SPD) traits. Using functional magnetic resonance imaging (fMRI), dynamic happy facial expression processing was examined by presenting video clips depicting happiness appearing and disappearing under happiness inducing ('praise') or reducing ('blame') interaction cues. The happiness appearing condition consistently elicited more brain activations than the happiness disappearing condition in the posterior cingulate bilaterally in all participants. Further analyses showed that the SPD group was less deactivated than the non-SPD group in the right anterior cingulate cortex in the happiness appearing–disappearing contrast. The SPD group deactivated more than the non-SPD group in the left posterior cingulate and right superior temporal gyrus in the praise–blame contrast. Moreover, the incongruence of cues and facial expression activated the frontal–thalamus–caudate–parietal network, which is involved in emotion recognition and conflict resolution. These results shed light on the neural basis of social interaction deficits in individuals with schizotypal personality traits.

1. Introduction

Central to successful social interaction is the understanding of and responding to social stimuli embedded in the environmental context. Impaired understanding and responding to social stimuli was found in patients with schizophrenia (Maat et al., 2012; Smith et al., 2012), especially those with a first episode of psychosis (Achim et al., 2012). As part of schizophrenia spectrum disorders, individuals with schizotypal personality disorder (SPD) display similar yet attenuated difficulties (Abbott and Green, 2012; H.J. Li et al., 2012; Roddy et al., 2012; Shi et al., 2012; Zong et al., 2010). In particular, Chan et al. (2012b) showed that individuals with SPD traits have deficits of hedonic capacity both physically and socially as compared to healthy controls. The reduced hedonic capacity is related to problems in the temporal experience of pleasure (Chan et al., 2012a). One of the social stimuli that provide pleasure information is happy facial expression (Wittfoth et al., 2010). Elucidating the neural mechanism of happy facial expression processing in the context of different social interaction cues in individuals with SPD may advance understanding of social cognition in schizophrenia spectrum disorders. In this study, we investigated the neural responses of individuals with and without SPD traits when they process dynamic happy facial expressions under different social interaction cues.

Although facial displays of emotion are dynamic in nature, most studies have primarily examined emotion identification or recognition through a series of static and categorized facial expression photographs (Gur et al., 2007; Kohler et al., 2010; Lee et al., 2010; Loughead et al., 2008). The use of static emotional expressions may undermine the ecological validity of the emotion-processing tasks in these studies (McDonald et al., 2011; Platt et al., 2010; Sato and Yoshikawa, 2007b).

Abbreviations: fMRI, functional Magnetic Resonance Imaging; SPD, schizotypal personality disorder; SPQ, schizotypal personality questionnaire; EPI, echoplanar imaging; TR, repetition time; TE, echo time; FOV, field of view; MP-RAGE, magnetization-prepared rapid gradient-echo imaging; SPM, Statistical Parametric Mapping software; A, happiness appearing; D, happiness disappearing; P, praise context; B, blame context; ROI, region of interest; ACC, anterior cingulate cortex; PCC, posterior cingulate cortex; THA, thalamus; CN, caudate nucleus; IFG, inferior frontal gyrus; REST, Resting-State fMRI Data Analysis Toolkit; STG, superior temporal gyrus; BOLD, blood-oxygen-level-dependent; MNI, Montréal Neurological Institute.

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Recent studies have shown that dynamic displays of emotion have more expressivity compared to that of static emotion stimuli, as indicated by electromyographic (Rymarczyk et al., 2011) and behavioral data (Sato and Yoshikawa, 2007a). The underlying mechanism of this facilitation relates to enhanced activation in visual areas (Recio et al., 2011), and to the emotion properties of dynamic facial expressions (Fujimura and Suzuki, 2010). Notably, static and dynamic facial expressions may differ in their neural substrates (Johnston et al., 2010; Pitcher et al., 2011) and dynamic information exchange may occur in multi-modal emotion communication (Regenbogen et al., 2012).

Among emotions, positive affect such as happiness serves as a source of information for judging meanings (Hicks et al., 2010). Examining the neural correlates of happy facial expression processing may increase our understanding of the neural system associated with the pursuit of happiness. In a previous review, Kringelbach and Berridge (2009) suggested that the neural network associated with happiness pursuit is composed of the orbitofrontal cortex, cingulate cortex, insula, amygdala, ventral pallidum, nucleus accumbens, ventral tegmentum area and hypothalamus. A voxel-based meta-analysis has provided convergent evidence for the neural correlates of happiness including the right superior temporal gyrus, left anterior cingulate cortex, left insula and left thalamus (Vytal and Hamann, 2010). Moreover, recent findings also implicate the frontostriatal neural network in happiness experience and perception. For example, the experience of happiness was associated with activities in the right frontal lobes, nucleus accumbens/ventral striatum and prefrontal cortex (Sharpley and Bitsika, 2010). Additionally, the offset of happy and onset of angry expressions show common activations in the orbitofrontal cortex bilaterally, the left amygdala and the left insula, while the onset of happy and the offset of angry expressions show common activations in the left dorsal striatum (Muhlberger et al., 2010).

The frontostriatal network associated with happiness provides insights into anhedonia, an inability to experience pleasure. Anhedonia can manifest in depression. Depressed individuals show a negative correlation between their depression severity and activation of the right fusiform gyri in response to happy facial expressions, while healthy individuals demonstrate linear increases in response to expressions of increasing happiness in the bilateral fusiform gyri and right putamen (Surguladze et al., 2005). Individuals with anhedonia in social interaction show less neural activity in facial expression discrimination regions such as the medial prefrontal cortex, the right superior temporal gyrus, and the left somatosensory cortex (Germine et al., 2011). Strong relationship was found among SPD traits, depressed mood and their poor social function (McCleery et al., 2012). Interpersonal aspects of SPD (particularly social anxiety) have also been associated with reduced accuracy on the facial expression recognition task (Abbott and Green, 2012). Moreover, individuals with SPD reported less pleasant affect compared with psychometrically defined controls and even stable schizophrenia patients (Cohen et al., 2012). Therefore, the current study aimed to investigate the neural activity of these at-risk individuals with social interaction difficulties when they process the dynamic happy facial expression.

Real-life scenarios are usually more complicated than simply decoding the emotion of facial expressions in an artificial laboratory environment. Facial expressions are typically decoded with various social cues that involve reciprocity with sensory inputs. Thus, in the current study, we used a dyadic conversation consisting of a question and a dynamic facial expression as a response to provide social interaction cues. We attempted to investigate the dynamic happy facial expression processing within social interaction contexts in people with and without schizotypal personality traits.

The neural activities underlying the congruence between expressed emotions and the social cues have received increased attention. When the self-expressed happy emotion is congruent with the observed others' emotion state, the medial orbitofrontal cortex and ventromedial prefrontal cortex, which have been associated with positive feelings and reward, are activated. In contrast, incongruent emotional states activate the dorsolateral prefrontal cortex and the posterior superior temporal gyrus (Kuhn et al., 2011). Moreover, incongruence of emotion valence in audiovisual integration activates a frontal–cingulate–parietal network (Muller et al., 2011). However, social cues in previous studies õseldom involved the social interaction component, which is the most common situation in our daily lives. Dyadic conversation is the simplest form of social interaction (Huang et al., 2009a, 2009b). Very little is known about the neural responses of dynamic happy facial expression processing with social cues in the dyadic conversation context. In this study, we first examined the general neural responses to a dynamic happy facial expression with social cues in a dyadic conversation context. Without social cues, happiness appearing on a neutral face will signify pleasure while happiness disappearing from a happy face would signify displeasure or disappointment. Based upon previous studies on the neural basis of happiness (Kringelbach and Berridge, 2009; Muhlberger et al., 2010; Sharpley and Bitsika, 2010; Vytal and Hamann, 2010), we hypothesized that 1) happiness appearing and disappearing will have both overlapping and distinct neural network, 2) the social interaction cues would influence the activation of regions associated with happiness processing, 3) brain areas associated with emotion–cue conflict resolution would be activated when the dynamic happy facial expression is incongruent with the cues in dyadic conversations. We then examined whether individuals with SPD traits demonstrated a different neural mechanism when compared to individuals without SPD traits. Given the similarity between SPD and schizophrenia, we hypothesized that compared to the psychometrically defined control (non-SPD) group, the SPD group would show different neural activities when processing happiness and incongruence with different social interaction cues.

2. Materials and method

2.1. Pilot study

We first conducted a pilot study to ensure the validity of the facial expressions and social cues in dyadic conversation. After providing written informed consent, 20 healthy volunteers (13 female; age M = 22.85, s.d. = 3.0) participated in the pilot study. They had to perform an emotion recognition task by selecting a label from 'happy', 'angry', 'fearful', 'neutral', and 'sad' below each facial expression. The happy and neutral facial expressions taken from 20 psychology graduates were subjected to emotion recognition. The happy and neutral images with the highest recognition accuracy in the pilot study were selected to be linearly morphed into video clips, which were used in the fMRI study. The subjects were also asked to rate the valence of the facial expressions and the valence of questions with 'blame' and 'praise' contents from 1 (most happy) to 5 (most angry). The questions with the most consistent ratings were selected for the dyadic conversations.

2.2. Subjects for fMRI study

Before the fMRI study, a large scale psychological investigation was conducted in the university and the community to assess the SPD trait in Chinese adults. This investigation has been reported earlier (Chan et al., 2011, 2012b; Shi et al., 2012). In this investigation, the score range and mean score of SPQ in general adult population were [Range: 1–64; Mean: 26.46]. For the purpose of this study, we used the Chinese version of the Schizotypy Personality Questionnaire (SPQ) (Chen et al., 1997). According to the scoring criteria suggested by Raine (1991), subjects whose scores were in the top 10th percentile of the score distribution were considered as individuals with SPD traits and subjects whose scores were in the lowest 50th percentile were considered as without SPD traits, i.e. psychometrically defined non-SPD group. In total, 14 individuals with SPD traits (7 males; age M = 22.3, s.d. = 2.1; SPQ score mean: 45.79 ± 1.84) and 14 individuals without SPD traits (8 males; age: 20.7 ± 0.46 years; SPQ mean score: