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Affective processing in positive schizotypy: Loose control of social-emotional information

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ABSTRACT

Behavioral studies suggested heightened impact of emotionally laden perceptual input in schizophrenia spectrum disorders, in particular in patients with prominent positive symptoms. De-coupling of prefrontal and posterior cortices during stimulus processing, which is related to loosening of control of the prefrontal cortex over incoming affectively laden information, may underlie this abnormality. Pre-selected groups of individuals with low versus high positive schizotypy (lower and upper quartile of a large screening sample) were tested. During exposure to auditory displays of strong emotions (anger, sadness, cheerfulness), individuals with elevated levels of positive schizotypal symptoms showed lesser prefrontal–posterior coupling (EEG coherence) than their symptom-free counterparts (right hemisphere). This applied to negative emotions in particular and was most pronounced during confrontation with anger. The findings indicate a link between positive symptoms and a heightened impact particularly of threatening emotionally laden stimuli which might lead to exacerbation of positive symptoms and inappropriate behavior in interpersonal situations.

1. Introduction

Proper processing of social-emotional information is essential for emotion communication, adaptive social behavior, and normal social relationships (Hobson, 1993; Izard, 2001; Keltner & Kring, 1998). Difficulties in social-emotional processing are a core feature of several psychopathologies including schizophrenia (Kring & Elis, 2013). The majority of research on affective processing in schizophrenia has been focused on difficulties in accurately identifying other people's emotional expressions (see Kohler, Walker, Martin, Healy, & Moberg, 2010 for review). So far, only little research has addressed abnormalities in the degree to which individuals are affected by social-emotional information. Exploring the brain processes underlying social-emotional information processing allows to explore subtle or transient features that are difficult to capture with self-report or behavioral observation (Allen, Kuppens, & Sheeber, 2012; McPartland & Pelphrey, 2012). A potentially relevant mechanism in this context, which was explored in the present study, may be de-coupling of prefrontal and posterior cortices during stimulus processing.

It has been proposed that patients with schizophrenia may have an impaired ability to control the influence of social-emotional input on their perceptions, judgments, behavior, and own affective states and that this may in part explain impairments in patients' social functioning (Hooker et al., 2011; Mujica-Parodi, Corcoran, Greenberg, Sackeim, & Malaspina, 2002). Evidence for this has been provided, for instance, by priming studies demonstrating an exaggerated influence of negatively valenced affective primes on subsequent emotional or social judgments of facial stimuli in patients with schizophrenia compared to healthy controls (Hooker et al., 2011; Höschel & Irle, 2001; Suslow, Roestel, & Arolt, 2003). The extent of the priming effect by negative emotional information was positively correlated with the patients' levels of positive schizophrenic symptoms (Hooker et al., 2011). Patients with schizophrenia, in particular patients with prominent positive symptoms (Alba-Ferrera, de Erausquin, Hirnstein, Weis, & Hausmann, 2013) were also found to be more susceptible to interfering incidental emotional prosody processing than healthy controls (Alba-Ferrera et al., 2013; Roux, Christophe, & Passerieux, 2010). Moreover, patients with schizophrenia self-rated their susceptibility to emotional contagion with negative emotions in everyday life higher than healthy individuals (Falkenberg, Bartels, & Wild, 2008). Taken together, these findings are compatible with the view that the brain configuration of individuals with schizophrenia may leave them less protected from becoming affected by emotional input.

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Positive schizotypy refers to traits such as odd beliefs and perceptual disturbances that are similar to positive symptoms in schizophrenia, however, these symptoms are not as profound as those found in individuals with schizophrenia (Meehl, 1962; Raine, 2006). Several authors supported the notion that psychometric measures of schizotypy including the positive symptoms scale of the Schizotypal Personality Questionnaire (SPQ; Raine, 1991) indicate vulnerability to schizophrenia and related psychopathology (Barrantes-Vidal et al., 2013; Chapman, Chapman, Kwapil, Eckblad, & Zinser, 1994; Gooding, Tallent, & Matts, 2005; Horan, Reise, Subotnik, Ventura, & Nuechterlein, 2008; Lenzenweger & Loranger, 1989; Vollema, Sitskoorn, Apples, & Kahn, 2002). Research with individuals at risk avoids many confounds associated with chronic schizophrenia such as effects of medication, institutionalization, and changes related to illness duration, and helps identify traits that may be part of the liability to the disorder (Phillips & Seidman, 2008).

In line with findings in patients with schizophrenia, greater impact of (especially negative) emotionally laden sensory input in terms of greater interference with cognitive processes was reported for nonclinical individuals with high levels of positive schizotypal symptoms compared to individuals scoring low on schizotypal symptoms, indicating impaired control over the influence of social-emotional input and greater vulnerability to emotional arousal (Karcher & Shean, 2012; Mohanty et al., 2008). In addition, positive schizotypy was positively correlated with greater self-reported impact of, especially negative, emotions on thoughts and behaviors (Cicero & Kerns, 2010; Martin, Becker, Cicero, Docherty, & Kerns, 2011). In contrast to individuals with negative symptoms who tend to report reduced intensity of emotions, individuals with high levels of positive schizotypal symptoms typically reported and showed increased reactivity to emotional stimuli (e.g., Karcher & Shean, 2012; van't Wout, Aleman, Kessels, Laroi, & Kahn, 2004; for review see Phillips & Seidman, 2008). A large proportion of individuals with positive schizotypal traits were classified as "emotionally overwhelmed" on the basis of self-report questionnaires (defined as high intensity, high attention, and low clarity of emotions), a trait that is linked to being more influenced by one's affect (Gohm, 2003; Kerns, 2005).

Neuroscientific models on affect regulation implicate pathways originating from the prefrontal cortex that modulate the activity of other brain structures, above all the amygdala (Davidson, 2002; Johnstone, van Reekum, Urry, Kalin, & Davidson, 2007; Phillips, Ladouceur, & Drevets, 2008). However, not only cortical–subcortical, but also cortico-cortical circuits play an important role in affective processing. Remote brain regions influence perceptual processing and awareness mediated by posterior sensory and association cortices (Vuilleumier & Driver, 2007). More specifically, there is evidence that the prefrontal cortex receives highly processed sensory information and in turn exerts feedback control on posterior association cortices, in order to further modulate perceptual representations of affectively relevant information (Decety & Moriguchi, 2007; Miskovic & Schmidt, 2010; Rudrauf et al., 2008). Connectivity and functional communication between two neural populations are modulated in support of dynamically changing processing demands (Sepulcre et al., 2010). These changes are indicated by changes of EEG coherence between two scalp areas (Fries, 2005; Srinivasan, Winter, Ding, & Nunez, 2007).

In the context of affective processing, it was shown that EEG coherence between prefrontal and posterior association cortex increased during exposure to highly threatening images, which was interpreted as activation of a regulatory mechanism protecting the individual from being unduly affected by the aversive input (Miskovic & Schmidt, 2010). Further research indicated that individuals considerably differ in their brain responses to social-emotional stimulation. Three studies focusing on these inter-individual differences demonstrated that diminished prefrontal–posterior coupling, indicated by reduced EEG beta coherences, was related to greater impact of the perceptual input on the individual (Papousek, Reiser, et al., 2013; Papousek, Weiss, et al. 2013; Reiser et al., 2012). Thus, more loose prefrontal–posterior coupling during social-emotional processing seems to be related to loosening of control of the prefrontal cortex over incoming affectively laden information, leaving the individual less protected from becoming affected by the emotional input.

Research has linked positive schizophrenia symptoms to disrupted functional connectivity (Lawrie et al., 2002; Nakamura et al., 2005; Vercammen, Knegtering, den Boer, Liemburg, & Aleman, 2010). More specifically, EEG studies showed that decreases of frontal–temporal coherence were correlated with increases of the severity of positive symptoms (Higashima et al., 2007). Reduced task-related inhibitory connectivity between frontal and posterior cortices during the performance of cognitive tasks were observed in patients with schizophrenia as compared to healthy controls (Koychev, El-Deredy, Mukherjee, Haenschel, & Deakin, 2012; Winterer, Coppola, Egan, Goldberg, & Weinberger, 2003) and in nonclinical individuals with elevated levels of schizotypal traits (Koychev, Deakin, Haenschel, & El-Deredy, 2011). It was proposed that these findings refer to attenuated top-down regulation of perceptual processing across the schizophrenia spectrum (Koychev et al., 2012; see also Dima, Dietrich, Dillo, & Emrich, 2010). Only very little research has addressed correlations between positive schizophrenia symptoms and prefrontal-posterior coupling in the context of social-emotional processing. One study using magnetic resonance imaging reported reduced functional coupling between prefrontal cortex, posterior cortex and amygdala during the processing of facial emotional expressions in patients with schizophrenia compared to healthy controls (Ioannides, Poghosyan, Dammers, & Streit, 2004).

The purpose of this study was to explore differences between individuals with relatively high levels of positive schizotypal symptoms and matched symptom-free controls in their pattern of prefrontal–posterior coupling or de-coupling during social-emotional stimulation. To this end, pre-selected groups were exposed to auditory displays of strong negative (anger, sadness) and positive (cheerfulness) emotions, and state-dependent changes of prefrontal–posterior EEG coherences during the stimulation were recorded. It was expected that participants scoring high on positive schizotypal symptoms would show reduced prefrontal–posterior coupling during the processing of the social-emotional input indicating loosening of control of the prefrontal cortex over incoming affectively laden information (cf. Papousek, Reiser, et al., 2013; Papousek, Weiss, et al., 2013; Reiser et al., 2012). Differences should be particularly evident during the processing of negative emotions. Additionally, it was supposed that individuals with elevated levels of positive schizotypal symptoms may feel overwhelmed and less able to cope in situations involving emotions. Therefore, it was examined whether the pre-selected groups would differ in their self-reported effectiveness to control negative affect in everyday life.

2. Material and methods

2.1. Participants

A total of 541 university students from four local universities and a variety of disciplines were screened using the Schizotypal Personality Questionnaire (Raine, 1991; German version with 5-point Likert scale system; Klein, Andresen, & Jahn, 1997; Wuthrich & Bates, 2005). Participants were recruited on the basis of their score on the positive schizotypy subscale. Participants