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Shyness and emotional face processing in schizophrenia: An ERP study

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ABSTRACT

Shyness in healthy controls has been related to early event-related potential (ERP) responses to emotional faces. Patients with schizophrenia typically demonstrate increased shyness that is stable and related to reduced social functioning. We indexed early ERP responses to emotional faces in relation to shyness in 40 outpatients with schizophrenia and 39 healthy controls. Patients with low-to-medium shyness showed reductions in P100 amplitude to emotional compared to neutral faces as shyness increased. Patients reporting medium-to-high shyness demonstrated the opposite pattern; P100 amplitude sharply increased as shyness increased, possibly reflecting heightened vigilance. When a restricted range of shyness scores was used to equalize scores between groups, patients showed increased N170 amplitude to emotional faces as shyness increased, whereas controls demonstrated the opposite pattern. The implications of the findings are discussed with respect to informing vulnerability to social functioning impairment and psychosocial stress in this population.

1. Introduction

One of the most disabling consequences of schizophrenia is a marked impairment in social functioning, leading some to consider schizophrenia a disorder of social communication (see Wible, 2012, for a review). Normal social interactions involve components of perception, interpretation, and response to interpersonal cues (Wallace, 1982), including cues signalling emotional states. Personality researchers have demonstrated that individual differences in approach-oriented (extroverted/outgoing) and withdrawal-oriented (introverted/avoidant) personality styles are related to the perception and interpretation of interpersonal cues. For example, approach-oriented personality styles have been related to the increased neural processing of happy faces (Canli, Sivers, Whitfield, Gotlib, & Gabrieli, 2002), sensitivity to the intensity of positively-valenced pictures (Yuan, He, Lei, Yang, & Li, 2009), and the subjective experience of positive emotion (Costa & McCrae, 1980), while avoidant styles have been related to the neural processing of threat-related faces (Jetha, Zheng, Schmidt, & Segalowitz, 2012; Perez-Edgar et al., 2010) and the experience of negative emotional states (Miskovic & Schmidt, 2012). Such findings are thought to reflect sensory or cognitive processing biases to emotional information, which have been implicated in the development and maintenance of emotional predispositions and vulnerability for psychopathology (Amir et al., 2009; Browning, Holmes, & Harmer, 2010; Williams, Mathews, & MacLeod 1996).

A number of studies that have examined differences in personality between patients with schizophrenia and healthy controls have reported higher levels of avoidant styles of responding (e.g., introversion, harm avoidance, and shyness) and reduced levels of approach-related styles of responding (e.g., extroversion, novelty seeking, and sociability) for patients compared to controls (Berenbaum & Fujita, 1994; Goldberg & Schmidt, 2001; Guillem, Bieu, Semkovska, & Debruille, 2002; Jetha et al., 2012). For example, patients have been shown to be higher on harm avoidance (more cautious, fearful, and passive) and lower on novelty-seeking behaviour (more indifferent, reflective, and detached) than controls (Guillem et al., 2002).

1.1. Shyness

Shyness is a particularly robust personality construct that is characterized by heightened fear and withdrawal-related behavior during social encounters (Pilkonis, 1977). Developmental research suggests that shy individuals may be biologically predisposed to be fearful during social interactions and have increased vulnerability for social skills deficits (Schmidt & Schulkin, 1999). Dysregulation of the fear system, including an inability to modulate fearful responses

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to novel social interactions, is thought to underlie and maintain shy behavior (Schmidt, 1999; Schmidt, Polak, & Spooner, 2005; Schmidt & Buss, 2010). A number of studies with healthy children, adults, and some clinical populations support this characterization reporting relations among shyness and distinct physiological (i.e., increased right frontal cortical activity, heart rate and cortisol), cognitive/affective (i.e., cognitive distress), and behavioral (i.e., social withdrawal and avoidance behavior) correlates during resting conditions and in response to novel social interactions (see Schmidt et al., 2005; Schmidt & Jetha, 2009, for reviews).

Individual differences in the reactivity and regulation of fear processing are also thought to play a role in unconscious associative learning (e.g., classical conditioning) and the subsequent automatic responses to socio-emotional stimuli (e.g., Cloninger, Svrakic, & Przybeck, 1993). Indeed, a number of studies using various methodologies have demonstrated heightened vigilance to threat-related information, including threat-related faces in individuals who exhibit disorders characterized by dysregulation of the fear system: general anxiety (Britton et al., 2011), social anxiety (Freitas-Ferrari et al., 2010), and behavioral inhibition (Blackford, Avery, Shelton, & Zald, 2009; Perez-Edgar et al., 2010).

In line with this notion, several studies have related shyness to face processing in healthy controls. Adults who reported more shyness showed increased amygdala activation when processing stranger compared to familiar faces than did adults who were more social (Beaton et al., 2008). In this same study, shy adults showed bilateral reductions in lateral fusiform cortex activation in response to stranger faces compared to adults who were more social (Beaton et al., 2008, 2009). A recent study that used ERPs and a passive emotional task, which allowed for the implicit processing of emotional faces, demonstrated that shyness in healthy adults was related to the very early perceptual processing of emotional faces (Jetha et al., 2012). Individuals who reported lower levels of shyness showed increased amplitude of the P100 component (approximately 100 ms after stimulus presentation) to happy and fearful faces compared to neutral faces, while individuals who reported higher levels of shyness showed a reduction in P100 amplitude for fearful compared neutral faces. These results likely reflect differences in attentional sensitivities to information carried in the low spatial frequency signal from emotional faces that is rapidly transmitted by subcortical pathways (i.e., colliculo–pulvinar–amydala pathways). For healthy controls who were higher in shyness, the authors interpreted the reduction in P100 amplitude to emotional faces as an avoidance bias in line with other studies that have used passive tasks and have evidenced reduced activation in amygdala regions (medial temporal lobe structures known to be central to the perception and experience of emotion) to aversive photos and visualizations of previously-viewed aversive photos as a function of harm avoidance (Baeken et al., 2010) and trait disgust (Schienle, Schafer, & Vaitl, 2008), respectively. Alternatively, differences in vigilance- and avoidant-processing biases across constructs may have been due to levels of fear in social situations. One limitation of the Jetha et al. (2012) study was that the sample did not allow for measures of extreme shyness. As such, extreme shyness may have been related to heightened vigilance during face processing; however, the restricted sample precluded examination of these relations.

Research regarding shyness in schizophrenia has shown that shyness is higher in patients than in healthy controls and may be a risk factor for more severe social dysfunction. For example, between-group analyses have shown that shyness is higher in both chronically ill inpatients (Flanagan, 1992) and in community outpatients (Goldberg & Schmidt, 2001; Jetha, Schmidt, & Goldberg, 2007; Jetha, Goldberg, & Schmidt, 2013) in comparison to healthy controls. Shyness was also shown to remain stable over a 7-month period and in response to an intensive social skills intervention in community outpatients (Jetha et al., 2007). Within-group analyses have also demonstrated that shyness in schizophrenia is related to reduced quality of life measures (Goldberg & Schmidt, 2001; Jetha et al., 2012) and more intractable post-intervention social skills responses (Jetha et al., 2007). In addition, shyness in community outpatients has been related to neurophysiological correlates of stress vulnerability (i.e., greater relative right frontal EEG asymmetry) (Jetha, Schmidt, & Goldberg, 2009), a similar pattern of relations found in shy and socially anxious adults and children (see Schmidt & Miskovic, 2014, for a review). Collectively, the results suggest that measures of shyness in schizophrenia, as for healthy adults and children, may index individual differences in the reactivity and regulation of fear processing, particularly in socially-evaluative contexts. As such, shyness in this population may also influence automatic responses to emotional faces, although this hypothesis has not been empirically tested to date.

1.2. Emotional face processing

Facial expressions are a rich source of interpersonal cues, conveying attentional focus, intention, and emotional states to the observer. Facial expressions, which communicate negative affect (e.g., fear and anger), signal threat and danger and elicit withdrawal-related behavior, whereas expressions of positive affect (e.g., happiness and joy) signal reward and interest and elicit approach-related behavior. Numerous imaging and psychophysiological studies have reported facilitated and enhanced processing of emotional compared to neutral faces (Palermo & Rhodes, 2007; Vuilleumier & Pourtois, 2007), suggesting that specialized neural systems have evolved for the rapid detection of the emotions expressed by faces.

The temporal processing of facial emotion is typically assessed using event-related potentials (ERPs) and magnetoencephalography (Palermo & Rhodes, 2007). In general, early components (<200 ms post-stimulus) reflect more automatic and reflexive sensory processing and are less influenced by higher-order cognitive factors than later components, which reflect more integrative processing. For example, the coarse discrimination of facial emotion occurs as early as 80–120 ms post-stimulus onset, as reflected in the amplitude modulation of the P100 component, which is sourced from ventral extrastriate visual areas and is sensitive to both low-level visual information (i.e., contrast, luminosity, and spatial frequency) (Nakashima et al., 2008; Rossion & Jacques, 2008) and visual attention (Hillyard & Anllo-Vento, 1998). The influence of emotion at this early stage, particularly for the emotion of fear, is thought to be driven by attention to visual information that is rapidly perceived and transmitted via subcortical pathways (i.e., colliculo–pulvinar–amydala pathways) that include bilateral amygdala regions (e.g., Pourtois, Dan, Grandjean, Sander, & Vuilleumier, 2005; Pourtois, Grandjean, Sander, & Vuilleumier, 2004). Although ERP measures are not able to measure amygdala activity directly, recent research with patients who have medial temporal lobe epilepsy strongly implicates the amygdala in producing the P1 fear effect (i.e., increased P100 amplitude for fearful faces over neutral faces) demonstrating a reduction of the P1 fear effect as a function of severity of amygdala damage (Rotshtein et al., 2010).

Another ERP component related to face processing is the N170 component, which occurs within 130–200 ms post-stimulus onset and is maximal over posterior lateral electrode sites. The N170 is thought to originate from occipitotemporal and fusiform cortex (Henson et al., 2003), although magnetoencephalography (MEG) evidence suggests the N170 could also be sourced in part from the inferior occipital gyrus (e.g., Itier, Herdman, George, Cheyne, & Taylor, 2006). The N170 is sensitive to high-level visual (configural and feature) information, reflecting the structural encoding of facial features (Rossion & Jacques, 2008). It is also sensitive to attentional