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Neurophysiological impairment in emotional face processing is associated with low extraversion in schizophrenia

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ABSTRACT

Patients with schizophrenia have low extraversion and high neuroticism. These personality traits affect the everyday life of patients with schizophrenia, making it important to investigate neurobiological basis of personality traits. In healthy people, extraversion is associated with hemodynamic responses in the amygdala and electrophysiological brain activity such as event-related potential and event-related desynchronization during emotional face processing. Patients with schizophrenia show abnormal neural activity during emotional face processing, such as an N170 amplitude reduction. However, few studies to date have reported an association between personality traits and neural activity during emotional face processing in schizophrenia. In the present study, we examined N170 during emotional face processing, and association with personality traits in patients with schizophrenia. Fifteen male patients with chronic schizophrenia and 15 healthy male subjects participated in this study. Patients with schizophrenia had reduced N170 amplitudes ($p = 0.007$). While healthy subjects had increased N170 amplitudes in response to emotional faces compared with neutral faces ($p = 0.003$), patients with schizophrenia showed no difference in N170 amplitudes between emotional and neutral faces ($p = 0.60$). Reduced N170 amplitude in response to neutral faces was correlated with low extraversion scores in patients with schizophrenia ($r_s = -0.69$, $p = 0.005$). The abnormal N170 and its association with extraversion in schizophrenia were found at the right rather than the left posterior temporal electrode. An abnormal N170 in schizophrenia may reflect impairments in the structural encoding of emotional faces, and indiscrimination between emotional and neutral faces at this stage of information processing. The association between abnormal N170 amplitudes and extraversion suggests that abnormal neural activity in the early stages of emotional face processing may underlie low extraversion characteristic of schizophrenia.

1. Introduction

Patients with schizophrenia have alterations in many mental domains such as cognition, language, thought, emotion, and behavior. Given that personality traits can explain individual differences in the ways that we perceive, interpret, and respond to the world around us, investigating the characteristics and neural basis for personality traits may help to improve our understanding and management of cognitive and social dysfunction in schizophrenia. High levels of neuroticism and low levels of extraversion are typically reported in patients with schizophrenia (Horan et al., 2008). These characteristics are strongly associated with reduced cognitive functions (Gurrera et al., 2005), lower quality of life (Kentros et al., 1997), and avoidant coping strategies (Lysaker and Taylor, 2007). However, very few studies to date have investigated the neurobiological basis underlying these personality traits in schizophrenia.

Previous studies have shown an association between extraversion and neural activity associated with emotional face processing in healthy people. Higher levels of extraversion are associated with greater activation in the amygdala during perception of happy faces (Canli et al., 2002). Extraverted people have smaller event-related desynchronization in the alpha band during emotional face processing (Fink, 2005) and have a face inversion effect of N170, while

Abbreviations: ANCOVA, analysis of covariance; ANOVA, analysis of variance; EEG, electroencephalography; ERP, event-related potential; GAF, Global Assessment of Functioning; NEO-FFI NEO, Five-Factor Inventory; PANSS, Positive and Negative Syndrome Scale; SCID, Structured Clinical Interview for DSM-IV Axis I Disorders.

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introverted people have no such inversion effect (Cheung et al., 2010). Because patients with schizophrenia are known to have impairments in emotional face processing (Edwards et al., 2002; Mandal et al., 1998), it is predicted that lower extraversion may be associated with abnormal emotional face processing in schizophrenia.

Event-related potential (ERP) is a suitable method for investigating the neural basis of emotional face processing. ERP can measure neural activities with a high temporal resolution and is useful for determining the particular stage of information processing at which emotional face processing is impaired. This is important because information regarding emotional faces is processed in several distinct brain regions, and these regions interact with each other (Vuilleumier and Pourtois, 2007). Face processing is known to be related to P100 and N170. P100 is a positive waveform arising around 100 ms post-stimulus at the occipital electrodes, related to basic visual processing (Rossion et al., 2003), and generated in the extrastriate visual cortex (Pourtois et al., 2005). N170 is a negative waveform arising around 170 ms post-stimulus at the posterior temporal electrodes. N170 reflects the structural encoding of faces (Eimer, 2000b) and is generated by the fusiform gyrus (Deffke et al., 2007). N170 is delayed and enhanced when faces, but not objects, are presented upside down (Eimer, 2000a; Rossion et al., 2000). This face inversion effect is considered as evidence that face perception is mediated by special cognitive and neurobiological mechanisms (Yovel and Kanwisher, 2004). Therefore, N170 is thought to reflect face-specific processing. Previous studies have reported that facial expressions were processed as part of later ERP components such as N250 (Streit et al., 1999) and P300 (Carretie and Iglesias, 1995). However, recent studies have found that facial expression affects not only later ERP components, but also P100 (Pourtois et al., 2005) and N170 (Blau et al., 2007).

Previous studies have investigated the neural basis of emotional face processing impairments in patients suffering from schizophrenia. Patients with schizophrenia showed intact P100 amplitudes during emotional face processing in many studies (Bediou et al., 2007; Johnston et al., 2005; Lee et al., 2010; Obayashi et al., 2009; Turetsky et al., 2007; Wynn et al., 2008), although a few (Caharel et al., 2007; Campanella et al., 2006) reported a reduction in P100 amplitude. Inconsistent findings may be due to differences in stimuli and tasks because P100 amplitude depends on visual features of stimuli and attention of subjects (Taylor, 2002). P100 amplitude reduction has also been reported in several studies that used non-face stimuli (Doniger et al., 2002; Haenschel et al., 2007; Yeap et al., 2006), making it unclear whether basic visual processing is intact in schizophrenia. However, basic visual processing as reflected by P100 does not appear to be related to emotional face processing impairments in schizophrenia. Patients with schizophrenia showed a reduction in N170 amplitude during emotional face processing in a number of studies (Bediou et al., 2007; Caharel et al., 2007; Campanella et al., 2006; Lee et al., 2010; Lynn and Salisbury, 2008; Obayashi et al., 2009; Turetsky et al., 2007), although several others reported intact N170 amplitude (Wynn et al., 2008) or an N170 amplitude increase (Ramos-Loyo et al., 2009). While healthy subjects showed increased N170 amplitude in response to emotional faces as compared to neutral faces, patients with schizophrenia showed no difference in N170 amplitude between emotional and neutral faces in a number of studies (Caharel et al., 2007; Campanella et al., 2006; Lynn and Salisbury, 2008). However, a few investigators have reported different findings (Obayashi et al., 2009; Turetsky et al., 2007). Together, these findings suggest that patients with schizophrenia are likely to have impairments in this stage of emotional face processing.

While many studies have investigated emotional face processing in schizophrenia, relatively few studies have investigated the possible association between extraversion and emotional face processing. A structural MRI study reported an association between low extraversion scores and a reduction in volume of the fusiform gyrus gray matter in schizophrenia (Onitsuka et al., 2005). Such a reduction in gray matter volume is associated with a reduced N170 amplitude in response to faces (Onitsuka et al., 2006), and worse facial memory (Onitsuka et al., 2003) in schizophrenia, a finding that suggests a possible link between extraversion and face processing in schizophrenia. To our knowledge, however, no study has reported any association between personality traits and neurophysiological activity during emotional face processing in schizophrenia. In this study, we measured N170 during emotional face processing and assessed personality traits in patients with schizophrenia, and in healthy subjects. We hypothesize that 1) patients with schizophrenia will have reduced N170 amplitude during emotional face processing; 2) patients with schizophrenia will have less of a difference in N170 amplitude between responses to emotional and neutral faces; and 3) abnormal N170 amplitude will be associated with low levels of extraversion in patients with schizophrenia.

2. Methods

2.1. Participants

Fifteen male patients with chronic schizophrenia and 15 age-matched healthy male subjects participated in this study (Table 1). The ethical committee of the University of Tokyo Hospital approved this study (no. 629-2). Written informed consent was obtained from all the subjects after a complete explanation of the study.

Patients with schizophrenia were recruited from outpatients at the University of Tokyo Hospital. Diagnosis was made through the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID) (First et al., 1997) by an experienced psychiatrist (K.K.). The exclusion criteria were neurological illness, traumatic brain injury with any known cognitive consequences or loss of consciousness for more than 5 min, a history of electroconvulsive therapy, and alcohol/substance abuse or addiction. All the patients recruited were receiving antipsychotic medication. Symptoms and social functioning on the day of testing were rated with the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987) and the Global Assessment of Functioning (GAF) Scale (American Psychiatric Association, 1994). Healthy subjects were screened with SCID non-patient edition. Subjects with a history of psychiatric illness or a family history of axis I disorder in their first-degree relatives were excluded. Other exclusion criteria for healthy subjects were the same

Table 1
Demographic and clinical characteristics of subjects.

	Patients with schizophrenia ($n=15$)		Healthy subjects ($n=15$)		Group difference
	Mean	SD	Mean	SD	p-value*
Age (year)	34.5	6.8	31.9	9.7	0.39
Handedness	72.3	61.3	84.6	51.3	0.56
Education (year)	14.1	2.9	17.3	1.9	0.002
Estimated premorbid IQ	100.8	15.7	114.0	6.9	0.006
NEO					
Neuroticism	55.3	11.1	51.2	10.6	0.31
Extraversion	45.5	12.2	49.1	14.0	0.47
Openness	52.0	10.5	48.8	8.4	0.37
Agreeableness	46.5	13.1	48.2	9.6	0.69
Conscientiousness	48.6	11.1	47.2	14.5	0.77
Age at onset (year)	22.0	6.3			
Duration of illness (year)	12.5	5.6			
Antipsychotic medication (mg/day)[a]	971.3	800.8			
PANSS					
Positive	11.5	4.8			
Negative	17.5	6.2			
General	28.7	8.6			
GAF	52.2	8.8			

IQ, intelligence quotient; PANSS, Positive and Negative Symptom Scale; GAF, Global Assessment of Functioning.
[a] Chlorpromazine equivalent dose.
* t-tests were used for testing group difference.