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Smaller superior temporal gyrus volume specificity in schizotypal personality disorder

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ABSTRACT

Background: Superior temporal gyrus (STG/BA22) volume is reduced in schizophrenia and to a milder degree in schizotypal personality disorder (SPD), representing a less severe disorder in the schizophrenia spectrum. SPD and Borderline personality disorder (BPD) are severe personality disorders characterized by social and cognitive dysfunction. However, while SPD is characterized by social withdrawal/anhedonia, BPD is marked by hyper-reactivity to interpersonal stimuli and hyper-emotionality. This is the first morphometric study to directly compare SPD and BPD patients in temporal lobe volume.
Methods: We compared three age-, sex-, and education-matched groups: 27 unmedicated SPD individuals with no BPD traits, 52 unmedicated BPD individuals with no SPD traits, and 45 healthy controls. We examined gray matter volume of frontal and temporal lobe Brodmann areas (BAs), and dorsal/ventral amygdala from 3-T magnetic resonance imaging.
Results: In the STG, an auditory association area reported to be dysfunctional in SPD and BPD, the SPD patients had significantly smaller volume than healthy controls and BPD patients. No group differences were found between BPD patients and controls. Smaller BA22 volume was associated with greater symptom severity in SPD patients. Reduced STG volume may be an important endophenotype for schizophrenia-spectrum disorders. SPD is distinct from BPD in terms of STG volume abnormalities which may reflect different underlying pathophysiological mechanisms and could help discriminate between them.

1. Introduction

Several previous studies have shown reduced superior temporal gyrus (STG) volume in individuals with schizophrenia (reviewed by Shenton et al., 2001). Recent work has found that schizotypal personality disorder (SPD) patients also show this abnormality but to a lesser extent than in schizophrenia (Buchsbaum et al., 1997; Dickey et al., 1999; Hazlett et al., 2008; Kawasaki et al., 2004; Takahashi et al., 2006), adding further support to existing evidence that SPD is in the schizophrenia spectrum. However, previous studies of STG volume in SPD compared patients with "supernormal" individuals who did not have Axis I or II psychopathology and also had no family history for psychiatric illness, perhaps increasing the likelihood of finding group differences (Kendler, 2003). Many biological findings in personality disorders appear to be present across different personality disorders, representing perhaps vulnerabilities to personality disorders per se (Kendler

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et al., 2008). Like other findings, it remains unclear whether STG volume abnormalities are specific to SPD or whether they are also present in other personality disorders, such as borderline personality disorder (BPD). This study aims to evaluate the specificity of STG abnormalities in SPD and BPD participants by comparing the volume of this region as well as other temporal and frontal lobe regions.

The diagnosis of SPD, characterized by asocial tendencies, difficulties with language and paranoid, odd behavior and magical thinking, was first introduced in the DSM-III and based on the clinical profiles of patients with "borderline schizophrenia" in the landmark Danish adoption schizophrenia studies (Rosenthal et al., 1971). These studies and earlier formulations of the disorder suggested that relatives of patients with schizophrenia may display deviant psychological functioning but not all signs of schizophrenia, providing evidence for a spectrum of schizophrenia-related disorders. Many of these earlier studies of "borderline schizophrenia" included symptoms related to conceptions of BPD, but diagnostic overlap decreased when borderline criterion for paranoid ideation under stress was introduced in DSM-III-R (Spitzer et al., 1979). BPD, characterized by affective instability and impulsive behavior, was first included as a personality disorder diagnosis in DSM-III (Gunderson and Singer, 1975; Kernberg, 1977). Nonetheless, the comorbidity of BPD and SPD is not uncommon (e.g., Zanarini et al., 1998).

Morphometric studies examining the temporal lobe in SPD report reduced gray matter volume in STG (Buchsbaum et al., 1997; Dickey et al., 1999; Hazlett et al., 2008; Kawasaki et al., 2004; Takahashi et al., 2006), middle and inferior temporal gyrus (Downhill et al., 2001), and Heschl's gyrus (Dickey et al., 2002a). Of note, Dickey et al. (2002a) found decreased STG volume in male but not female SPD patients (Dickey et al., 2003). While volume reductions in medial temporal regions, including amygdala and/or hippocampal complex, are reported in schizophrenia (reviewed by Shenton et al., 2001), these findings have not been consistently observed in SPD (Dickey et al., 2002b). Only one study (Suzuki et al., 2005) reported bilateral reductions in both of these structures in SPD, while Dickey et al. (2007) recently reported reduced hippocampal volume in SPD. Volume reductions in frontal cortex regions have also been reported in studies with schizophrenia patients, but several studies suggest that these areas may be relatively preserved in SPD (Hazlett et al., 2008; Kawasaki et al., 2004; Suzuki et al., 2005). Our group and others (Haznedar et al., 2004; Takahashi et al., 2004) previously reported no morphologic differences in cingulate gyrus in SPD but, using a larger sample size, we later found smaller cingulate volume compared with healthy controls, particularly in anterior cingulate cortex (ACC) gray matter (Hazlett et al., 2008).

On the other hand, BPD studies examining the frontal lobe have reported reductions in overall frontal lobe volume (Lyoo et al., 1998), left orbitofrontal cortex and right anterior cingulate volume (Tebartz van Elst et al., 2003), and anterior cingulate (BA24) gray matter volume (Hazlett et al., 2005). It should be noted that Tebartz van Elst and colleagues later found no significant differences in these regions using voxel-based morphometric MRI (Rusch et al., 2003). Some studies also report hippocampal (Irle et al., 2005; Zetzsche et al., 2007) and amygdala volume loss in BPD (Driessen et al., 2000; Schmahl et al., 2003; Tebartz van Elst et al., 2003), while others have shown no significant structural differences between BPD patients and controls in these regions (Chanen et al., 2008; New et al., 2007). Another study found smaller hippocampal volume but no differences in amygdala volume (Brambilla et al., 2004). To date, the above-mentioned studies have looked at these patient groups separately and findings suggest SPD patients have smaller STG volume, both SPD and BPD patients have abnormalities in frontal regions, particularly smaller anterior cingulate volume, and amygdala findings are less clear.

The aim of this study was to examine volume of frontal and temporal lobe regions in three age-, sex-, and education-matched groups: patients with BPD but no SPD traits, patients with SPD but no BPD traits, and healthy controls. This is the first study to directly compare these groups and test whether morphometric abnormalities in these brain regions are specific to one personality disorder and not the other, or whether the two patient groups differ from healthy controls in opposite directions. While both SPD and BPD patients exhibit symptoms that have been linked to temporal and frontal lobe abnormalities, these symptoms differ phenomenologically from one another. Specifically, emotion dysregulation and impulsivity are hallmark features of BPD (Skodol et al., 2002), while blunted affect and executive dysfunction are frequently associated with SPD (Kirrane and Siever, 2000). In this sense, abnormal volume in prefrontal and temporal regions may underlie affect-related symptoms in BPD (Soloff et al., 2008); in SPD, abnormal frontal and temporal lobe volume may be associated with cognitive and/or executive functioning deficits (McCloskey et al., 2005). Due to these different patterns of symptom presentation in our clinical groups, we expected to find different patterns of frontal/temporal structural abnormalities in these groups as well. Of note, since we want to be able to draw conclusions about regional specificity, we looked at a number of different frontal and temporal regions. Specifically, in the frontal lobe, our analyses focused on prefrontal and cingulate cortex Brodmann areas (BAs)—important in attention and the modulation of executive function and emotion. In the temporal lobe, we focused on regions that contribute to executive and emotion processing and have been shown to have dense interconnections: temporal gyrus regions and amygdala (Barbas, 2007; Pandya, 1995; Price, 2007). The specific temporal gyrus regions included primary auditory cortex corresponding to BA41 and BA42 and auditory association areas corresponding to BA22/STG. Also, since fMRI studies (Kim et al., 2003; Whalen et al., 2001) have begun identifying differential roles of amygdaloid subnuclei and their respective connections with the frontal lobe, we parcellated amygdala into dorsal and ventral regions.

Previous work shows that, in SPD, functional impairment such as odd speech is associated with smaller STG volume (Dickey et al., 2003). This finding is consistent with basic research (Binder et al., 2000; Joanisse and Gati, 2003) and schizophrenia work (e.g., Wible et al., 2001) suggesting the importance of temporal lobe function in language processing and production. In order to investigate individual differences in SPD, we examine correlations between symptom severity, including odd speech/thinking symptomatology, and volume of our hypothesized regions of interest.

We hypothesized that our patient groups would show different frontal–temporal volume patterns from each other and the healthy control group. More specifically, we