European Neuropsychopharmacology (2016) **26**, 1657–1666

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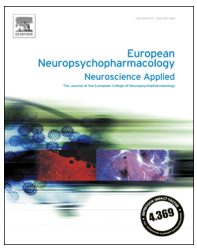

Degree connectivity in body dysmorphic disorder and relationships with obsessive and compulsive symptoms

Jan C. Beucke[a,d,*], Jorge Sepulcre[c,d,e], Ulrike Buhlmann[f], Norbert Kathmann[a], Teena Moody[b], Jamie D. Feusner[b]

[a]*Department of Psychology, Humboldt-Universität zu Berlin, Berlin, Germany*
[b]*Department of Psychiatry and Biobehavioral Sciences, University of California Los Angeles, Los Angeles, CA, USA*
[c]*Department of Radiology, Massachusetts General Hospital, Boston, MA, USA*
[d]*Athinoula A. Martinos Center for Biomedical Imaging, Charlestown, MA, USA*
[e]*Department of Psychology and Center for Brain Science, Harvard University, Cambridge, MA, USA*
[f]*Department of Psychology, Westfälische Wilhelms-Universität Münster, Münster, Germany*

Received 19 January 2016; received in revised form 26 April 2016; accepted 28 April 2016

KEYWORDS
Body dysmorphic disorder;
Obsessive-compulsive disorder;
Amygdala;
Orbitofrontal cortex;
Connectivity

Abstract
Individuals with body dysmorphic disorder (BDD) and obsessive-compulsive disorder (OCD) are categorized within the same major diagnostic group and both show regional brain hyperactivity in the orbitofrontal cortex (OFC) and the basal ganglia during symptom provocation. While recent studies revealed that degree connectivity of these areas is abnormally high in OCD and positively correlates with symptom severity, no study has investigated degree connectivity in BDD. We used functional magnetic resonance imaging (fMRI) to compare the local and distant degree of functional connectivity in all brain areas between 28 unmedicated BDD participants and 28 demographically matched healthy controls during a face-processing task. Correlational analyses tested for associations between degree connectivity and symptom severity assessed by the BDD version of the Yale-Brown obsessive-compulsive scale (BDD-Y-BOCS). Reduced local amygdalar connectivity was found in participants with BDD. No differences in distant connectivity were found. BDD-Y-BOCS scores significantly correlated with the local connectivity of the posterior-lateral OFC, and distant connectivity of the posterior-lateral and post-central OFC, respectively. These findings represent preliminary evidence that individuals with BDD exhibit brain-behavioral associations related to obsessive thoughts and compulsive behaviors that are highly similar to correlations previously found in OCD, further underscoring their

*Correspondence to: Humboldt-Universität zu Berlin, D-12489 Berlin, Germany. Tel.: +030 2093 4940; fax: +030 2093 4859.
E-mail address: jan.beucke@hu-berlin.de (J.C. Beucke).

http://dx.doi.org/10.1016/j.euroneuro.2016.04.011

related pathophysiology. This relationship could be further elucidated through investigation of resting-state functional connectivity in BDD, ideally in direct comparison with OCD and other obsessive–compulsive and related disorders.

1. Introduction

The most recent version of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (American Psychiatric Association, 2013) categorizes body dysmorphic disorder (BDD), a severely impairing (Phillips et al., 2005; Phillips and Diaz, 1997) psychiatric condition characterized by preoccupation with perceived defects in a person's own appearance, in the chapter of obsessive–compulsive and related disorders (OCRD) (American Psychiatric Association, 2013), after it had been viewed as a somatoform disorder in previous editions. This diagnostic change is based on several overlapping features, including clinical observations that OCRD including BDD are all characterized by obsessive thoughts and/or repetitive, compulsive behaviors. Moreover, the severity of these symptoms can be reliably assessed using analogous psychometric expert ratings in BDD and OCD (Goodman et al., 1989; Phillips et al., 1997).

In addition to these similarities in clinical phenotype, the recent change in classification intensifies efforts studying all OCRD to understand the brain circuitry of compulsivity (van den Heuvel et al., 2015), and motivates the search for neurobiological abnormalities common to intensively (such as OCD) and less intensively studied OCRD (such as BDD). For example, a recent study predicted and confirmed lower striatal dopamine $D_{2/3}$ receptor availability in BDD based on previous examinations of patients with OCD (Denys et al., 2004; Figee et al., 2014). A further common phenomenon observed in both BDD and OCD is regional hyperactivation patterns in frontostriatal brain areas during symptom provocation. More specifically, relative hyperactivity in the orbitofrontal cortex (OFC) and the striatum has been demonstrated in BDD participants when being presented with their own face compared to familiar faces (Feusner et al., 2010), and abnormally high responses in these areas is a well-known and replicated finding in participants with OCD presented with stimuli triggering their OCD symptom profile (Breiter et al., 1996; Rauch et al., 1994; Simon et al., 2010).

Considering the fundamental intrinsic network structure of the brain, the field of connectomics has received increasing interest in psychiatry recently (Menon, 2011; Taylor, 2014). This discipline uses graph theoretical approaches to compute metrics indexing brain network properties on the basis of structural and functional magnetic resonance imaging (MRI) data (Buckner et al., 2009; Bullmore and Sporns, 2009; Sepulcre et al., 2010). For example, degree connectivity (also termed node degree or centrality) quantifies the number of connections of all regions, and thus identifies the most central areas in the network. Noteworthy, degree connectivity can be quantified both for local and distant connections, and on the basis of resting-state as well as task functional MRI data (Sepulcre et al., 2010). Connectomics is thought to have the potential to provide novel insights into brain correlates of psychopathology (Taylor, 2014), while at the same time allowing testing of predictions inferred from existing brain circuit models of neuropsychiatric conditions. In OCD, abnormally high degree connectivity of the OFC and the basal ganglia (Beucke et al., 2013; Hou et al., 2014), and positive correlations between OCD symptom severity and degree connectivity of the OFC and striatum were found in unmedicated patients. Importantly, contemporary neuroanatomical models of OCD (Milad and Rauch, 2012) and compulsivity (van den Heuvel et al., 2015) suspect abnormalities not only in frontostriatal, but also in limbic circuits, referencing observations of heightened responses of the amygdala in some symptom provocation studies (Breiter et al., 1996; Simon et al., 2014; Simon et al., 2010), and during processing of OCD-related words (van den Heuvel et al., 2005), respectively, in patients with OCD. Still there have been very few neuroimaging studies in BDD, and no study has investigated degree connectivity in participants with BDD to date.

The present study sought to investigate degree connectivity abnormalities in unmedicated participants with BDD using fMRI data acquired during a face-processing task. Even though differences in study design and data acquisition between the present study in BDD and the previous study in OCD (Beucke et al., 2013) did not permit a direct comparison of the two patient groups, we sought to use an established approach (Sepulcre et al., 2010) previously applied in OCD (Beucke et al., 2013) to test whether connectivity abnormalities previously reported in OCD can also be found in BDD participants. Based on the similarities in diagnostic classification, symptomatology and abnormal regional activation patterns, we hypothesized that individuals with BDD would exhibit similar degree connectivity abnormalities previously described in OCD, i.e. higher degree connectivity of the OFC and the basal ganglia in those with BDD as compared to healthy controls, and positive correlations between the degree connectivity of these regions with BDD symptom severity. Further, given observations of amygdala hyperactivity in OCD and the emphasis on limbic circuit alterations in recent neuroanatomical models of OCD and compulsivity, we also tested for altered amygdala connectivity in patients with BDD.

2. Experimental procedures

2.1. Participants

Twenty-eight individuals meeting the DSM-IV diagnosis of BDD who were recruited from the community, as well as 28 mentally healthy controls that were matched for demographic variables (age, gender, and education) participated in the study. All were right-handed. The included participants were all unmedicated; they had not taken psychiatric medications for at least 8 weeks prior to the imaging