



Nonlinear relationships between anxiety and visual processing of own and others' faces in body dysmorphic disorder

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ABSTRACT

Individuals with body dysmorphic disorder (BDD) often experience anxiety, as well as perceptual distortions of appearance. Anxiety has previously been found to impact visual processing. This study therefore tested the relationship between anxiety and visual processing of faces in BDD. Medication-free participants with BDD ($N=17$) and healthy controls ($N=16$) viewed photographs of their face and a familiar face during functional magnetic resonance imaging. Blood-oxygen-level dependent signal changes in regions involved in anxiety (amygdala) and detailed visual processing (ventral visual stream—VVS) were regressed on anxiety scores. Significant linear relationships between activity in the amygdala and VVS were found in both healthy controls and individuals with BDD. There was a trend of a quadratic relationship between anxiety and activity in the right VVS and a linear relationship between anxiety and activity in the left VVS for the BDD sample, and this was stronger for own-face stimuli versus familiar-face. Results suggest that anxiety symptoms in BDD may be associated with activity in systems responsible for detailed visual processing. This may have clinical implications related to heightened perceptual distortions associated with anxiety.

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1. Introduction

Individuals with body dysmorphic disorder (BDD) are preoccupied with perceived appearance defects. They subsequently believe that they look disfigured and ugly, and suffer distress and functional impairment. BDD affects approximately 1–2% of the population (Otto et al., 2001; Rief et al., 2006; Koran et al., 2008), and is associated with high lifetime rates of psychiatric hospitalization (48%) and suicide attempts (22–27.5%) (Phillips, 2007).

Despite its prevalence and severity, little is known of the pathophysiology or neurobiology of BDD. Clinical observation suggests that patients focus primarily on details of their appearance at the expense of global or configural aspects, which may account for their perceptual distortions. Patients most often perceive “defects” of their face and head areas, such as skin, hair, and nose (Phillips, 2005), although perceived defects of other body parts are sometimes present. Neuropsychological data suggest that individuals with BDD demonstrate abnormal patterns of information processing consisting of selective recall of details rather than global features (Deckersbach et al., 2000).

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A previous functional magnetic resonance imaging (fMRI) study reported abnormal neural correlates of own-face processing in BDD relative to healthy controls. Results demonstrated correlations in the BDD group between BDD symptoms and activity in visual processing and frontostriatal systems (Feusner et al., 2010a, 2010b). Participants in this study had varying degrees of anxiety, and in some cases comorbid generalized anxiety disorder (GAD), major depressive disorder (MDD) and/or dysthymia. The complex relationship between different symptom dimensions and brain pathophysiology is not entirely clear. Because lifetime prevalence of other Axis I comorbid disorders are high in BDD: 36–76% for major depressive disorder, 34–47% for social phobia, 21–39% for OCD, 16–26% for other anxiety disorders (including 18.8% for GAD (Zimmerman and Mattia, 1998)), and 10–32% for eating disorders (Gunstad and Phillips, 2003; Phillips et al., 2005; Ruffolo et al., 2006), it is important to understand the relationship between co-occurring symptom dimensions and brain pathophysiology. Thus, the present study analyzed data from this previous study, focusing on the impact of a frequently comorbid psychiatric symptom: anxiety.

We focus on the effects of anxiety in the present study because previous studies suggest that anxiety may influence visual processing. Degree of trait anxiety correlates with enhanced contrast detection (Laretzaki et al., 2008), and viewing fearful faces

appears to enhance contrast sensitivity both independently of, and synergistically with, attention (Phelps et al., 2006). Several functional imaging studies have demonstrated that, in healthy controls (Bradley et al., 2003; Junghofer et al., 2005; Sabatinelli et al., 2005) and social phobia (Goldin et al., 2009; Straube et al., 2005), viewing of pictures with emotional content is associated with enhanced activation in the amygdala, as well as occipital and inferior temporal regions.

Connections between the amygdala and the ventral visual stream (VVS) may carry top-down signals regarding emotional valence of stimuli to the visual cortex, resulting in enhanced visual processing of emotionally salient stimuli. Evidence of this comes from neuroimaging studies in which amygdala activation was found to correlate with activation in the visual cortex (Morris et al., 1998a, 1998b; Pessoa et al., 2002). In patients with amygdala damage this correlation is attenuated (Vuilleumier et al., 2004).

Given these previous findings of anxiety effects on visual processing, and given the prevalence of the symptom of anxiety and evidence for abnormal visual processing in BDD, the primary objective of the current study was to use fMRI to determine the relationship between anxiety and neural systems associated with visual processing in individuals with BDD. We selected the VVS as our region of interest because of the importance of this region in visual processing, as well as the aforementioned correlations between activity in the amygdala and visual cortex in healthy controls. Although the fusiform face area has been implicated as an important region for face processing in prior studies (Kanwisher et al., 1997), we focused on the VVS as a whole because the relationship between anxiety/limbic system activity and activity in the visual system appears to encompass a broader visual processing network (Morris et al., 1998a, 1998b; Bradley et al., 2003; Vuilleumier et al., 2004; Junghofer et al., 2005; Sabatinelli et al., 2005).

We hypothesized that anxiety scores would correlate positively with activity in the VVS in individuals with BDD, as a result of a greater propensity for emotional arousal and therefore subsequent enhanced analytic and detailed visual processing, and that these relationships would be similar across BDD participants regardless of comorbid diagnoses of anxiety or depressive disorders. Although individuals with comorbid diagnoses will tend to have higher levels of anxiety (hence meeting threshold criteria for diagnosis), the effect of anxiety depending on comorbidity is more likely to be a quantitative rather than qualitative one. We also predicted that these relationships would be stronger for own-face relative to familiar-face stimuli because of greater emotional salience in BDD. Finally, we hypothesized that correlations between amygdala and VVS activity would be stronger for own-face relative to familiar-face viewing as a result of greater emotional salience. We predicted these correlations would be similar between BDD and healthy control groups, although the resultant effect in the BDD group would likely be heightened because they experience greater emotional arousal for their own face.

2. Methods

2.1. Participants

The UCLA Institutional Review Board approved the study protocol. We obtained informed consent from 17 right-handed participants with BDD and 16 healthy control participants of equivalent age and gender, all recruited from the community. All participated in a previously-reported study comparing BDD participants to healthy controls (Feusner et al., 2010a, 2010b) and some participated in a study of object processing (Feusner et al., 2011). All BDD participants met DSM-IV BDD criteria, as determined by the last author (JDF), who has clinical expertise with this population. Diagnoses were made using the Body Dysmorphic Disorder Module (Phillips et al., 1995), a reliable diagnostic module modeled after the Structured Clinical Interview for DSM. In addition, we screened participants

with the Mini International Neuropsychiatric Inventory (MINI) (Sheehan et al., 1998). All BDD participants were required to have a score of ≥ 20 on the BDD version of the Yale-Brown Obsessive-Compulsive Scale (BDD-YBOCS) (Phillips et al., 1997). We allowed participants with delusional beliefs about their appearance, as delusional beliefs are common in BDD. Moreover, delusional variants appear to exist on a continuum with nondelusional variants, as they are similar in most demographics, clinical features, and course of illness (Phillips et al., 2006; Mancuso et al., 2010). In line with this research, we believe that visual processing of faces would be similar across this continuum.

Exclusion criteria for both BDD participants and healthy controls included: active substance abuse, neurological disorder, pregnancy, or current medical disorders that might affect cerebral metabolism. We excluded BDD participants with concurrent Axis I disorders besides dysthymia, MDD, or GAD. As depression and anxiety are frequently comorbid in this population, we believed it would not be a representative sample to exclude these. Although other disorders are also common in BDD, such as OCD, eating disorders, and social phobia, we only allowed comorbid disorders that did not have overlapping symptom presentations (e.g., obsessiveness, anxiety in social situations, or detail-focused processing). This allows us to ensure that group differences between BDD and healthy controls are more likely due to BDD rather than related comorbidity. However, we required that BDD be the primary diagnosis as defined by the MINI ("Which problem troubles you the most or dominates the others or came first in the natural history?"). Although this approach limits the generalizability of the findings across all comorbidities, disallowed comorbidities resulted in the exclusion of 13 (37%) of the 35 total participants evaluated. We excluded participants whom the investigator judged were suicidal. We excluded healthy control participants with any Axis I disorder. We administered the 17-item Hamilton Depression Rating Scale (HDRS) (Hamilton, 1960), the Hamilton Anxiety Rating Scale (HARS) (Hamilton, 1969) to all participants, and the BDD-YBOCS to the BDD group.

All participants were free from psychoactive medications for at least eight weeks prior to entering the study, and none were receiving cognitive-behavioral therapy. Participants had normal or corrected vision, as verified by Snellen eye chart.

2.2. Procedures

2.2.1. Stimuli

Stimuli consisted of digital photographs of participants' frontal view, neutral expression faces. We used Adobe Photoshop® CS3 software to create standard black backgrounds for the face and neck and to convert to grayscale. A neutral expression, grayscale photograph of a famous male actor provided one of the control conditions, matched for size and luminosity. We chose the actor based on 100% familiarity and a medium degree of attractiveness (4.25 ± 1.75 on a scale of 0 to 10), as tested prior to the experiment in 10 healthy volunteers. All participants in the study recognized the actor. A low-level baseline control consisted of grey ovals approximately the same size as the faces and of the same luminosity. Participants wore fMRI-compatible goggles to view the stimuli. If participants wore eyeglasses, appropriate corrective lenses for the goggles were inserted. We used MacStim 3.0 (White Ant Occasional Publishing, West Melbourne, Australia) to present stimuli and record responses.

2.2.2. Task

The task consisted of viewing own-face, familiar-face, and oval images while in the MRI scanner. Participants were equipped with a button-box in their right hand and were instructed to push the button whenever the face or oval image disappeared from the screen. This ensured that they attended to the image for its full duration.

Own-face and familiar-face images appeared for 3 s, with a 1 s interstimulus interval following the face stimuli, followed by oval images. Twelve of each of the own-face, familiar-face, and oval images were presented in an event-related design. The order of the own-face and familiar-face stimuli was randomized and jittered with respect to the oval control, to minimize anticipation; the oval randomly occurred for either 3, 6, or 9 s, while the faces all appeared for 3 s. The oval stimuli were jittered to allow varying degrees of deconvolution to occur in visual and emotional processing systems between presentations of face stimuli, as these oval stimuli served as a baseline given that they contained only low-level visual and no emotional features. We used Optseq (<http://surfer.nmr.mgh.harvard.edu/optseq/>), a genetic algorithm, to create jittered presentation timing with the highest efficiency. There were three different sets of stimuli order, which we counterbalanced between participants. Total time for each run was seven minutes. There were two runs per experiment per participant, the second presented in a different order.

2.2.3. Functional MRI

We used a 3-Tesla Allegra (Siemens) MRI scanner to evaluate BOLD contrast, using T2*-weighted echo planar imaging gradient-echo pulse sequence (TR=2.0 s, TE=35 ms, Flip-Angle=90°, Matrix=64 × 64, field-of-view=24 × 24 cm, in-plane voxel size 3.125 mm × 3.125 mm, slice thickness 3 mm, 1 mm intervening spaces,

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