Journal of Psychiatric Research 44 (2010) 1088–1094

Contents lists available at ScienceDirect

Journal of Psychiatric Research

journal homepage: www.elsevier.com/locate/psychires

Inverted face processing in body dysmorphic disorder☆,☆☆

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A R T I C L E I N F O

Article history:
Received 9 November 2009
Received in revised form
17 March 2010
Accepted 23 March 2010

Keywords:
Body dysmorphic disorder
Inverted faces
Face inversion effect
Face processing
Global and local

A B S T R A C T

Individuals with body dysmorphic disorder (BDD) are preoccupied with perceived defects in appearance. Preliminary evidence suggests abnormalities in global and local visual information processing. The objective of this study was to compare global and local processing in BDD subjects and healthy controls by testing the face inversion effect, in which inverted (upside–down) faces are recognized more slowly and less accurately relative to upright faces. Eighteen medication-free subjects with BDD and 17 matched, healthy controls performed a recognition task with sets of upright and inverted faces on a computer screen that were either presented for short duration (500 ms) or long duration (5000 ms). Response time and accuracy rates were analyzed using linear and logistic mixed effects models, respectively. Results indicated that the inversion effect for response time was smaller in BDD subjects than controls during the long duration stimuli, but was not significantly different during the short duration stimuli. Inversion effect on accuracy rates did not differ significantly between groups during either of the two durations. Lesser inversion effect in BDD subjects may be due to greater detail-oriented and piecemeal processing for long duration stimuli. Similar results between groups for short duration stimuli suggest that they may be normally engaging configural and holistic processing for brief presentations. Abnormal visual information processing in BDD may contribute to distorted perception of appearance; this may not be limited to their own faces, but to others' faces as well.

1. Introduction

Body Dysmorphic Disorder (BDD) is a psychiatric disorder in which individuals are preoccupied with an imagined defect of appearance or are excessively concerned about a slight physical abnormality, which causes distress and/or functional impairment (American Psychiatric Association, 2000). BDD affects approximately 1–2% of the population (Faravelli et al., 1997; Koran et al., 2008; Otto et al., 2001; Rief et al., 2006), and is associated with high lifetime rates of psychiatric hospitalization (48%) (Phillips and Diaz, 1997a) and suicide attempts (22–27.5%) (Phillips et al., 2005; Phillips and Diaz, 1997a; Phillips and Menard, 2006; Veale et al., 1996). Previous studies estimate that 27–60% are delusional in their beliefs (Mancuso et al., 2010; Phillips, 2004). Individuals with BDD tend to engage in repetitive and compulsive behaviors such as checking their appearance in the mirror and scrutinizing details of others' appearances to compare to their own (Phillips, 2005). Despite the prevalence and severity of the disorder, relatively little is known about the pathophysiology underlying various symptom domains.

Clinical observation and neuropsychological data suggest that abnormal information processing may underscore the apparent perceptual abnormalities in BDD. Clinically, they often focus on details of their appearance, frequently involving their faces, at the expense of global or configural aspects. A neuropsychological study using the Rey–Osterrieth Complex Figure Test demonstrated that BDD patients performed poorly relative to controls due to differences in organizational strategies including selective recall of details instead of larger organizational design features (Deckersbach et al., 2000). Individuals with BDD may also have abnormalities in own-face processing, as evidenced by a study in which they perceived distortions that were not actually present (Yaryura-Tobias et al., 2002). Moreover, studies by Buhlmann et al.

☆ Funding for this study was provided by the NIMH and the Obsessive–Compulsive Foundation.
☆☆ Results presented in part at the 16th Annual Obsessive Compulsive Foundation Conference; August 7th, 2009: Minneapolis MN.
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doi:10.1016/j.jpsychires.2010.03.015

(2004, 2006) found abnormalities in emotional face processing in BDD consisting of recognition biases and/or misinterpretation of faces that were perceived as contemptuous or otherwise negative (Buhlmann et al., 2006,2004). Whether these recognition biases or misinterpretations are the result of abnormalities in visual processing is not clear.

In general, face processing is an important function of the brain, underscored by how critical it is for social functioning. Efficient face processing relies both on featural and configural information (Moscovitch et al., 1997). Featural information about faces includes details such as skin smoothness, blemishes, lines, hair texture, etc. and is conveyed by high spatial frequency information (Norman and Ehrlich, 1987; Schyns and Oliva, 1999). Configural information includes basic spatial relationships of features (e.g. eyes above the mouth), distances between features, and holistic elements (i.e. the face as one percept) (Maurer et al., 2002) and is conveyed by low spatial frequency information (Costen et al., 1996; Sergent, 1985). At short viewing durations lower spatial frequencies are primarily processed (Breitmeyer, 1975; Breitmeyer and Ganz, 1977), as they occur on a faster timescale than processing of high spatial frequencies (Peyrin et al., 2006; Schyns and Oliva, 1994). In addition, no more than two eye fixations typically occur for exposure durations of 500 ms or less, while detail processing is serial in nature and requires multiple eye fixations and therefore longer viewing times (Castelhano et al., 2009; Hsiao and Cottrell, 2008).

In healthy adults, viewing inverted faces impairs recognition, which is believed to be the result of disrupted configural processing. Yin (1969) first reported that inversion of faces, but not objects, disrupted behavioral performance on a recognition task (Yin, 1969). This “face inversion effect” is defined as the difference in performance between upright and inverted photographs of faces (Farah et al., 1995; Leder and Bruce, 2000; Valentine, 1988). This most likely occurs because the presence of a general structure or uniform set of features allows for a configural template for efficient processing of different faces, although variations exist between individual faces (Freire et al., 2000). However, this template does not apply when faces are inverted; individuals may then have to rely more on the faces’ component parts. The face inversion effect is eliminated in healthy controls when they are forced to learn the faces in terms of their component parts and then asked to recognize them when inverted (Farah et al., 1995). This supports the idea that the face inversion effect is dependent on holistic processing of upright images.

Another study demonstrated that, given longer exposure to the stimuli, subjects experienced an increased ability to recognize inverted faces (Barton et al., 2001). This suggests that configural, or global, processing provides an advantage over component, or local, processing only given stimuli with shorter presentation times, and that longer times may allow for part decomposition.

Clinical observation and neuropsychological and neuroimaging studies suggests the hypothesis that individuals with BDD may have an abnormal propensity towards detail processing, and/or abnormalities in configural/holistic processing. If so, then they may also demonstrate less of a face inversion effect than healthy controls. To our knowledge, no study to date has tested the face inversion effect in BDD subjects.

The objective of this study was to investigate the face inversion effect in a cohort with BDD compared to healthy controls, in order to understand global (holistic) and local (detailed) processing of faces. The experiment included both short and long duration of stimuli in order to test differential abnormalities in global and/or local processing, respectively. BDD subjects and healthy controls engaged in a recognition task consisting of upright and inverted faces, and response times and accuracy were recorded and analyzed. We hypothesized that individuals with BDD would have less of an inversion effect on response time and accuracy than controls for long duration stimuli, reflecting a greater propensity for local visual processing, but not for the short duration, reflecting no differences for global processing at short stimulus times.

2. Method

2.1. Participants

Eighteen right-handed BDD patients and 17 healthy controls, matched for gender, age, handedness, and years of education, were recruited from the community and participated in the study. The investigation was carried out in accordance with the latest version of the Declaration of Helsinki and the study design was reviewed and approved by the Institutional Review Board at UCLA. We obtained informed consent of the participants after fully explaining the nature of the procedures. All BDD subjects met the Diagnostic and Statistical Manual (DSM-IV) criteria for Body Dysmorphic Disorder, using the Body Dysmorphic Disorder Module (Phillips et al., 1995), a reliable and standard diagnostic module modeled after the Structured Clinical Interview for DSM. All BDD subjects were required to have a Body Dysmorphic Disorder version of the Yale-Brown Obsessive–Compulsive Disorder Scale (BDD–YBOCS) score of $\geq$20. The BDD–YBOCS is a validated scale that is a widely-used standard to evaluate symptom severity in BDD, with a range of scores from 0 to 48 (Phillips et al., 1997c). It has excellent interrater and test-retest reliability (intra-class correlation coefficients for total score = .99 and .88, respectively), internal consistency (Cronbach’s alpha = .80), and convergent validity ($r = .55$ with the CGI) (Phillips et al., 1997b). In addition to the BDD–YBOCS, we also administered the Hamilton Depression Rating Scale-17 (Hamilton, 1960) and the Hamilton Anxiety Rating Scale (Hamilton, 1969), which have similar standards for validity and reliability. We performed a clinical psychiatric evaluation on all participants and administered the Mini International Neuropsychiatric Inventory (MINI) (Sheehan et al., 1998) to screen for comorbid diagnoses. Subjects with comorbidity of any current (or lifetime for psychotic disorders and bipolar disorder) Axis I disorders were excluded, with the exception of major depressive disorder, dysthymia, and generalized anxiety disorder. As depression and anxiety are so frequently comorbid in this population, we believed it would not be a representative sample to exclude these. We excluded subjects whom the investigator judged were suicidal. Other exclusion criteria for both subjects and controls were active substance abuse, current neurological disorder with or without medication, pregnancy, or any current medical disorder that may affect cerebral metabolism. All subjects had normal or corrected-to-normal visual acuity, as verified by the Snellen eye chart.

2.2. Stimuli

Stimuli consisted of grayscale photographs of neutral-expression faces of men and women of average attractiveness, from the Psychological Image Collection at Stirling (http://pics.psych.stir.ac.uk/). We obtained attractiveness ratings of the face stimuli from a separate set of 8 healthy controls, and eliminated the two highest and two lowest outlier faces, to minimize interference in processing that might result from the BDD subjects reacting emotionally to very attractive or unattractive faces. The mean attractiveness ratings for the faces ($\pm$SD) on a Likert scale of 0–10 was 3.95 $\pm$ .88. Photos were cropped to an oval to remove clothing and hair.

We also created “incorrect selection” faces by morphing of each of the 28 individual “correct selection” faces 50% with another gender-matched face using FantaMorph (Abrosoft http://www.fantamorph.com/), and then equalizing the luminance (Fig. 1).