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Review article

The neurobiology of body dysmorphic disorder: A systematic review and theoretical model

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ABSTRACT

There has been an increase in neuroimaging research in body dysmorphic disorder (BDD), yet little is known about the underlying neurobiological basis of the disorder. We aimed to provide a systematic overview of the literature on the neurobiology of BDD. Two reviewers undertook a search of three electronic research databases: PubMed, PsycINFO, and Google Scholar. The search consisted of synonyms commonly associated with BDD and methods to evaluate brain structure, function, and network organisation. Out of an initial yield of 175 articles, 19 fulfilled inclusion criteria and were reviewed. We identified differences in brain activity, structure, and connectivity in BDD participants in frontostriatal, limbic, and visual system regions when compared to healthy control and other clinical groups. We put forth a neurobiological model of BDD pathophysiology that involves wide-spread disorganisation in neural networks involved in cognitive control and the interpretation of visual and emotional information. This review considers how this model might aid in the development of future research and understanding of BDD.

1. Introduction

Body dysmorphic disorder (BDD) is a psychiatric illness with relatively unknown aetiology despite reported lifetime prevalence rates of 1.7–2.4% (Buhlmann et al., 2010). The disorder is characterised by distress and markedly excessive preoccupation with perceived flaws and defects in physical appearance which are unobservable to others (Castle et al., 2006; Phillips et al., 2005). These preoccupations are typically focused on the face, skin, hair, or nose; however, concerns may be reported for any aspect of the body, and often encompass numerous aspects of body image (Veale et al., 1996). The symptom profile of BDD comprises repetitive thoughts, feelings, and compulsive behaviours in response to appearance concerns. The ritualistic nature of this symptom profile has led to the classification of BDD as an Obsessive-Compulsive and Related Disorder (OCRD), alongside obsessive-compulsive disorder (OCD) (American Psychiatric Association, 2013). Quality of life is markedly poor in BDD cohorts with patients exhibiting significant distress, disability, extreme cosmetic surgery, suicidal ideation, and high rates of suicide attempts (DeMarco et al., 1998; Marazziti et al., 2006; Phillips and Menard, 2006).

Due to the highly sensitive and personal nature of symptoms, BDD often goes undiagnosed or misdiagnosed as another disorder, leading to ineffective care and psychiatric treatment (Phillips, 2004). Perhaps, as a result, despite high rates of prevalence and chronicity, relatively little is known about the underlying neurobiology and aetiological origins of the disorder. In this article, we describe a systematic review of extant neuroimaging research in BDD, and through collation of their findings, we put forward an up-to-date neurobiological model of BDD. Conclusions drawn from neuroimaging research may inform the development of targeted identification and treatment strategies.

1.1. Objectives

Focusing on neuroimaging and psychophysiological research, we aimed to provide insight into the pathogenic mechanisms of BDD and highlight important directions for future research. We summarised these results in an updated neurobiological model of BDD.

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2. Methods

2.1. Search strategy

Article selection was conducted according to the PRISMA guidelines (Moher et al., 2009; Shamseer et al., 2015; see Supplementary material I). The literature was searched using the PubMed, PsycINFO, and Google Scholar databases, and by additional hand searches through reference lists and specialist OCD and body image journals. The following search terms were used: ("body dysmorphic disorder" OR "body dysmorphia" OR BDD or "body dysmorphic*") AND (neuro* OR brain OR neurobiology OR neuroimaging) OR (EEG OR electroencephalography OR magnetoencephalography OR MEG OR SPECT OR PET OR "magnetic resonance imaging" OR MRI OR fMRI OR "Diffusion Tensor Imaging" OR functional OR structural OR connectomics OR network). All studies before December 2016 were included.

2.2. Study selection and eligibility criteria

Two authors (SG and RK) screened all titles and abstracts in the electronic databases. Studies were included if they met the following eligibility criteria: (1) the full-text was published in the English language; (2) used only human participants; (3) the clinical group was diagnosed according to DSM criteria; (4) a healthy control group had to be present; and (5) used clinical populations with BDD and not non-clinical populations with BDD symptoms. Articles were excluded that: (1) used a single case-report; and (2) were reviews or meta-analyses of the literature. Only peer-reviewed original articles were included. A qualitative approach was chosen in place of quantitative methodologies, such as meta-analysis, as the information needed to compute effect sizes was limited due to the small number of neuroimaging investigations available in BDD research to date.

2.3. Risk of bias in individual studies

In observation of PRISMA guidelines, we chose the Cochrane Collaboration tool for examining study bias (Higgins et al., 2011). Two authors (SG and RK) independently conducted quality ratings for the included studies, with discrepancies resolved by discussion.

3. Results

3.1. Study selection

The electronic database search provided a total of 2037 records, and 1959 remained after removal of duplicates. After reviewing article titles and abstracts, 1892 were excluded based on identifying at least one feature of the article that warranted exclusion. A total of 31 articles were selected for full-text review, after which 21 studies were identified for inclusion in this systematic review. A flowchart of this selection process is displayed in Fig. 1.

3.2. Study characteristics

The following data were extracted from all selected papers: patient characteristics, including sample size, age and gender distribution, handedness, medication use, patient comorbidities; the procedure and design of the relevant neuroimaging technique; and brain regions implicated in the significant findings of the study. All studies were published between 2003 and 2016 and, except for two studies, most studies were performed by three research centres (University of California, Stanford University and Swinburne University/St Vincent's Hospital).

Among the neuroimaging methods available, magnetic resonance imaging (MRI) is the most widely employed in BDD research, with 18 out of the 19 studies utilising functional or structural MRI. Based on the use of structural and morphometric MRI methods, six studies

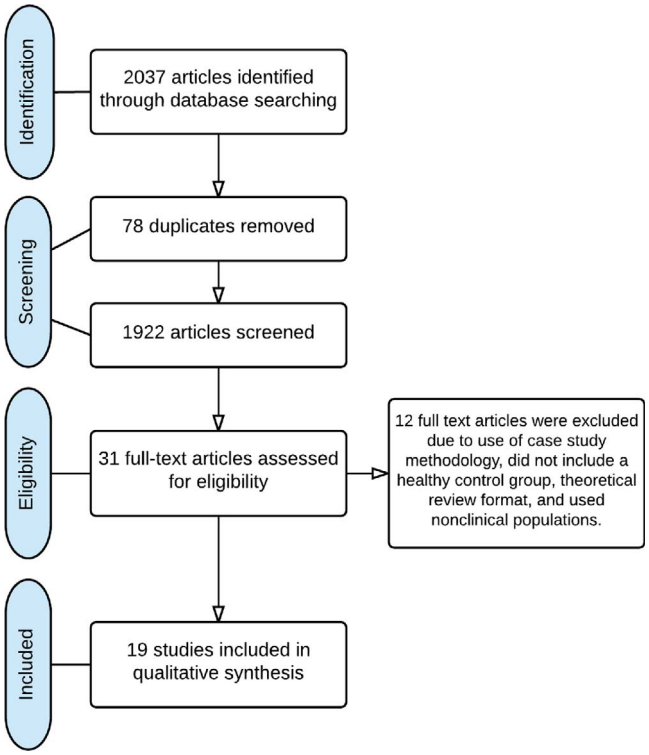

Fig. 1. PRISMA flow diagram of the article screening and selection process. Article selection was conducted in accordance with PRISMA guidelines for reporting systematic reviews (Moher et al., 2009).

investigated structural brain differences in BDD (Table 1). Six studies investigated functional differences using functional MRI (fMRI) or EEG (Table 2), and six studies examined functional network organisation and white matter connectivity in BDD using white matter tractography or functional connectivity analysis (Table 3). One study examined psychopharmacological characteristics *in vivo* using Single Photon Emission Computed Tomography (SPECT) (Table 4). These articles yielded a total of 198 BDD patients, of which three patients (1.5%) were left-handed, 62 patients (32%) were males, and the age range was 18–65 years. The vast majority of patients (79%) were unmedicated and had a comorbid mental disorder, most commonly major depressive disorder, generalised anxiety disorder or dysthymia.

3.3. Risk of bias within studies

Overall, bias in study methodology was low (see Supplementary material II), however, upon review of patient characteristics, there was substantial overlap in the patient cohort used across all of the included studies: Bohon et al. (2012); Feusner et al. (2010b); Leow et al. (2012) used the same sample; Buchanan et al. (2014); Buchanan et al. (2013); Grace et al. (2017) used the same sample; Feusner et al. (2007); Feusner et al. (2009); Li et al. (2015a,b) used the same sample; and Arienzo et al. (2013); Feusner et al. (2013) used the same sample.

3.4. Study synthesis

3.4.1. Structural brain differences

Table 1 provides detailed methodological information and summarises findings of the six studies that report on structural MRI. Total sample sizes range from 8 to 49 BDD patients, adding up to a total of 197 individuals, including 101 patients and 96 controls.

Of the six studies of brain morphometry in BDD, two found greater total white matter volumes (Atmaca et al., 2010; Rauch et al., 2003), and one found decreased total grey matter (Buchanan et al., 2014).