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Interoceptive sensitivity deficits in women recovered from bulimia nervosa

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ABSTRACT

Self-report studies suggest that patients with bulimia nervosa (BN) evidence difficulties with interoceptive awareness. Indeed, interoceptive deficits may persist after recovery of BN and may be a biological trait that predisposes symptom development in BN. However, no studies to date have directly assessed interoceptive sensitivity, or accuracy in detecting and perceiving internal body cues, in patients with or recovered from BN. Nine women who had recovered from BN and 10 healthy control women completed the Heart Beat Perception Task (HBPT) in which individuals were required to estimate the number of heartbeats between intervals of time. Accuracy scores were compared between groups. Significant differences were found between the groups on the HBPT ($(F_{1,19}) = 7.78$, $p = .013$, Cohen's d = 1.16) when controlling for age. These results suggest that deficits in interoceptive sensitivity are present in individuals recovered from BN. Thus interoceptive deficits may be one factor that bridges the gap between brain dysfunction and symptom presentation in BN.

1. Introduction

Bulimia nervosa (BN) is a serious psychiatric disorder that causes significant and costly medical problems. The financial costs associated with treating BN are high (Stuhldreher et al., 2012). BN also has one of the highest mortality rates of all psychiatric disorders, estimated to occur in 3.9% of cases (Crow, Frisch, et al., 2009; Crow, Peterson, et al., 2009). Despite the fact that 1.5% of the population develops BN during his or her lifetime, mechanisms underlying symptom presentation in BN are poorly understood (Hudson, Hiripi, Pope, & Kessler, 2007). Evidence for the effectiveness of treatment for BN is accumulating (Brown & Keel, 2012), however, it remains important to improve the understanding of the psychophysiology of BN. New research, for example, suggests that BN has biological and genetic components (Hinney, Scherag, & Hebebrand, 2010), however, little research has been conducted to better understand the role that biological processes play in the development and maintenance of symptoms in BN. More research in this area is clearly required in order to develop better treatments and prevention strategies.

Key symptoms that characterize BN are eating a large amount of food in a short period of time, the experience of a loss of control and the use of compensatory behaviors such as vomiting (American Psychiatric Association, 1994). Bruch was the first to suggest that such symptoms result from "disturbances in accuracy of perception or cognitive interpretation of stimuli arising from the body" (Bruch, 1962, p. 189). In the eating disorder field, these disturbances have been described as problems in interoceptive awareness (Garfinkel, Moldofsky, Garner, Stancer, & Coscina, 1978). Recently, interoceptive sensitivity has been studied and refers to "the ability to perceive consciously signals arising from the body" (Pollatos, Fustos, & Critchley, 2012, p. 1680). Disturbances in detecting and/or interpreting stimuli from the body, particularly hunger and satiety cues, could directly contribute to the development and maintenance of symptoms such as restrictive eating, binging and purging in BN. Difficulties in detecting and interpreting stimuli from the body could lead to misinterpretation of hunger and satiety cues. Binging and purging symptoms may reflect a difficulty in internally regulating misinterpreted hunger and satiety cues. Research on the neurobiological basis of interoception suggests that interoceptive processing occurs in several stages and follows a posterior to anterior physical progression in the insula cortex. Physiological cues involved in maintaining internal homeostasis are thought to be detected without conscious awareness in the posterior portion of the insula. Further, it has been suggested that interoceptive awareness occurs as these signals are processed into the anterior insula as an individual reflects upon his or her physical state (Craig, 2009).

Numerous studies exploring various biological aspects of BN suggest that possible interoceptive deficits are involved in the development and maintenance of BN. For example, several studies have demonstrated that the threshold for detecting body cues in BN is higher than in controls; therefore, those with BN appear to require more intense stimuli in order to detect a baseline level of stimulation. These studies suggest that interoceptive deficits may be present and have examined pain

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processing, hunger, satiety, sensitivity to gastric distention, and taste detection in BN (De Zwaan, Biener, Bach, Wiesnagrotzki, & Stacher, 1996; Geliebter & Hashim, 2001; Kissileff et al., 1996; Lautenbacher, Pauls, Strian, Pirke, & Krieg, 1991; Papezova, Yamamotova, & Uher, 2005; Rodin, Bartoshuk, Peterson, & Schank, 1990; Stein et al., 2003; Sunday & Halmi, 1990; Zimmerli, Walsh, Guss, Devlin, & Kissileff, 2006). Findings are consistent with neuroimaging studies in BN that have indicated decreased activation in both the posterior and anterior insula in those currently with BN (Bohon & Stice, 2011) and increased activation in the anterior insula in women recovered from BN (Oberndorfer et al., 2013). Therefore, interoceptive processing deficits may be related to abnormal functioning in interoceptive neural networks.

Prior to this study, disturbances in interoception have been assessed in BN by a self-report measure (the Interoceptive Awareness scale on the Eating Disorder Inventory); results suggest that those with BN have lower scores than controls when measured by this subscale (Fassino, Piero, Gramaglia, & Abbate-Daga, 2004; Lilenfeld, Wonderlich, Riso, Crosby, & Mitchell, 2006; Pryor, Wiederman, & McGilley, 1996; Taylor, Parker, Bagby, & Bourke, 1996). However, to date, no studies have used an objective physiological measure to assess the biological aspects of interoception in BN, which is important for reliability and validity.

And, although there are proposed physiological processes that are related to disturbed interoception in BN, no studies to date have directly assessed interoceptive sensitivity in BN. The gold standard task for assessing interoception deficits, and specifically interoceptive sensitivity, is the Heart Beat Perception Task (HBPT). The HBPT assesses one's accuracy in detecting and perceiving his or her heartbeats (Schandry, 1981). Individuals with anxiety disorders, particularly panic disorder, have shown increased accuracy in heartbeat detection whereas individuals with anorexia nervosa have demonstrated decreased accuracy in heartbeat detection (Domschke, Stevens, Pfleiderer, Gerlach, 2010; Pollatos et al., 2005). In healthy adults, studies have shown that accurate performance on the HBPT task activated both posterior and anterior regions of the insula (Pollatos, Gramann, & Schandry, 2007; Pollatos et al., 2008; Wiens, 2005). Additionally, HBPT scores have been shown to correlate with right insula volume in healthy adults (Critchley, 2005). The HBPT can be considered to measure one's ability to detect internal interoceptive stimuli without confounding by competing external stimuli such as in pain, gastric, and taste processing. In addition, the HBPT is simple to administer, and an EKG is the only piece of equipment needed to complete the task. This task can, therefore, be administered in clinical settings and in non-medical facility laboratories.

In this study, women recovered from BN (BN-R) were studied in order to control the confounding effects of binge–purge symptoms. Physiological effects of active binging and purging include longer QTc intervals as measured on an EKG, changes in blood sugar levels, EEG abnormalities, abdominal and urinary disturbances, dental problems and inflammation of the esophagus (Peebles, Hardy, Wilson, & Lock, 2010). Physiological effects of active restricting, binging and purging, particularly EKG abnormalities, may confound one's ability to detect and perceive his or her heart beat.

In order to understand the biological traits that may lead to the development of BN, we chose to study interoceptive sensitivity using the HBPT in BN-R. Interoceptive sensitivity in BN is important to study since directly measuring the interoceptive sensitivity of non-food related body cues in BN could help elucidate whether disturbances in interoception are due to intentional repression of food related body cues or organic global interoceptive deficits. Such disturbances in detecting and/or interpreting stimuli from the body, particularly hunger and satiety cues, could directly contribute to the development and maintenance of symptoms such as restrictive eating, binging and purging in BN. Therefore, interoception is important to study. We hypothesized that BN-R would display deficits on the HBPT task relative to healthy control participants, therefore, suggesting that interoceptive sensitivity deficits are present after symptom resolution in BN.

2. Materials and methods

2.1. Participants

Participants were women recovered from BN (BN-R; n = 9) and healthy control participants (HC; n = 10), between the ages 18 to 45 years. We chose to study only women as eating disorders among males are relatively rare (10%) and have atypical features (Mangweth-Matzek et al., 2010). BN-R were recruited nationally via postings on national eating disorder websites, treatment program websites, flyers distributed at eating disorder conferences, and flyers sent to local eating disorder therapists as part of a larger fMRI study (data presented elsewhere). BN-R participants met a lifetime DSM-IV diagnosis of BN with no history of anorexia nervosa. The onset of their illness must have occurred at least 4 years prior to their participation in this study. This criterion was implemented in order to prevent the possible conversion from anorexia to BN, therefore, guaranteeing a diagnostically "pure" BN group. The participants were considered recovered if no eating disorder behaviors or symptoms were reported by the potential participant during a structured interview to be present within 12 months prior to the start of the study. Eating disorder behaviors included food restriction, any binging, or purging. Additionally, the participants maintained a stable weight (±3.0 kg) between 90% and 120% absolute body weight and had a regular menstrual cycle within 12 months prior to the study. These criteria for recovery have been used to assess recovery in patients who previously met the criteria for BN in other published studies by this research group (Frank et al., 2007). Healthy control women were recruited locally via posting distributed throughout San Diego county and did not display current or previous psychopathology as determined by structured interviews (see below). Inclusion criteria for this group also included maintaining an absolute body weight between 90% and 120% of their ideal body weight since menarche and a lack of family members with an eating disorder history.

Exclusionary criteria for all participants included a) history of alcohol or substance abuse/dependence; b) any neurological/medical conditions; c) use of psychotropic medication within the three months prior to the study (participants were permitted to use birth control and over the counter medications for minor pain and allergies); and d) pregnancy. BN-R and healthy control participants were demographically matched on ethnicity. Participant demographics are presented in Table 1.

2.2. Procedures

The study was approved by the University of California, San Diego Institutional Review Board and informed consent was obtained from all participants. The participants completed a brief phone screen that was administered by a trained research associate. If initial criteria were met, the participants were administered with the Structured Clinical Interview for the DSM-IV (SCID; First, Spitzer, Gibbon, & Williams, 2002), Module H of the SCID (First et al., 2002), the Yale Brown Obsessive Compulsive Scale (YBOCS; Goodman et al., 1989) and the Yale Brown Cornell Eating Disorder Scale (YBC-EDS; Mazure, Halmi, Sunday, Romano, &

Table 1
Sample demographic/clinical data.

Demographic	BN-R	Controls	
	M (SD)	M (SD)	*p*
Average BMI	21.86 (0.48)	21.86 (0.56)	$p > .05$
Lowest lifetime BMI	19.80 (1.25)	21.8 (3.70)	$p > .05$
Highest lifetime BMI	24.89 (2.67)	23.3 (2.14)	$p > .05$
Age of onset	15.78 (2.05)	N/A	N/A
Average years of recovery	8.08 (4.16)	N/A	N/A
Age	30.00 (8.67)	22.70 (2.11)	$p = .02$
Percentage Caucasian	67%	80%	$p > .05$
Percentage Asian	33%	20%	$p > .05$