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The Power Within: The Experimental Manipulation of Power Interacts with Trait BDD Symptoms to Predict Interoceptive Accuracy

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Abstract

Background and Objectives—This study tested whether relatively low levels of interoceptive accuracy (IAcc) are associated with body dysmorphic disorder (BDD) symptoms. Additionally, given research indicating that power attunes individuals to their internal states, we sought to determine if state interoceptive accuracy could be improved through an experimental manipulation of power.

Method—Undergraduate women (N = 101) completed a baseline measure of interoceptive accuracy and then were randomized to a power or control condition. Participants were primed with power or a neutral control topic and then completed a post-manipulation measure of state IAcc. Trait BDD symptoms were assessed with a self-report measure.

Results—Controlling for baseline IAcc, within the control condition, there was a significant inverse relationship between trait BDD symptoms and interoceptive accuracy. Continuing to control for baseline IAcc, within the power condition, there was not a significant relationship between trait BDD symptoms and IAcc, suggesting that power may have attenuated this relationship. At high levels of BDD symptomology, there was also a significant simple effect of experimental condition, such that participants in the power (vs. control) condition had better interoceptive accuracy. These results provide initial evidence that power may positively impact interoceptive accuracy among those with high levels of BDD symptoms.

Limitations—This cross-sectional study utilized a demographically homogenous sample of women that reflected a broad range of symptoms; thus, although there were a number of participants reporting elevated BDD symptoms, these findings might not generalize to other populations or clinical samples.

Conclusions— This study provides the first direct test of the relationship between trait BDD symptoms and IAcc, and provides preliminary evidence that among those with severe BDD

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symptoms, power may help connect individuals with their internal states. Future research testing the mechanisms linking BDD symptoms with IAcc, as well as how individuals can better connect with their internal experiences is needed.

Keywords

interoceptive accuracy; power; body dysmorphic disorder symptoms

Body dysmorphic disorder (BDD) is characterized by an intense preoccupation with and shame regarding perceived flaws in one's physical appearance (American Psychiatric Association, 2013). Unlike the focus on overall weight and shape seen in eating disorders, concerns in BDD tend to be focused on specific body features such as one's hair, nose, or skin (Phillips, 2005). Importantly, the shame and preoccupation associated with BDD leads to significant distress and/or impairment, in spite of the fact that perceived flaws in one's appearance are either not observable or appear very slight to others (APA, 2013; Buhlmann & Wilhelm, 2004). Hence, there is a discrepancy between perceived and objective appearance.

The present study investigated this paradox in perception by evaluating interoceptive accuracy (IAcc)—or the ability to accurately detect internal bodily sensations (Garfinkel, Seth, Barrett, Suzuki, & Critchley, 2015)—as a correlate of BDD symptoms.¹ We hypothesized that in addition to biased perceptions of their physical appearance, those high in BDD symptoms might also be out of touch with their inner bodily experience, resulting in relative deficits in IAcc. Additionally, given the established importance of interoception to emotion and psychological well-being (e.g., Damasio, 1998; Pollatos, Herbert, Matthias, & Schandry, 2007; Wiens, Mezzacappa, & Katkin, 2000), we also attempted to temporarily improve interoceptive accuracy with an experimental manipulation of power that has been found to sensitize people to their inner states (e.g., Guinote, 2010). Since power improves many of the psychological deficits at the root of BDD symptoms (e.g., low self-esteem, self-criticism, negative self-perceptions; Phillips, 2005; Fast, Sivanathan, Mayer, & Galinsky, 2012; Kifer, Heller, Perunovic, & Galinsky, 2013; Wojciszke & Struzynska-Kujalowicz, 2007), those high in BDD symptoms may have the most to gain from the psychological experience of power. Thus, we tested whether power's capacity to improve state interoceptive accuracy would increase with BDD symptom severity.

Interoceptive Accuracy and BDD Symptoms

Integrating external and internal cues may be important in body image formation. For instance, researchers found that individuals who had poorer interoceptive accuracy, assessed with a heartbeat monitoring task, were more likely to be tricked into believing that a rubber hand was a part of their body, as compared to those with better interoceptive accuracy (Tsakiris, Tajadura-Jimenez, & Costantini, 2011). This finding illustrates a basic disconnect between body representation and inner, tactile experiences for those low in IAcc. Moreover,

¹Note that although this study focused on interoceptive accuracy, recent research suggests that there are meaningful distinctions between aspects of interoception. In particular, Garfinkel et al. (2015) outline differences between interoceptive accuracy (i.e., internal assessments of physiological indices like heart rate) vs. interoceptive sensibility (i.e., self-evaluated interoception ability) vs. interoceptive awareness (i.e., confidence-accuracy relationship).

this disconnect with inner experiences suggests that those low in interoceptive accuracy are vulnerable to external influences that may undermine accurate body image and contribute to BDD symptoms. In contrast, those with the capacity to “anchor” their body image and sense of self by integrating accurate information about their internal cues, such as the steadiness of their breathing or heart rate, are presumably less influenced by potentially harmful external information. Consistent with this idea, researchers have found that although individuals with BDD ($n=17$) did not differ from healthy controls ($n=17$) or individuals with schizophrenia ($n=17$) in susceptibility to the rubber hand illusion (i.e. being tricked into believing a rubber hand was a part of their own body), significant positive correlations existed between participants’ susceptibility to the rubber hand illusion and BDD-relevant symptoms and traits such as body dissatisfaction (Kaplan, Enticott, Hohwy, Castle, & Rossell, 2014). Further, positive associations trending towards significance were found between susceptibility to the illusion and dysmorphic concerns. Although speculative, one explanation for these findings is that interoceptive accuracy may connect people with their inner emotional and physiological experiences (e.g., Damasio, 1998), and armor them against the types of external influences that can otherwise undermine body perception and satisfaction (e.g., Thompson & Stice, 2001).

By comparison, diminished interoceptive accuracy may partially explain why individuals with heightened BDD symptoms persist in having such distorted negative views of their physical appearance. For instance, poor interoceptive accuracy could inadvertently lead someone with BDD to focus more on what his nose or skin *visually* looks like, as opposed to how it *feels* on his face. This is problematic because individuals with little internal input to ground their sense of self will presumably be more likely to “over-focus” and fixate on the small visual details and perceived flaws of their noses (or skin, hair, etc.). Indeed, this lack of connection to one’s internal experience may be one reason that cognitive-behavioral models of BDD predict that individuals “interpret normal visual input, such as minor flaws, in a biased way that results in further negative mental, emotional, and behavioural consequences” (Wilhelm & Neziroglu, 2002, p. 210; see also Buhlmann & Wilhelm, 2004). In other words, it may be that relative deficits in interoceptive accuracy make it difficult to effectively process physical cues like hair and skin due to a disconnect between the self and one’s inner physiological states. Further, consistent with cognitive-behavioral conceptualizations of BDD that emphasize that body image is “constructed” (Veale, 2001), one who lacks the ability to synthesize external and internal cues may be more susceptible to catastrophic misinterpretations (e.g., “my date thinks I’m hideously unattractive”) and subsequently, unhealthy behavioral patterns (e.g., avoidance and social withdrawal).

Interoceptive Accuracy and Power

In addition to evaluating the link between BDD symptoms and interoceptive accuracy, we also employed a subtle power manipulation with the goal of temporarily enhancing state IAcc. Social psychological research demonstrates that power—operationally defined as asymmetric control over interpersonal resources (see Fiske, 1993; Overbeck, 2010)—fundamentally changes cognition and behavior (see Keltner, Gruenfeld, & Anderson, 2003; Magee & Smith, 2013 for review). When people have power over others, their access to social and material resources increases and they are immunized to the actions, evaluations,

and objections of others. Consequently, by providing individuals with the capital to achieve their goals and freeing them from the sanctions of others, power attunes people to their inner states. This theoretical prediction is supported by a wealth of empirical evidence that illustrates that objective and imagined social power puts people in touch with their emotions, attitudes, goals, and even some physiological states (e.g., Galinsky, Magee, Gruenfeld, Whitson, & Liljenquist, 2008; Guinote, 2010; Hecht & LaFrance, 1998). For instance, compared to controls, hungry people eat and happy people smile more when in power (Guinote, 2010; Hecht & LaFrance, 1998). Power increases flirtatiousness among sexually unrestricted individuals, selfishness among the egocentric, and responsibility among communally-oriented people (Chen, Lee-Chai, & Bargh, 2001; Kunstman & Maner, 2011). Power amplifies self-directed goal pursuit and sensitizes individuals to personal states (e.g., Chen et al., 2001; Guinote, 2010; Kunstman & Maner, 2011). In keeping with this past work, we predict that like other personal cues, power will also increase sensitivity to bodily states like breathing and heart rate, ultimately leading to temporary increases in state interoceptive accuracy.

In addition to sensitizing individuals to their inner states, power has also been shown to improve mental health and reduce maladaptive behaviors. For instance, among healthy samples, experimental manipulations of power increase positive affect, self-esteem, and well-being, satisfy basic psychological needs for autonomy, choice, and personal control, and reduce self-criticism and negative self-perceptions (Briñol, Petty, Valle, Rucker, & Becerra, 2007; Fast, Gruenfeld, Sivanathan, & Galinsky, 2009; Fast et al., 2012; Inesi, Botti, Dubois, Rucker, & Galinsky, 2011; Kifer et al., 2013; Magee & Galinsky, 2008; Wojciszke & Struzynska-Kujalowics, 2007). Power has even been shown to decrease caloric restriction among those at risk for developing eating disorders (Kunstman, Smith, & Maner, 2014). Collectively, this research suggests that power leads people to see the best in themselves while simultaneously reducing both self-criticism and compensatory behaviors associated with mental illness. Based on the suggestive evidence from these healthy samples, the psychological experience of power may be particularly beneficial for those high in BDD symptoms, because power attenuates the negative affect and self-criticism that is fundamental to this disorder (Phillips, 2005). Consistent with this theorizing, it may be that power increases state interoceptive accuracy most for those high in BDD symptoms.

Summary and Study Aims

To summarize, the goals of the present study are twofold. First, we investigated whether BDD symptoms, assessed in a variety of ways, are negatively associated with interoceptive accuracy. Second, controlling for baseline IAcc, we tested whether the psychological experience of power can temporarily improve state interoceptive accuracy, especially among those with high (vs. low) levels of pre-existing, trait BDD symptoms. We predicted that in the control condition BDD symptoms would be inversely related with IAcc. However, we expected that this negative relationship would be weakened in the power condition. Moreover, we hypothesized that among those especially high in BDD symptoms, power would increase state interoceptive accuracy compared to control. We tested these hypotheses in a lab study in which participants completed a baseline measure of interoceptive accuracy

and then were either primed with power or a neutral control topic and then completed a post-manipulation measure of IAcc.

Method²

Participants

Given the primary aims of this study, participants were only included if they had baseline and post-manipulation interoceptive accuracy data. Data from five participants were lost due to machine malfunction, unreadable data, and/or experimenter error. This resulted in a final sample of 101 undergraduate women who completed this study in exchange for course credit. See Table 1 for sample characteristics, reported by condition.

Materials

BDD and depression and anxiety symptoms—The 7-item *Dysmorphic Concerns Questionnaire* (DCQ; Oosthuizen, Lambert, & Castle, 1998) has been validated as a brief, sensitive, and specific screening measure of trait-level BDD symptoms (Mancuso, Knoesen, & Castle, 2010). In the current sample ($M=6.14$, $SD=4.23$, $range=0-18.0$), the scale demonstrated good reliability ($\alpha = .87$). The 4-item *Patient Health Questionnaire-4* (PHQ-4; Löwe et al., 2010) was included to screen for Condition differences in anxiety and depression ($\alpha = .80$).

Power Manipulation—Power was manipulated with a word search puzzle, as well as an experiential writing prime developed by Galinsky and colleagues (2003) to induce a state of high-power. Specifically, participants were first asked to work on a word search puzzle for 3 minutes; participants in the power condition completed a word search puzzle containing words associated with power (e.g., authority, dominance, control), whereas participants in the control condition completed a word search puzzle containing neutral words (e.g., pencil, chair, dog). For the next five minutes, participants in the power condition wrote in detail about a time they had power over others whereas participants in the control condition wrote about a neutral topic. Specifically, participants in the power condition responded to the following prompt:

Please recall a particular incident in which you had power over another individual or individuals. By power, we mean a situation in which you controlled the ability of another person or persons to get something they wanted or were in a position to evaluate those individuals. Please describe this situation in which you had power-what happened, how you felt, etc.

In the control condition, participants wrote about the events of the previous day for 5 minutes:

Please describe what you did yesterday. Please describe this situation in as much detail as possible-what happened, how you felt, etc.

²Only measures relevant to the current study hypotheses are included here. Please contact the first author for details on the full study battery.

Consistent with past research (e.g., Kunstman & Maner, 2011; Kunstman et al., 2014; Maner, Gailliot, Menzel, & Kunstman, 2012), brief manipulations of power do not tend to influence stable individual differences like BDD symptoms. Indeed, a preliminary independent samples t-test indicated that participants in the power and control condition did not differ in BDD symptoms (DCQ; $t_{(99)} = .56, p = 0.58, d = .11$).

Interoceptive Accuracy—Interoceptive accuracy was assessed with the mental tracking method at baseline and following the experimental manipulation (Pollatos et al., 2007; Schandry, 1981). Without taking their pulse, participants were asked to report the number of heartbeats that occurred during a several-second interval. At baseline, participants reported the number of heart beats that occurred at 20, 30, and 55 second intervals. Following the experimental manipulation, participants reported beats at intervals of 25, 30, and 50 seconds. During these trials, heart rate was objectively measured with an electrocardiogram (ECG) and recorded by the experimenter. Using these recorded and reported measures of heart rate, accuracy was calculated separately for baseline and crucial trials using the formula: $\text{Accuracy} = 1/3 \sum [1 - (|\text{recorded heartbeats} - \text{reported heartbeats}| / \text{recorded heartbeats})]$

Heart Rate—In order to measure heart rate, three disposable electrodes were placed on participants in a lead II configuration. Heart rate was wirelessly recorded by a Biopac MP150 data acquisition unit and transmitted to and saved in Acqknowledge software (Biopac MP150, AcqKnowledge; Biopac Systems Inc., Goleta, CA), and each interval of heart beat data was saved separately. Next, QRSTool, a software program designed to calculate metrics of cardiac variability (Allen, Chambers, & Towers, 2007) was used to process the data. First, a text copy was made for each data file (Allen et al., 2007; available for download at www.psychofizz.org); afterwards, the data were imported into QRSTool. Once imported the threshold function was applied to identify all beats that occurred during the interval. Each interval series was visually inspected for missed or extra beats and manually corrected. Finally, all beats were manually counted and recorded.

Mirror Gazing Task—To evaluate the relationship between interoceptive accuracy and state-level, *in vivo* responses to a BDD stressor, participants were guided through a mirror gazing task (modified from Clerkin & Teachman, 2009). Specifically, participants were asked to look into a full-length mirror for up to 1 minute. To heighten potential distress, participants were asked not to make adjustments to their hair, face, or clothing while looking into the mirror. Following the task, participants were asked to report their peak distress associated with the task, assessed with the 10-item *Positive and Negative Affect Schedule-Negative Affect* subscale (PANAS-NA; Watson & Clark, 1994). To further evaluate state concerns, participants also reported how much they wanted to avoid looking into the mirror on a scale ranging from 0 (not at all) to 100 (extremely; referred to as Desired Avoidance). Time spent engaged in the task was initially considered as a proxy for behavioral avoidance, but was not meaningful because everyone with data engaged in the task for nearly the full 60 seconds (all > 58 seconds). Finally, participants had their heart rate recorded before and during the mirror task. To record baseline standing heart rate, participants were instructed to look at a neutral spot on the wall for one minute. They were then asked to look at themselves in the mirror for one minute.

Interpretation Bias—To evaluate the relationship between interoceptive accuracy and cognitive symptoms of BDD, the 11-item appearance subscale from the Interpretation Questionnaire (IQ-Appearance; Buhlmann, Wilhelm, McNally, Tuschien-Caffier, Baer, & Jenike, 2002) was used. Specifically, participants were asked to read and imagine themselves in 11 ambiguous scenarios (e.g., “Two people are whispering and laughing behind you. You cannot hear them”), followed by the question: “What thoughts occur to you?” They then rate the likelihood of three thoughts coming to mind, including one that related to negative body-image concerns (“They are making fun of how I look.”) on a 0 (*very unlikely*) to 4 (*very likely*) scale. Higher scores on this measure indicate greater interpretation bias ($\alpha = .89$).

Procedure

Upon enrolling in the study, participants were randomly assigned to either the power ($n = 51$) or control ($n = 50$) condition. Following informed consent, disposable, adhesive ECG sensors were attached to the participants. Researchers then measured participants’ baseline interoceptive accuracy with a heartbeat perception task, according to the mental tracking method (Pollatos, Herbert, Kaufmann, Auer, & Schandry, 2007; Schandry, 1981). Next, power was manipulated through the use of the word search puzzles and writing tasks. Following the power manipulations, participants’ interoceptive accuracy was measured for a second time. Participants then completed the mirror gazing task while heart beat data were collected and recorded. Following this task, the ECG sensors were detached from the participants and disposed of, and participants were then asked to report their desired avoidance (i.e. how much they wanted to avoid looking in the mirror), and their peak distress during the mirror task (assessed with the Positive and Negative Affect Schedule-Negative Affect subscale). Participants then completed the Dysmorphic Concerns Questionnaire, the Interpretation Questionnaire, and the Patient Health Questionnaire-4, in randomized order. Participants’ height and weight were also measured and used to calculate participants’ Body Mass Index (BMI) to ensure potential effects related to interoceptive accuracy were not the product of participant body mass. Finally, participants were debriefed and given copies of the debriefing and consent forms. Procedures were approved by the Institutional Review Board, and all participants received course credit in exchange for their participation.

Results

Sample Characteristics

Means and standard deviations for demographic characteristics and psychological variables are listed in Table 1 by Condition. Importantly, our sample included a broad range of BDD symptom severity, with 22.8% ($n = 23$ participants) of our sample scoring at or above the recommended DCQ cutoff score (9) for correctly classifying the presence of BDD among individuals diagnosed with BDD (Mancuso et al., 2010).

Chi-square tests indicated no significant differences between Condition for race (coded as White vs. Other; $\chi^2_{(1, N = 101)} = .86, p = .35$). T-tests indicated that there were no statistically significant differences between Condition for age ($t_{(99)} = 1.10, p = .27, d = .22$), BDD

symptoms assessed with the DCQ ($t_{(99)} = .56, p = 0.58, d = .11$), or depression and anxiety assessed with the PHQ-4 ($t_{(99)} = 1.08, p = 0.28, d = .22$). As well, preliminary analyses revealed that participants in the power ($M=23.08; SD = 3.89$) and control ($M=22.32; SD=2.64$) conditions did not significantly differ on BMI scores, $t(96)=1.12, p = .26$. The lack of Condition effects on these demographic, psychological, and BMI variables suggests that our attempt to randomize the groups was successful.

Initial analyses also tested for conditional differences in heart rate. These analyses revealed that there were not conditional differences in heart rate at baseline ($t_{(99)}=.77, p=.44$) or post-manipulation ($t_{(99)}=.60, p=.55$).

Trait BDD Symptoms and Power on Interoceptive Accuracy

To evaluate the influence of Condition and trait BDD symptoms on interoceptive accuracy, a hierarchical linear multiple regression was conducted in which Condition (Power vs. Control), trait BDD symptoms (assessed with the DCQ), and the interaction of Condition x BDD symptoms were regressed on post-manipulation IAcc, controlling for baseline IAcc. All predictor variables (Baseline IAcc, Condition, BDD Symptoms) were mean centered and interactions were probed following procedures outlined in Aiken and West (1991) and Hayes (2013). As expected, baseline IAcc significantly predicted post-manipulation interoceptive accuracy ($B = .72, p < .001$). Although there was neither a main effect of condition ($B = .008, p = .74$) nor BDD symptoms ($B = -.003, p = .33$), as predicted there was a significant condition by BDD symptoms interaction ($B = .01, p = .04, R^2 = .02$).³

To test the hypothesized negative relationship between trait BDD symptoms and interoceptive accuracy, we first tested the simple effect of trait BDD symptoms within the control condition, controlling for baseline IAcc. As predicted, within the control condition, higher trait BDD symptoms predicted worse interoceptive accuracy, $B = -.01, p = .02, r_p = -.23$. Within the power condition, the relationship between trait BDD symptoms and interoceptive accuracy was not significant, $B = .002, p = .65, r_p = .05$, suggesting that power may have attenuated the negative relationship between BDD symptoms and IAcc. To test our hypothesis that power's effect on interoceptive accuracy would increase with the severity of trait BDD symptoms, we probed the simple effect of condition at 1.00 ($B = .07, p = .07, r_p = .18$), 1.50 ($B = .10, p = .047, r_p = .20$), and 2.00 ($B = .12, p = .04, r_p = .21$) standard deviations above the DCQ mean (see Figure 1). In keeping with hypotheses, as trait BDD symptoms increased, so too did the magnitude of power's effect on IAcc. The more severe participants' BDD symptoms, the better the interoceptive accuracy for those in the power compared to control condition. The moderator value defining the Johnson-Neyman significance region was a DCQ score of 12.12 ($p = .05$), which corresponds to roughly 1.5 standard deviations above the DCQ mean ($M = 6.14, SD = 4.23$). This suggests that power may have improved interoceptive accuracy for those with clinically severe scores on the DCQ. Equivalent probes at 1.00 ($B = -.05, p = .18, r_p = -.14$), 1.50 ($B = -.08, p = .10, r_p =$

³Since weight can influence cardiovascular responses, a similar analysis was conducted in which BMI was also included as a covariate in a model predicting post-manipulation IAcc. Not only was BMI unrelated to post-manipulation interoceptive accuracy ($B = -.005, p = .22$), the inclusion of this covariate increased the magnitude of the interactive effect of the DCQ and condition ($B = .02, p = .02$). These results suggest that the present effects related to the joint effect of BDD symptoms and experimental condition exist over-and-above any variance accounted for by BMI.

-.17), and 2.00 ($B = -.11$, $p = .07$, $r_p = -.18$) standard deviations below the mean yielded only a marginal simple effect of condition at very low levels of trait BDD symptoms, such that those in the control condition had greater interoceptive accuracy than those in the power condition. Please see Table 3 for interoceptive accuracy scores at specific DCQ cutoffs.

Relationships Among Measures

Finally, relationships between interoceptive accuracy and a range of BDD symptoms were tested. Given the Condition x trait BDD symptoms interaction on interoceptive accuracy, correlations were computed separately for the Power vs. Control conditions. See Table 4.

Within the control condition, results were mostly consistent with the hypothesis that interoceptive accuracy inversely related to BDD symptoms. First, there was a significant negative relationship between post-manipulation interoceptive accuracy and trait BDD symptoms (DCQ). Further, there were small negative relationships between both baseline and post-manipulation IAcc, and most *in vivo* responses to a BDD stressor (Desired Avoidance and Heart BPM [residual]), and cognitive BDD symptoms (IQ-Appearance), albeit these effects did not reach significance. In contrast, within the power group, the relationships between interoceptive accuracy and Desired Avoidance, IQ-Appearance and Heart BPM (residual) were small and nonsignificant (all $r \leq .13$). Further, there were small, nonsignificant positive relationships between both baseline and post-manipulation IAcc and trait BDD symptoms (DCQ) and small, nonsignificant negative relationships between baseline and post-manipulation IAcc and negative affect in response to the mirror task (PANAS-NA).

Discussion

To our knowledge, the current study provides the first empirical test of the association between BDD symptoms and interoceptive accuracy. Consistent with hypotheses, in the control condition, above-and-beyond baseline IAcc, there was a significant inverse relationship between trait BDD symptoms and IAcc. These results provide initial evidence that when accounting for individual differences in IAcc, increasing levels of trait BDD symptoms may be associated with relatively worse interoceptive accuracy.

Consistent with predictions, within the power condition, there was not a significant relationship between trait BDD symptoms and IAcc, suggesting that power may have attenuated the negative relationship. Further, as hypothesized, power increased state levels of interoceptive accuracy among those with the highest levels of BDD symptoms. Moreover, power's effect on IAcc grew progressively larger as BDD symptoms increased. That is, the greater participants' BDD symptomology, the greater the accuracy for participants in the power condition compared to the control condition. This suggests that as BDD symptoms increased, so too did power's capacity to increase state interoceptive accuracy. These results provide initial evidence that the psychological experience of power may have positive effects on those most at risk for developing BDD.

Also consistent with this logic, bivariate analyses indicate that in the control condition, continued bodily introspection (i.e., repeating the mental tracking of heart rate task) may

have heightened the inverse relationship between trait BDD symptoms and relative interoceptive accuracy (pre-manipulation $r = -.21$, post-manipulation $r = -.36$). By comparison, power may have buffered participants against the potential negative consequences of repeated bodily introspection, resulting in comparable (non-significant) relationships between trait BDD and interoceptive accuracy throughout the experiment (pre-manipulation $r = .21$, post-manipulation $r = .20$). These results further speak to the potential protective psychological effects of power.

Theoretical and Clinical Implications of Relatively Low Interoceptive Accuracy

The finding that trait BDD symptoms were inversely linked to interoceptive accuracy within the control condition, controlling for baseline interoceptive accuracy, indicates that increasing levels of trait BDD symptoms may be associated with relatively worse interoceptive accuracy. However, given the weak, non-significant relationships between interoceptive accuracy and other aspects of BDD symptomatology (e.g., cognition and state responses to a mirror gazing task), determining *which* aspects of BDD symptomatology are associated with interoceptive accuracy will be critical. Additionally, the relationship between trait BDD symptoms and IAcc measured at a single time point (baseline) was small and not significant across both conditions. When considered alongside the regression findings, this points to the importance of assessing IAcc more than once within the same study, possibly because repeated bodily introspection strengthens the negative relationship between trait BDD symptoms and interoceptive accuracy (see above). Further, repeated assessment enables researchers to account for the substantial variability in individual differences in IAcc task performance (i.e., account for error variance in IAcc due to factors like task difficulty), thus providing a more accurate test of the relationship between trait BDD symptoms and IAcc. Regardless, when interpreting significant findings from the regression analyses, it is critical to recall that these findings reflect post-manipulation interoceptive accuracy, controlling for baseline IAcc.

Bearing these caveats in mind, a number of meaningful theoretical and clinical implications follow from the potential relationship between trait BDD symptoms and relatively poor interoceptive accuracy. Research has shown that relative deficits in interoceptive accuracy can significantly influence external body representations (Tsakiris, et al., 2011). Thus, relatively poor interoceptive accuracy could contribute to BDD symptoms by decreasing individuals' ability to integrate these cues and form accurate body representations. For instance, Mele and colleagues (2013) asked a small sample of university students to view images of various sized bodies. After participants viewed images of round bodies they reported increased liking judgments of round bodies. However, participants who self-reported their interoception abilities as low did not exhibit this change; when exposed to round bodies, they were less likely than participants with higher interoception ratings to show increased liking of round bodies. Thus, relatively poorer interoceptive sensibility (i.e., self-reported assessment of interoception ability; Garfinkle et al., 2015) may be associated with a decreased ability to incorporate external stimuli into existing perceptions and bodily judgments. In the context of BDD, this could potentially lead to inflexible judgments of personal bodily flaws, and thus greater stability of beliefs associated with BDD.

That interoceptive accuracy might contribute to the onset and maintenance of BDD is consistent with findings from studies of related disorders that are also characterized by intense body dissatisfaction. Similar to those with BDD, individuals with eating disorders typically exhibit a distorted image of their bodies and preoccupation with their appearance and shape (American Psychiatric Association, 2013). Studies utilizing prospective designs have shown that poor self-reported interoceptive sensibility predicts subsequent ED symptoms (Bizeul, Sadowsky, & Rigaud, 2001; Leon, Fulkerson, Perry, & Early-Zald, 1995), suggesting that interoceptive sensibility may have a causal influence on one's experience of the body. Further, patients with anorexia nervosa consistently display relative deficits in both self-reported interoceptive sensibility and objectively assessed interoceptive accuracy (Pollatos et al., 2008). This research not only links relatively low levels of interoceptive sensibility and accuracy to body dissatisfaction, but also suggests that improving interoception may benefit the treatment of other psychological disorders like BDD in which individuals have biased or disconnected perceptions of their body.

In addition to evidence suggesting that relatively poorer interoceptive accuracy could be causally related to the development of BDD symptoms, there is also theoretical support for a causal relation between BDD symptoms and subsequent deficits in IAcc. This hypothesis is supported by research demonstrating that poorer interoceptive accuracy is associated with more somatoform disorder symptoms (Schaefer, Egloff, & Withöft, 2012). Somatoform disorders represent a classification of disorders that are associated with unexplained physical symptoms such as chronic pain without a medical diagnosis. Until very recently, BDD was classified as a somatoform disorder given its shared emphasis on and distortion of body-related perceptions (APA, 2000, 2013). Schaefer and colleagues (2012) suggest that heightened selective attention paid to symptoms of somatoform disorders monopolizes a large amount of attentional resources, and thus prevents a shift of attention towards normal internal signals. Consistent with cognitive-behavioral conceptualizations of BDD, biased schematic processing is also observed in individuals with BDD symptoms (e.g., Buhlmann et al., 2002; Clerkin & Teachman, 2009); hence, these individuals may subsequently have less attentional resources for perceiving internal cues and sensations, which may lead to relative deficits in IAcc.

Limitations, Future Directions, and Conclusions

There were several methodological limitations of the present study design. First, the convenience sample used in the current study was fairly demographically homogenous, and thus results may not generalize to non-college, non-White, non-female individuals. Future research might test these effects among ethnically diverse populations and men. Second, although our sample reflected a broad range of likely clinical symptom severity, with a substantial proportion of participants (22.8%) scoring at or above the recommended DCQ clinical cutoff for correctly classifying the presence of BDD among individuals diagnosed with BDD, it is unclear whether findings will generalize to clinical populations. Hence, future research might test whether the effects documented in the current study generalize to individuals diagnosed with BDD via a structured clinical interview. Third, although the current study measured BMI and found that statistically accounting for BMI actually increased the interactive effect of BDD symptoms and condition on IAcc, we did not

measure other factors that might influence interoceptive accuracy like exercise level and participant medication.

Future research might also explore power's effect on those high in BDD symptoms with other measurements of interoceptive accuracy, given potential limitations of the mental tracking method used in this study (see Ring, Brener, Knapp, & Mailloux, 2015). Further, in the current study, interoceptive accuracy was measured only at rest, which can sometimes be difficult for participants to assess (e.g., Ring et al., 2015). Yet, despite the challenging nature of the task, power and BDD symptoms still interacted to predict interoceptive accuracy. These results provide a conservative test of the current hypotheses and suggest that the interaction between power and BDD symptoms may be even larger when tested under conditions in which interoceptive accuracy is more accessible, such as during conditions of increased arousal or during a mirror gazing task. As well, considering other aspects of interoception (e.g., interoceptive sensibility and interoceptive awareness), and how these aspects map onto BDD symptoms, will be valuable.

Finally, given potential associations between relatively poor interoception and disorders emphasizing the body (e.g., BDD, eating disorders), future research could consider clinical interventions to improve IAcc. Potential interventions might provide individuals with cardio-visual feedback (e.g., Aspell et al., 2013), or train participants to turn their attention nonjudgmentally towards their bodies in a mirror task (e.g., Ainley, Maister, Brokfeld, Farmer, & Tsakiris, 2013; Ainley, Tajadura-Jiménez, Fotopoulou, & Tsakiris, 2012). That said, while there may be potential benefits of increasing IAcc, it is also important to point out that greater interoception does not uniformly function as a protective factor for psychopathology. In fact, some evidence suggests that relatively *greater* IAcc may function as a *risk* factor for anxiety and panic (see Domschke, Stevens, Pleiderer, & Gerlach, 2010, for a review). For instance, Domschke et al. reviewed evidence that individuals with high (vs. low) anxiety sensitivity, which is a hallmark symptom and risk factor for panic disorder (e.g., Schmidt, Lerew, & Jackson, 1997; Ehlers, 1995), are more accurate in detecting their heartbeat. Thus, given the overlapping features that anxiety disorders and BDD share (Phillips, 2005), clinicians and researchers must carefully monitor the extent to which increasing IAcc is actually beneficial in the context of BDD symptoms.

It will also be critical for future research to investigate the psychological mechanism(s) underlying power's potential protective effect on those high in BDD symptoms. As referenced above, there are at least two possible pathways by which power might increase interoceptive accuracy for those high in BDD symptoms. Among participants scoring high on the DCQ's index of BDD symptom severity, power may have restored access to inner states and experiences, allowing them to introspect at levels comparable with those scoring low in BDD symptom severity. Conversely, power may have reduced the negative cognitions and self-criticism commonly experienced by those with elevated BDD symptoms. By enhancing positive self-perception, power may have allowed those high in BDD symptom severity to more comfortably attend to their inner experiences. Future research should investigate how self-focus and self-criticism—either alone or in tandem—relate to power's capacity to improve interoceptive accuracy among those high in BDD symptoms.

The present study provided an important first step in understanding the relation between BDD symptoms and interoceptive accuracy, although additional research will be needed to understand the causal direction and mechanisms of this relationship. This research also provided initial evidence that among those high in trait BDD symptoms, the experience of power may be one intervention which could buffer individuals from becoming disconnected from their internal bodily cues. Ultimately, understanding the strength of the association between BDD symptoms and interoceptive accuracy might help to inform unique treatment approaches aimed at helping individuals connect with their inner emotional and physiological experiences.

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Highlights

- This study tested whether relatively lower interoceptive accuracy (IAcc) is associated with body dysmorphic disorder (BDD) symptoms, and whether IAcc could be improved through an experimental manipulation of power.
- Within the control condition, there was a significant inverse relationship between trait BDD symptoms and IA accuracy, controlling for baseline IAcc.
- At high levels of BDD symptomology, there was also a significant simple effect of experimental condition, such that participants in the power (vs. control) condition had better interoceptive accuracy, controlling for baseline IAcc.
- These results provide initial evidence that power may positively impact interoceptive accuracy among those with high levels of BDD symptoms.

Figure 1.

The Impact of Condition X Body Dysmorphic Disorder Symptoms on interoceptive accuracy, controlling for baseline interoceptive accuracy, at 2 SD above and below the DCQ mean.

Note. $*p < .05$; DCQ = Dysmorphic Concerns Questionnaire. Controlling for baseline IAcc, within the control condition, higher trait BDD symptoms predicted worse interoceptive accuracy, $B = -.01$, $p = .02$. For individuals with elevated trait BDD symptoms (+2.0 SD above the DCQ mean), interoceptive accuracy was significantly greater for participants in the power (vs. control) condition, $B = .12$, $p = .04$.

Table 1
Sample Characteristics, Interoceptive Accuracy, and Psychological Variables by Condition

	Condition						Full Sample	
	Power		Control		Full Sample		M or N	SD or %
	M or N	SD or %	M or N	SD or %	M or N	SD or %		
Age	18.41	0.70	18.58	0.84	18.50	0.77		
Race								
Asian	3.00	5.88%	5.00	10.00%	8.00	7.92%		
Black	--	--	1.00	2.00%	1.00	0.99%		
White	46.00	90.20%	42.00	84.00%	88.00	87.13%		
Bi- or multiracial	1.00	1.96%	1.00	2.00%	2.00	1.98%		
Other	1.00	1.96%	1.00	2.00%	2.00	1.98%		
Ethnicity								
Hispanic/Latino	2.00	3.92	1.00	2.04	3	3.00%		
Not Hispanic/Latino	49.00	96.08	48.00	97.96	97	100.00%		
Baseline IAcc	0.66	0.18	0.68	0.15	0.67	0.16		
Post-manipulation IAcc	0.70	0.17	0.71	0.17	0.71	0.17		
DCQ	6.37	4.90	5.90	3.45	6.14	4.23		
PHQ-4	3.04	2.47	3.60	2.73	3.32	2.60		
PANAS-NA	16.10	5.93	15.65	6.27	15.88	6.07		
IQ-Appearance	1.74	0.75	1.61	0.73	1.67	0.74		
Desired Avoidance	40.49	29.03	31.73	26.70	36.20	28.12		

Note. Baseline IAcc = Baseline Interoceptive Accuracy; Post-manipulation IAcc = Post-manipulation Interoceptive Accuracy; DCQ = Dysmorphic Concerns Questionnaire; PHQ-4 = Patient Health Questionnaire; PANAS-NA = PANAS-Negative Affect; IQ-Appearance = Interpretations Questionnaire-Appearance subscale (item level). There were no significant effects of Condition on any of these demographic or psychological variables.

Table 2
Baseline IAcc, Condition, and BDD Symptoms Predicting Post-Manipulation IAcc

Step		B	St. Error	t	p	R ²
1	(Constant)	.71	.01	57.06	<.001	.475
	Baseline IAcc	.72	.08	9.46	<.001	
2	Baseline IAcc	.73	.08	9.44	<.001	.006
	Condition	.008	.03	.34	.74	
3	BDD Symptoms	-.003	.003	-.98	.33	
	Baseline IAcc	.70	.08	8.98	<.001	.024
	Condition	.009	.03	.35	.73	
	BDD Symptoms	-.005	.003	-.165	.10	
	Condition X BDD Symptom Interaction	.01	.006	2.14	.04	

Note: Results from hierarchical regression analysis predicting condition and BDD symptoms' s joint effect on post-manipulation IAcc (covarying baseline IAcc task performance). All predictor variables were mean centered. B = unstandardized regression coefficient. Baseline IAcc = Baseline Interoceptive Accuracy.

Table 3

Interoceptive Accuracy at Specific DCQ Scores

	Low DCQ (n = 21)		High DCQ (n = 23)	
	Power <i>M (SD)</i>	Control <i>M (SD)</i>	Power <i>M (SD)</i>	Control <i>M (SD)</i>
Baseline IAcc	0.58 (0.19)	0.75 (0.13)	0.69 (0.21)	0.63 (0.14)
Post-manipulation IAcc	0.62 (0.12)	0.78 (0.17)	0.72 (0.20)	0.59 (0.17)

Note. Low DCQ refers to participants scoring in the bottom 21st percentile of the sample (scores of 0, 1, or 2 on the DCQ). High DCQ refers to participants scoring in the top 23rd percentile of the sample (scores of 9 or greater on the DCQ, which also reflects the DCQ cutoff score). IAcc = Baseline Interoceptive Accuracy; Post-manipulation IAcc = Post-manipulation Interoceptive Accuracy.

Table 4
Pearson Correlations Between Pre- and Post-manipulation Interoceptive Awareness and BDD Symptoms

	Power Condition		Control Condition	
	Baseline IAcc	Post-manipulation IAcc	Baseline IAcc	Post-manipulation IAcc
DCQ	.21	.20	-.21	-.36*
PANAS-NA	-.24	-.20	-.10	.00
Desired Avoidance	-.04	-.06	-.18	-.26
IQ-Appealance	.09	.02	-.19	-.21
Heart BPM (residual)	.13	.07	-.09	-.19

* $p < .05$ level;

Note. Baseline IAcc = Baseline Interoceptive Accuracy; Post-manipulation IAcc = Post-manipulation Interoceptive Accuracy; DCQ = Dysmorphic Concerns Questionnaire; PANAS-NA = PANAS-Negative Affect; IQ-Appealance = Interpretations Questionnaire-Appealance subscale; Heart BPM (residual) = Standardized residual of baseline beats per minute predicting beats per minute while looking into the mirror. Missing values were deleted pairwise.