

## Interoceptive Awareness Moderates the Relationship Between Perceived and Physiological Genital Arousal in Women



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### ABSTRACT

**Introduction:** In general, laboratory studies have shown low correlations between subjective (ie, self-report) and physiologic (ie, vaginal pulse amplitude) measurements of sexual arousal in women. One explanation for this presumed low concordance is that women might not be attending to their genital responses and/or might be unable to accurately perceive their genital responses.

**Aim:** To examine the extent to which women can perceive their genital arousal sensations, the role that interoceptive awareness plays in this ability, and whether interoceptive awareness influences sexual concordance in women.

**Methods:** Twenty-six sexually functional women viewed an erotic film while their physiologic and perceived genital sexual arousal levels were measured continuously. Self-report measurements of sexual function and bodily awareness also were administered.

**Main Outcome Measures:** Physiologic sexual arousal was measured with a vaginal photoplethysmograph, and perception of genital arousal was measured with an arousometer. Degree of bodily awareness was measured with the Multidimensional Assessment of Interoceptive Awareness questionnaire.

**Results:** Women exhibited a significant degree of agreement between physiologic and perceived genital arousal ( $P < .05$ ). Interoceptive awareness was found to significantly moderate this relation ( $P < 0.05$ ), such that a greater degree of interoceptive awareness facilitated greater agreement between physiologic and perceived genital arousal. Interoceptive awareness also was found to facilitate greater concordance between subjective and physiologic sexual arousal ( $P < .05$ ).

**Conclusion:** Women can perceive their genital response, and interoceptive awareness influences this ability and the relation between subjective and physiologic sexual arousal. Increasing bodily awareness could be a plausible route for treatment development.

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**Key Words:** Sexual Function; Sexual Arousal; Awareness; Concordance

### INTRODUCTION

During the past four decades, laboratory studies have shown varying degrees of concordance between subjective (ie, self-report) and physiologic (ie, vaginal pulse amplitude [VPA]) measurements of sexual arousal in women. For example, an early study by Heiman<sup>1</sup> reported significant, positive correlations ( $r = 0.44$ – $0.68$ ) in women, whereas in the same year Osborn and Pollack<sup>2</sup> reported a non-significant, but nevertheless substantial, negative relation ( $r = -0.40$ ) between subjective and physiologic arousal. In 2010, a meta-analysis of 132 relevant articles showed that, overall, there seems to be a small, positive relation ( $r = 0.26$ ) between women's subjective and

physiologic sexual arousal.<sup>3</sup> When examining this relation by factors such as stimulus content or method of measurement, this relation varies from an average of 0.25 to 0.55. Understanding this variation among women has important implications. Treatments focused on increasing genital cues might not be beneficial if women cannot perceive these cues. Recent research has suggested that treatments that aim to increase awareness of bodily sensations and genital cues might increase sexual arousal in women with sexual difficulties.<sup>4</sup> If women can perceive their genital sensations, and the degree to which they can do so is dependent on their level of bodily awareness, then treatments designed to increase bodily awareness might be warranted. Identifying individuals with low bodily awareness might be a worthwhile strategy for determining which patients would most benefit from awareness-based treatments such as biofeedback or mindfulness.

Researchers have attempted to explain low concordance rates in women by examining continuous and discrete measurements

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of self-reported sexual arousal. Subjective sexual arousal is most commonly assessed retrospectively as an average of several Likert-scale responses to statements such as “During the film, I felt sexually aroused.”<sup>5</sup> A weakness of retrospective discrete measurements of sexual arousal is that they cannot be compared contemporaneously with genital arousal and might be measuring one’s current post-stimulus state rather than one’s arousal during stimulus exposure. Alternatively, continuous measurements allow for the measurement of subjective arousal throughout the stimulus presentation. Also, unlike retrospective self-report questionnaires, continuous measurements of sexual arousal have been found useful in differentiating women with from those without sexual arousal disorders.<sup>6</sup> However, it should be noted that continuous measurements of subjective sexual arousal require women to assess their arousal state in real time on a moment-to-moment basis. As such, this methodology might have the added effect of leading women to attend more closely to genital cues than would a discrete questionnaire assessment and, in doing so, positively affect the concordance between genital and subjective measurements of arousal.

Although continuous measurements of subjective arousal could feasibly affect concordance rates, when continuous measurements of subjective sexual arousal are analyzed with traditional correlational analyses, low correlations of subjective and physiologic arousal are generally still found. This suggests that choice of analytic technique could help explain low concordance.<sup>3</sup> Concordance is typically measured as a change score, which condenses genital arousal data collected continuously throughout the assessment into a single data point. This compromises the richness of continuous data collection. Hierarchical linear modeling (HLM), a statistical technique designed to analyze repeated measures data nested within subjects, has been shown effective at detecting varying degrees of genital-subjective concordance in women.<sup>7</sup> HLM fits models to multilevel data while accounting for variability across each level by estimating coefficients based on subjects’ unique slopes and intercepts. This allows for the analysis of group data while accounting for individual differences. Similarly, smoothing regression splines, which balance the fit between data points with the number of bends in the modeled trajectory, has been suggested as an analytic tool sensitive enough for the detection of sexual arousal patterns.<sup>8</sup>

It also has been hypothesized that women’s attitudes toward sex and sexual stimuli might influence the concordance between subjective and physiologic sexual arousal. For example, negative affect from “man-made” erotica has been suggested to decrease concordance. However, when women are shown “woman-made” erotica, reports of subjective arousal increase but concordance does not meaningfully change.<sup>9</sup> Cultural messages women receive to inhibit sexuality also can play a role in these changing levels of concordance. Social desirability could negatively influence self-report measurements of sexual arousal by causing women to under- or over-report certain responses to the sexual films but is unlikely to affect physiologic arousal. Indeed, one study found

that measurements of impression management significantly negatively affected discrete measurements of subjective sexual arousal. When examining the effect of impression management on continuous measurements of subjective sexual arousal, a small, negative effect was found, although this did not reach statistical significance.<sup>10</sup>

Women who show low concordance between their subjective and genital arousal responses might be unable to accurately perceive their genital responses. Despite the growing body of research examining interoceptive awareness in relation to sexuality, little research has examined women’s awareness of their genital arousal.<sup>11,12</sup> One study found that nearly half the women in the sample reported minimal or no change in genital arousal during periods of greatest engorgement (as measured by vaginal blood volume and VPA), which suggests that women might not notice genital arousal despite being physiologically aroused.<sup>1</sup> Perceptions of genital arousal were assessed retrospectively and this finding did not reach statistical significance. Researchers also have found that women’s accuracy of their perception of their genital arousal might be independent of the strength of their genital response.<sup>13</sup> Women with higher mean VPA were no more likely to perceive their genital arousal than were women with lower mean VPA. This is an important finding, because it suggests that it might not be necessary to have a robust genital arousal response to be aware of it. However, it also could be that women were not attending to their genital cues. That is, it was not so much that they were unable to perceive their level of arousal, but rather they were not focused on attending to their arousal. Indeed, results from a more recent study suggested that bringing attention to one’s body could increase subjective arousal.<sup>14</sup> Unfortunately, the study did not examine the impact of this relation on VPA. The degree to which there might be individual variability among women in their ability to perceive genital sensations has, to our knowledge, not directly been assessed.

To better understand the degree to which women can perceive their genital sensations during sexual arousal and to explore whether identifiable individual variability exists in this ability, the present study had three aims:

1. To examine whether women can perceive their level of genital arousal when specifically told to attend to genital sensations.
2. To examine whether a self-report measurement of interoceptive (bodily) awareness can identify women who can accurately perceive their genital responses.
3. To examine whether interoceptive awareness can, in part, explain the relation between subjective and physiologic sexual arousal in women.

## METHODS

### Participants

Twenty-six women were recruited through advertisements in undergraduate psychology courses. Women were eligible to

**Table 1.** Participant characteristics (N = 26)

	Mean (SD)	Range	n (%)
Age (y)	19.0 (0.82)	18–21	
Ethnicity			
African American or black			1 (3.8)
Asian			4 (15.4)
Caucasian or white			12 (46.2)
Hispanic			8 (30.8)
Other			1 (3.8)
Relationship status			
Single, not dating			3 (11.5)
Single, dating			3 (11.5)
In a committed relationship			20 (76.9)
Relationship length (mo)	21.8 (17.9)	3–61	

participate if they were older than 18 years, premenopausal, fluent in English, heterosexual or bisexual (because of the erotic stimulus), and reported no history of sexual abuse. Participants' sexual functioning was assessed with the Female Sexual Function Index (FSFI) and a brief screening for female sexual arousal disorder.<sup>15</sup> Only women without sexual difficulties were eligible to participate. All participants reported being sexually active within the past 4 weeks (Table 1 lists participant characteristics).

**Procedure**

After receiving informed consent, the experimenter provided a brief educational session explaining the difference between mental sexual arousal (how “turned on” you are in your mind) and physiologic sexual arousal (feeling tingling, throbbing, or other sensations in your genitals). This was done to ensure that participants understood this distinction and therefore report solely on their genital arousal during the assessment. Participants were instructed to attend to their genital sensations and move an arousometer throughout the films to indicate how aroused they felt in their genitals.<sup>7</sup> Then, participants completed the modified film scale and inserted the vaginal photoplethysmograph. Participants viewed an 8-minute film presentation composed of a neutral (2-minute) and an erotic (6-minute) film clip while their genital and perceived genital sexual arousal levels were measured. After the film presentation, participants completed a second film scale, a questionnaire on genital attending (Table 2), and the Multidimensional Assessment of Interoceptive Awareness questionnaire (MAIA).<sup>16</sup> Then, they were instructed to remove the vaginal photoplethysmograph and get dressed and were compensated with course credit. This study was approved by the institutional review board at the University of Texas at Austin.

**Measurements**

**Physiologic Sexual Arousal**

A vaginal photoplethysmograph was used to assess genital response to the film presentation. The VPA signal was sampled at

**Table 2.** Descriptive statistics for Attention to Genital Cues questionnaire\*

	n (%)
How often do you attend to your genital sensations during sexual arousal and/or sexual activity?	
Almost always	4 (16.0)
Most times	12 (48.0)
Sometimes	6 (24.0)
A few times	3 (12.0)
Almost never	0 (0.0)
How easy or difficult is it for you to attend to your genital sensations during sexual arousal and/or sexual activity?	
Not difficult	16 (64.0)
Slightly difficult	8 (32.0)
Difficult	1 (4.0)
Very difficult	0 (0.0)
Extremely difficult or impossible	0 (0.0)
How important is being aware of your genital sensations to your mental sexual arousal (how turned on you feel in your mind)?	
Very important	15 (60.0)
Moderately important	8 (32.0)
Equally important and unimportant	1 (4.0)
Moderately unimportant	1 (4.0)
Not at all important	0 (0.0)

\*One participant reported not attending to genital sensations during sexual activity; therefore, results presented in this table are based on the 25 women reporting that they do attend to genital sensations.

a rate of 200 samples/second throughout the entire 120 seconds of neutral film presentation and 360 seconds of erotic film presentation. Each wave was recorded in millivolts, bandpass filtered (0.5–30 Hz), and recorded on a Pentium computer in the next room using AcqKnowledge III 3.8.1 (BIOPAC Systems, Inc, Santa Barbara, CA, USA) and a Model MP150 data acquisition unit (BIOPAC Systems, Inc.) for analog-to-digital conversion.

**Perceptions of Genital Arousal**

Perception of genital sexual arousal (ie, how aroused participants felt in their genitals) was measured continuously during the film presentation with an arousometer.<sup>7</sup> The arousometer is a computer mouse attached to a lever numbered from 0 (no genital arousal) to 7 (maximum genital arousal), which the participant moves throughout stimuli presentation to indicate changes in sexual arousal. The device is positioned on a small table at the side of the participant’s chair. The participant begins with the lever set at 0 and is instructed to move the mouse up or down to indicate perceptions of increasing or decreasing genital arousal during the stimuli presentation.

**Subjective Sexual Arousal**

Subjective arousal was measured discretely before and after the films with a modified version of the film scale of Heiman and Rowland.<sup>5</sup> The film scale contains 15 items that measure

perceptions of physiologic arousal, subjective (mental) sexual arousal, and positive and negative affect related to sexual arousal. Items are rated on a seven-point Likert scale ranging from 1 (not at all) to 7 (intensely).

### Genital Attending

To understand whether the changing concordance between subjective and physiologic sexual arousal in women might be due in part to women's lack of attention to genital cues, genital attending was measured with the Attention to Genital Cues questionnaire.<sup>17</sup> It includes questions on frequency, difficulty, and importance of attending to genital sensations during sexual arousal to capture attending as a characteristic of one's general sexual experiences. Question 1 asks "Do you attend to your genital sensations during sexual arousal and/or sexual activity?" The response is yes or no. If participants choose "yes," then they complete questions 2 to 6, which contain four items that are scored on a five-point scale and one free-response item.

### Interoceptive Awareness

Interoceptive awareness was measured with the MAIA, a 32-item self-report questionnaire that measures interoceptive bodily awareness.<sup>16</sup> Questions are answered on a six-point Likert scale ranging from 0 (never) to 5 (always). The MAIA measures five domains through eight subscales: the awareness of body sensations domain contains the noticing subscale; the emotional reaction and attentional response to sensations domain contains the not-distracting and not-worrying subscales; the capacity to regulate attention domain contains the attention regulation subscale; the awareness of mind-body integration domain contains the emotional awareness, self-regulation, and body listening subscales; and the trusting body sensations domain contains the trusting subscale.

### Sexual Functioning

To ensure that participants had no sexual difficulties, they completed the FSFI, a 19-item self-report questionnaire assessing desire, arousal, lubrication, pain, orgasm, satisfaction, and overall sexual functioning.<sup>15</sup> Total scores range from 2 to 36, where poorer sexual function is represented by lower scores. The FSFI has been found to have good internal reliability ( $r = 0.89-0.97$ ), test-retest reliabilities ( $\alpha = 0.79-0.88$ ), and confirmed discriminant validity in discriminating women with from women without sexual complaints.<sup>15,18,19</sup> Participants also were screened for female sexual arousal disorder by assessing their current level of genital sexual arousal by referencing specific genital responses typically experienced during sexual activity (eg, tingling, throbbing, and warmth).

### Data Reduction

Physiologic data were assessed for movement artifacts at data collection. Artifact smoothing was performed by hand following visual inspection of the data by a study investigator. Then, data

were binned in 5-second epochs representing mean peak-to-peak VPA response, yielding a total of 96 data points per participant.

### Data Analysis

HLM software<sup>20</sup> (HLM7) was used to examine the extent to which continuous measurements of participants' perceived and physiologic genital arousal co-varied throughout the film presentation. HLM is a multilevel modeling technique that allows for the analysis of changes within an individual, such that individual slopes and intercepts at level 1 become the respective outcome variables at level 2. This is particularly useful when examining VPA because baseline VPA varies from person to person, and HLM allows for each participant to serve as her own control.

In this study, level 1 variables were standardized and centered before analyses and modeled as random. Level 1 analyses with repeated measures were used to evaluate the relation between VPA and perceived genital arousal. The following is an example equation of the model:

$$\text{Perceived genital arousal} = \beta_{0j} + \beta_{1j}(\text{VPA}) + r_{ij}(\text{level 1})$$

where  $\beta_{0j}$  is the intercept or expected perceived genital arousal for participant  $j$  whose VPA is that participant's average;  $\beta_{1j}$  is the slope or expected change in perceived genital arousal associated with a 1-U increase of VPA for participant  $j$ ; and  $r_{ij}$  is the residual. The reverse equation also was assessed (ie, VPA predicted by perceived genital arousal).

Eight level 2 moderation analyses were conducted to determine whether measurements of interoceptive awareness changed the degree of agreement between VPA and perceived genital arousal. The following is an example equation of the model:

$$\text{Perceived genital arousal} = \beta_{0j} + \beta_{1j}(\text{VPA}) + r_{ij}(\text{level 1})$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01j} + u_{0j}(\text{level 2})$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11j}(\text{interoceptive awareness}) + u_{1j}$$

where  $\gamma_{00}$  and  $\gamma_{10}$  are the mean intercepts for all participants adjusted for VPA;  $\gamma_{01}$  is the association between VPA and perceived genital arousal for participant  $j$ ;  $\gamma_{11}$  is the association between VPA and perceived genital arousal for participant  $j$  moderated by interoceptive awareness; and  $u_{0j}$  and  $u_{1j}$  are the residuals.

The extent to which interoceptive awareness can explain the relation between VPA and subjective arousal was analyzed according to methods described in previous research.<sup>21</sup> Change in genital arousal was calculated by subtracting mean genital arousal during the neutral film from mean genital arousal during the erotic film, dividing this change score by mean genital arousal during the neutral film, and multiplying by 100, to yield a percentage of change. Subjective arousal was calculated as a percentage of change using pre-film and post-film means. Percentages of change were standardized within participants.

**Table 3.** Descriptive statistics for each Multidimensional Assessment of Interceptive Awareness subscale

	Mean	SD	Range
Noticing	3.68	0.77	1.75–5.00
Not distracting	1.62	0.83	0.33–3.67
Not worrying	1.76	0.71	0.67–3.00
Attention regulation	3.12	0.73	1.57–4.57
Emotional awareness	3.90	0.63	2.40–5.00
Self-regulation	2.60	0.68	1.50–4.25
Body listening	2.46	1.01	0.67–4.33
Trusting	3.80	0.93	1.33–5.00

## RESULTS

### Genital Attending

Nearly all women (25 of 26) reported typically attending to their genital sensations during sexual arousal and/or sexual activity, and 16 (64%) rated doing so as “not difficult” (see Table 2 for complete results of the Attention to Genital Cues questionnaire). This suggests that not attending to genital arousal is unlikely to explain the low concordance between subjective and physiologic sexual arousal in women.

### Relation Between VPA and Perceptions of Genital Arousal

To examine the degree to which women’s perceptions of their genital arousal co-varied with their physiologic genital arousal, we conducted two two-level HLMs. The null models (ie, with no predictors) were significant ( $P < .001$  for the two comparisons), suggesting that multilevel modeling was warranted. Within the multilevel model, VPA and perceived genital arousal significantly co-varied with VPA as the outcome ( $\beta = 2.962$ ,  $t = 2.293$ ,  $P = .031$ ). This coefficient indicates that for every standardized unit of VPA, women showed an average corresponding increase of 2.962 U of perceived genital arousal, which is equivalent to a 6.46-SD increase.

VPA and perceived genital arousal also significantly co-varied in the multilevel model with perceived genital arousal as the outcome ( $\beta = 0.038$ ,  $t = 2.740$ ,  $P = .011$ ). This coefficient indicates that for every standardized unit of perceived genital arousal, women showed an average corresponding increase of 0.038 U of VPA, which is equivalent to a 0.06-SD increase. These findings suggest a linear relation between women’s physiologic and perceived genital arousal.

### Interceptive Awareness as a Moderator of the Relation Between VPA and Perceptions of Genital Arousal

To examine whether interoceptive awareness influenced the relation between VPA and perceived genital arousal, eight separate level 2 moderation analyses were conducted to determine whether subscales of the MAIA influenced the relation between

**Table 4.** Associations between perceived genital arousal and vaginal pulse amplitude, with vaginal pulse amplitude as the outcome and subscales of the Multidimensional Assessment of Interceptive Awareness as moderators

	Coefficient	SE	t Ratio	P value
Noticing	2.034264	1.424333	1.428	.166
Not distracting	-0.148874	1.237804	-0.120	.905
Not worrying	-1.169539	1.584394	-0.738	.468
Attention regulation	-0.507677	1.557844	-0.326	.747
Emotional awareness	1.804351	1.771990	1.018	.319
Self-regulation	0.974554	1.652173	0.590	.561
Body listening	2.682751	1.022053	2.625	.015*
Trusting	0.287218	1.244959	0.231	.819

SE = standard error.  
\*df = 24.

women’s physiologic and perceived genital arousal.<sup>16</sup> Complete results for the MAIA and results for all moderation analyses are presented in Tables 3 and 4, respectively. The body listening subscale was found to significantly moderate this relation, such that higher body listening scores led to a greater association between VPA and perceived genital arousal. This model was significant only when VPA was the outcome ( $\beta = 2.682$ ,  $t = 2.625$ ,  $P = .015$ ). This suggests that women with higher bodily listening scores exhibit a stronger relation between their physiologic and perceived genital sexual arousal.

Post hoc simple slopes analyses indicated that significant gains in concordance between perceived and physiologic genital arousal were made for women with high ( $\beta = 6.031$ ,  $t = 21.624$ ,  $P < .001$ ) and low ( $\beta = 2.191$ ,  $t = 6.325$ ,  $P < .001$ ) scores on the body listening subscale. This suggests that, for women who are high in body listening, the agreement between their perceived and physiologic genital arousal will be high than for those who are low in body listening.

### Interceptive Awareness as a Moderator of the Relation Between VPA and Subjective Arousal

A correlation analysis was conducted to examine the relation between VPA and subjective arousal (represented as percentage of change scores). These variables were not significantly related ( $r_{24} = -0.168$ ,  $P = .411$ ).

Eight multiple regressions were used to examine the extent to which interoceptive awareness (as measured by the MAIA subscales) influences the (lack of) correlation between VPA and subjective arousal. Only the noticing subscale added significantly to this relation ( $\beta = 0.571$ ,  $t = 2.249$ ,  $P < .05$ ). Adding this subscale to the model explained a significant portion of the variance in concordance between subjective and physiologic sexual arousal ( $r^2 = 0.212$ ,  $F_{2,23} = 2.507$ ,  $P < .05$ ). In other words, higher scores on the noticing subscale are related to increases in the agreement between subjective and physiologic sexual arousal.

## DISCUSSION

This study examined the extent to which women can attend to their genital sensations and how measurements of interoceptive awareness can affect women's awareness of their genital arousal and sexual concordance. Results indicate a linear relation between women's physiologic and perceived genital arousal and that measurements of interoceptive awareness influence this ability: women with greater overall bodily listening exhibited a stronger relation between physiologic and perceived genital arousal. Given that mindfulness training, which increases interoceptive awareness, has been shown to improve women's recognition of sexual stimuli, it is not surprising that women with higher levels of interoceptive awareness might be better able to detect their own genital sexual arousal.<sup>22</sup> The present study's findings also are consistent with previous research linking greater interoceptive awareness to an increased ability to detect one's emotional state, heartbeat, and respiratory rate.<sup>23–25</sup>

Examining the relation between physiologic and subjective arousal using correlational analyses showed no significant correlation. This is consistent with previous research that has often reported low correlations between self-report and genital arousal.<sup>3</sup> The fact that most women reported attending to genital sensations during sexual activity suggests the low concordance between these measurements likely is not due to women not willfully attending to genital cues. However, a novel finding in the present study is that the ability to notice bodily sensations might account in part for changing levels of concordance between subjective and physiologic sexual arousal in women. Interoceptive awareness facilitated women's sexual concordance, such that women with higher scores on the noticing subscale had greater agreement between their subjective and physiologic arousal. Previous research exploring this topic has failed to find a relation between concordance and laboratory measurements of interoceptive awareness.<sup>11,12</sup> In these prior studies, participants watched a short film while their heart and respiration rates were recorded. These physiologic measurements were correlated with participants' responses to the question "What was your heart/respiration rate during the film?" to provide an assessment of interoceptive awareness. It is possible that interoceptive awareness relies on various mechanisms, and that the measurements used in these studies were not related to sexual concordance. Perhaps the questionnaire used in the present study was broad enough to capture various forms of bodily awareness (eg, "I notice where in my body I am comfortable" vs "I listen for information from my body about my emotional state"), thus yielding a significant correlation between concordance and interoceptive awareness.

One recent study examining the effects of an 8-week mindfulness-based sex therapy for women with low sexual desire found that adherence to at-home mindfulness activities throughout the course of treatment significantly increased concordance.<sup>26</sup> The researchers suggested that greater exposure to the integration of awareness and bodily sensations through

these activities might have facilitated concordance gains. Recent research by Velten et al<sup>27</sup> showed that other measurements such as sexual inhibition also can influence concordance. They found that concerns about sexual function moderated sexual concordance such that women with higher sexual concern scores had higher levels of sexual concordance. They posited that women with greater levels of concern might tend to focus more on their physiologic arousal, thus increasing levels of concordance. This finding is of particular relevance to the present study because it suggests that awareness of bodily sensations can have differential effects on women's sexual concordance given other factors such as a measurement of sexual inhibition.

Results from the present study have implications for treatment matching and development. Identifying women with low interoceptive awareness with the use of a simple questionnaire could allow clinicians to easily and quickly identify women who might benefit from treatments for sexual dysfunction focused on increasing bodily awareness, such as mindfulness or biofeedback. Biofeedback could be particularly beneficial at enhancing interoceptive awareness because it teaches individuals to properly notice, interpret, and (often) manipulate their bodily sensations and/or functions. Thus, such training might teach women with sexual difficulties how to respond to sexual stimuli. Studies have shown that, when prompted, women can have some voluntary control over their physiologic sexual response in a laboratory setting.<sup>28–30</sup> In one study, women were instructed to increase or decrease their genital arousal while receiving auditory biofeedback or no feedback. Women demonstrated less control during auditory biofeedback compared with no feedback, and overall levels of physiologic arousal were lower in the auditory biofeedback condition.<sup>28</sup> This suggests that auditory feedback can actually hinder physiologic arousal in women. A later study that included a visual biofeedback condition reported that women exhibited the most control in the visual feedback condition, although the greatest increase in physiologic arousal was seen in the no-feedback condition.<sup>29</sup> However, it is important to note that participants in these studies were sexually functional. Women with sexual difficulties, especially those with genital arousal-specific concerns, might exhibit different response patterns to feedback than women without sexual concerns.<sup>6</sup>

Various experimental treatments for female sexual arousal disorder focus on increasing genital arousal to increase subjective arousal. Such treatments include phosphodiesterase type 5 inhibitors (eg, sildenafil), topical estrogen creams,  $\alpha$ - or  $\beta$ -agonists (eg, ephedrine), and the EROS clitoral device (NuGyn, St Paul, MN, USA). However, the lack of support for strong correlations between subjective arousal and VPA suggests that solely targeting genital arousal might not be the most effective treatment for sexual arousal dysfunction in all women. The present study demonstrated that aspects of body awareness influence women's perception of their genital arousal and the concordance between subjective and genital measurements of arousal. This suggests that targeting changes in body awareness

could prove to be an important adjunct to treatment for sexual arousal concerns in women. In support of this notion, one study that attempted to increase body awareness by placing a mirror in front of women before watching an erotic film found significantly higher ratings of subjective arousal compared with the control group where no mirror was present.<sup>14</sup> Unfortunately, no validity data were reported for the mirror manipulation, so it is unclear whether this difference was due to body awareness or other factors.

There are a few study limitations that warrant mention. Because this study was conducted using a sample of sexually functional college students, the results might not generalize to an older population of women or to women with sexual concerns. Given the potential implication of this research for treatment matching, it is especially important that these findings be replicated in a sexually dysfunctional population of women. Moreover, in this study the participants were specifically told to attend to their genital arousal during the assessment. This was done to ensure that results reflected women's *ability* to attend to their arousal response. Although this methodology controlled for women not knowing how to focus on their genital arousal, it might have made the testing environment less reflective of women's sexual experience in a natural setting (ie, at home when they are not explicitly told to attend to their genital sensations). However, results from the Attention to Genital Cues questionnaire suggest that women do attend to their genital sensations during typical sexual activity, and that doing so is not thought to be difficult. The linear relation that was seen in the laboratory coupled with these self-report data supports the generalizability of the present study. Had women exhibited relations between perceived and physiologic arousal in the laboratory, but reported not attending to their genital sensations or having great difficulty doing so during typical sexual activity, the results of the study would have been less reflective of this group of women's experience of sexual arousal.

Another study limitation is the fact that interoception was assessed after participants had continuously attended to their genital sensations during the erotic film. Completing a task that requires women to pay attention to bodily sensations might have inadvertently led to higher scores on the MAIA, a scale that asks individuals to reflect on their tendency to notice and/or interpret bodily sensations. This might have positively influenced the extent to which the MAIA subscales moderate concordance. Having administered the MAIA before participants completing the experimental task might have yielded more accurate results.

Women's perceptions of their bodies also could have influenced the results of this study, because poor interoceptive awareness is believed to be a key feature of eating disorders.<sup>31–33</sup> Because interoceptive awareness refers to the ability to recognize and label internal states, it is unsurprising that such a deficit would be common in individuals with body image concerns.<sup>34</sup> These deficits have been shown to be present in non-clinical

samples of women with negative body perception.<sup>35,36</sup> It is feasible to believe that, in the present study, women with negative perceptions of their bodies would have exhibited lower levels of interoceptive awareness, thus negatively affecting the results of this study. Future research should explore the role that body perception might play in the relation between interoceptive awareness and sexual concordance in women.

Despite these limitations, the relation between body awareness and sexual arousal is an area worthy of further investigation, and continuing to assess the relation between interoceptive awareness and sexual arousal in women with sexual dysfunction would be a valuable next step. Results from this study suggest that being aware of overall bodily sensations could help facilitate awareness of genital arousal and concordance between subjective and physiologic sexual arousal. Furthermore, treatments focused on increasing bodily awareness might be beneficial to women with arousal concerns. The use of a simple questionnaire to assess interoceptive awareness could provide clinicians with insight as to which women might benefit from specific treatments.

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### Category 3

#### (a) Final Approval of the Completed Article

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## REFERENCES

1. Heiman JR. A psychophysiological exploration of sexual arousal patterns in females and males. *Psychophysiology* 1977;14:266-274.
2. Osborn CA, Pollack RH. The effects of two types of erotic literature on physiological and verbal measures of female sexual arousal. *J Sex Res* 1977;13:250-256.

3. Chivers ML, Seto MC, Lalumière ML, et al. Agreement of self-reported and genital measures of sexual arousal in men and women: a meta-analysis. *Arch Sex Behav* 2010;39:5-56.
4. Brotto LA, Erskine Y, Carey M, et al. A brief mindfulness-based cognitive behavioral intervention improves sexual functioning versus wait-list control in women treated for gynecologic cancer. *Gynecol Oncol* 2012;125:320-325.
5. Heiman JR, Rowland DL. Affective and physiological response patterns: the effects of instruction on sexually functional and dysfunctional men. *J Psychosom Res* 1983;27:105-116.
6. Meston CM, Rellini AH, McCall K. The sensitivity of continuous laboratory measures of physiological and subjective sexual arousal for diagnosing women with sexual arousal disorder. *J Sex Med* 2010;7:938-950.
7. Rellini AH, McCall KM, Randall PK, et al. The relationship between women's subjective and physiological sexual arousal. *Psychophysiology* 2005;42:116-124.
8. Pulverman CS, Hixon JG, Meston CM. Uncovering category specificity of genital sexual arousal in women: the critical role of analytic technique. *Psychophysiology* 2015; 52:1396-1408.
9. Laan E, Everaerd W, van Bellen G, et al. Women's sexual and emotional responses to male- and female-produced erotica. *Arch Sex Behav* 1994;23:153-169.
10. Huberman JS, Suschinsky KD, Lalumière ML, et al. Relationship between impression management and three measures of women's self-reported sexual arousal. *Can J Behav Sci* 2013;45:259.
11. Suschinsky KD, Lalumière ML. Is sexual concordance related to awareness of physiological states? *Arch Sex Behav* 2012; 41:199-208.
12. Suschinsky KD, Lalumière ML. The relationship between sexual concordance and interoception in anxious and non-anxious women. *J Sex Med* 2014;11:942-955.
13. Laan E, Everaerd W, Velde J, et al. Determinants of subjective experience of sexual arousal in women: Feedback from genital arousal and erotic stimulus content. *Psychophysiology* 1995; 32:444-451.
14. Seal BN, Meston CM. The impact of body awareness on sexual arousal in women with sexual dysfunction. *J Sex Med* 2007; 4:990-1000.
15. Rosen R, Brown C, Heiman J, et al. The Female Sexual Function Index (FSFI): a multi-dimensional self-report instrument for the assessment of female sexual function. *J Sex Marital Ther* 2000;26:191-208.
16. Mehling WE, Price C, Daubenmier JJ, et al. The Multidimensional Assessment of Interoceptive Awareness (MAIA). *PLoS One* 2012;7:e48230.
17. Handy AB, Meston, CM. Attention to Genital Cues. Unpublished questionnaire.
18. Meston CM. Validation of the Female Sexual Function Index (FSFI) in women with female orgasmic disorder and in women with hypoactive sexual desire disorder. *J Sex Marital Ther* 2003;29:39-46.
19. Wiegel M, Meston C, Rosen R. The Female Sexual Function Index (FSFI): cross-validation and development of clinical cutoff scores. *J Sex Marital Ther* 2005;31:1-20.
20. Raudenbush A, Bryk A, Cheong YF, et al. HLM7: hierarchical linear and nonlinear modeling. Chicago, IL: Scientific Software International; 2011.
21. Chivers ML, Seto MC, Blanchard R. Gender and sexual orientation differences in sexual response to sexual activities versus gender of actors in sexual films. *J Pers Soc Psychol* 2007;93:1108.
22. Silverstein RG, Brown ACH, Roth HD, et al. Effects of mindfulness training on body awareness to sexual stimuli: Implications for female sexual dysfunction. *Psychosom Med* 2011;73:817.
23. Wiens S, Mezzacappa ES, Katkin ES. Heartbeat detection and the experience of emotions. *Cogn Emot* 2000;14:417-427.
24. Whitehead WE, Drescher VM, Heiman P, et al. Relation of heart rate control to heartbeat perception. *Appl Psychophysiol Biofeedback* 1977;2:371-392.
25. Daubenmier J, Sze J, Kerr CE, et al. Follow your breath: respiratory interoceptive accuracy in experienced meditators. *Psychophysiology* 2013;50:777-789.
26. Brotto LA, Chivers ML, Millman RD, et al. Mindfulness-based sex therapy improves genital-subjective arousal concordance in women with sexual desire/arousal difficulties. *Arch Sex Behav* <http://dx.doi.org/10.1007/s10508-015-0689-8>. E-pub ahead of print.
27. Velten J, Scholten S, Graham CA, et al. Investigating female sexual concordance: Do sexual excitation and sexual inhibition moderate the agreement of genital and subjective sexual arousal in women? *Arch Sex Behav* <http://dx.doi.org/10.1007/s10508-016-0774-7>. E-pub ahead of print.
28. Cerny JA. Biofeedback and the voluntary control of sexual arousal in women. *Behav Ther* 1978;9:847-855.
29. Hoon EF. Biofeedback-assisted sexual arousal in females a comparison of visual and auditory modalities. *Appl Psychophysiol Biofeedback* 1980;5:175-191.
30. Prause N, Barela J, Roberts V, et al. Instructions to rate genital vasocongestion increases genital and self-reported sexual arousal but not coherence between genital and self-reported sexual arousal. *J Sex Med* 2013;10:2219-2231.
31. Bruch H. Perceptual and conceptual disturbances in anorexia nervosa. *Psychosom Med* 1962;24:187-194.
32. Garner DM, Olmstead MP, Polivy J. Development and validation of a multidimensional eating disorder inventory for anorexia nervosa and bulimia. *Int J Eat Disord* 1983;2:15-34.
33. Merwin RM, Zucker NL, Lacy JL, et al. Interoceptive awareness in eating disorders: Distinguishing lack of clarity from non-acceptance of internal experience. *Cogn Emot* 2010;24:892-902.
34. Fassino S, Pierò A, Gramaglia C, et al. Clinical, psychopathological and personality correlates of interoceptive awareness in anorexia nervosa, bulimia nervosa and obesity. *Psychopathology* 2004;37:168-174.
35. Ackard DM, Croll JK, Kearney-Cooke A. Dieting frequency among college females: association with disordered eating, body image, and related psychological problems. *J Psychosom Res* 2002;52:129-136.
36. Klemchuk HP, Hutchinson CB, Frank RI. Body dissatisfaction and eating-related problems on the college campus: usefulness of the Eating Disorder Inventory with a nonclinical population. *J Couns Psychol* 1990;37:297.