

Effects of Mindfulness Training on Body Awareness to Sexual Stimuli: Implications for Female Sexual Dysfunction

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Objectives: Treatments of female sexual dysfunction have been largely unsuccessful because they do not address the psychological factors that underlie female sexuality. Negative self-evaluative processes interfere with the ability to attend and register physiological changes (interoceptive awareness). This study explores the effect of mindfulness meditation training on interoceptive awareness and the three categories of known barriers to healthy sexual functioning: attention, self-judgment, and clinical symptoms. **Methods:** Forty-four college students (30 women) participated in either a 12-week course containing a “meditation laboratory” or an active control course with similar content or laboratory format. Interoceptive awareness was measured by reaction time in rating physiological response to sexual stimuli. Psychological barriers were assessed with self-reported measures of mindfulness and psychological well-being. **Results:** Women who participated in the meditation training became significantly faster at registering their physiological responses (interoceptive awareness) to sexual stimuli compared with active controls ($F(1,28) = 5.45, p = .03, \eta_p^2 = 0.15$). Female meditators also improved their scores on attention ($t = 4.42, df = 11, p = .001$), self-judgment, ($t = 3.1, df = 11, p = .01$), and symptoms of anxiety ($t = -3.17, df = 11, p = .009$) and depression ($t = -2.13, df = 11, p < .05$). Improvements in interoceptive awareness were correlated with improvements in the psychological barriers to healthy sexual functioning ($r = -0.44$ for attention, $r = -0.42$ for self-judgment, and $r = 0.49$ for anxiety; all $p < .05$). **Conclusions:** Mindfulness-based improvements in interoceptive awareness highlight the potential of mindfulness training as a treatment of female sexual dysfunction. **Key words:** mindfulness, meditation, interoceptive awareness, self-evaluation, female sexuality, arousal.

FSAD = female sexual arousal disorder; **MAAS** = Mindful Attention Awareness Scale; **FFMQ** = Five Facet Mindfulness Questionnaire; **SPWB** = Scales of Psychological Well-being; **BSI** = Brief Symptom Inventory; **SAM** = Self-Assessment Manikin.

INTRODUCTION

Every year, a multibillion-dollar market share supports drug treatments of erectile dysfunction. This massive market, with its aggressive advertising, masks the reality that a greater number of women suffer from sexual dysfunction than men (1). Although female sexual dysfunction is much less apparent in the media, nearly \$2 billion are spent each year on the often-ineffective treatment of women’s sexual complaints (2). The well-financed hunt for women’s equivalent drug, a pursuit termed the “pinking of Viagra” (2,3), has been unsuccessful because women’s sexuality differs from men’s and relies much more on psychological than physiological factors (4,5). This article investigates the promise of a behavioral intervention—mindfulness meditation training—to address many of the psychological barriers to healthy female sexual functioning.

Human sexual arousal encompasses a dynamic interaction between physiological and psychological components. These

components interact differently in women compared with men, highlighting some of the unique features of female sexuality. Compared with men, women experience a higher level of discordance between their physiological arousal and their subjective experience of arousal when presented with sexual stimuli (6). Whereas men’s physiological arousal and self-reported arousal are closely correlated, women are significantly more likely to report feeling unaroused even when their bodies show objective signs of physiological arousal (6). Women diagnosed with female sexual arousal disorder (FSAD), an umbrella term encompassing many subgroups of women who have complaints about sexual arousal, exhibit an even higher level of discordance (7). Physiologically based treatments (Viagra) only heighten this discordance: the level of physiological arousal is irrelevant if psychological barriers are not addressed (8).

The degree of discordance between the subjective experience of arousal and the physiological response has been hypothesized as a function of *interoceptive awareness* or the ability to consciously register internal bodily sensations (9,10). Judgmental thoughts of inadequacy, embarrassment, guilt, and anxiety can monopolize cognitive resources, draw attention away from the present moment, and interfere with interoceptive awareness (7,11).

The psychological factors or “barriers” that interfere with interoceptive awareness and sexual functioning encompass three general categories: a) *attention*, the inability to sustain focus or notice or differentiate body sensations (12); b) *self-judgment*, the negative self-evaluation or lack of self-acceptance (13); and c) *clinical symptoms*, such as depression and anxiety (14,15).

These barriers can distract a woman from interoceptively experiencing her physiological arousal, leaving her subjectively and effectively “unaroused.”

Mindfulness meditation has been independently found to improve all three of these psychological barriers. Mindfulness has its roots in Buddhist meditative practices, where purposefully focusing attention on bodily sensations during meditation cultivates a nonjudgmental moment-to-moment awareness

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This research was supported by grants from the National Institutes of Health (MH067553-05 and K23 AT006328-01A1), the Mind and Life Institute, the Frederick Lenz and Hershey Foundations, and the Brown University Contemplative Studies Initiative.

This was not an industry-supported study. The authors have indicated no financial conflicts of interest.

Received for publication November 21, 2010; revision received July 4, 2011.

DOI: 10.1097/PSY.0b013e318234e628

that permeates into daily life (16). Mindfulness-based practices have been widely adapted into therapies such as Mindfulness-Based Stress Reduction (16) and Mindfulness-Based Cognitive Therapy (17).

Mindfulness and other forms of meditative practices have consistently been associated with improvement in attentional capacities (18–29) and clinical symptoms of anxiety and depression (30–38). Mindfulness meditation-based improvements in both attention and negative emotional states have been found to be associated with decreases in self-judgment (i.e., secondary self-referential, ruminative and evaluative processes, and increases in self-acceptance and self-compassion) (38–42).

There is also evidence that mindfulness practice can improve interoceptive awareness. Several studies have shown that mindfulness is associated with increased cortical volume in brain areas associated with interoceptive awareness, such as the insula and the anterior cingulate cortex (43–47), and one recent study showed a higher level of concordance between physiological and subjective responses to emotional stimuli in mindfulness meditators compared with controls (48).

Because mindfulness training has been associated with improvements in the psychological barriers to body awareness (attention, self-judgment, and clinical symptoms), mindfulness is now being investigated as a method to promote healthy female sexual functioning. One correlational study found that self-reported mindfulness scores in female college students were associated with a higher level of sexual self-esteem (49). Others have incorporated mindfulness into a psychoeducational treatment program for FSAD. In addition to mindfulness training, this psychoeducational program included cognitive-behavioral therapy, sexual therapy, and relationship therapy. Although this multicomponent treatment has been found to yield positive outcomes related to sexual functioning distress (50,51), it is unclear what role, if any, was played by mindfulness meditation. Whereas mindfulness training was assumed to cultivate non-judgmental body awareness, a mindfulness-only intervention is needed to confirm this hypothesis. The addition of a mindfulness questionnaire would help assess the acquisition of mindfulness skills and whether these skills are required for the therapeutic benefit. Furthermore, active controls (rather than waitlist controls) are needed to isolate the specific effects of mindfulness over and above the general effects of an active intervention.

Our study incorporates these methodological improvements by using an isolated mindfulness meditation intervention with active controls and measuring the acquisition of mindfulness skills. First, we verified previous reports that the three categories of psychological barriers (attention, self-judgment, and clinical symptoms) were associated with impaired interoceptive awareness to sexual stimuli in women compared with men. Then, we assessed the effects of a 12-week mindfulness meditation training on women's interoceptive awareness and these psychological barriers, in comparison with an active control condition. We predicted that mindfulness training would produce greater improvements in interoceptive awareness and psychological barriers. Furthermore, we predicted that the improvements

in interoceptive awareness would parallel improvements in psychological barriers.

METHODS

Participants

Participants included Brown University undergraduates ($N = 44$; mean [standard deviation {SD}] age = 20 [1.0] years; range, 18–22 years) who were enrolled in three types of courses: a) courses that included both didactic class time and experiential laboratory sessions about mindfulness meditation, b) courses with a similar format (didactic and experiential laboratory sessions) but different content (i.e., music courses), and c) courses with similar content (i.e., religious studies courses) but no practice laboratory.

There were 14 women in the meditation condition and 16 women in the control condition. In addition, there were 14 men who also received meditation and served as a reference group to demonstrate gender differences in interoceptive awareness to sexual slides.

Participants were recruited in the first week of classes and completed written informed consent procedures. The study protocol was approved by the Brown University institutional review board. There were no exclusion criteria besides age.

Procedures

Participants completed assessments at the beginning and end of a 12-week course. Assessments included self-reported questionnaires and a 2-hour in-laboratory neuropsychological battery. The experiments were conducted between January 2008 and December 2009 on the Brown University campus in Providence, Rhode Island. There were no adverse events during the study.

Self-Reported Measures

The Mindful Attention Awareness Scale (MAAS) (52) is a 15-item scale measuring levels of attention and awareness of the present moment (“I could be experiencing some emotion and not be conscious of it until some later time”—reverse scored). MAAS items are scored on a 1 (“almost always”) to 6 (“almost never”) measurement scale, and the mean of all 15 items yields a total score, with higher scores indicating greater mindful awareness. The psychometric properties of the MAAS have been demonstrated in both nonclinical (52,53) and clinical populations (54). Cronbach α values in the current study were 0.83 to 0.84.

A second measure of mindfulness, the Five Facet Mindfulness Questionnaire (FFMQ) (55), is a 39-item inventory with five subscales aimed to assess different aspects of mindfulness: observing, describing, acting with awareness, accepting without judgment, and nonreactivity to inner experience (Cronbach $\alpha = 0.88$). FFMQ responses range from 1 (“never or very rarely true”) to 5 (“very often or always true”). The entire FFMQ was administered to measure mindfulness, and certain relevant subscales were also assessed individually. We used the “observing” and “describing” scales to measure *mindful attention*—the ability to sustain attention and recognize qualities of the present moment. The observing scale is intended to assess the tendency to observe or notice internal and external present-moment experiences, and the describing scale is intended to assess the ability to differentiate or label them. The nonjudging scale was used to measure the tendency to experience thoughts and feelings without judgment or evaluation. Although the MAAS shares five items with the FFMQ, the different response options and the $r < 0.50$ correlation between scales indicate that they are not identical and measure slightly different aspects of mindfulness.

The Scales of Psychological Well-being (SPWB) (56) is an 84-item self-reported questionnaire that assesses six areas of well-being. In the current study, we used the self-acceptance scale to assess positive attitude toward the self, or to what extent the participant acknowledges and accepts multiple aspects of the self, including good and bad qualities (Cronbach $\alpha = 0.94$). Whereas the FFMQ measures the relationship to thoughts and feelings, this acceptance is more directed toward the self as a whole, “Everyone has their weaknesses, but I seem to have more than my share” (reverse score). We also used the SPWB—total score as an overall indicator of psychological well-being (Cronbach $\alpha = 0.84$).

The Brief Symptom Inventory (BSI) (57) is a 53-item self-reported symptom inventory designed for the assessment of a range of clinical syndromes (Cronbach $\alpha = 0.92$). Psychometric evaluation has suggested that it is an acceptable short alternative to the much longer Symptom Checklist-90-Revised

MINDFULNESS AND INTEROCEPTIVE AWARENESS

scale, from which it was adapted (58). For this study, we used the anxiety and depression subscales because they are known barriers to healthy sexual functioning (14,15) and interoceptive awareness (59).

Objective Measures

Participants were presented with a series of pictures selected from the International Affective Picture System, using DMDX software (60). Participants were instructed to rate the intensity of their physiological response to pleasant, unpleasant, and neutral slides on an arousal scale from 1 to 9. After the practice trials, they were shown a series of 31 slides, consisting of 4 sexual (slides 4599, 4641, 4660, and 4670; mean [SD] valence = 7.28 [1.42], mean [SD] arousal = 6.11 [1.91]) and 27 nonsexual slides (mean [SD] valence = 6.37 [1.86], mean [SD] arousal = 4.36 [2.11]). Slides with normed valence or arousal ratings that differed significantly between men and women were not used. Slides were displayed for 8 seconds each, with a 1-second interslide interval, and block randomized so that no slides of the same valence appeared consecutively. Two separate sets of slides were counterbalanced for precourse and postcourse administration. Each slide was followed by a 5-second opportunity to make a rating of one's own physiological arousal, using the Self-Assessment Manikin (SAM) (61) as shown in Figure 1. The arousal rating asked participants to indicate how physiologically "calm," "excited," or "aroused" they felt during the presentation of the previous slide. Participants entered their responses using the numbers 1 to 9 that correspond with the images on the SAM. Participants were told that they would have 5 seconds to make their rating, but there were no instructions related to the speed of response. The SAM arousal domain was not intended to measure sexual arousal but rather capture awareness of "the physiological activation parameter of affective experience" (62), which includes a range of physiological changes including those involved in sexual arousal.

Interoceptive awareness was measured by how long it took a participant to register and rate the intensity of her bodily arousal (i.e., reaction time). SAM reaction time to slides from the International Affective Picture System has been previously found to be a valid measure of "processing efficiency" for assessing one's own response to slide content (63). The more quickly a participant can register the changes in her body (i.e., higher level of interoceptive awareness), the faster her reaction time. We predict that poor attention, self-judgment, and clinical symptoms will interfere with the ability to attend to body states (interoceptive awareness) and result in slower reaction times.

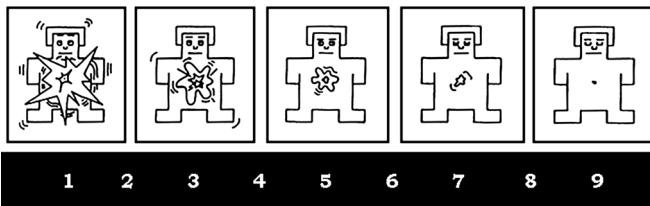


Figure 1. The Self-Assessment Manikin for arousal ratings. Self-Assessment Manikin © Peter J. Lang 1994. Reprinted with permission.

Intervention

The women in the meditation condition participated in a semester-long East Asian/Religious Studies course that incorporated "meditation laboratories" that were designed to allow students to experience the contemplative practices that they learned and read about during the didactic class periods. In addition to 2.5 hours a week of didactic class time, participants met for an additional 3 hours a week for meditation practice time. Meditation training included both Samatha and Vipassana forms of practice, which included focused awareness training on a single object (such as the breath) or a class of objects (such as body sensations) but did not include objectless meditation (open monitoring or choiceless awareness) (64). Whereas the meditation instructions emphasized attention allocation rather than the acceptance that is central to western styles of mindfulness, it incorporated ideals of letting go of evaluation.

Meditation laboratories were scheduled for 1 hour three times per week and included approximately 30 minutes of a specific contemplative practice from

Buddhist or Taoist traditions. The meditation laboratory is taught by a professor, a published scholar of Buddhist and Taoist contemplative practices with more than 30 years of personal practice experience in the Rinzaï Zen tradition. The meditation period is followed by a 5- to 10-minute written reflection period and question-and-answer period. Many students also meditated outside class, although this was optional.

Controls

The control group consisted of female college students participating in courses with either similar content/different format or similar format/different content to the meditation laboratory courses. Courses of similar content included Religious Studies courses that covered similar didactic material but did not include a meditation laboratory. Courses with similar format included music courses with both didactic and experiential laboratory sessions. The ratio of didactic class time to experiential practice learning in these courses was comparable with the meditation course.

Statistical Analyses

Preliminary Analysis

Before analysis, all variables were examined for normality, and any outlying cases were winsorized such that outliers were replaced with the next highest nonoutlying value (65). Preliminary analyses were used to describe baseline characteristics and participant flow/adherence and investigate any baseline group differences that might affect the main analyses. Preliminary analysis also included a manipulation check of our hypotheses at baseline: a) that women's reaction times were slower (as compared with men) on sexual (but not nonsexual) stimuli and b) that slower reaction times to sexual slides were associated with all three categories of psychological barriers (attention, self-judgment, and clinical symptoms).

Main Analysis

The main analyses investigated the effect of the intervention on interoceptive awareness (reaction time) to sexual stimuli and the three categories of psychological barriers. We conducted separate two-way repeated-measures analyses of variance to examine changes in variables from baseline to after treatment. Variables were two-level within-subject variables (before and after) and consisted of reaction time, attention (MAAS, FFMQ-total, FFMQ-observe, and FFMQ-describe), self-judgment (FFMQ-nonjudge and SPWB-self-acceptance), and clinical symptoms (BSI-anxiety, BSI-depression, and SPWB-well-being total). The between-subjects variable was treatment (meditation course or active control course). Men were only analyzed as a reference group for reaction time.

Secondary analyses used Pearson product-moment correlation coefficients to examine the relationships between the change in reaction time and improvement in psychological barriers and mindfulness. Data were analyzed using SPSS 17.0 software (SPSS Inc, Chicago, IL). Statistical significance was set at α levels $<.05$, two-tailed. Results are reported as mean (SD) or number/percentage unless otherwise indicated. Effect sizes were reported as partial η^2 (η_p^2 ; small = 0.01, medium = 0.06, large = 0.14) Partial η^2 is the "the proportion of total variability attributable to a factor" (66) and the standard SPSS calculation for effect size (67,68).

RESULTS

Preliminary Analyses

Participant Flow

Forty-four individuals completed all baseline assessments before training started (14 female meditators, 14 male meditators, and 16 female controls). Two meditating women did not complete the postintervention questionnaires but were included in reaction time analyses.

Intervention Adherence

The participants in the courses with meditation laboratories meditated an average of 1763 minutes (approximately 30 hours)

over the course of the semester, including meditation practice outside class.

Baseline Characteristics

There were no significant differences between female intervention groups in age, reactions times, or any self-reported measure at baseline. Average baseline BSI scores indicated that clinical symptoms (i.e., depression and anxiety) were in the mild range and slightly above average for a nonpatient sample, spanning the clinical cutoff and ranging from subclinical to moderately severe (69).

Manipulation Check: Women's Versus Men's Reaction Times to Sexual Slides

As displayed in Figure 2, at baseline, women's reaction times to sexual slides were slower compared with those of men ($t = 2.11$, $df = 42$, $p = .04$). Women's overall reaction time for all slides did not differ from men's ($t = -0.17$, $df = 42$, $p = .86$), which suggests that slower reaction time was because of the sexual content of the stimuli and not because of gender differences in motoric control.

At baseline, slower reaction times to sexual slides correlated with higher levels of depression ($r = 0.54$, $p = .04$) and anxiety ($r = 0.49$, $p = .08$) and lower levels of self-acceptance ($r = -0.68$, $p = .007$) and nonjudgment ($r = -0.60$, $p = .02$). These correlations confirm our hypothesis that impaired interoceptive awareness (measured by reaction time) is associated with negative self-judgment and clinical symptoms.

Main Analyses: Reaction Time to Sexual Slides Time Main Effect

There was a significant time main effect for changes in reaction time to sexual slides ($F(1,28) = 4.70$, $p = .04$, $\eta_p^2 = 0.14$),

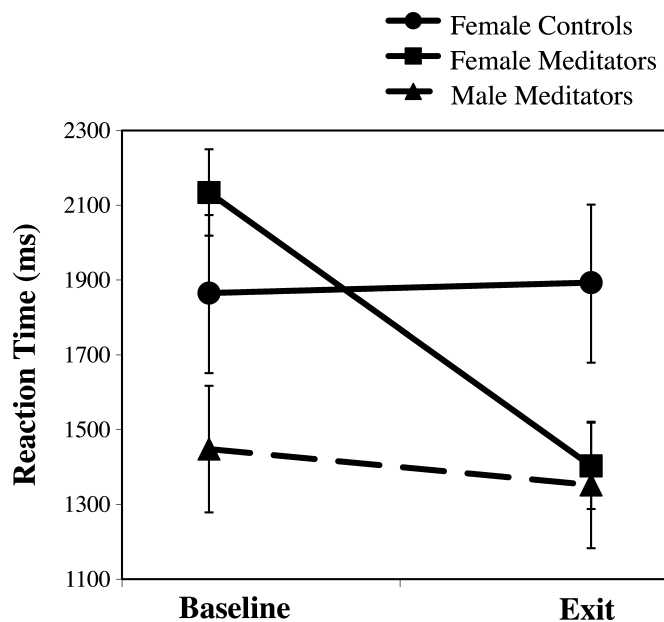


Figure 2. Reaction times to sexual slides in male and female meditators and controls.

although this effect was carried by the faster reaction times of female meditators.

Treatment-by-Time Effect

The mean decrease in reaction time to sexual slides was significantly greater for female meditators than female controls ($F(1,28) = 5.45$, $p = .03$, $\eta_p^2 = 0.15$).

Female Meditators

Female meditators' reaction times to sexual slides were 730 milliseconds faster than baseline after mindfulness training ($t = -3.12$, $df = 13$, $p = .008$), whereas the controls' reaction time did not change after their courses.

Sexual Slides Versus Nonsexual Slides

The decrease in reaction time of female meditators to sexual slides was significantly greater than the average decrease in reaction time for rating arousal for all pictures ($t = -2.16$, $df = 13$, $p < .05$), which suggests that the faster reaction time was specific to sexual slides and not to a general improvement.

Main Analyses: Attention

Time Main Effect

Significant main effects for time indicated an increase in attention-related scores in the MAAS ($F(1,26) = 6.02$, $p = .02$, $\eta_p^2 = 0.19$), the FFMQ-total ($F(1,26) = 20.17$, $p < .001$, $\eta_p^2 = 0.44$), the FFMQ-describe subscale ($F(1,26) = 6.90$, $p = .03$, $\eta_p^2 = 0.21$), and the FFMQ-observe subscale ($F(1,26) = 5.21$, $p = .01$, $\eta_p^2 = 0.17$) across all participants.

Treatment-by-Time Effect

There was a significant two-way interaction for the MAAS ($F(1,26) = 13.19$, $p = .001$, $\eta_p^2 = 0.34$), the FFMQ-total ($F(1,26) = 12.95$, $p = .001$, $\eta_p^2 = 0.33$), and the FFMQ-describe subscale ($F(1,26) = 7.00$, $p < .05$, $\eta_p^2 = 0.14$). The FFMQ-observe subscale showed a trend toward a two-way interaction but was not significant ($F(1,26) = 2.96$, $p = .09$, $\eta_p^2 = 0.10$).

Female Meditators

Female meditators significantly improved their scores on the MAAS ($t = 3.00$, $df = 11$, $p = .01$), the FFMQ-total score ($t = 4.42$, $df = 11$, $p = .001$), the FFMQ-observe ($t = 2.84$, $df = 11$, $p = .02$), and FFMQ-describe subscales ($t = 2.75$, $df = 11$, $p = .02$). The controls' scores on these measures did not change.

Main Analyses: Self-Judgment

Time Main Effect

There were significant main effects for time for FFMQ-nonjudgment subscale ($F(1,26) = 15.68$, $p < .001$, $\eta_p^2 = 0.38$) and SPWB-self-acceptance subscale ($F(1,26) = 5.08$, $p = .03$, $\eta_p^2 = 0.16$).

Treatment-by-Time Effect

Significant two-way interactions for the FFMQ-nonjudgment subscale ($F(1,26) = 4.10$, $p < .05$, $\eta_p^2 = 0.14$) and the SPWB-self-acceptance subscale ($F(1,26) = 10.66$, $p = .003$, $\eta_p^2 = 0.29$)

MINDFULNESS AND INTEROCEPTIVE AWARENESS

indicate that improvement on these measures was greater for meditators than controls.

Female Meditators

Female meditators significantly improved their scores on the FFMQ–nonjudge subscale ($t = 3.1, df = 11, p = .01$) and the SPWB–self-acceptance subscale ($t = 3.4, df = 11, p = .006$); controls showed no improvement.

Main Analyses: Clinical Symptoms

Treatment-by-Time Effect

All clinical measures improved significantly more in meditators compared with controls, including decreased BSI–depression scores ($F(1,26) = 4.00, p < .05, \eta_p^2 = 0.13$), decreased BSI–anxiety scores ($F(1,26) = 5.00, p = .03, \eta_p^2 = 0.16$), and increased SPWB–well-being total scores ($F(1,26) = 4.28, p < .05, \eta_p^2 = .14$). There were no time main effects.

Female Meditators

Female mediators showed significant improvement the BSI–anxiety ($t = -3.17, df = 11, p = .009$) and BSI–depression scales ($t = -2.13, df = 11, p < .05$). They also showed trend-level

improvements in the SPWB–well-being total ($t = 2.10, df = 11, p = .06$). There were no significant changes on these scales for controls (Table 1).

Relationship Between Changes in Reaction Time and Self-Reported Measures

As shown in Table 2, Pearson correlations revealed that decreases in reaction time to sexual slides were associated with increases in overall mindfulness, attention, nonjudgment, self-acceptance, and well-being and with decreases in self-judgment and anxiety. As mindfulness and psychological barriers to interoceptive awareness improved, reaction time became faster. See Figures 3 and 4.

DISCUSSION

This study investigated the effect of mindfulness meditation training on women's ability to register their own bodily response to sexual stimuli, or interoceptive awareness. Female college students who participated in university course-based meditation training were compared with female students from courses with similar content or format on tests of interoceptive awareness and

TABLE 1. Outcome Table for Female Meditators and Controls

Variable	Condition	N	Baseline		After Treatment		Treatment-by-Time Effect, <i>F</i>	<i>p</i>	η_p^2
			M	SD	M	SD			
Reaction time ^a	Men	14	1448.4	727.3	1351.6	632.6			
	MED	14	2134.1	856.8	1403.6	462.3	5.5	.03	0.16
	CON	16	1865.1	800.4	1893.6	780.6			
Attention									
MAAS–total	MED	12	3.8	0.5	4.3	0.5	13.2	.001	0.34
	CON	16	4.1	0.4	4.0	0.4			
FFMQ–total	MED	12	123.5	13.8	139.9	11.8	13.0	.001	0.33
	CON	16	133.3	8.5	135.1	9.5			
FFMQ–observe	MED	12	27.1	4.1	29.8	3.5	3.0	.09	0.10
	CON	16	27.6	3.9	28.0	5.0			
FFMQ–describe	MED	12	26.9	5.7	29.4	5.8	6.9	.04	0.14
	CON	16	27.6	4.7	27.9	4.7			
Self-judgment									
FFMQ–nonjudge	MED	12	25.8	6.4	31.3	6.3	4.1	.05	0.14
	CON	16	28.1	4.6	29.8	3.8			
SPWB–self-acceptance	MED	12	62.8	11.3	69.6	8.9	10.7	.003	0.29
	CON	16	65.2	10.6	63.9	8.3			
Clinical/well-being									
SPWB–well-being	MED	12	383.7	37.8	403.5	35.9	4.3	.04	0.14
	CON	16	380.9	42.5	380.4	36.8			
BSI–depression	MED	12	4.6	4.1	2.6	3.3	4.0	.05	0.13
	CON	16	3.5	3.7	4.3	3.6			
BSI–anxiety	MED	12	3.8	3.1	2.1	1.7	5.0	.03	0.16
	CON	16	4.4	2.9	4.8	2.6			

M = mean; SD = standard deviation; MED = meditation condition; CON = control condition; MAAS = Mindful Attention Awareness Scale; FFMQ = Five Facet Mindfulness Questionnaire; SPWB = Scales of Psychological Well-being; BSI = Brief Symptom Inventory.

^a Reaction time to sexual slides.

TABLE 2. Correlations Between Changes in Reaction Time and Changes in Self-Reported Measures

Self-Report Scale	Correlation With Reaction Time
Attention	
MAAS-total	-0.37*
FFMQ-observe	-0.37†
FFMQ-describe	-0.39*
FFMQ-total	-0.44*
Nonjudgment	
FFMQ-nonjudge	-0.42*
SPWB-self-acceptance	-0.46**
Clinical measures	
BSI-anxiety	0.49**
BSI-well-being	-0.48**

MAAS = Mindful Attention Awareness Scale; FFMQ = Five Facet Mindfulness Questionnaire; SPWB = Scales of Psychological Well-being; BSI = Brief Symptom Inventory.

† $p < .10$.

* $p < .05$.

** $p < .01$.

three categories of psychological barriers that interfere with such awareness (attention, self-judgment, and clinical symptoms). The main findings were the following:

1. When assessing their bodily responses to sexual stimuli, women took significantly longer than men did to register their bodily responses (i.e., less interoceptive awareness), and this impaired body awareness in women was associated with high levels of self-judgment and clinical symptoms.
2. Women who underwent mindfulness meditation training had larger increases in interoceptive awareness than women

who practiced music or took similar courses without meditation.

3. Mindfulness training was also associated with greater improvements on self-reported measures of attention, self-judgment, and clinical symptoms compared with active controls.
4. Decreased reaction time, or higher interoceptive awareness, was correlated with improvements in self-reported attention, self-judgment, and clinical symptoms.

Each of these findings will be discussed in detail below.

Negative Self-Evaluation Contributes to Women’s Impaired Body Awareness

Before completing any course, women in all groups took longer to assess their bodily response to sexual slides than men. This gender difference in reaction time, found only for sexual photographs, supports existing evidence that women are less in tune with their bodily arousal to sexual stimuli (6). In addition, women’s slower reactions times correlated with higher levels of depression, anxiety, and self-judgment, the same barriers thought to impede healthy female sexual functioning (7,14). This relationship supports the idea that anxious, depressive self-evaluation can interfere with interoception, causing the women to take longer to register their bodily response to sexual stimuli.

Mindfulness Improves Interoceptive Awareness

As predicted, the women in the mindfulness-based course showed greater decreases in reaction time in rating bodily responses to sexual stimuli compared with the active control group. After mindfulness training, female meditators’ reaction times to sexual stimuli did not differ significantly from men’s. Faster reaction times suggest that female meditators could more

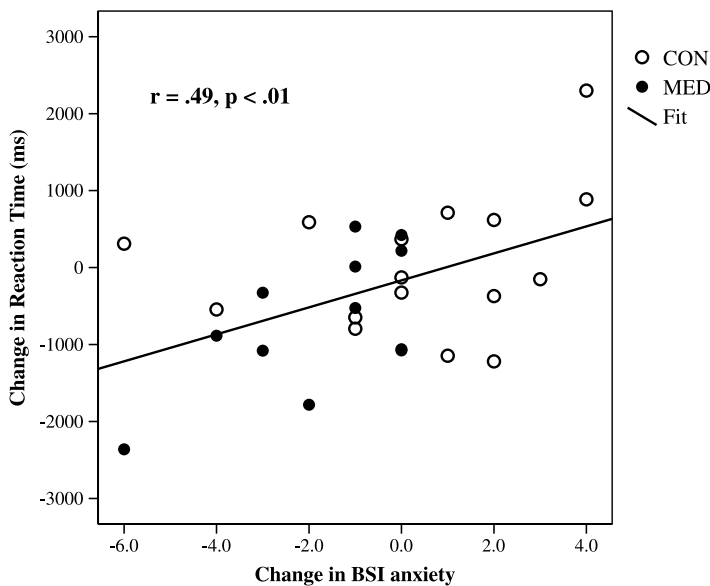


Figure 3. Pearson correlation between changes in reaction time and changes in Brief Symptom Inventory (BSI)-anxiety. Decreases in anxiety are associated with decreases in reaction time. CON = control; MED = meditators; fit = line of best fit.

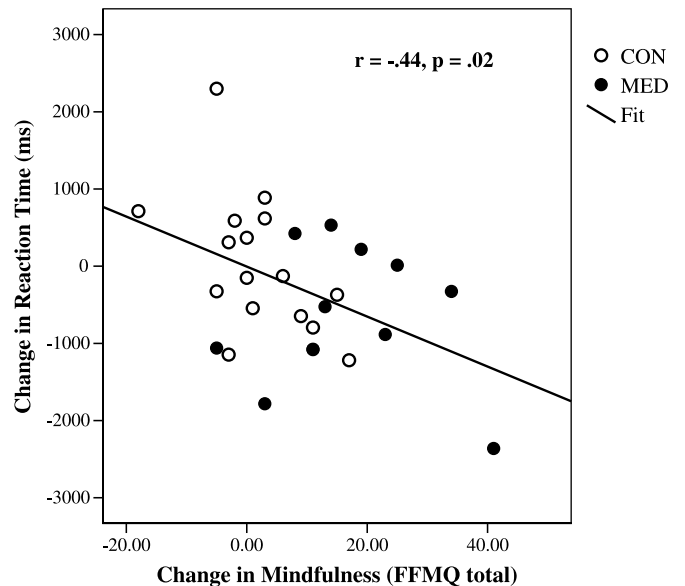


Figure 4. Correlation between changes in reaction time and changes in mindfulness (Five Facet Mindfulness Questionnaire [FFMQ]-total). Increases in mindfulness are associated with decreases in reaction time. CON = control; MED = meditators; fit = line of best fit.

MINDFULNESS AND INTEROCEPTIVE AWARENESS

readily register changes in their bodies, indicating improvements in interoceptive awareness. Mindfulness meditation has been associated with increased cortical thickness and gray matter concentration in the insula cortex (43–47), the brain area most commonly associated with interoceptive awareness (70). The faster reaction times to sexual stimuli in the female meditators may be related to increased insula-based interoceptive awareness.

Mindfulness Training Improves Psychological Barriers to Interoceptive Awareness

As predicted, female meditators significantly improved their scores on measures of mindfulness and all three categories of psychological barriers, including attention, self-judgment, and clinical symptoms. Meditating women improved their ability to notice and differentiate bodily sensations, as indicated by their higher scores on the MAAS, FFMQ–total, and FFMQ–describe subscale. They also increased their ability to experience their internal states with less judgment and more self-acceptance. Mindfulness training was also associated with improved clinical symptoms, including anxiety, depression, and overall psychological well-being. These results add to the growing evidence that mindfulness interventions can improve attention (18–29), reduce negative self-evaluative thinking (38–42), and improve emotional well-being (30–38).

Improvements in Body Awareness Are Associated With Improvements in Psychological Barriers

The decreases in reaction time to sexual stimuli in the female meditators were associated with increases in improvements in all three categories of psychological barriers. Faster reaction times were correlated with increases in mindfulness (attention and nonjudgment) and decreases in anxiety. Because the meditating women increased nonjudgmental attention and decreased in anxiety, they were quicker at registering their level of arousal to sexual stimuli. These results imply that, by reducing the barriers to interoceptive awareness when viewing sexual stimuli, mindfulness meditation allowed women to more quickly register and access their bodily arousal.

A recent study found that increased body awareness associated with mindfulness meditation was related to higher levels of concordance between physical and emotional responses. Meditators' self-reported responses to emotional stimuli were more highly correlated with their physical responses than the non-meditators' (48). Our results suggest that this increased concordance between physical and emotional responses may rise from the removal of psychological barriers to interoceptive awareness.

Implications for the Treatment of Female Sexual Dysfunction

Although this study assessed women in a nonclinical population, it may have implications for clinical interventions in women evaluated with FSAD. FSAD is characterized by a high level of discordance between physiological and subjective arousal states, such that women are unaware of their own bodily sen-

sations (i.e., low interoceptive awareness) (7). Although previous studies have found that mindfulness as part of a larger intervention can positively affect FSAD (50,51), the role or mechanism of mindfulness was unclear. Results from this study suggest that mindfulness alone may promote more direct access to body sensations by training attention and decreasing negative self-evaluation.

Implications for Educational Settings

The focus of this article has been on the role of mindfulness training on the barriers to female body awareness, in the larger context of female sexual functioning. However, the fact that participation in a college course could improve attention, anxiety, and depression has widespread implications for schools as delivery systems for psychological wellness. This issue deserves further consideration.

Limitations

The present study has several limitations, most notably the small sample size, and limited statistical power. The use of a nonclinical sample limits the ability to generalize to a treatment-seeking clinical population such as women with FSAD. The university women who volunteered for the study were not seeking treatment of sexual problems, although sexual dysfunction among college women is estimated to be approximately 40% (71).

Our measure of interoceptive awareness used SAM reaction times rather than a heartbeat detection paradigm (48,72). Although reaction times are thought to reflect “processing efficiency” for assessing one’s own response to slide content (63), it is possible that the faster reaction times are related to an increased willingness to acknowledge or admit the experience of high arousal states. Thus, it may be that mindfulness training reduces the social or self-imposed proscription to report arousal in an experimental context rather than increased body awareness. In addition, the measure of arousal assessed general physiological changes in response to sexual stimuli, which is not specific to, but may include, sexual arousal. Future studies should assess the effects of mindfulness training alone on sexual objective measures of sexual arousal and reports of sexual satisfaction.

The current study suggests that increases in interoceptive awareness are associated with meditation-related improvement in mindfulness, self-judgment, and clinical symptoms. However, more complex analyses with a larger sample are needed to elucidate the precise mechanism of action and the relationship between these variables.

Sexual orientation, general sensitivity disorders, and menstrual cycle factors are all important in evaluating sexual response but were not included in this study. Although previous research has not shown female sexual orientation to predictably alter an individual’s physiological response to sexual stimuli (73–75), future studies should assess participants’ sexual orientation given the complexity of the female sexual response. In addition, there was no evaluation of general sensitivity disorders, general sexual distress, phase of menstrual cycle at time of study, or menstrual cycle abnormalities. Future studies should

use specific tools for assessing these factors and general sexual-related distress.

CONCLUSIONS

Women who underwent mindfulness meditation training improved their ability to detect their own physiological responses to sexual stimuli. This improvement in interoceptive awareness was associated with improvements in attention, self-judgment, and clinical symptoms, which are known psychological barriers to healthy sexual functioning. These findings highlight the potential for mindfulness training as a treatment of female sexual dysfunction.

We would like to thank Dr. John Allen for his comments and give special thanks to the research assistants in the Britton Lab for their time and effort.

REFERENCES

- Laumann EO, Paik A, Rosen RC. Sexual dysfunction in the United States: prevalence and predictors. *JAMA* 1999;281:537–44.
- Hartley H. The ‘pinkings’ of Viagra culture: drug industry efforts to create and repackage sex drugs for women. *Sexualities* 2006;9:363–78.
- Triggle D. Treating desires not diseases: a pill for every ill and an ill for every pill? *Drug Discov Today* 2007;12:3–4.
- Bancroft J. The medicalization of female sexual dysfunction: the need for caution. *Arch Sex Behav* 2002;31:451–5.
- Bancroft J, Loftus J, Long JS. Distress about sex: a national survey of women in heterosexual relationships. *Arch Sex Behav* 2003;32:193–208.
- Chivers ML, Seto MC, Lalumiere ML, Laan E, Grimbos T. Agreement of self-reported and genital measures of sexual arousal in men and women: a meta-analysis. *Arch Sex Behav* 2010;39:5–56.
- Basson R. A model of women’s sexual arousal. *J Sex Marital Ther* 2002;28:1–10.
- Chivers ML, Rosen RC. Phosphodiesterase type 5 inhibitors and female sexual response: faulty protocols or paradigms? *J Sex Med* 2010;7:858–72.
- Salonia A, Giraldi A, Chivers ML, Georgiadis JR, Levin R, Maravilla KR, McCarthy MM. Physiology of women’s sexual function: basic knowledge and new findings. *J Sex Med* 2010;7:2637–60.
- Khalsa SS, Rudrauf D, Damasio AR, Davidson RJ, Lutz A, Tranel D. Interoceptive awareness in experienced meditators. *Psychophysiology* 2008;45:671–7.
- Janssen E, Everaerd W, Spiering M, Janssen J. Automatic processes and the appraisal of sexual stimuli: toward an information processing model of sexual arousal. *J Sex Res* 2000;37:8–23.
- de Jong D. The role of attention in sexual arousal: implications for treatment of sexual dysfunction. *J Sex Res* 2009;46:237–48.
- Graham C, Sanders S, Milhausen R, McBride K. Turning on and turning off: a focus group study of the factors that affect women’s sexual arousal. *Arch Sex Behav* 2004;33:527–38.
- Lykins AD, Janssen E, Graham CA. The relationship between negative mood and sexuality in heterosexual college woman and men. *J Sex Res* 2006;43:136–43.
- Basson R. Using a different model for female sexual response to address women’s problematic low sexual desire. *J Sex Marital Ther* 2001;27:395–403.
- Kabat-Zinn J. *Full Catastrophe Living: Using the Wisdom of Your Body and Mind to Face Stress, Pain and Illness*. New York, NY: Delacorte Press; 1990.
- Segal ZV, Williams JM, Teasdale JD. *Mindfulness-Based Cognitive Therapy for Depression: A New Approach to Preventing Relapse*. London, UK: Guilford; 2002.
- Slagter HA, Lutz A, Greischar LL, Francis AD, Nieuwenhuis S, Davis JM, Davidson RJ. Mental training affects distribution of limited brain resources. *PLoS Biol* 2007;5:e138.
- Chan D, Woollacott M. Effects of level of meditation experience on attentional focus: is the efficiency of executive or orientation networks improved? *J Altern Complement Med* 2007;13:651–7.
- Pagnoni G, Cekic M. Age effects on gray matter volume and attentional performance in Zen meditation. *Neurobiol Aging* 2007;28:1623–7.
- Jha AP, Krompinger J, Baime MJ. Mindfulness training modifies sub-systems of attention. *Cogn Affect Behav Neurosci* 2007;7:109–19.
- Srinivasan N, Bajjal S. Concentrative meditation enhances preattentive processing: a mismatch negativity study. *Neuroreport* 2007;18:1709–12.
- Tang YY, Ma Y, Wang J, Fan Y, Feng S, Lu Q, Yu Q, Sui D, Rothbart MK, Fan M, Posner MI. Short-term meditation training improves attention and self-regulation. *Proc Natl Acad Sci U S A* 2007;104:17152–6.
- Valentine E, Sweet P. Meditation and attention: a comparison of the effects of concentrative and mindfulness meditation on sustained attention. *Ment Health Relig Cult* 1999;2:59–70.
- Wenk-Sormaz H. Meditation can reduce habitual responding. *Altern Ther Health Med* 2005;11:42–58.
- Lutz A, Slagter HA, Rawlings NB, Francis AD, Greischar LL, Davidson RJ. Mental training enhances attentional stability: neural and behavioral evidence. *J Neurosci* 2009;29:13418–27.
- Brefczynski-Lewis JA, Lutz A, Schaefer HS, Levinson DB, Davidson RJ. Neural correlates of attentional expertise in long-term meditation practitioners. *Proc Natl Acad Sci U S A* 2007;104:11483–8.
- Bushnell WC. New beginnings: evidence that the meditational regimen can lead to optimization of perception, attention, cognition, and other functions. *Ann N Y Acad Sci* 2009;1172:348–61.
- Chambers R, Lo B, Allen NB. The impact of intensive mindfulness training on attentional control, cognitive style and affect. *Cogn Ther Res* 2008;32:303–22.
- Specia M, Carlson L, Goodey E, Angen M. A randomized, wait-list controlled clinical trial: the effect of a mindfulness meditation-based stress reduction program on mood and symptoms of stress in cancer outpatients. *Psychosom Med* 2000;62:613–22.
- Shapiro SL, Schwartz G, Bonner G. Effects of Mindfulness-Based Stress Reduction on medical and premedical students. *J Behav Med* 1998;21:581–99.
- Kabat-Zinn J, Massion AO, Kristeller J, Peterson LG, Fletcher K, Pbert L, Linderking W, Santorelli SF. Effectiveness of a meditation-based stress reduction program in the treatment of anxiety disorders. *Am J Psychiatry* 1992;149:936–43.
- Grossman P, Niemann L, Schmidt S, Walach H. Mindfulness-Based Stress Reduction and health benefits. A meta-analysis. *J Psychosom Res* 2004;57:35–43.
- Kenny MA, Williams JM. Treatment-resistant depressed patients show a good response to Mindfulness-Based Cognitive Therapy. *Behav Res Ther* 2007;45:617–25.
- Kuyken W, Byford S, Taylor RS, Watkins E, Holden E, White K, Barrett B, Byng R, Evans A, Mullan E, Teasdale JD. Mindfulness-Based Cognitive Therapy to prevent relapse in recurrent depression. *J Consult Clin Psychol* 2008;76:966–78.
- Witek-Janusek L, Albuquerque K, Chroniak KR, Chroniak C, Durazo-Arvizu R, Mathews HL. Effect of mindfulness based stress reduction on immune function, quality of life and coping in women newly diagnosed with early stage breast cancer. *Brain Behav Immun* 2008;22:969–81.
- Allen NB, Chambers R, Knight W. Mindfulness-based psychotherapies: a review of conceptual foundations, empirical evidence and practical considerations. *Aust N Z J Psychiatry* 2006;40:285–94.
- Jain S, Shapiro SL, Swanick S, Roesch SC, Mills PJ, Bell I, Schwartz GE. A randomized controlled trial of mindfulness meditation versus relaxation training: effects on distress, positive states of mind, rumination, and distraction. *Ann Behav Med* 2007;33:11–21.
- Ramel W, Goldin PR, Carmona P, McQuaid JR. The effects of mindfulness meditation on cognitive processes and affect in patients with past depression. *Cogn Ther Res* 2004;28:433–55.
- Shahar B, Britton W, Sbarra D, Figueredo A, Bootzin R. Mechanisms of change in Mindfulness-Based Cognitive Therapy for depression: preliminary evidence from a randomized controlled trial. *Int J Cogn Ther* 2010;3:402–18.
- Kuyken W, Watkins E, Holden E, White K, Taylor RS, Byford S, Evans A, Radford S, Teasdale JD, Dalgleish T. How does Mindfulness-Based Cognitive Therapy work? *Behav Res Ther* 2010;48:1105–12.
- Van Dam NT, Sheppard SC, Forsyth JP, Earleywine M. Self-compassion is a better predictor than mindfulness of symptom severity and quality of life in mixed anxiety and depression. *J Anxiety Disord* 2011;25:123–30.
- Holzel BK, Ott U, Gard T, Hempel H, Weygant M, Morgen K, Vaitl D. Investigation of mindfulness meditation practitioners with voxel-based morphometry. *Soc Cogn Affect Neurosci* 2008;3:55–61.

MINDFULNESS AND INTEROCEPTIVE AWARENESS

44. Lazar SW, Kerr CE, Wasserman RH, Gray JR, Greve DN, Treadway MT, McGarvey M, Quinn BT, Dusek JA, Benson H, Rauch SL, Moore CI, Fischl B. Meditation experience is associated with increased cortical thickness. *Neuroreport* 2005;16:1893-7.
45. Hölzel BK, Carmody J, Vangel M, Congleton C, Yerramsetti SM, Gard T, Lazar SW. Mindfulness practice leads to increases in regional brain gray matter density. *Psychiatry Res* 2011;191:36-43.
46. Farb NA, Segal ZV, Mayberg H, Bean J, McKeon D, Fatima Z, Anderson AK. Attending to the present: mindfulness meditation reveals distinct neural modes of self-reference. *Soc Cogn Affect Neurosci* 2007;2:313-22.
47. Farb NA, Anderson AK, Mayberg H, Bean J, McKeon D, Segal ZV. Minding one's emotions: mindfulness training alters the neural expression of sadness. *Emotion* 2010;10:25-33.
48. Sze JA, Gyurak A, Yuan JW, Levenson RW. Coherence between emotional experience and physiology: does body awareness training have an impact? *Emotion* 2010;10:803-14.
49. Fink S, Foran KA, Sweeney AC, O'Hea EL. Sexual body esteem and mindfulness in college women. *Body Image* 2009;6:326-9.
50. Brotto LA, Basson R, Luria M. A mindfulness-based group psychoeducational intervention targeting sexual arousal disorder in women. *J Sex Med* 2008;5:1646-59.
51. Brotto LA, Heiman JR, Goff B, Greer B, Lentz GM, Swisher E, Tamimi H, Van Blaricom A. A psychoeducational intervention for sexual dysfunction in women with gynecologic cancer. *Arch Sex Behav* 2008;37:317-29.
52. Brown KW, Ryan RM. The benefits of being present: mindfulness and its role in psychological well-being. *J Pers Soc Psychol* 2003;84:822-48.
53. Cordon SL, Finney SJ. Measurement invariance of the Mindful Attention Awareness Scale. *Meas Eval Couns Dev* 2008;40:228-45.
54. Carlson LE, Brown KW. Validation of the Mindful Attention Awareness Scale in a cancer population. *J Psychosom Res* 2005;58:29-33.
55. Baer RA, Smith GT, Hopkins J, Krietemeyer J, Toney L. Using self-report assessment methods to explore facets of mindfulness. *Assessment* 2006;13:27-45.
56. Ryff CD. Happiness is everything, or is it? Explorations on the meaning of psychological well-being. *J Pers Soc Psychol* 1989;57:1069-81.
57. Derogatis LR, Melisaratos N. The Brief Symptom Inventory: an introductory report. *Psychol Med* 1983;13:595-605.
58. Derogatis LR. *Symptom Checklist-90-Revised*. Minneapolis, MN: NCS Assessments; 1975.
59. Pollatos O, Traut-Mattausch E, Schandry R. Differential effects of anxiety and depression on interoceptive accuracy. *Depress Anxiety* 2009;26:167-73.
60. Forster KI, Forster JC. DMDX: a windows display program with millisecond accuracy. *Behav Res Methods Instrum Comput* 2003;35:116-24.
61. Hodes RL, Cook EW 3rd, Lang PJ. Individual differences in autonomic response: conditioned association or conditioned fear? *Psychophysiology* 1985;22:545-60.
62. Bradley M, Lang P. The International Affective Picture System (IAPS) in the study of emotion and attention. In: Coan J, Allen J, editors. *Handbook of Emotion Elicitation and Assessment*. New York, NY: Oxford University Press; 2007.
63. Calvo MG, Avero P. Reaction time normative data for the IAPS as a function of display time, gender, and picture content. *Behav Res Methods* 2009;41:184-91.
64. Lutz A, Slagter HA, Dunne JD, Davidson RJ. Attention regulation and monitoring in meditation. *Trends Cogn Sci* 2008;12:163-9.
65. Cohen B. *Explaining Psychological Statistics*. New York, NY: John Wiley & Sons; 2001.
66. Cohen J. eta-Squared and partial eta-squared in fixed factor ANOVA designs. *Educ Psychol Meas* 1973;33:107-12.
67. Green S, Salkind N. *Using SPSS for Windows and Macintosh: Analyzing and Understanding Data*. 4th ed. Upper Saddle River, NJ: Pearson Education; 2005.
68. Young M. Supplementing tests of statistical significance: variation accounted for. *Tutorial. J Speech Hear Res* 1993;36:644-56.
69. Derogatis LR. *Brief Symptom Inventory: Administration, Scoring and Procedures Manual*. Minneapolis, MN: NCS Pearson Inc; 1993.
70. Critchley HD, Wiens S, Rotshtein P, Ohman A, Dolan RJ. Neural systems supporting interoceptive awareness. *Nat Neurosci* 2004;7:189-95.
71. Wilson J. Prevalence of female sexual dysfunction among college students. *Undergrad Res J Human Sci* 2004;3:1-7.
72. Schandry R. Heart beat perception and emotional experience. *Psychophysiology* 1981;18:483-8.
73. 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;93:1108-21.
74. Chivers ML, Bailey JM. A sex difference in features that elicit genital response. *Biol Psychol* 2005;70:115-20.
75. Chivers ML, Rieger G, Latty E, Bailey JM. A sex difference in the specificity of sexual arousal. *Psychol Sci* 2004;15:736-44.