

# Mindfulness-Based Sex Therapy Improves Genital-Subjective Arousal Concordance in Women With Sexual Desire/Arousal Difficulties

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**Abstract** There is emerging evidence for the efficacy of mindfulness-based interventions for improving women's sexual functioning. To date, this literature has been limited to self-reports of sexual response and distress. Sexual arousal concordance—the degree of agreement between self-reported sexual arousal and psychophysiological sexual response—has been of interest due to the speculation that it may be a key component to healthy sexual functioning in women. We examined the effects of mindfulness-based sex therapy on sexual arousal concordance in a sample of women with sexual desire/arousal difficulties ( $n = 79$ ,  $M$  age 40.8 years) who participated in an in-laboratory assessment of sexual arousal using a vaginal photoplethysmograph before and after four sessions of group mindfulness-based sex therapy. Genital-subjective sexual arousal concordance significantly increased from pre-treatment levels, with changes in subjective sexual arousal predicting contemporaneous genital sexual arousal (but not the reverse). These findings have implications for our understanding of the mechanisms by which mindfulness-based sex therapy improves sexual functioning in women, and suggest that such treatment may lead to an integration of physical and subjective arousal processes. Moreover, our findings suggest that future research might consider the adoption of sexual arousal concordance as a relevant endpoint in treatment outcome research of women with sexual desire/arousal concerns.

**Keywords** Sexual desire · Sexual arousal · Vaginal photoplethysmography · Mindfulness · DSM-5 · Sexual dysfunction

## Introduction

Lack of motivation for sex affects up to 40 % of women aged 16–44 (Mercer et al., 2003; Mitchell et al., 2013) and is the most common reason prompting women to seek sex therapy. When clinically significant distress accompanies the loss of sexual desire, estimates reveal that up to 12 % of women are affected (Shifren, Monz, Russo, Segreti, & Johannes, 2008). The 5th edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) defines this syndrome as “Female Sexual Interest/Arousal Disorder” (SIAD; American Psychiatric Association, 2013) and a diagnosis is made when any three of six criteria are met for a minimum duration of 6 months and accompany clinically significant distress. The criteria include: (1) lack of desire for sex, (2) lack of sexual thoughts/fantasies, (3) lack of initiation and receptivity of sexual activity, (4) lack of sexual pleasure, (5) inability for sexual stimuli to trigger desire, and (6) an impaired physical sexual arousal response.

To date, the most widely studied treatment for low sexual desire in women has been testosterone. A large number of randomized controlled studies have demonstrated the efficacy of topical testosterone in surgically menopausal women (reviewed by Davis, 2013). Moreover, estimates suggest that 4.1 million prescriptions for off-label testosterone are made annually in the U.S. alone (Davis & Braunstein, 2012). Nonetheless, testosterone remains unregulated, and although it was approved for use in patch form in Europe (for surgically menopausal women with low sexual desire), it is currently unavailable in North America. Various other pharmaceutical agents have been the subject of clinical

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trials for treatment of low sexual desire, but as of October 2015, flibanserin is the only medication approved in the U.S. for this condition.

Despite considerable interest in testing pharmacological options for women's low sexual desire, psychological treatment has been the mainstay of therapy for women with sexual desire difficulties. Because cognitive distraction during sexual activity is prevalent among women with sexual dysfunction, and negatively impacts their sexual satisfaction and desire (Nobre & Pinto-Gouveia, 2006), this provides justification for the application of cognitive challenging strategies (i.e., identifying, challenging, and replacing irrational thoughts) inherent to cognitive behavioral therapy (CBT). Trudel et al. (2001) compared the effects of CBT (which included both cognitive challenging as well as behavioral strategies) to a wait-list control in 74 couples in which women met criteria for Hypoactive Sexual Desire Disorder (HSDD). After 12 weeks, 74 % of women no longer met diagnostic criteria for HSDD, and this stabilized to 64 % after 1-year follow-up. In addition to significantly improved sexual desire, women also reported improved quality of marital life and perception of sexual arousal, but the group couple therapy format may not be feasible in typical clinical settings. Another treatment outcome study of 10 sessions of CBT, 2–3 of which included the partner, found only a 26 % reduction in the proportion of women who had significant concerns with low sexual desire (McCabe, 2001). Taken together, these studies suggest that CBT is effective for a proportion of women with low sexual desire, but such an approach may also have limitations. Specifically, because of the often-noted distractibility, anxiety-proneness, judgmental intrusions, and inattention described by women with low sexual desire (Meston, 2006), and also because of the varied ways in which desire is experienced (Meana, 2010; Sand & Fisher, 2007), other skill-based approaches may be necessary for women who do not benefit from cognitive challenging. To address these gaps, third-generation CBT approaches, such as mindfulness-based cognitive therapy, have been gaining traction in many domains of physical and psychological health.

Mindfulness meditation has a 3500 year history and for nearly the past four decades has made its way into Western medicine. Defined as present-moment, non-judgmental awareness with curiosity, openness, and acceptance (Bishop et al., 2004), mindfulness meditation has been a major addition to the psychological treatment arsenal for the treatment of anxiety, depression, substance use, childhood behavior problems, and a host of medical concerns, including pain, irritable bowel syndrome, fibromyalgia, and high blood pressure (Grossman, Niemann, Schmidt, & Walach, 2004; Merkes, 2010). Although the precise mechanisms by which mindfulness is associated with symptom relief is not fully understood, its benefits may be associated with an increase in metacognitive awareness, or the ability to experience thoughts merely as mental events (Teasdale et al., 2002). Over the past 10 years, mindfulness has been applied to and found effective for the treatment of sexual dysfunction in women (Brotto,

Basson, & Luria, 2008a; Brotto et al., 2008c, 2012a; Brotto, Seal, & Rellini, 2012b).

The mechanisms by which mindfulness led to these improvements in women with sexual dysfunction are not entirely clear and may relate to a decrease in spectating—defined by Masters and Johnson (1970) as the process of watching oneself during sexual activity from a third person perspective—a decrease in anxiety, encouraging an attitude of acceptance and non-judgment, and/or an increase in perception of physical sexual response. In support of the latter, one laboratory-based study in which female students without sexual difficulties were randomized to either an 8-week mindfulness meditation group or to an active control rated the intensity of their physiological responses after viewing emotional photos (Silverstein, Brown, Roth, & Britton, 2011). The primary analysis focused on *interoceptive awareness*, the capacity to accurately detect physical sensations, after the mindfulness intervention. Interoception has long been of interest to emotion researchers, and is known to correspond to an afferent pathway from parts of the body to the spinal cord, brain stem, and ultimately to the right anterior insular cortex (Craig, 2002). Study participants were shown a series of 31 pictures containing sexual and non-sexual images and were asked to indicate their level of physiological arousal (calm, excited, and aroused). Reaction time, or how quickly an individual rated the intensity of arousal in their body, was used as an index of greater interoceptive awareness. Women in the meditation group had significantly faster reaction times than women in the control group, and the quicker reaction time significantly correlated with increases in mindfulness, attention, non-judgment, self-acceptance, and well-being, and with decreases in self-judgment and anxiety. Silverstein et al. inferred this to mean increased interoceptive awareness following mindfulness training that may correspond with activity in the insula cortex.

There is marked individual variability in the ability to detect internal physical sensations, with some individuals being highly interoceptively aware, and others being relatively naïve to changes in bodily reactions. Furthermore, there is marked variation in sexual concordance among women. In their meta-analysis of the sexual psychophysiology literature, Chivers et al. (2010) found, using a pooled sample of  $n = 2345$  women, that variation in women's sexual concordance was not accounted for by a variety of methodological factors such as the number of stimulus trials in a given experiment, the use of female-centered versus male-centered erotic stimuli, or stimulus length; however, higher sexual concordance was associated with using stimuli that varied in content, intensity, or modality ( $r = .49$ ) and method of calculating correlations (between-subjects [ $r = .29$ ] versus within-subjects [ $r = .43$ ]). Chivers et al. also found that concordance among women was related to method of assessing genital response, with genital temperature (e.g., labial thermistors and thermographic imaging) yielding higher estimates of sexual concordance than vaginal photoplethysmography (.55 vs. .26, respectively), although thermographic methods of assessing genital response also produce wide

inter-individual variation in sexual concordance, similar to vaginal photoplethysmography (Kukkonen, Binik, Amsel, & Carrier, 2010). Regardless of measurement method, broad variation in sexual concordance suggests the presence of moderators, of which sexual functioning may be one (Boyer, Pukall, & Chamberlain, 2013).

Low sexual concordance can manifest in one of two ways: increases in genital sexual response in the absence of genital awareness or sexual affect, or the converse. Consistently, it is the former that is the case for sexually functional women; genital response to sexual stimuli is rapidly and automatically evoked by processing of sexual stimuli (Chivers & Bailey, 2005), but genital awareness or sexual affect may not be simultaneously reported (Chivers et al., 2010). This pattern is also common among women with Female Sexual Arousal Disorder (FSAD)—which the former DSM-IV-TR characterized as self-reported impairments in genital vasocongestion (American Psychiatric Association, 2000)—such that they self-reported lower sexual affect to sexual stimuli in the laboratory but showed a robust genital response, similar to women without sexual arousal problems (Laan, van Driel, & van Lunsen, 2008; Meston, Rellini, & McCall, 2010). In their meta-analysis, Chivers et al. reported the average correlation for women with various sexual difficulties ( $n = 235$ ) as .04 (−.10 to .17), whereas for women without sexual difficulties ( $n = 1144$ ), the correlation was .26 (.21 to .37).

Sexual concordance may be related to sexual functioning among healthy women, such that greater concordance is associated with more frequent experience of orgasm (Adams, Haynes, & Brayer, 1985; Brody, 2007; Brody, Laan, & van Lunsen, 2003). Coupled with data showing higher sexual concordance among women without as opposed to with a sexual dysfunction, these data suggest that sexual concordance may be a key component to healthy sexual functioning in women. Current treatments for sexual dysfunction, however, do not focus on skills that may enhance women's sexual concordance nor have treatment efficacy studies used sexual concordance as a primary outcome.

In light of mounting evidence that mindfulness improves women's self-report of sexual function and awareness of bodily sensations, and that concordance between genital and self-reported arousal may be relevant to women's sexual interoceptive awareness, the current study was designed with these themes in mind. Specifically, the goals were to: (1) examine the effects of a group mindfulness-based sex therapy (MBST) on concordance between genital and subjective sexual arousal; (2) examine the effects of treatment on self-reported sexual arousal and, separately, on genital arousal; and (3) test the relationship between changes in concordance and improvements in clinical symptoms (i.e., sexual desire and sex-related distress) with treatment. A separate publication documents the significant beneficial effect of this MBST compared to a delayed treatment control group on the primary endpoint of self-reported sexual desire (Cohen's  $d_{\text{treatment}} = 0.97$ ;  $d_{\text{control}} = 0.12$ ) (Brotto & Basson, 2014). Sex-related distress also significantly improved with treatment, and

did not significantly differ from the control group (Cohen's  $d$  full sample = −0.56).

In this article, we focused on changes in concordance between genital sexual response (vaginal pulse amplitude; as measured by vaginal photoplethysmography) (Sintchak & Geer, 1975) and continuously reported subjective sexual arousal (Rellini, McCall, Randall, & Meston, 2005) following treatment. Given that the MBST encouraged the daily practice of focusing on and experiencing general and genital arousal responses non-judgmentally, we expected treatment to be associated with significant increases in genital-subjective concordance. Since participants were encouraged to practice mindfulness exercises daily between group sessions, we predicted degree of homework compliance would moderate the increased concordance after treatment. As an exploratory analysis, we also included age, diagnosis of FSAD, and arousal scores from a validated measure (both subjective arousal as well as lubrication) to moderate improvements in concordance. Furthermore, we hypothesized an increase in self-reported sexual arousal with treatment, consistent with previous findings. We did not expect to find an effect of treatment on genital sexual response per se, given evidence that vaginal pulse amplitude may not differ between women with and without sexual dysfunction (Laan et al., 2008). Finally, we predicted changes in concordance to be associated with improvements in sexual desire and with decreases in sex-related distress.

## Method

### Participants

Participants were part of a larger study evaluating outcomes of group mindfulness-based sex therapy on various indices of sexual desire, sexual response, and affect (Brotto & Basson, 2014). Women seeking treatment for sexual desire and/or arousal concerns from the British Columbia Centre for Sexual Medicine, whether the difficulties were lifelong or acquired, were eligible to participate. Inclusion criteria included: age between 19 and 65 years, fluent in English, and willing to complete all four group sessions, regular homework, as well as assessment measures (consisting of both self-report questionnaires and a laboratory-based psychophysiological sexual arousal assessment) at three time points. Women with difficulties in achieving orgasm were also included as long as those were not experienced as more distressing than the desire and/or arousal concerns. We excluded any woman with dyspareunia (chronic genital pain not resolved with a personal lubricant).

The original study describing treatment efficacy included 117 women who provided pre-treatment assessment data. The data here focus on 79 women who had complete data from their psychophysiological assessments (both genital and subjective arousal) at all three time points—immediate pre-treatment, post-treatment, and 6-month follow-up. The sample included 41 (51.9 %) women

who were assigned to the immediate treatment group and 38 (48.1 %) women who received treatment after an initial 3-month wait-list period. Only pre- to post-treatment data for women in the control group were included (i.e., their wait-list data were not). Also, in this article, we did not include data from the control group for their two pre-treatment assessments, so the present analyses did not compare the effects of treatment versus wait-list control on concordance. The mean age of the sample was 40.8 years ( $SD$  11.5, range 20–65). A total of 84.6 % were in a committed relationship, 6.4 % were casually dating, and 9.0 % were single. The mean relationship length was 13.2 years ( $SD$  10.7). Most participants were of Euro-Canadian descent (81.0 %) followed by East Asian (7.6 %) and South Asian (2.5 %). This was a highly educated group in that 67.1 % had some post-secondary education, and 22.8 % had an advanced graduate degree.

Although all participants self-reported difficulties with sexual desire and/or arousal and met criteria for the DSM-5 diagnosis of SIAD, 33 (41.8 %) women met DSM-IV-TR (American Psychiatric Association, 2000) diagnostic criteria for HSDD and 24 (30.4 %) women met criteria for FSAD. The remaining 22 (27.8 %) women met criteria for both HSDD and FSAD.

## Measures

### *Assessment of Psychophysiological Sexual Arousal*

Genital response was measured with a vaginal photoplethysmograph (Sintchak & Geer, 1975) consisting of a tampon-shaped acrylic vaginal probe, inserted in private by the participant. The probe (Behavioral Technology Inc., Salt Lake City, UT) continuously measured vaginal pulse amplitude (VPA) during the neutral and erotic film segments. VPA was recorded using a personal computer (HP Pentium M Laptop) that collected, converted (from analog to digital, using a Model MP150WSW data acquisition unit [BIOPAC Systems, Inc.]), and transformed psychophysiological data, using the software program AcqKnowledge III, Version 3.8.1 (BIOPAC Systems, Inc., Santa Barbara, CA). The signal was sampled at 200 Hz and band pass filtered (0.5–30 Hz). A trained research assistant performed artifact smoothing of the signal following visual inspection of the data and before data were analyzed. VPA data were subsequently divided into 30-s epochs, producing six data points for the neutral film and 13 data points for the erotic film for each sexual arousal assessment.

### *Contemporaneous Assessment of Subjective Sexual Arousal*

Subjective sexual response was measured continuously during the neutral and erotic films with an arousometer that was constructed by a local engineer modeled after the one described by Rellini et al. (2005). This device consisted of a computer optic mouse mounted on a plastic track with 10 intervals, and was affixed to the arm rest of the recliner so that the participant could easily move the mouse, while simultaneously reclining and

viewing stimuli. Women were instructed to move the mouse up and down the track over the course of the film to indicate their level of subjective sexual arousal, from 7 to  $-2$ , with 7 = *Highest Level of Sexual Arousal*, 0 = *No Sexual Arousal*, and  $-2$  = *Sexually Turned Off*. We have previously used this device in treatment outcome studies on women with sexual dysfunction (Brotto et al., 2012b). Like VPA data, the mean contemporaneous sexual arousal response was obtained every 30-s, producing six data points during the neutral film and 13 data points during the erotic film, corresponding with the 30-s epochs of VPA data.

### *Discrete Measure of Sexual Response and Affect*

The Film Scale, a 33-item self-report questionnaire, was used to assess subjective arousal and affective reactions to the erotic films. This scale was adapted from Heiman and Rowland (1983) and assessed six domains: subjective sexual arousal (1 item), perception of genital sexual arousal (4 items), autonomic arousal (5 items), anxiety (1 item), and positive and negative affect (11 items each). The scale has been found to be a valid and sensitive measure of emotional reactions to erotic stimuli. Items were rated on a 7-point Likert scale from *Not at All* (1) to *Intensely* (7). Pre-treatment reliability for the Film Scale during the neutral phase was very good (Cronbach's  $\alpha = 0.82$ ) and excellent following the erotic phase (Cronbach's  $\alpha = 0.94$ ).

### *Homework Compliance*

Homework compliance was rated by the group facilitators on a Likert scale from 0 (*did not complete homework/did not attend sessions*) to 2 (*notable efforts at completing homework/attending sessions*). A rating was given for each participant at each of the four group sessions, and then a mean score across the sessions was derived.

### *Female Sexual Arousal Disorder symptoms*

Subscales of "Arousal" and "Lubrication" on the Female Sexual Function Index (FSFI) (Rosen et al., 2000) were used in moderation analyses. The FSFI is a 19-item self-report questionnaire considered to be the gold standard measure of sexual function in women. There were 4 items in the Arousal domain and 4 items in the Lubrication domain; responses were coded on a 5-point Likert scale. A respondent who had not engaged in sexual activity for the past 4 weeks was excluded from those items. Cronbach's  $\alpha$  for these two domains was excellent ( $\alpha = 0.89$  and  $\alpha = 0.93$ , respectively) for the current sample.

Sexual Desire was measured with the 14-item Sexual Interest/Desire Inventory (SIDI) (Clayton et al., 2006). Possible total scores range from 0 to 51, with higher scores indicating higher levels of sexual interest and desire. The SIDI has excellent internal consistency (Cronbach's  $\alpha = 0.90$ ). Item-total correlations

were high for “Receptivity,” “Initiation,” “Desire-frequency,” “Desire-satisfaction,” “Desire-distress,” and “Thoughts-positive” ( $r > .70$ ), good for “Relationship-sexual,” “Affection,” “Arousal-ease,” and “Arousal-continuation” ( $r > .50$ ), but poor for the orgasm item ( $r = .10$ ) (Clayton et al. 2006). Cronbach’s alpha for the current sample was  $\alpha = 0.76$ .

Sexual Distress was measured with the 12-item Female Sexual Distress Scale (FSDS) (DeRogatis, Rosen, Leiblum, Burnett, & Heiman, 2002). Scores can range from 0 to 48, where higher scores represent higher levels of distress. The FSDS has been shown to have good discriminant validity in differentiating between sexually dysfunctional and sexually functional women, with 88 % correct classification rate, and found to have satisfactory internal consistency (ranging from 0.86 to 0.90) (DeRogatis et al., 2002). Reliability for the current sample was excellent at  $\alpha = 0.92$ .

## Procedure

Following a comprehensive assessment by an experienced sexual medicine clinician, eligible women were informed about the study. If interested, they were provided with a one-page brochure outlining information about the study and contact information for the study’s coordinator. Next, they took part in a telephone screen that further explained the study procedures, provided some information about the treatment content, and informed women about upcoming schedules for the MBST groups. They were then mailed a consent form. The return of a signed consent form indicated informed consent, at which time women were assigned to participate in either the immediate treatment group or the delayed treatment group. Whenever possible, we utilized random assignment to group; however, in cases where participants’ schedules were not flexible, we assigned women to the group that accommodated their schedules. Participants were then scheduled for a baseline sexual arousal assessment to take place in a sexual psychophysiology laboratory. Women were also mailed a package of questionnaires and asked to return them completed at the time of their sexual arousal assessment. These same questionnaires and sexual arousal assessment were repeated 2–4 weeks after the completion of their MBST group as well as 6 months later. The duration between baseline and the two subsequent assessments was relatively equal across all participants, with no more than 2-week variation, typically at the follow-up assessment.

The sexual arousal assessment took place in a sexual psychophysiology laboratory, located in the university hospital, and housed a comfortable reclining chair, a large screen TV, and an intercom. A thin blanket was placed over the seating area of the chair. Following written consent, participants were tested by a female researcher. Women were first shown the vaginal photoplethysmograph and encouraged to ask any questions about how to insert it. The female researcher then left the room, while participants inserted the probe and informed the researcher via intercom of their readiness. In order to habituate to the testing

environment, participants were encouraged to relax on a comfortable reclining chair for a 10-min period after the probe was inserted. Subjective sexual arousal and affect were assessed at the end of the adaptation period using the Film Scale, which served as the discrete assessment of arousal and affect before the erotic film sequence.

Before the film sequence began, women were reminded to use the arousometer to capture their subjective sexual arousal throughout the film sequence. The researcher instructed participants to: “Monitor your subjective feelings of sexual arousal to the film by using this device. By ‘subjective feelings of sexual arousal,’ we mean how mentally sexually aroused you are in your mind while you’re watching the film.” Further instructions were given on the numerical demarcations on the device and what the upper (most sexual arousal you have experienced or can imagine) and lower (sexually turned off) anchors reflect. Participants practiced moving the arousometer in the presence of the researcher and any questions on its operation were addressed before the film sequence began.

The researcher then initiated the video sequence from the adjoining room. The audio component was delivered via wireless headphones to the participant. Women watched a 3-min neutral documentary about Hawaii followed by a 7-min erotic film that depicted a heterosexual couple engaging in foreplay, oral sex, and penile–vaginal intercourse. There were three different film sequences counterbalanced across women and sessions so that participants viewed the same film only once over the three testing sessions. Immediately after the video sequence, participants completed the Film Scale a second time, which asked them to evaluate their subjective sexual arousal and affect to the erotic film. They were then instructed to remove the probe and meet the researcher in a separate room. After a debriefing period, the researcher disinfected the probe in a solution of Cidex OPA (ortho-phthalaldehyde 0.55 %), a high level disinfectant (Advanced Sterilization Products, Irvine, CA, USA), promptly following each session.

All procedures were approved by the Clinical Research Ethics Board at the University of British Columbia and the Vancouver Coastal Health Research Institute. All procedures were carried out in accordance with the provisions of the World Medical Association Declaration of Helsinki.

## Mindfulness-Based Sex Therapy

The MBST (Brotto, Basson, & Luria, 2008b) was based on an integration of psychoeducation, sex therapy, and mindfulness-based skills, the latter of which have received extensive empirical support in other populations (Grossman et al., 2004). Stemming from evidence that women with sexual desire/arousal difficulties are often distracted during sexual activity and/or judgmental (of themselves or their partners), mindfulness skills were primarily aimed at orienting the woman to the present experience, while simultaneously noting negative thoughts as “mental

events”—something to be noticed but not focused on. Consistent with mindfulness-based cognitive therapy for prevention of depression relapse (Teasdale et al., 2000), MBST aims to help women develop awareness in all areas of their life, including real and anticipated sexual situations. At least 4 weeks were spent encouraging women to practice mindful self-awareness in non-sexual situations as a means of developing the skill of moment-by-moment awareness. In-session “inquiries” following mindfulness practice were intended to allow participants to view their practice as a departure from their typical mode of being, which may have been characterized as future-oriented, multi-tasking, and/or ruminative about past events. At later stages of the group, women were then encouraged to apply their new skills in progressively more sexual situations—first on their own (following exposure to an erotic stimulus such as a vibrator or erotic film), and next together with a partner (if applicable, during actual sexual activity). The aim of the home practice was to encourage participants to develop a regular mindfulness practice and acquire experience observing thoughts, especially negative ones, as mental events, before introducing practice together with a partner, or applying mindfulness during at-home sexual activities. Although sensate focus shares with mindfulness the goal of present-moment awareness, the former requires a partner to be present and does not have the advantage of portability that mindfulness has (i.e., in homework activities women were encouraged to use informal mindfulness practice throughout their days to complement the formal practices). Concurrent with the principles of mindfulness, women were encouraged at the start of Session 1 to “let be” strong wishes for change, and for the duration of the sessions to focus instead on being fully in the present. Goals for the group were not elicited.

In the current study, treatment was delivered by two group facilitators (selected from a trained pool of six sexual medicine physicians, psychologists, and upper-level residents/graduate students) to groups consisting of 4–7 women. Sessions took place in a large group room at the BC Centre for Sexual Medicine, and each 90 min session was spaced 2 weeks apart.

### Contents

Session 1 provided educational information on the prevalence and known etiology of low desire and arousal. Mindfulness was then introduced through in-session practice of the “Body Scan,” which is also the foundational practice in mindfulness-based therapies (Teasdale et al., 2000). By orienting attention to various parts of the body, women were encouraged to become aware of sensations in that region and any subsequent “mental events” (thoughts, beliefs, emotions, other cognitive activity) that follow on the awareness of sensations. After a guided in-session practice, participants were encouraged to practice the Body Scan daily at home, and were provided an audio-recorded guide.

Session 2 provided an opportunity for in-depth homework review, followed by psychoeducation on sexual anatomy and physiology and the circular sexual response cycle (Basson, 2001).

In-session mindfulness practice centered on “Breath and body” as the focus of attention. Like the Body Scan, participants were guided to notice and attend to various parts of the body, including sensations associated with breathing and the breath itself. In mindfulness-based therapy for depression (Basson, 2001), this practice also typically follows a foundation of practice using the Body Scan. For homework, participants were encouraged to do a “seeing meditation” with their genitals as the focus of the practice. They were asked to observe their genitals with a hand-held mirror, and in addition to noticing moment-by-moment visual and bodily sensations, they were also asked to take note of any follow-on thoughts, emotions, or beliefs as a result of the seeing practice.

Session 3 began with an in-depth review of the home body-oriented mindfulness practice, and participants were encouraged to start to think about the relevance of this practice to their sexuality more broadly. Next, there was in-session psychoeducation on Gottman’s principles for lasting relationships (Gottman & Silver, 1999). The guided in-session practice utilized mindfulness of thoughts, and the practice was followed by a discussion on the high prevalence of automatic thoughts/logical errors of thinking, and using the cognitive behavioral model to illustrate the association between thoughts, emotions, and behaviors. The discussion also highlighted how mindfulness skills are aimed at simply bringing awareness to negative/judgmental thoughts and were contrasted with CBT skills, which are aimed at identifying and challenging problematic thoughts. For home practice, women were encouraged to repeat the mindfulness of genitals exercise from the previous 2 weeks in which they observed their genitals moment-by-moment and non-judgmentally, but this time were also encouraged to incorporate the sensation of touch. This was framed as a non-masturbatory exercise designed to enhance mindful awareness of genital sensations.

Session 4 was devoted to home practice review followed by an introduction of sensate focus to be used with a partner (if available). The facilitator explained the first (of three) phase of sensate focus as originally defined by Masters and Johnson (1970). Specifically, sensate focus was described as having the goals of: tuning into sensations (and in this way, women were encouraged to use the mindfulness skills they had been developing), relaxation, and providing feedback to a partner about the received touch. In-session trouble-shooting around common barriers, such as finding the time for the hour-long practice, then followed. Sensate focus was described specifically as a non-demand exercise (Weiner & Avery-Clark, 2014); if women (or their partners) experienced sexual excitement, they were encouraged to notice the accompanying sensations in the same way they had practiced noticing sensations during the Body Scan. The second half of the final session provided an overview on the use of cognitive and tactile tools to augment sexual response (e.g., fantasy, erotica, and vibrators) during mindfulness practice. Specifically, instructions were provided to women to elicit a sexual arousal response using one of these tools, and then use those sensations as the focus during a

mindfulness practice, and they were encouraged to try this at least two times at home. By eliciting a stronger bodily response with these erotic aids, we hypothesized greater facilitation of interoceptive awareness. The group ended following a discussion of strategies for maintaining mindfulness practice at home, and with the encouragement to view these four sessions as potentially the beginning of a lifelong practice using mindfulness both in sexual and non-sexual aspects of their lives. Whenever possible, the facilitators referenced published findings on the efficacy of mindfulness therapy in other populations, and integrated emerging knowledge on the impact of mindfulness practice on neural plasticity and brain function. All material was compiled into a facilitator and participant manual that included space for personal practice notes and observations (Brotto et al., 2008b).

## Data Analyses

### Hypothesis 1

We predicted a significant effect of MBST on increasing concordance between genital and subjective sexual arousal. Multilevel methodology was used to assess this question as it allows for the examination of changes within an individual (rather than averages across individuals) and has specifically been used to examine changes in sexual concordance (Clifton, Seehuus, & Rellini, 2015; Rellini et al., 2005). We used the Hierarchical Linear Modeling software program (HLM 6.08) (Raudenbush, Bryk, & Congdon, 2004) to test whether concordance significantly increased from pre-treatment to post-treatment, and again at six-month follow-up.

We used a two-level model with repeated measures modeled at Level 1 to estimate intercepts (mean of the outcome variable at the start of the erotic film) and trajectories of change (slopes) in the outcome. We standardized all Level 1 variables across waves prior to analyses, allowing for the interpretation of the coefficients as standardized betas. All coefficients were modeled as random (Nezlek, 2001).

First, we assessed the effect of the intervention on the contemporaneous (e.g.,  $T_{30s} \rightarrow T_{30s}$ ,  $T_{60s} \rightarrow T_{60s}$ , and so on) relation between genital and continuous subjective arousal (i.e., whether genital arousal predicted contemporaneous subjective arousal, and whether subjective arousal predicted contemporaneous genital arousal). The model tested the simple slopes of sexual concordance in each time period separately (i.e., against a slope of zero). Dummy coded time variables were included to control for any mean differences in the outcome of interest at the different assessment points.

Second, we conducted five Level 2 moderation analyses to determine if age, homework compliance, or FSAD status [assessed in two ways; firstly, as a dichotomous variable according to whether the woman had a clinical diagnosis of FSAD or not, and secondly using continuous scores on the lubrication and arousal

subscales of the FSFI (Rosen et al., 2000)] changed the degree of concordance between genital and subjective sexual arousal at each of the time points.

To aid in the interpretation of the magnitude of concordance between genital and subjective sexual arousal, we also carried out within-subjects and between-subjects Pearson  $r$  correlation coefficients on VPA and continuous self-reported arousal during the erotic segment of the film only. In this way, concordance estimates could be compared to the mean concordance values from a meta-analysis of several psychophysiological studies (Chivers et al., 2010).

### Hypothesis 2

We predicted that treatment would be associated with significant improvements in self-reported sexual arousal and affect but not with any significant changes in genital sexual response measured in-laboratory. We took difference scores from responses following the erotic stimulus minus mean scores during the baseline period, as per Clifton et al. (2015). We next carried out a repeated measures analysis of variance (ANOVA) across the three assessment points on these difference scores. To examine the effects of treatment on genital sexual response, a similar mixed within-between repeated measures ANOVA was carried out on VPA percent change score, which was calculated as follows: (mean erotic VPA minus mean neutral VPA) divided by mean neutral VPA, as per Clifton et al. (2015).

### Hypothesis 3

We predicted an association between concordance and clinical symptoms—namely, sexual desire, and sex-related distress. Firstly, Spearman's rank correlation coefficient ( $\rho$ ) was used as the estimate of concordance between VPA and subjective arousal for each woman at each time point (pre-, post-treatment, and follow-up) separately. These concordance estimates were then used as a fixed variable in a mixed-effects model examining the relationship between either SIDI scores (measuring sexual desire) and concordance over time points, or FSDS scores (measuring sex-related distress) and concordance. The models included concordance, time point (pre-, post-treatment, and follow-up), and their interaction, as well as participant ID as a random nesting effect.

## Results

### Concordance Between Genital and Continuous Subjective Sexual Arousal (Hypothesis 1)

Results of the contemporaneous analyses are shown in Table 1 and indicated that genital and subjective arousal covaried

**Table 1** Contemporaneous reciprocal associations between genital and subjective arousal

	Coefficient	SE	t ratio	p
SA → VPA				
Pre-treatment	$5.71 \times 10^{-2}$	0.005	10.92	<.001
Post-treatment	$6.40 \times 10^{-2}$	0.004	16.68	<.001
Follow-up	$5.98 \times 10^{-2}$	0.005	12.85	<.001
SA <sub>Pre-treatment</sub>	$8.12 \times 10^{-3}$	0.004	1.99	.05
SA <sub>Post-treatment</sub>	$5.25 \times 10^{-3}$	0.001	3.50	.001
SA <sub>Follow-up</sub>	$5.01 \times 10^{-3}$	0.001	3.40	.001
VPA → SA				
Pre-treatment	1.82	0.26	6.87	<.001
Post-treatment	1.88	0.23	8.22	<.001
Follow-up	1.70	0.19	8.97	<.001
VPA <sub>Pre-treatment</sub>	1.79	0.50	3.58	.001
VPA <sub>Post-treatment</sub>	1.37	0.28	4.96	<.001
VPA <sub>Follow-up</sub>	1.08	0.26	4.20	<.001

$df = 78$

VPA Vaginal pulse amplitude (genital arousal), SA subjective arousal

throughout treatment. Specifically, increases in subjective arousal predicted contemporaneous increases in genital arousal, and increases in genital arousal predicted contemporaneous increases in subjective arousal.

#### Subjective Arousal Predicting Genital Arousal

When examining the association between subjective arousal and contemporaneous genital arousal, SA<sub>Pre-treatment</sub> (top half of Table 1) represents this association during pre-treatment. This coefficient was significant, indicating that for every one standardized unit of subjective arousal increase, women showed an average corresponding increase of 0.008 millivolts in VPA, equivalent to a 0.16 standard deviation increase in VPA. SA<sub>Post-treatment</sub> and SA<sub>Follow-up</sub> were also statistically significant, indicating that for every one standardized unit of subjective arousal increase, women showed an average corresponding increase of 0.00525 millivolts in VPA at post-treatment and 0.00501 millivolts in VPA at follow-up, respectively. This corresponds to an average increase of 0.15 standard deviations in VPA at post-treatment and 0.12 standard deviations at follow-up.

To examine whether sexual concordance significantly differed at pre-treatment, post-treatment, and follow-up, we examined the model with no constraints and compared this to models constraining every unique pair of concordance ratios to be equal. The models were compared using standard  $\chi^2$  difference tests in which the goodness-of-fit for two models is differentiated (Schermelleh-Engel, Moosbrugger, & Müller, 2003). If the model with more constraints results in a significant increase in the overall  $\chi^2$ , this is indicative of a poorer fit, and the model with no constraints is retained. After applying the conservative Bonferroni correction for multiple tests ( $\alpha = 0.05/3 = .017$ ), results

of all  $\chi^2$  difference tests comparing the unconstrained and constrained models, pre-treatment = post-treatment,  $\chi^2(1) = 10.40$ ,  $p = .001$ ; pre-treatment = follow-up,  $\chi^2(1) = 10.34$ ,  $p = .001$ ; post-treatment = follow-up,  $\chi^2(1) = 12.30$ ,  $p < .001$ , showed that the unconstrained model fits the data significantly better. In other words, the degree of concordance between subjective and genital arousal at each time point was significantly different from every other time point. Further, these differences were in the expected direction such that beta values decreased over time (i.e., there was less change in genital arousal associated with the same level of subjective arousal over time).

#### Genital Arousal Predicting Subjective Arousal

In examining the association between genital arousal and contemporaneous subjective arousal, VPA<sub>Pre-treatment</sub> (bottom half of Table 1) represents this association during pre-treatment. This coefficient was significant, indicating that for every one standardized unit of genital arousal increase, women showed an average corresponding increase of 1.79 units of subjective arousal, equivalent to a 1.16 standard deviation increase in subjective sexual arousal. VPA<sub>Post-treatment</sub> and VPA<sub>Follow-up</sub> were also statistically significant, indicating that for every one standardized unit of physiological arousal increase, women showed an average corresponding increase of 1.37 units of subjective arousal at post-treatment and 1.08 units of subjective arousal at follow-up, respectively. This corresponds to an average increase of 0.76 standard deviations in subjective sexual arousal at post-treatment and 0.64 standard deviations at follow-up.

To examine whether sexual concordance significantly differed at pre-treatment, post-treatment, and follow-up, we again examined the model with no constraints and compared this to models



constraining every unique pair of concordance ratios to be equal. Results of all  $\chi^2$  difference tests comparing the unconstrained model with constrained models showed no statistically significant difference in fit, pre-treatment = post-treatment,  $\chi^2(1) = 0.71$ ,  $p = .40$ ; pre-treatment = follow-up,  $\chi^2(1) = -0.56$ ,  $p = .46$ ; post-treatment = follow-up,  $\chi^2(1) = 1.49$ ,  $p = .22$ , indicating that the degree of concordance between genital and subjective arousal at each time point was not significantly different from any other time point.

We calculated both within-subjects correlations and between-subjects correlations and these are shown in Table 2. Across time points, the magnitude of the correlation between genital and subjective sexual arousal was larger for within-subjects correlations (range .28 to .33) than for between-subjects correlations (range .13 to .22). Using a paired samples  $t$  test comparing pre- to post-treatment, and a separate one from post-treatment to follow-up revealed no statistically significant differences for within-subjects concordance estimates. The same non-significant results were found using Fisher's  $r$ -to- $z$  transformation for the between-subjects concordance estimates (Table 2).

Focusing specifically on the within-subjects correlations, the range of concordance estimates at pre-treatment was  $-.90$  to  $+.91$ . A total of 19.1 % had negative concordance (defined here as  $r \leq -.25$ ), 10.6 % had no concordance (defined here as  $-.24 < r < .24$ ), and 70.2 % had positive concordance (defined here as  $r \geq .25$ ). At post-treatment, the range was similarly large:  $-.80$  to  $.94$  with 15 % having negative concordance, 20 % having no concordance, and 65 % having a positive concordance.

#### Moderation of the Association Between Genital and Continuous Subjective Arousal

Five separate Level 2 moderation analyses were conducted to determine if age ( $n = 79$ ), homework compliance ( $n = 78$ ), or

**Table 2** Concordance between genital and continuous subjective sexual arousal calculated with within-subjects correlations and between-subjects correlations across three time points

	Pre-treatment	Post-treatment	Follow-up
Within-subjects correlations	.30 (.54) $n = 47$	.33 (.47) $n = 60$	.28 (.47) $n = 76$
Between-subjects correlations	.22 $n = 79$	.13 $n = 79$	.14 $n = 79$

Within-subjects correlations used responses during the erotic segment of the film only and continuous measures of subjective sexual arousal. Sample sizes vary due to missing data. Paired samples  $t$  test revealed no significant difference from pre- to post-treatment,  $t(46) = -0.21$ ,  $p = .835$ ; or from post-treatment to follow-up,  $t(58) = 0.76$ ,  $p = .448$ . Between-subjects correlations were calculated with percent change in genital sexual arousal from neutral to erotic film conditions, and using the difference between neutral to erotic film conditions for discrete self-reported sexual arousal. Fisher's  $r$ -to- $z$  transformation found no significant difference from pre- to post-treatment,  $z = 0.61$ ,  $p = .542$ ; or from post-treatment to follow-up,  $z = -0.06$ ,  $p = .952$ .

FSAD status (assessed dichotomously according to whether women had a clinician-determined diagnosis of FSAD or not;  $n = 79$ ), and using mean scores on the lubrication ( $n = 62$ ) and arousal ( $n = 62$ ) domains of the FSFI (measured continuously) changed the degree of concordance between genital and subjective sexual arousal at each of the time points. All time points were included in the moderation analyses for age and FSAD status, while only post-treatment and follow-up were included in the moderation analyses involving homework compliance (homework had not yet been assigned at pre-treatment).

Neither age, diagnosis of FSAD, continuous FSFI scores on the lubrication and arousal domains, nor homework compliance moderated the association between contemporaneous subjective and genital arousal as an outcome ( $ps$  ranged from .21 to .79). Similarly, neither age nor FSAD status (assessed dichotomously and continuously with the FSFI) moderated the contemporaneous ( $ps$  ranged from .35 to .92) association between genital and subjective sexual arousal as an outcome. Degree of homework compliance was, however, found to moderate this association, such that greater homework compliance was associated with an increase in the number of subjective arousal units associated with a standardized unit increase in genital arousal (Table 3). Specifically, for every standardized unit increase of genital arousal, women showed a marginally significantly greater increase in subjective arousal with more homework compliance at post-treatment ( $t = 1.67$ ,  $p = .10$ ) and a significantly greater increase in subjective arousal with greater homework compliance at follow-up ( $t = 2.13$ ,  $p = .04$ ).

#### Effects of Erotic Film and Treatment on Self-Reported Sexual Arousal and Affect (Hypothesis 2)

To test the ability of the erotic film to significantly increase self-reported sexual arousal and affect, a paired samples  $t$  test was used to compare mean scores on Film Scale domains before the neutral film and after the erotic film at post-treatment. There was a significant increase in perception of genital sexual arousal,  $t(78) = -10.53$ ,  $p < .001$ ,  $d = 1.93$ ; subjective sexual arousal,  $t(78) = -8.66$ ,  $p < .001$ ,  $d = 1.38$ ; positive affect,  $t(78) = -6.43$ ,  $p < .001$ ,  $d = 1.20$ ; autonomic arousal,  $t(78) = -7.36$ ,  $p < .001$ ,  $d = 1.23$ ; negative affect,  $t(78) = -3.47$ ,  $p = .001$ ,  $d = 0.59$ , and a significant decrease in self-reported anxiety,  $t(78) = 2.62$ ,  $p = .011$ ,  $d = -0.42$ , following the erotic film. These findings suggest that the erotic film was effective at eliciting a subjective sexual response at post-treatment (Table 4).

A repeated measures ANOVA did not find a significant effect of treatment on subjective sexual arousal difference scores,  $F(2, 156) < 1$ ,  $p = .861$ ,  $d = 0.05$  from pre- to post-treatment;  $d = 0.06$  from post-treatment to follow-up. Perception of genital sexual arousal similarly did not significantly change with treatment,  $F(2, 156) < 1$ ,  $p = .747$ ,  $d = 0.07$  from pre- to post-treatment;  $d = 0.05$  from post-treatment to follow-up.

Focusing on affect, a repeated measures ANOVA did not find a significant effect of treatment on the change in positive affect

**Table 3** Homework compliance as a moderator of the association between genital and contemporaneous subjective arousal as an outcome

	Coefficient	SE	<i>t</i> ratio	<i>p</i>
VPA <sub>(T)</sub> → SA <sub>(T)</sub>				
Post-treatment				
Low HC	1.76	0.20	8.94	<.001
High HC	2.79	0.36	2.83	.006
Follow-up				
Low HC	1.45	0.14	10.46	<.001
High HC	2.50	0.33	3.22	.002
VPA <sub>Post-treatment</sub>				
Low HC	0.94	0.23	4.16	<.001
High HC	1.57	0.38	1.67	.10
VPA <sub>Follow-up</sub>				
Low HC	0.59	0.12	5.06	<.001
High HC	1.14	0.26	2.13	.04

*df* = 76

VPA vaginal pulse amplitude (genital arousal), SA subjective arousal, HC homework compliance

from neutral to erotic film conditions,  $F(2, 156) = 2.54, p = .082$ ,  $d = 0.14$  from pre- to post-treatment;  $d = 0.08$  from post-treatment to follow-up. A similar pattern was found for negative affect, with no significant effect of treatment,  $F(2, 156) < 1, p = .948$ ,  $d = 0.00$  from pre- to post-treatment;  $d = 0.04$  from post-treatment to follow-up.

### Effects of Erotic Film and Treatment on Genital Sexual Arousal (Hypothesis 2)

To test the ability of the erotic film to significantly increase genital sexual response at each time point, a paired samples *t* test was used to compare mean VPA (in mV) from the neutral to the erotic film. A paired samples *t* test revealed that the erotic film significantly

increased VPA at pre-treatment,  $t(78) = -2.00, p = .049$ ; at post-treatment,  $t(78) = -2.00, p = .049$ ; at post-treatment,  $t(78) = -2.78, p = .007$ ; and at follow-up,  $t(78) = -2.19, p = .032$ , verifying the sexually arousing properties of our erotic stimuli (Table 4).

To examine the effects of treatment on VPA percent change scores, a repeated measures ANOVA across all three time points was carried out and found not to reach statistical significance,  $F(2, 156) = 2.58, p = .079$ ;  $d = 0.28$  from pre- to post-treatment;  $d = -0.34$  from post-treatment to follow-up.

### Association Between Sexual Concordance and Clinical Symptoms Using the Sexual Interest/Desire Inventory and the Female Sexual Distress Scale (Hypothesis 3)

Significance of the interaction term and the main effects were estimated using likelihood-ratio tests comparing the fit of the model containing the term versus the fit of the model with the term removed. *p*-values <.05 were considered as indicating a significant relationship between the term of interest and the outcome variable. There was no significant interaction between time and concordance for either SIDI or FSIDS (Likelihood-ratio test statistic [LRT] = 3.9,  $p = .15$ , and LRT = 3.2,  $p = .21$ , respectively). This suggests that any relationship between concordance and the clinical symptoms of desire (SIDI) and distress (FSIDS) did not differ significantly over the time periods. If the interaction terms were removed, there was still no significant relationship between either SIDI or FSIDS and concordance (LRT = 0.2,  $p = .68$ , and LRT = 0.0,  $p = .99$ , respectively); however, there was a significant effect of time period for both outcomes (SIDI: LRT = 17.3,  $p = .0002$ ; FSIDS: LRT = 9.0,  $p = .01$ ), with SIDI scores increasing significantly post-treatment and remaining high at follow-up, and FSIDS scores decreasing significantly at post-treatment and remaining low at follow-up.

**Table 4** Effects of erotic film on discrete measures of subjective sexual arousal, perception of genital arousal, positive affect, negative affect, autonomic arousal, anxiety, and vaginal pulse amplitude (VPA) from neutral to erotic films at pre-treatment, post-treatment, and follow-up

	Pre-treatment		Post-treatment		Follow-up	
	Neutral	Erotic	Neutral	Erotic	Neutral	Erotic
Subjective arousal	2.91 1.14***	4.27 1.41	3.04 1.19***	4.47 1.30	2.97 1.10***	4.32 1.34
Perception of genital arousal	1.45 0.58***	2.80 1.31	1.51 0.66***	2.93 1.36	1.46 0.59***	2.83 1.29
Positive affect	1.71 0.64***	2.49 1.41	1.63 0.66***	2.57 1.46	1.54 0.53***	2.57 1.38
Negative affect	1.38 0.44***	1.52 0.57	1.26 0.36***	1.40 0.50	1.28 0.35***	1.43 0.53
Autonomic arousal	1.58 0.54***	2.25 0.92	1.56 0.62***	2.37 1.00	1.52 0.61***	2.35 0.96
Anxiety	2.06 1.08**	1.66 1.19	1.68 0.87**	1.39 0.90	1.59 0.81	1.41 0.84
VPA (mV)	.044 .063*	.058 .037	.043 .063**	.063 .029	.044 0.67*	.060 .043

Data represent means and SD

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .0001$  paired samples *t* test from Neutral to Erotic conditions. All variables, except VPA, have a 1–7 range

## Discussion

We examined the effects of a group mindfulness-based sex therapy on concordance between genital and subjective sexual arousal in women seeking treatment for concerns of sexual desire and/or arousal using a series of hierarchical linear models, first with subjective arousal predicting genital response and then the reverse. We found evidence of significant sexual concordance at all time points, with subjective arousal predicting contemporaneous genital arousal, and significant increases from pre- to post-treatment, such that there was less change in genital arousal associated with the same level of subjective arousal, suggesting greater coherence between these two aspects of the sexual response (Brotto et al., 2012b). In contrast, although genital response predicted significant increases in subjective arousal contemporaneously at all time points, we found no change in this measure of sexual concordance as a function of treatment. Within-subjects correlations revealed the magnitude of the association (between .28 and .33) to be within the range found among several other psychophysiological studies of women (Chivers et al., 2010). These results suggest that increases in sexual concordance associated with mindfulness-based sex therapy may be driven by changes in subjective sexual response rather than genital response.

Interestingly, although the erotic film significantly increased self-reported sexual arousal, affect, and genital sexual response at each time point, there was no significant effect of treatment on either self-reported or genital response compared to baseline, suggesting that the change in sexual concordance following treatment was not a straightforward consequence of increases in self-reported or genital response. Clifton et al. (2015) also found similar effects, with women higher in SESII excitation scores and passionate-romantic scores showing higher genital-subjective concordance, despite no significant association between individual predictors and genital or subjective sexual response separately; women who rate themselves as more easily arousable may be more in tune with their body's physiological responses to sexual stimuli, even though the magnitude of their actual physiological or subjective sexual response is no different from women with lower excitation scores. Similarly, we found a significant effect of mindfulness treatment on concordance (compared to pre-treatment levels) but not on genital or subjective sexual response separately, suggesting that treatment may have contributed to women's capacity to detect and integrate their experience of sexual excitation.

FSAD diagnostic status and FSFI lubrication and arousal domain scores did not significantly moderate sexual concordance at any of the time points. This was a surprising result, given both clinical domains improved after treatment (Brotto & Basson, 2014), and other research has noted relationships between sexual functioning and sexual concordance in healthy women (Brody et al., 2003) and in women with sexual difficulties (Chivers et al., 2010). Our findings suggest, perhaps, that sexual concordance

and self-reported clinical symptoms of (low) desire and sexual distress reflect different, unrelated aspects of the female sexual response, accounting for their lack of significant association.

Conversely, homework compliance did significantly moderate sexual concordance, such that, for every standardized unit increase of genital arousal, women showed a significantly greater increase in subjective arousal with greater homework compliance at follow-up. This suggests that recommended daily at-home mindfulness practices, designed to cultivate better integration of awareness and physical sensations, may have contributed to the increase in concordance. Of note, this moderation was significant at follow-up, but not at immediate post-treatment, suggesting cumulative effects of mindfulness practice over the 6-month follow-up period. Other data showing a dose–response relationship between duration of mindfulness practice and improvements in symptoms of depression and anxiety supports this interpretation (Krusche, Cyhlarova, & Williams, 2013). Others have also found that amount of at-home mindfulness practice is associated with self-report measures of affect and well-being, but not with indices of medical health (Carmody & Baer, 2008). Our homework compliance scores were assigned by group facilitators; therefore, future studies could have participants monitor amount of at-home practice to correlate mindfulness practice with changes in outcomes.

### Sexual Concordance as a Potential Study Endpoint?

Our findings suggest that skills aimed at enhancing a woman's concentration training and compassionate self-acceptance may be associated with greater integration of physical and mental sexual responses to erotic stimuli in a laboratory setting. Considered in the context of prior research showing similar effects of attention training on sexual arousal (Meston, Rellini, & Telch, 2008), and the specificity of mindfulness interventions (versus cognitive behavioral sex therapy) on changes in sexual concordance (Brotto et al., 2012b), we propose that sexual concordance be considered a meaningful study endpoint in sexual psychophysiology research. In treatment outcome research, it is not uncommon to see the treatment effects on self-reported but not genital response (Diamond et al., 2006). Elsewhere, we have proposed that sexual concordance may reveal treatment effects that might otherwise be overlooked when examining only self-reported or psychophysiological sexual response alone (Chivers & Rosen, 2010). Others have shown that sexual concordance is meaningfully associated with cognitive and schematic aspects of women's sexual functioning, such as higher sexual excitation and passion- and romance-related cognitive schemas, in the absence of direct effects between these variables (Clifton et al., 2015). In the current study, we demonstrated a similar pattern with sexual concordance increasing after treatment but no detectable change in either aspect of sexual response throughout treatment. Taken together, these findings provide preliminary support for the possibility of sexual concordance being a more relevant and sensitive study endpoint.

## Mechanisms of Action

The direction of concordance effects, with subjective arousal predicting contemporaneous genital arousal (but not the reverse), suggests that mechanisms underlying change in sexual concordance are predominantly, as expected, top-down, as opposed to bottom-up. As women deliberately guided their attention onto different foci—whether the breath, body, sounds, or thoughts—this may have translated into an improved ability to detect sensations in the body associated with sexual arousal. Silverstein et al. (2011) found decreased reaction time to rating bodily reactions to sexual stimuli in women following mindfulness training. Given that the insular cortex mediates interoceptive ability (Critchley, Wiens, Rotshtein, Öhman, & Dolan, 2004), and is associated with increased thickness following mindfulness practice (Hölzel et al., 2010), it is possible that insula-mediated increases in interoceptive ability from the various mindfulness exercises contributed to the improved concordance between genital and subjective arousal.

Because sexual concordance was not significantly different with treatment when genital arousal predicted subjective sexual arousal, this suggests that it was unlikely that genital sensations led women to experience more subjective arousal, thereby driving concordance. Furthermore, it has been argued that treatments aimed at improving genital response may be ineffective without the capacity to detect and positively appraise those physiological changes (Chivers & Rosen, 2010). The genital arousal response to erotic cues is relatively automatic (Chivers & Bailey, 2005; Chivers, Rieger, Latty, & Bailey, 2004; Laan, Everaerd, van Bellen, & Hanewald, 1994), regardless of women's age or sexual dysfunction status; indeed, women with a diagnosis of FSAD had the same magnitude of VPA as sexually healthy controls (Laan et al., 2008). In the current study, there was no immediate effect of treatment on VPA. Therefore, it is not likely that our treatment led to changes in genital responding, which then drove an increase in concordance. A top-down mechanism in which women deliberately focused attention on emerging, moment-by-moment sensations over the course of treatment, likely led to their contemporaneous detection of genital arousal in the laboratory setting, thereby increasing sexual concordance.

In addition to mindfulness practice increasing awareness of visceral (and likely genital) cues, current models of the mechanisms of mindfulness (Teper, Segal, & Inzlicht, 2013) suggest that increases in acceptance and self-compassion may have cultivated an openness to all elements of our participants' experience of sexual response without attempting to alter them. Teper et al. surmised that when one observes and accepts current emotions, this may facilitate emotion regulation. Given evidence that negative affect during sexual encounters may significantly predict sexual difficulties (Nobre & Pinto-Gouveia, 2006), it is possible that women experienced an improved ability to regulate such emotions and thereby tune into and accept their visceral sensations.

## Limitations

There were limitations in this study that must be considered. Firstly, treatment included a combination of (primarily) mindfulness exercises, psychoeducation, and sex therapy. It is unknown whether benefits were due to one specific component of treatment or to their synergistic effects. Of note, however, previous research testing a similar (but not identical) treatment protocol found that participants self-reported the mindfulness component to be the most effective aspect of treatment (Brotto & Heiman, 2007). Future research that dismantles these components and tests them against one another is needed in order to empirically substantiate these observations.

Secondly, our measure of sexual functioning (i.e., the FSFI) was limited because it excluded women who were not sexually active in the preceding 4 weeks, and assessed only the intensity and frequency of sexual arousal, without consideration for the multiple ways in which sexual arousal may be experienced in women. Our ability to detect associations between change in sexual concordance and change in clinical symptoms may be related to these limitations. Relatedly, we were also unable to examine correlations between concordance and the orgasm domain given the large proportion of missing data in the FSFI. Importantly, this sample represents only a small cross-section of women with sexual desire difficulties, and we limited the upper age to 65 in recognition of the large heterogeneity in the ways women experience (loss of) sexual desire (Meana, 2010). It is possible that such an intervention would have yielded different results in a much larger, more representative sample of women with sexual desire complaints.

Thirdly, our capacity to detect associations between change in sexual concordance and sexual functioning was limited by examining these relationships in a clinical sample only, such that range restriction in sexual functioning may have hampered the detection of an association that may have been observed if women without sexual dysfunction were included. To that end, there was considerable variability in the range of concordance estimates across participants, both at pre- and at post-treatment, but with the majority of participants showing a positive concordance estimate. Also, in the absence of a no-treatment control group, the magnitude of any change in subjective or genital sexual response with treatment cannot be established and should be the focus of future research.

To examine whether sexual concordance changed during two pre-treatment assessments before treatment was administered, genital arousal and continuous self-reported sexual arousal during the erotic film segment were analyzed for 25 women who received two pre-treatment assessments. Within-subjects correlations were calculated, then statistically compared using a dependent samples *t* test. There was no significant difference between the concordance estimates at the two pre-treatment assessment points (data not shown), suggesting that the repeated assessment

of concordance does not significantly impact the concordance estimates themselves. Furthermore, this finding strengthens our conclusion that the increases in sexual concordance observed with treatment are not likely attributable to the passage of time.

## Implications

The incentive motivation model (Both, Everaerd, & Laan, 2007) proposes that sexual desire is triggered by sexual arousal, whereas previously, sexual desire and arousal were viewed as distinct and sequential phases of sexual response (Masters & Johnson, 1966). According to the incentive motivation model that informs current DSM-5 definitions of SIAD, sexual desire and arousal are reciprocally reinforcing, such that sexual desire emerges from experiencing sexual arousal (Toates, 2009). Genital responses alone may not, however, be sufficient for generating sexual desire; instead, the integration of physiological and psychological sexual response (presumably captured with a concordance estimate) may be more strongly associated with triggered sexual desire. Likewise, conscious awareness and positive appraisal of physiological response may be integral to the experience of sexual desire. In this way, sexual concordance as a study endpoint may be fruitful for disambiguating the long-debated relationship between sexual arousal and desire.

The incentive motivation model further proposes that low desire and arousal may be the result of weak associations between a sexual stimulus and reward or that it may be associated with a more narrow range of stimuli that are considered rewarding (McCall & Meston, 2006, 2007). This view proposes that women with low arousal and desire are capable of a physical sexual response, but stimuli are appraised as neutral or negative, and thus fail to trigger sexual desire. Another possible contributor to low arousal and desire may be an inability to consciously experience and recognize a state of sexual arousal. In the current study, cultivation of attention to raw sensations improved concordance and fostered greater mind–body integration. These findings provide support for treatments aimed at increasing sexual interoception and non-judgemental awareness of sexual responding.

Overall, the present findings contribute to an emerging literature supporting the clinical application of mindfulness for the treatment of sexual dysfunction in women (Brotto, 2013; Brotto & Goldmeier, 2015). Given women's frequent claims of "feeling disconnected sexually" when presenting for sex therapy, our data suggest that mindfulness may improve the integration between genital and self-reported sexual arousal. Although this study did not identify individual differences predicting treatment-related improvements in sexual concordance, the wide range in concordance estimates across participants suggests that future research could identify characteristics associated with treatment response. In the long-run, and given the recent approval of the first-ever medication for the treatment of women's sexual desire (flibanserin; <http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm458734.htm>), there is an opportunity for identifying individual patient characteristics predictive of a

positive response to treatment such that therapies (whether psychological or pharmacological) can be individually tailored to women's needs.

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## Compliance with Ethical Standards

**Conflict of interest** None of the authors have any conflicts of interest to disclose.

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