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Psychophysiological Sexual Arousal in Women with a History of Child Sexual Abuse

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*On the basis of literature that suggests that child sexual abuse (CSA) survivors with post traumatic stress disorder (PTSD) have higher baseline sympathetic nervous system (SNS) activity than healthy controls and research that suggests that the SNS plays a critical role in female physiological sexual arousal, we examined the impact of SNS activation through intense exercise on sexual arousal in women with CSA and PTSD. We measured physiological and subjective sexual arousal in women with CSA (*n = *8), women with CSA and PTSD (*n = *10), and healthy controls (*n = *10) during exposure to nonerotic and erotic videos. After exercise, women with CSA and women with CSA and PTSD showed no significant differences in the physiological sexual response compared with no exercise, which was different from the increased physiological sexual response after exercise observed in control women.*

Child sexual abuse (CSA) is a social problem that, depending on the definition of CSA, is estimated to affect between 22.3% and 28% of the female population (Gorey & Leslie, 1997; Rind, Tromovitch, & Bauserman, 1998). A number of studies have noted a high incidence of sexual difficulties in women with a history of CSA (e.g., Finkelhor, Hotaling, Lewis, & Smith, 1989; Leonard & Follette, 2002), in particular avoidance disorder, arousal disorder, and anorgasmia (for a review, see Bartoi & Kinder, 1998). Additionally, CSA survivors often are observed to experience posttraumatic stress disorder (PTSD; Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). Sexual problems affect the survivor's ability to develop healthy and satisfying intimate relationships (Finkelhor et al., 1989) and often are associated with relationship dissatisfaction (DiLillo & Long, 1999; Fleming, Mullen Sibthorpe, & Bammer,

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1999). As noted by Brier (1992), the inability to develop intimate relationships may pose an obstacle in the recovery process because intimate relationships are key to the healing of CSA survivors after the abuse.

Despite the detrimental impact of PTSD on women's relationships, few treatments have been developed specifically for couples' issues experienced by CSA survivors with PTSD (Buttenheim & Levendosky, 1994; Johnson, 1989), and even fewer therapies address sexual dysfunction experienced by this population (e.g., Barnes, 1995). Most studies to date have looked at factors that protect against the development of sexual dysfunction, exclusively from a cognitive and social point of view. Some of the identified factors are social support (Dahl, 1993, cited in van Berlo & Ensink, 2000), coping style (Compass, Banez, & Malcarne, 1991), resiliency (Grossman et al., 1992), and stress resistance (Garmezy, 1987). Although the cognitive aspects of PTSD are important for understanding sexual dysfunction that follows abuse (Meston & Heiman, 2000), it is possible that biological factors also play a key role in the development of problems experienced by CSA survivors with PTSD (CSA + PTSD). An understanding of the biological factors associated with PTSD may help elucidate the difference between women with a history of CSA + PTSD who develop sexual dysfunction and those who do not. To the best of our knowledge, no previous research has specifically examined biological explanations for the sexual dysfunction afflicting women with a history of CSA + PTSD and how this may differ from women with CSA and no PTSD (hereafter referred to as CSA).

Studies conducted on women with a history of CSA + PTSD show increased sympathetic nervous system (SNS) baseline levels. During a stressful experience, the SNS becomes activated and releases catecholamines, such as norepinephrine, which increase glucose availability, heart rate, and blood pressure (Bremner, Krystal, Southwick, & Charney, 1996). After a nontraumatic stressor, the body returns to its original state. However, after a trauma, the homeostasis of the individual is often altered, and this is associated with the development of PTSD. The literature on veterans and adult survivors of childhood maltreatment shows that baseline levels of SNS activity are higher in trauma survivors with PTSD than in healthy control women (e.g., Yehuda, 2003; Southwick et al., 1999).

Impairments in the hypothalamic-pituitary-adrenal (HPA) axis also are found in women with PTSD; these include higher levels of adrenocorticotropin hormone (ACTH), lower levels of cortisol, and a down regulation of glucocorticoid receptors (e.g., Southwick, Yehuda, & Morgan, 1995). Lower levels of cortisol may lead to excessive SNS activity, which may cause an overexpenditure of energy and a maladaptive adjustment to subsequent stressors. In support of this theory, researchers have observed heart rate and blood pressure, signs of SNS activity that were significantly higher in veterans with PTSD compared with a matched group of asymptomatic veterans (review by Shalev & Rogel-Fuchs, 1993).

The SNS is also thought to play an important role in the early stages of female sexual arousal. In healthy control women, activation of the SNS via either acute intense exercise or 50 mg ephedrine was found to have a facilitatory effect on levels of vaginal engorgement (Meston & Gorzalka, 1995, 1996b; Meston, Gorzalka, & Wright, 1997; Meston & Heiman, 1998), a measure of physiological sexual arousal. An additional study by Meston and Gorzalka (1996a) found support for the idea that there may be an optimal level of SNS activity for facilitation of sexual arousal and that too much or too little SNS activity may have a detrimental impact on physiological sexual responding.

Levels of SNS activity naturally increase during sexual activity. Studies conducted in laboratory settings show a significantly greater increase in norepinephrine levels (a SNS neurotransmitter) during sexual arousal associated with erotic videos compared with levels during nonerotic videos (Exton et al., 1999). Norepinephrine also was shown to increase during orgasm achieved via masturbation in both men and women (Kruger et al., 1998; Exton et al., 1999).

It is conceivable that when women with PTSD engage in sexual behaviors, their SNS baseline levels become excessively activated due to their high SNS baseline levels (Southwick et al., 1999). This may have a negative impact on their physiological sexual responses. Hypothetically, this could explain the high incidence of sexual arousal difficulties noted in women with a history of CSA + PTSD. This present study was designed to investigate this hypothesis.

METHOD

Participants

We recruited from the community through ads and fliers women with a history of CSA and with clinically diagnosed PTSD, women with a history of CSA and no PTSD symptoms, and healthy control women with no current and lifetime PTSD and no sexual dysfunction. We defined PTSD according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 2000). We used Bartoi and Kinder's (1998) definition of CSA in this study: an experience before age 16 during which the woman felt forced or coerced into sexual activity that involved touching or penetration of genitals. The sample consisted of 4 (10.3 %) Hispanic, 5 (12.8%) African-American, 28 (71.8%) Caucasian, and 2 (5.1%) Native-American women. We excluded participants from the study if they reported current involvement in an abusive relationship, presence of any trauma (including sexual abuse) that occurred in the previous two months, bodily injuries to the genital area caused by sexual trauma, current or recent pregnancy, or current use of antidepressants. Other medications, such

as lithium and benzodiazepines, were not excluded from the study because of the lack of knowledge of their impact on sexual function and the high use of medications among the population with PTSD. Three women in the CSA + PTSD group were taking lithium or benzodiazepines. Exclusion criteria for the control group were a history of a psychiatric disorder, sexual abuse at any age, any traumatic event that caused PTSD symptoms, childhood physical abuse, and self-reported sexual concerns. Data from 10 women in the CSA + PTSD group, 8 women in the CSA group, and 10 control women were complete and included in the final data analysis.

Procedures

Participants attended two visits during which they were exposed to a nonerotic video immediately followed by an erotic video. The visits were scheduled on two consecutive days between 4:00 p.m. and 6:00 p.m. during participants' luteal phase of their menstrual cycle to minimize hormonal fluctuations. Participants were instructed to avoid consumption of coffee, tobacco products, caffeine, and chocolate on the days of the study, because these substances are believed to impact SNS activity.

Visit 1: no exercise

After reading the consent form, each participant was questioned about food and caffeine consumption in the previous 24 hr in order to ensure compliance with the protocol. In order to assess levels of cortisol by electroimmuno assays, we collected saliva samples after 45 min from the beginning of the study. The participant then completed a series of questionnaires on demographics, sexual functioning, and history of current sexual relationship. She was left alone in a private room that was locked from the inside and equipped with a 27-inch TV, a recliner chair, and an intercom system that facilitated communication between the experimenter and the participant. The participant was instructed on how to insert the vaginal photoplethysmograph. We assessed continuous measures of subjective sexual arousal throughout the video sequence using a device termed arousometer, created by the Female Sexual Psychophysiology Laboratory at the University of Texas at Austin. Each participant moved the arousometer along a track with intervals from 0 to 7 to indicate how sexually aroused or "turned on" she was feeling during the videos. After a 10-min habituation interval, the experimenter started the nonerotic/erotic video sequence. Each video sequence featured the word "RELAX" (1 min), a nonerotic video (3 min), then immediately following, an erotic video (10 min). The content of the erotic videos was standardized in behavior (foreplay, oral sex, and vaginal sex), duration (240 s each behavior ±50 s), and duration of scenes that showed male and female genitalia. The two video sequences (nonerotic/erotic videos) were counterbalanced

between participants and across visits. After the video exposure, the participant answered questions on dissociation during the erotic videos and completed a short questionnaire on her subjective responses to the erotic video.

Visit 2: exercise

The second visit followed a similar protocol to the first visit, with the addition of 20 min of intense exercise on a treadmill prior to viewing the video sequence. We did not counterbalance exercise between visits because past studies examining the effects of exercise on sexual arousal found no significant order effect between first and second visits in physiological or subjective levels of sexual arousal (Meston & Gorzalka, 1995, 1996a, 1996b). Prior to exercise, the investigator measured the participant's resting heart rate and blood pressure, which we used in the Karvonen reserve heart rate formula to calculate the target heart rate corresponding to the 70% of maximum VO^2 intake. This type of exercise is categorized as intense exercise and has been documented to induce SNS activity that remains present for 15–30 min post exercise (Nakamura, Yamamoto, & Muraoka, 1993). After the video sequence, the participant completed a questionnaire on her subjective response to the erotic video and a questionnaire assessing past upsetting experiences. Trauma-related questionnaires were scheduled at the end of the study to ensure that unwanted memories induced by these questions would not adversely impact the participant's response to the erotic videos. At the end of the second visit, an advanced and trained graduate student conducted the Clinician Administered Posttraumatic Stress Disorder Scale (CAPS: Blake et al., 1990) interview to assess frequency and severity of PTSD symptoms. The interview showed a high correlation ($r(37) = .877$, $p < .001$) with scores obtained with the self-reported Distressing Event Questionnaire (Orsillo, 2001). Before study completion, we debriefed each participant thoroughly and compensated her $60.00. This study was approved by the Institutional Review Board at the University of Texas at Austin.

Measures and Data Reduction

Assessment of sexual function

We assessed levels of sexual functioning using the Female Sexual Function Index (FSFI; Rosen et al., 2000), a 19-item questionnaire subdivided into 6 domains supported by factor analysis: desire (2 items), arousal (4 items), lubrication (4 times), orgasm (3 items), satisfaction (3 items), and pain (3 items). The questionnaire was standardized on 131 healthy control women (age range, 21–68) and 128 age-matched participants (age range, 21–69) diagnosed with female sexual arousal disorder (Rosen et al., 2000) and 44 women with female orgasm disorder (Meston, 2003). The FSFI has

demonstrated good internal reliability, test-retest reliabilities, and divergent validity with the Locke-Wallace Marital Adjustment Test (Locke & Wallace, 1959).

We assessed sexual concerns associated with relationship difficulties or attitudes towards sexuality using the Sex History Form (Creti et al., 1998), a 28-item questionnaire standardized on 92 Caucasian couples (ages 29 to 40) that has demonstrated good test-retest reliability, internal consistency, and inter-item correlations.

Assessment of sexual responding

Physiological sexual response. We measured physiological sexual arousal using a vaginal photoplethysmograph (Sintchak & Geer, 1974). We sampled the data at the rate of 80 samples/s throughout the nonerotic and erotic videos and later edited signals associated with movement artifact (sudden and drastic increment in pulse amplitude) with a software program after visual inspection in agreement with previous studies on vaginal pulse amplitude (VPA; Meston & Gorzalka, 1996a, 1996b; Meston & Heiman, 1998). We filtered noise with a band-pass filter (0.5–30 Hz). In accordance with the maximum change technique used to analyze VPA data, we used in the analyses the percentage of increase from the maximum scores of the nonerotic video to the maximum scores of the erotic video.

Continuous subjective sexual arousal. We assessed subjective levels of sexual arousal with the arousometer, a device developed by the Female Sexual Psychophysiology Laboratory at the University of Texas at Austin. (For details, see Rellini, McCall, Randall, & Meston, 2005.) The device consists of an optic IntelliMouse Explorer (Microsoft) mounted on a track that allows the participant to move the mouse from 0 (neutral) to 7 (very aroused or turned on). This device was developed to detect levels of subjective sexual arousal continuously and simultaneously during exposure to an erotic video, thereby allowing comparison of the changes in levels of subjective sexual arousal with changes in VPA throughout exposure to nonerotic and erotic videos.

Responses to the erotic video. We measured positive and negative emotions using a questionnaire adapted from Heiman & Rowland (1983). Participants answered the degree to which they felt a variety of negative and positive emotions on a 7-point Likert Scale, from 0 = not at all to 7 = intensely.

Trauma measures

Life stressor checklist revised (LSC). To assess history of stressful events, we asked participants to complete the Life Stressor Checklist Revised (LSC-R; Wolfe & Kimerling, 1997), a measure composed of questions on 30 types of stressful events. For each type of event, the participant answers questions regarding levels of fear, horror, and helplessness experienced during the event, age when it occurred, and impact on life at the time of the event and at present.

Clinician administered posttraumatic stress scale. A trained interviewer administered the Clinician Administered Posttraumatic Stress Scale (CAPS; Blake et al., 1990), a widely published standardized interview based on the DSM-IV-TR (APA, 2000) criteria for PTSD. This interview has shown strong test-retest reliability, appropriate internal consistency for the total score (Blake et al., 1990), and strong convergent validity (Keane, Caddell, & Taylor, 1998; King, Leskin, King, & Weathers, 1998; Lyons & Keane, 1992). Because of the dimensional nature of PTSD, We used the total CAPS score in a regression analysis.

Dissociation. We assessed dissociation after the erotic video using two questions on a three-point Likert scale (no, somewhat, yes): "Have you felt yourself looking away from the video or thinking of something else 'spacing out' during the erotic video?" and "Have you felt yourself wandering outside your body, or not really being present during the video?"

Depression. We assessed presence and severity of depression, using the Beck Depression Inventory (Beck, Steer, & Garbin, 1988), a 21-item questionnaire with well-published reliability and validity characteristics.

Cortisol. We obtained the quantitative measurement of derivatized cortisol in saliva with a commercially available electroimmuno assay kit (Salimetrics LLC, PA). The minimum amount of cortisol change this kit is able to detect is 0.003 μg/dL. After collection, samples of saliva were immediately frozen at -10°C to be later acylated within 2 months from their collection. Samples were retained if the coefficient of variation was below 17%; assays above this level were run a second time. We asked participants to abstain from smoking and to not brush their teeth, eat, or chew gum for 2 hours prior to the study, because these activities could interfere with the salivary pH in the mouth and thereby confound the assays. We collected a sample of saliva 45 min after the beginning of the first session to assess for baseline levels of cortisol.

RESULTS

Participants Characteristics

On average, women with a history of CSA reported the first incident of sexual abuse at the age of 10, and there were no significant differences between the CSA and the CSA + PTSD groups ($t(14) = 29$, $p = .78$).

The arousal subscale of the FSFI showed significantly lower levels of sexual functioning in women with CSA + PTSD compared with controls, $t(19) = 2.0$, $p = .05$, as did the full score of the FSFI, $t(17) = -2.06$, $p = .05$ (see Table 1).

Because a potential confounding factor in the subjective sexual response to the erotic videos is a woman's attitude toward erotic material, we asked participants: "What is your usual reaction to erotic or pornographic materials

TABLE 1. Differences in Demographics, Sexual, Trauma, and Relationship Variables Between Groups

Demographics, sexual and trauma variables	Controls ($n = 10$) Mean (*SD*)	CSA ($n = 8$) Mean(*SD*)	CSA + PTSD ($n = 10$) Mean(*SD*)
Age	37.30 (7.3)	31.70 (9.7)	35.36 (9.2)
Weight (lbs.)	132.50 (21.4)	152.13 (34.8)	163.18 (52.8)
Income[1]	1.50 (0.5)	1.60 (0.8)	1.27 (0.5)
Years of education	4.10 (0.6)^a	3.38 (1.1)^b	3.18 (1.2)^b
Trauma			
# Traumas	0.60 (0.9)^a	9.00 (3.9)^b	9.50 (6.1)^c
Sum of CAPS	2.30 (8.6)^a	17.40 (14.8)^b	33.30 (8.6)^c
Depression[2]	7.40 (8.7)	8.50 (7.5)	13.44 (6.9)
Adult revictimization *n* (%)		6.00 (75)	10.00 (100)
Female sexual function Index (Roser et al., 2000)			
Arousal	16.89 (2.5)^a	14.43 (5.1)^{a,b}	11.83 (5.5)^b
Orgasm	12.33 (4.7)	9.78 (5.4)	8.33 (4.5)
Desire	7.00 (1.5)	5.56 (2.3)	6.00 (1.7)
Satisfaction	10.40 (5.4)	7.33 (4.6)	6.96 (4.3)
Full scale	29.14 (7.6)^a	26.69 (5.6)^{a,b}	21.88 (7.8)^b
Sexual history			
Length relationship[3]	33.70 (39.0)	81.57 (58.6)	33.10 (31.8)
Arousal to erotica[4]	1.70 (0.7)	2.00 (0.0)	1.70 (0.9)
Partner's erectile dysfunction[5]	1.50 (0.8)	1.83 (0.7)	1.44 (0.5)
Frequency sexual activity with Partner[6]	4.20 (2.2)	4.33 (1.8)	4.82 (2.7)
Frequency masturbation[7]	5.50 (2.1)	5.29 (2.0)	4.36 (2.6)
Feelings of sexual relationship with partner[7]	1.50 (0.7)	2.00 (0.9)	2.1 (0.7)

[1]1 = <$50,000/year, 2 = between $50,0001 and $ 100,000; [2]Measured with BDI; cutoff for clinical depression = 20; [3]Measured in months; [4]Measured with Sexual History Questionnaire, range = 1–4, 1 = greatly aroused, 4 = negative–disgusted, repulsive; [5]Measured with Sexual History Questionnaire, range = 1–6, 1 = never, 2 = rarely, 6 = nearly always, over 90% of the time; [6]Measured with Sexual History Questionnaire, range = 1–9, 1 = more than once daily, 4 = twice a week, 9 = not at all; [7]Measured with Sexual History Questionnaire, range = 1–5; 1 = very enjoyable, 5 = very disgusting. Different letters next to values indicate significant group differences.

(pictures, movies, books)?" (Creti et al., 1998). There were no statistical differences between groups in the way women reported reacting to erotic material, Likelihood Ratio (6, $N = 28$) = 10.19, $p = .11$. A total of 90% of women in the control group, 100% of women in the CSA + PTSD group, and 87.5% of women in the CSA group reported that they usually get at least somewhat aroused by erotic material.

All participants were in sexually active relationships with a male partner. Women in the three groups did not report differences in satisfaction with their partners as lovers, $F(2, 25) = 1.61$, $p = .22$, or with their relationship satisfaction in general, $F(2, 25) = .96$, $p = .40$. There were no differences between groups in the desired frequency of sexual activities,

$F(2, 25) = .03$, $p = .97$, or the reported frequency of masturbation, $F(2, 25) = 7.41$, $p = .49$.

Analyses of Physiological Sexual Arousal

We used a repeated measure analysis of variance (ANOVA) to assess group X condition differences (Control/CSA/CSA + PTSD X exercise/no exercise) in the percentage of VPA increase from nonerotic to erotic videos (Figure 1). The dependent variable in this analysis was the percentage of VPA increase from nonerotic to erotic video. The Mauchly's test for the hypothesis of sphericity showed the assumption was met ($W = 1.0$). The observed power to detect between groups difference was Cohen's $d = .95$ (partial $\eta^2 = .44$), for detecting differences within groups it was $d = .54$ (partial $\eta^2 = .17$), and for detecting interaction effects it was $d = .80$ (partial $\eta^2 = .32$).

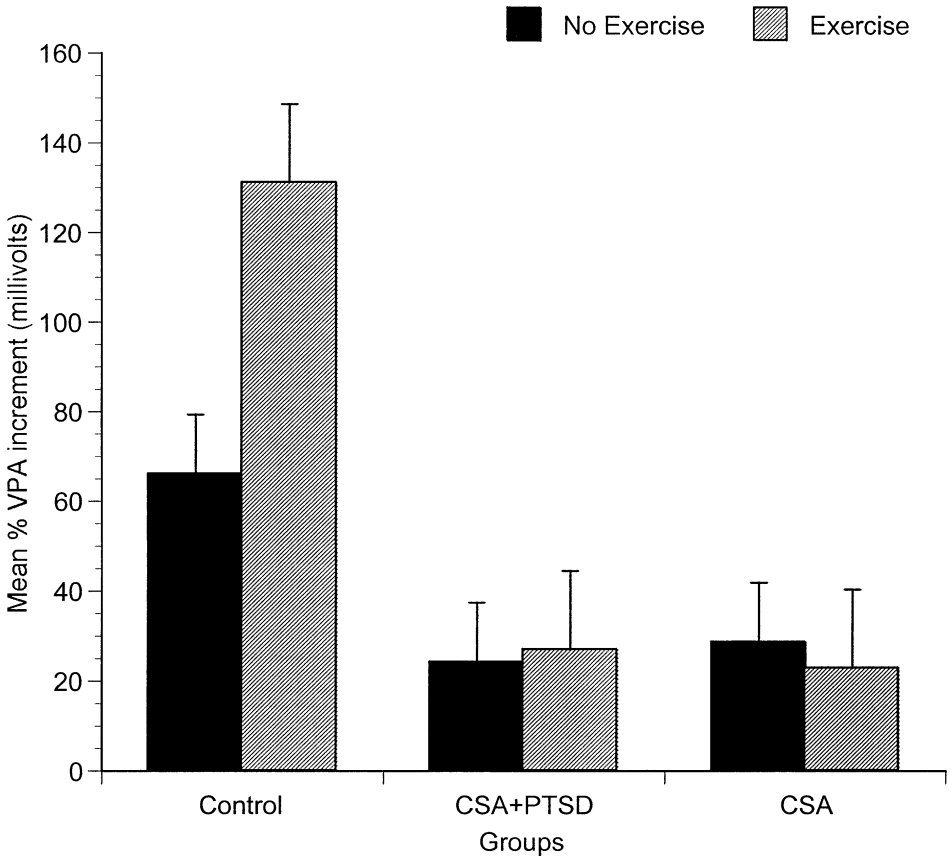

FIGURE 1. Average of percentage vaginal pulse amplitude increase during no exercise and exercise conditions for control, CSA + PTSD and CSA women.

TABLE 2. Summary of the Analysis of Variance for the Model Group (Control/CSA + PTSD/CSA)* Condition (No Exercise/Exercise)

Factors	*df*	*MS*	*F*	*p*
Between subjects				
Groups	2	31312.51	8.91	.001
Within subjects				
Condition	1	5534.94	4.63	.042
Condition*Groups	2	6533.19	5.47	.011

We found significant effects for group, condition, and group X condition, suggesting that the VPA response varied between exercise and no exercise according to group (Figure 1). The univariate statistics are presented in Table 2. The within-subject test identified a main effect of condition (exercise/no exercise). Overall, there was a greater increase in VPA during the exercise compared with the no-exercise condition. The between-subjects tests also identified a main effect of group. Women in the control group had a significantly higher percentage of VPA response compared with CSA and CSA + PTSD women. When we took the interaction effect into consideration, we found that the main effect of condition was accounted for by the control groups strong increase in VPA during exercise as compared to no exercise (see Figure 1). As shown in Figure 1, and as confirmed by post hoc Bonferroni tests, the main effect of condition was mostly explained by the great difference in percentage of VPA from the no exercise ($M = 66.04$, $SD = 44.31$) to the exercise condition ($M = 131.04$, $SD = 94.97$) specific to the control group. The difference in percent of VPA increase between exercise and no exercise for CSA and CSA + PTSD women (see Figure 1) was significantly less compared with controls ($p < .01$).

Because PTSD is a dimensional construct rather than a categorical one, we also conducted a regression analysis on PTSD severity (measured with the CAPS interview) and VPA difference between exercise and no exercise. PTSD severity and VPA difference were highly correlated ($r = -.432$, $p < .05$), and PTSD severity predicted 15% of the variance in VPA difference, $F(1, 24) = 5.51$, $p < .05$.

Cortisol

We excluded data for 3 of the 28 women from analyses because of high coefficient of variation. As illustrated in Figure 2, women with CSA + PTSD ($n = 8$, M = .167 μg/dL, $SD = .08$) and women with CSA ($n = 6$, $M = .121$ μg/dL, $SD = .05$), had significantly lower levels of cortisol, $F(2, 22) = 7.35$, $p < .01$, compared with control women ($n = 10$, $M = .277$ μg/dL, $SD = .15$). A Bonferroni Post Hoc analysis showed that control women differed significantly from women with CSA + PTSD (*M difference* = .109 μg/dL, $p < .05$)

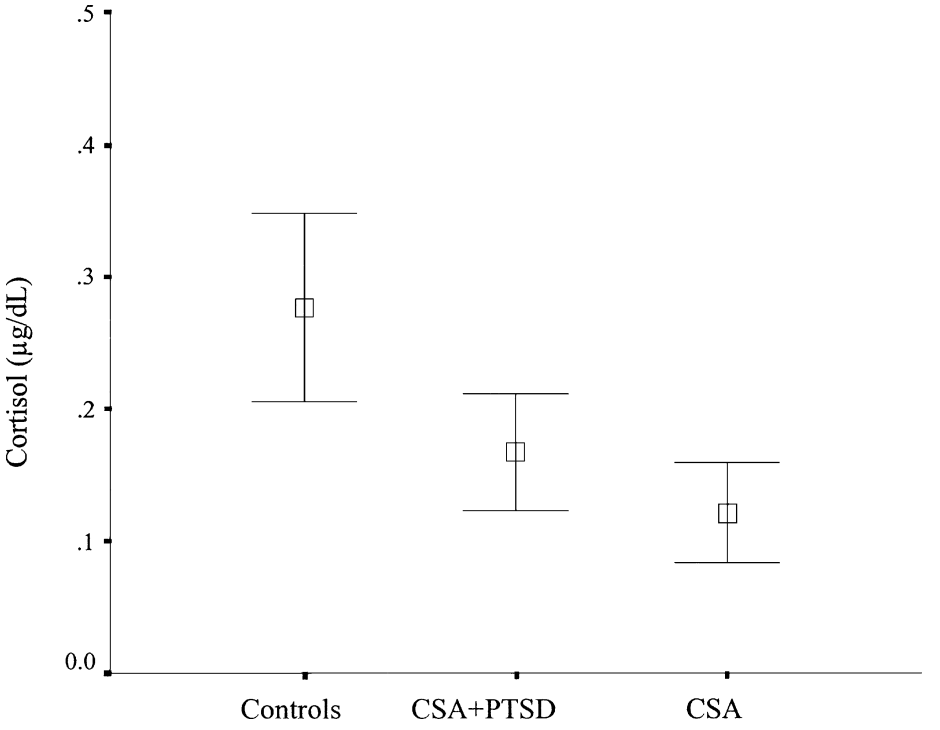

FIGURE 2. Average baseline cortisol for control, CSA + PTSD and CSA women.

and from women with CSA (*M difference* = .156 μg/dL, $p < .01$). Women with CSA + PTSD and with CSA did not differ significantly from each other (*M difference* = .005 μg/dL, $p = .98$).

Analyses of Subjective Responses to the Videos

We conducted repeated measures ANOVA on levels of continuous subjective sexual arousal (condition X film X group). There was a film main effect, $F(2, 25) = 9.98$, $p < .001$, indicating that as the movie progressed from nonerotic to foreplay to oral sex, and vaginal sex participants reported a proportional increase in subjective sexual arousal. However, there was no between-group difference, $F(2, 25) = 0.00$, $p = .99$, and paired t-tests revealed no differences between the subjective sexual arousal during the no exercise and the exercise conditions (foreplay $t = -.129$, $p = .90$; oral sex $t = .725$, $p = .48$, vaginal sex $t = 1.572$, $p = .14$).

Only 5 women (CSA + PTSD) during the no exercise condition and 2 women (CSA + PTSD) during the exercise condition reported "spacing out" or mildly dissociating during the erotic videos. Three women in the CSA + PTSD group experienced a mild disembodiment during the erotic video—two

women during the no exercise condition and one woman during the exercise condition.

We found no significant differences between controls, CSA, and CSA + PTSD groups or conditions for negative affect (Ms = 1.46, 1.54, and 1.64, respectively) or positive affect (Ms = 3.00, 2.98, and 2.97, respectively) reported during the erotic videos.

Relationship Between Physiological Sexual Arousal and Continuous Subjective Sexual Arousal

We conducted a hierarchical linear modeling (HLM) analysis to investigate the strength with which subjective sexual arousal predicted VPA. HLM calculates the regression slope for VPA and subjective sexual arousal for each individual and then uses the population of slopes as the dependent variable for a regression analysis in which condition (exercise/no exercise) and group (controls/CSA/CSA + PTSD) are the predictors. Because group is not a continuous variables, we created dummy variables to allow for a comparison between controls and CSA and between controls and CSA + PTSD. Because participants were instructed to begin moving the arousometer starting with the erotic video, we used only data from the erotic videos for this analysis. During the no exercise condition, continuous subjective sexual arousal (arousometer) significantly predicted levels of VPA in control women, $\beta = 0.023083$, $t = 6.86$, $p < .001$. In women in the CSA group, the strength of the relationship between VPA and continuous subjective sexual arousal was significantly weaker than in controls, $\beta = -.020871$, $t = -4.37$, $p < .001$. In women with CSA + PTSD, the relationship between VPA and continuous subjective sexual arousal was also weaker than in controls, $\beta = .021895$, $t = -5.08$, $p < .001$. During the exercise condition, control women showed a stronger relationship between VPA and continuous subjective sexual arousal compared with the no exercise condition, $\beta = .010905$, $t = 3.43$, $p < .01$. The relationship between VPA and continuous sexual arousal also increased for women with CSA, although the ratio with which it increased between conditions was not significantly different from controls, $\beta = -.005562$, $t = -1.26$, $p = .22$. Conversely, women with CSA + PTSD showed a significantly weaker relationship between VPA and continuous sexual arousal during the exercise condition compared with controls.

DISCUSSION

This study investigated the hypothesis that during a state of heightened SNS activity, similar to what naturally occurs during sexual activity, the overactivity of the SNS in women with CSA + PTSD adversely affects their physiological sexual response. This would be in contrast to the enhancing effect that

exercise has on the sexual response of healthy women (Meston & Gorzalka, 1995, 1996a, 1996b).

Control women, women with a history of CSA, and women with CSA + PTSD showed increases in physiological sexual arousal (VPA) with exposure to both erotic videos during the no exercise and exercise conditions, indicating that the manipulation of sexual arousal via erotic videos was effective. As predicted, women in the control group showed an increase in VPA following exercise that was significantly greater than that during the no exercise condition. These results are consistent with past studies that show exercise enhances vaginal engorgement in response to erotic videos in healthy control women (Meston & Gorzalka, 1995, 1996a, 1996b). Consistent with past studies on exercise and sexual response (Meston & Gorzalka, 1995, 1996a, 1996b), exercise did not significantly influence overall levels of subjective sexual arousal in any of the groups.

As we hypothesized, women in the CSA + PTSD and in the CSA-only groups showed no additional increase in VPA response to erotic videos during the exercise condition compared with the no exercise condition. This finding is the opposite of what was observed in control women who showed an increased VPA response during the exercise versus no exercise condition. When we used PTSD as a continuous rather than a categorical variable, we observed a moderate effect ($r = -.43$) between the increase in VPA associated with exercise and PTSD severity. In summary, although control women increased their physiological sexual response during the exercise condition, women with CSA and women with CSA + PTSD did not show an increase in sexual response. Findings suggest that this may be associated with the severity of PTSD experienced by these participants. Perhaps the combination of PTSD symptoms and heightened SNS activity experienced during sexual activity impairs physiological sexual arousal.

One potential explanation is that, as speculated by Meston and Gorzalka (1996a), excessive SNS activity may have a detrimental impact on female physiological sexual arousal. Because women with PTSD have a higher than normal SNS activity at rest (e.g., Southwick et al., 1999), it may be that in women with PTSD, sexual activity increase SNS activity to a level detrimental for vaginal engorgement. In support of this theory, levels of anxiety, which often are comorbid with hyperarousability symptoms in trauma survivors, were found to be significantly associated with sexual dysfunction (Bartoi, Kinder, & Tomianovic, 2000). Further support for this hypothesis was provided by the lower cortisol observed in both women in the CSA and the CSA + PTSD groups as compared with controls. Lower cortisol levels have been associated with an impairment in the HPA axis and have been linked to SNS baseline hyperactivity. Unfortunately, the lack of a group of women with PTSD and no history of CSA does not allow us to isolate the contributions of PTSD from CSA. Future studies testing the hypothesis that it is PTSD rather than CSA that impacts the relationship between exercise and VPA

increase via SNS should include women with PTSD not associated with sexual abuse.

It is interesting to note that the strength of the association between physiological and subjective sexual arousal was significantly weaker in women with a history of CSA and with CSA + PTSD compared with controls. Past studies using continuous measures of subjective sexual arousal analyzed with HLM have found evidence for a strong association between physiological and subjective sexual arousal during exposure to erotic videos in healthy sexually functional women (Rellini et al., 2005). It also is worth noting that the relationship between physiological and subjective sexual arousal increased during the exercise condition for both control women and CSA women but not for CSA + PTSD women. One potential explanation is that exercise magnifies the sensations normally felt during sexual arousal (i.e., increased heart rate, increased respiration), making them more detectable for control and CSA women. Women with CSA + PTSD may have, to some degree, learned to turn off the sensations felt in their bodies. In support of this explanation, the literature is rich in survivors' self-reports indicating feelings of betrayal by their bodies and a struggle to reestablish a connection with their bodies (Levine, 1997).

A potential cognitive explanation for the group differences observed in the effects of exercise on VPA is that there may be a difference in the interpretation of physiological symptoms resulting from exercise. Intense exercise increases heart rate, perspiration, and respiration rates, sensations caused by increased SNS activity that also are experienced during traumatic events. Because one of the predominant symptoms of PTSD is the reoccurrence of vivid traumatic memories, it is feasible that for women with PTSD, the physiological sensations generated by SNS arousal may be automatically associated with negative attributions that impair sexual arousal.

Because SNS activity was indirectly manipulated through exercise, several other explanations for the increases in VPA with exercise noted among control women but not women with CSA and with CSA + PTSD are plausible. For example, exercise is known to influence steroid hormones, such as testosterone and estrogen, both of which could differentially impact physiological sexual arousal in women with and without PTSD symptoms. Unfortunately, there is a lack of information on differences in steroid hormones between women with CSA + PTSD, women with CSA, and healthy control women. Future studies that measure more direct SNS indicators, such as baseline norepinephrine levels, would help clarify the link between levels of SNS and physiological sexual arousal in women.

If replicated, the current findings may have implications for treating women with CSA + PTSD who experience difficulties becoming physiologically sexually aroused. If exaggerated levels of SNS activity are indeed associated with physiological sexual arousal difficulties, potential treatment for women with CSA + PTSD might include decreasing SNS levels during sexual

activities. Consistent with this suggestion, treatments specifically developed for trauma survivors tend to focus on emotional regulation (Berger, 2004). The current finding that women with CSA + PTSD showed a weaker relationship between subjective sexual arousal and VPA than control women may also have treatment implications. Possibly, the disconnection between VPA and subjective sexual arousal may be a conditioned response learned during the traumatic event. That is, during the trauma, the woman may have learned to associate increases in SNS activity with nonpleasurable sexual emotions. Subsequently, when the woman is in a pleasurable sexual scenario, the accompanying increase in SNS arousal may trigger negative nondesirable sexual cognitions. If so, treatments that focus on establishing an association between SNS arousal and positive cognitions (i.e., feelings of control, safety, enhanced arousal) may prove beneficial.

There are several limitations to the current findings that warrant mention. As in most studies on sexual response, the population that volunteered for the study may differ significantly from other women with CSA and with CSA + PTSD. It may be the case that participants with PTSD who responded to the advertisement had less severe PTSD symptoms than the average women with a diagnosis of PTSD. Also, this sample may be unrepresentative in the etiology of sexual problems experienced by the population. The vast majority of women in the current study reported enjoying erotic material. Possibly, their attitude toward sex and the physiological responses that they experience to erotic material may be different from women with CSA and women with CSA + PTSD who may be more likely to avoid sexual behaviors and may be bothered by erotic material.

In conclusion, this study found that women with CSA and with CSA + PTSD have a physiological sexual response to erotic stimuli that differs from the response of control women. Of particular interest is the finding that, although exercise enhances physiological sexual response in control women, it decreased the physiological sexual response of women with CSA and with CSA + PTSD. The groups also differed on other measures such as cortisol and levels of subjective sexual arousal. Although we provide several physiological and cognitive hypotheses to explain these findings, future studies are needed to further investigate this phenomenon and its relevance for understanding the sexual functioning of women with a history of CSA.

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