

Differential Effects of Sympathetic Activation on Sexual Arousal in Sexually Dysfunctional and Functional Women

Cindy M. Meston

University of Washington School of Medicine

Boris B. Gorzalka

University of British Columbia

The effects of sympathetic nervous system (SNS) activation, induced via acute exercise, on sexual arousal in women was studied. In 2 experimental sessions, 36 women viewed a neutral film followed by an erotic film. In 1 session, the women were exposed to 20 min of intense exercise before viewing the films. Twelve women were sexually functional, 12 experienced significant impairments in sexual desire, and 12 experienced primary or secondary anorgasmia. Acute exercise significantly increased vaginal pulse amplitude (VPA) and vaginal blood volume (VBV) responses to an erotic film among sexually functional women and those with low sexual desire. Among anorgasmic women, exercise significantly decreased VPA but had no effect on VBV responses to an erotic film. Acute exercise had no significant effect on the women's perceptions of sexual arousal. Results suggest that increased SNS arousal may affect physiological sexual responding in women.

The usefulness of independently assessing cognitive, physiological, and behavioral components of psychological disorders has been well established (e.g., Hawton, Salkovskis, Kirk, & Clark, 1991). An understanding of the individual contributions of these three response systems to a particular disorder can assist not only in the effective assessment and treatment of the disorder, but it also may allow for a more accurate picture of change after psychological intervention. The combined measurement of cognitive, physiological, and behavioral systems may be particularly important when assessing disorders in which desynchrony between measures is likely to exist (Rachman & Hodgson, 1974). Given the numerous reports of discordance between cognitive and physiological components of the sexual response in women (e.g., Meston & Gorzalka 1995, 1996; Morokoff & Heiman, 1980; Steinman, Wincze, Sakheim, Barlow, & Mavissakalian, 1981; Wincze, Hoon, & Hoon, 1976), the assessment and treatment of sexual dysfunctions in women may be one category of psychological disorders

in which the measurement of multiple response systems is especially warranted.

Despite the potential importance of measuring multiple response systems, clinical assessment protocols for sexual dysfunctions in women typically do not include the measurement of physiological sexual responsiveness. This is probably because clinical researchers have not identified reliable sexual response correlates of sexual disorders in women. For example, Wincze et al. (1976) and Palace and Gorzalka (1990, 1992) found lower levels of vaginal blood volume (VBV) responses to an erotic film among women with arousal and orgasmic difficulties compared with control women. By contrast, however, Morokoff and Heiman (1980) failed to find differences in vaginal pulse amplitude (VPA) between women with and without sexual difficulties, and Wincze, Hoon, and Hoon (1978) found no significant differences in physiological (VBV) sexual responses in women who were assessed before and after sexual therapy.

The contradictory results of these previous studies suggest that VBV and VPA responsiveness may not play an important role in female sexual disorders. On the other hand, we could find only five studies conducted in this area to date, and a number of potentially important methodological limitations may help explain these inconsistencies. First, previous researchers on sexual dysfunction in women have combined women with a variety of sexual difficulties, including low sexual desire, arousal difficulties, and anorgasmia, into one heterogeneous experimental group. Given that these disorders correspond to different stages of the female sexual response, there is no apparent a priori reason to assume that women with different sexual difficulties will show similar patterns of physiological sexual responding. Hence, insufficient specificity in the classification of sexual disorders might have obscured differences in physiological sexual responding between functional women and women with specific sexual complaints. Second, in previous studies researchers have used either VPA or VBV to assess physiological sexual responding. Given the generally low correlation between these two indexes of sexual responding (e.g., Meston & Gor-

Cindy M. Meston, Department of Psychiatry and Behavioral Sciences, University of Washington School of Medicine; Boris B. Gorzalka, Department of Psychology, University of British Columbia, Vancouver, British Columbia, Canada.

This research was supported by a Natural Sciences and Engineering Research Council of Canada Postgraduate Scholarship, a British Columbia Health Research Foundation Studentship Grant, and a University of British Columbia Social Science Grant. We are especially grateful to Bob Hare for the use of his polygraph machine and for providing his expertise in psychophysiological measurement, Angelo Belcastro for providing his expertise in exercise physiology, and Julia Heiman and Paul Trapnell for their helpful comments on an earlier version of this article.

Correspondence concerning this article should be addressed to Cindy M. Meston, Department of Psychiatry and Behavioral Sciences, University of Washington School of Medicine, 4225 Roosevelt Way, NE, Suite 306, Seattle, Washington 98105. Electronic mail may be sent via the Internet to meston@u.washington.edu.

zalka, 1995, 1996; Zingheim & Sandman, 1978), some of the inconsistencies noted between past studies may be accounted for by the use of different sexual response variables.

A third variable that might have obscured the detection of reliable physiological sexual response differences between functional and dysfunctional women is ecological validity. Previous studies on sexually dysfunctional women have either measured sexual arousal during baseline levels of autonomic arousal or attempted to increase arousal by methods (i.e., anxiety films) that failed to induce measurable increases in autonomic arousal (e.g., Palace & Gorzalka, 1990). Given that significant changes in autonomic arousal are believed to accompany real-life sexual activity (Masters & Johnson, 1966), it is possible that differences in physiological sexual responding have been disguised in laboratory settings that induce lower levels of sympathetic nervous system (SNS) arousal. The notion that increased autonomic activity might differentially influence sexual responses among sexually functional and dysfunctional individuals is consistent with Barlow's (1986) working model of sexual dysfunction. Although based primarily on research conducted in men, Barlow suggested that in both men and women, increased autonomic arousal can facilitate sexual responding in functional individuals by increasing the attentional focus on erotic cues and can inhibit sexual responding in dysfunctional individuals by increasing the attentional focus on the consequences of not performing.

In the current study, we examined the effects of heightened SNS activity on physiological and subjective sexual arousal in sexually functional and dysfunctional women. We wanted to determine whether the measurement of VBV responses, VPA responses or both to erotic stimuli under conditions of increased autonomic arousal would provide an effective physiological means of assessing sexual dysfunction in women. Twelve sexually functional women, 12 women with impairments in sexual desire, and 12 women with either primary or secondary anorgasmia participated in two experimental conditions in which they viewed a neutral film followed by an erotic film. In one of these conditions, participants engaged in 20 min of intense exercise before viewing the films. Subjective (self-report) and physiological (photoplethysmograph) sexual responses were measured in response to the neutral and erotic films. We predicted that exercise-induced high levels of SNS arousal would enhance sexual responding among functional women and inhibit sexual responding among women with low sexual desire or anorgasmia.

The current investigation follows from three recent studies conducted in sexually functional women (Meston & Gorzalka, 1995, 1996, Meston, Gorzalka, & Wright, in press) in which significant increases in VPA and marginally significant increases in VBV responses to an erotic film were noted after exercise preexposure. In each of Meston and Gorzalka's studies, and in Meston et al. (in press) and in the current study, exercise was used to induce SNS activity because numerous studies have shown that activation of the SNS becomes prominent at high levels of exercise (e.g., Nakamura, Yamamoto, & Muraoka, 1993). In addition, we chose exercise as a means of activating the autonomic nervous system on the basis of Meston and Gorzalka's (1995, 1996), and Meston et al. (in press) findings that exercise, in contrast to anxiety-evoking films, reliably increases

heart rate responses and has less of an effect on cognitive processes.

The current investigation extends previous research on sexually dysfunctional women in several respects. First, both VBV and VPA were used as indexes of physiological sexual arousal. Comparison of these responses may provide insight into the inconsistencies noted in previous studies of sexually dysfunctional women that have used only one or the other of these two measures. Second, to verify that exercise had a significant effect on autonomic nervous system activity, we measured heart rate throughout the stimulus exposure during both experimental conditions. Third, to examine potential differences in sexual responding between women with various sexual difficulties, we distinguished between women with primarily sexual desire difficulties and those with primarily orgasmic difficulties. This means of participant classification allowed what might be the first empirical consideration of potential differences in sexual arousal between subgroups of women with sexual difficulties.

Method

Participants

Thirty-six women were recruited through a psychology department undergraduate research participant pool and through local newspaper advertisements requesting volunteers for an experiment. Two sets of advertisements were run concurrently with the following headings: "Are you interested in participating in research on the female sexual response?" and "Are you currently experiencing sexual difficulties?" The remainder of the advertisements were identical. Individuals who telephoned in response to the advertisements were given a detailed description of the experimental procedures involved and also were informed that they would be viewing brief visual stimuli, some of which could include erotic content. Respondents were informed that the purpose of the study was to examine the effects of heightened nervous system arousal, induced via acute exercise, on sexual arousal in women. Individuals who were interested in participating in the study then were asked a number of questions about their sexual and medical histories. They were excluded from participation if they were not aged 18-45 years; if they were lesbian, pregnant, or had begun menopause; if they were currently using or had used any medications other than birth control pills in the past 6 months; if they reported any heart problems, high or low blood pressure, dizzy spells, or any bone or joint problem that might be aggravated by 20 min of cycling. Two participants were diabetic and were referred for participation in a different study.

Respondents who met these initial inclusion criteria then were asked the following question regarding their sexual history: "Are you currently experiencing any sexual difficulties or concerns? For example, some women feel that their interest in sexual activity or their libido has decreased, some experience difficulty becoming sexually aroused or becoming lubricated during sexual activity, some women experience difficulty having orgasms, and some women feel discomfort or pain during intercourse. Do any of these sound like something you are currently experiencing?" Respondents who answered no to this question were classified as "functional," respondents who reported decreased sexual interest or libido (defined as a decreased desire for sexual activity, masturbation, or both) with no difficulty in attaining orgasm were classified as "low sexual desire," and respondents who reported having difficulty attaining orgasm with or without desire problems were classified as "anorgasmic." Respondents who did not fit into one of these three initial classifications were excluded from the study. None of the participants who met the inclusion criteria were currently involved in sexual ther-

apy. Individuals who expressed continued interest in participating in the study were scheduled for a first session with the female experimenter.

During the first session, respondents filled out an adapted version of the Physical Readiness Exam for Fitness Test (developed by the British Columbia Ministry of Health), the Derogatis Sexual Functioning Inventory (DSFI; Derogatis, 1978), and the Orgasmic Functioning Questionnaire (OFQ; Meston, Jung, Hanson, & Gorzalka, 1993). The Physical Readiness Exam for Fitness Test assesses respondents' current medical functioning and fitness level and is designed to screen for individuals who would be put at risk when exercising. None of the respondents were considered at risk when exercising. In response to the question "Have you ever suffered from any medical illness that has required you to go to the hospital, take medications, or visit a doctor on more than one occasion?" 1 participant reported having experienced a back injury several years earlier. None of the respondents reported any medical conditions that might be expected to influence sexual functioning. Nine sexually functional, 8 low sexual desire, and 7 anorgasmic respondents reported being currently involved in a regular (two or more times per week) aerobic program.

The DSFI is a standardized self-report multidimensional inventory comprised of 10 distinct subtests designed to measure current levels of sexual functioning. Retest coefficients for the DSFI subscales range from more than .90 for Experience, Attitude, Symptoms, and Fantasy to .77 for Drive (Derogatis & Melisaratos, 1979). Internal consistency coefficients for the DSFI subscales range from more than .90 for Experience and Affect to .56 for Information (Derogatis & Melisaratos, 1979). The DSFI subtest scores are summed to provide an overall measure of sexual functioning (Sexual Functioning Index). In addition, responses to the single item "How satisfying is your sexual relationship? (0 = could not be worse, 8 = could not be better) provide a global subjective rating of sexual functioning (Global Sexual Satisfaction Index). The Brief Symptom Inventory (BSI; Derogatis, 1975) subtest of the DSFI was used to screen participants for the absence of general psychopathology. The BSI is a distinct psychometric diagnostic instrument that has been validated empirically as an independent measure of psychopathology. Two participants scored below the 30th percentile (i.e., below 2 *SDs* of the normative mean) on the BSI and were excluded from the study. Data from the Experience subtest of the DSFI were used to ensure that all participants scored within the normative range of sexual experience and to later verify that the women in the functional, low sexual desire, and anorgasmic groups had comparable sexual experience. One participant scored below the 30th percentile (i.e., below 2 *SDs* of the normative mean) on the Experience subtest and was excluded from the study.

Data from the OFQ and from the Drive subscale of the DSFI were used to validate differences between designated participant groups. The OFQ is a self-report inventory of one's ability to achieve orgasm in response to a wide variety of sexual activities (e.g., intercourse, oral stimulation, masturbation). Participants are asked to indicate whether they have ever had an orgasm and whether they have had an orgasm during the past 6 months by endorsing either "yes," "no," or "have never tried" to each of the sexual activities listed. Respondents who indicate yes to an activity are asked to indicate the approximate number of times they attain orgasm out of 10 attempted trials. Participants in the functional group scored more than 50% on the OFQ (i.e., they were able to achieve orgasm by at least one form of sexual activity on more than 5 of 10 attempted trials) and more than the 50th percentile on the Drive subscale. Participants in the low sexual desire group scored more than 50% on the OFQ and less than or equal to the 50th percentile on the Drive subscale. Although diagnostic criteria from the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV*; American Psychiatric Association, 1994) for hypoactive sexual desire disorder were not used to define those with low sexual desire in the current study, women in this group reported intercourse frequency rates

comparable to those reported by clinically diagnosed individuals. As was the case in the current study, Schreiner-Engel and Schiavi (1986) found that the majority of patients with hypoactive sexual desire disorder attempted intercourse only once per month or less. Masturbation frequency rates reported by those in the low sexual desire group also were comparable to those revealed by Schreiner-Engel and Schiavi (1986), in which 35% of the patients with hypoactive sexual desire disorder did not masturbate at all, and 45% reported masturbating once per month or less. Participants in the anorgasmic group scored 50% or less on the OFQ. Because of the high comorbidity of anorgasmia with low sexual desire, we did not use the Drive subscale as a criterion for the anorgasmic group. Of the 12 women with anorgasmia, 10 experienced primary anorgasmia (never achieved orgasm by any means), and 2 experienced secondary anorgasmia (had difficulty achieving orgasm). Participants in the anorgasmic group could have been comparable to women who meet *DSM-IV* diagnostic criteria for female orgasmic disorder only to the extent that they had either never experienced orgasm or had difficulty attaining orgasm. Note that, as was the case with women with low sexual desire, categorization of anorgasmic participants in the current study was not based on extensive structured interviews necessary for *DSM-IV* diagnostic assessment. The mean scores by group for the DSFI subtests and global scores and for the OFQ are presented in Table 1. The frequency rates of intercourse, masturbation, kissing and petting, and fantasies, as well as estimated ideal frequency of intercourse, by participant groups also are presented in Table 1.

The functional group consisted of 5 undergraduate students and 7 individuals employed in professions outside the university. They were aged 19–38 years ($M = 24$ years, $SD = 5.25$ years). The low sexual desire group and the anorgasmic group each were comprised of 4 undergraduate students and 8 individuals employed in professions outside the university. Participants in the low sexual desire group were aged 18–45 years ($M = 29$ years, $SD = 10.41$ years); those in the anorgasmic group were aged 19–36 years ($M = 25$ years, $SD = 5.15$ years). Because of reported ethnic differences in sexual behavior (e.g., Meston, Trappnell, & Gorzalka, 1996), we recorded background information on each respondent. All participants were White, except for 1 native of Hong Kong in the functional group and 3 natives of Hong Kong in each of the low sexual desire and anorgasmic groups. One participant in the functional group was married, and 2 participants in each of the low sexual desire and anorgasmic groups were married.

Data for 5 respondents were eliminated because of technical difficulties related to decreased battery output from the optical isolator, which could have influenced the results. Thirty-six participants met all inclusion criteria and served as participants in the study. Respondents were paid \$25 for their participation.

Apparatus and Materials

Stimuli

To prevent the possible habituation of sexual responding with repeated erotic stimulation, we used different film stimuli (referred to here as Sequence A and Sequence B) for each of the two experimental conditions. Each sequence consisted of a 1-min display of the word *relax* followed by a 3-min neutral travelogue film and a 3-min erotic film. Sequences A and B differed only in the content of the neutral and erotic films. The neutral film in Sequence A depicted geographic scenes from the Antarctic; Sequence B depicted wildlife scenes from the Antarctic. In both sequences, the erotic films depicted a nude heterosexual couple engaging in foreplay and intercourse. The erotic films were accompanied by fast-paced music and included explicit sexual communication by the couple. The two erotic films used in Sequences A and B were matched on the number, order, type, and duration of sexual acts and included the same actors and settings. The films were identical to those

Table 1
Group Differences on Profile Scores From the Derogatis Sexual Functioning Inventory
and the Orgasmic Functioning Questionnaire

Measure	Functional		Low sexual desire		Anorgasmic		F(2, 33)	p
	M	SD	M	SD	M	SD		
Information	50.58	12.27	56.60	6.39	46.70	15.60	2.35	.11
Experience	51.42	7.00	47.17	8.81	46.50	10.70	1.20	.32
Drive (total score)	62.17 _a	6.56	43.83 _b	2.62	51.33 _b	10.17	19.93	.0000
Intercourse frequency	4.58 _a	1.00	1.50 _{b,c}	0.67	3.50 _{b,d}	1.09	33.51	.0000
Masturbation frequency	3.83 _a	.94	2.00 _b	0.43	2.25 _b	1.36	12.26	.0001
Kissing and petting frequency	5.83 _a	1.34	2.50 _{b,c}	2.54	5.08 _d	3.26	5.83	.007
Sexual fantasy frequency	4.83	2.29	3.17	1.80	3.50	2.43	1.95	.16
Ideal intercourse frequency	5.00 _a	1.13	2.33 _{b,c}	0.65	4.58 _d	0.79	31.85	.0000
Attitude	28.75	3.28	30.50	2.39	32.50	2.58	5.48	.009
Symptoms (BSI)	46.83	12.90	42.17	8.35	49.67	11.60	1.39	.26
Affect	49.71	12.10	43.13	14.40	49.42	11.25	1.05	.36
Gender role	51.67	9.37	49.17	13.79	52.50	9.65	0.29	.75
Fantasy	56.25	6.70	50.83	11.49	50.08	14.93	1.02	.37
Body image	42.71	12.66	34.50	12.48	39.25	13.92	1.20	.31
Satisfaction	55.17	8.70	44.00	8.31	42.92	11.10	6.64	.004
SFI (global score)	49.18	9.39	35.79	12.42	39.92	12.61	4.22	.02
GSSI (global score)	57.33	8.08	44.25	8.38	50.67	12.43	5.31	.01
OFQ	92.50 _a	13.60	94.20 _a	6.70	11.70 _b	18.50	140.16	.0000

Note. The means for Derogatis Sexual Functioning Inventory items are based on raw scores that were converted to established percentile rankings (*t* scores). The means for the OFQ are based on the highest estimated percentage of trials on which a participant achieved orgasm by any method. Mean DSFI Drive frequency ratings are based on an item response format of 0 (*not at all*), 1 (*<once/month*), 2 (*1-2/month*), 3 (*1/week*), 4 (*2-3/week*), 5 (*4-6/week*), 6 (*1/day*), 7 (*2-3/day*), and 8 (*4+/day*). Within measure categories, means with a Subscript a differ from those with a Subscript b, and those with a Subscript c differ from those with a Subscript d at the .05 level (Newman-Keuls comparison of means). BSI = Brief Symptom Inventory; SFI = Sexual Functioning Index; GSSI = Global Sexual Satisfaction Index; OFQ = Orgasmic Functioning Questionnaire.

used by Meston and Gorzalka (1995, 1996), and Meston et al. (in press).

Physiological Measurement

A vaginal photoplethysmograph (Sintchak & Geer, 1975) was used to obtain physiological measures. Changes in VBV, VPA, and heart rate were monitored simultaneously during both experimental conditions. Vaginal blood volume, the direct current signal, is thought to reflect slow changes in the pooling of blood in the vaginal tissue (Hatch, 1979). Vaginal pulse amplitude, the alternating current signal, reflects short-term changes in engorgement (Rosen & Beck, 1988). Several investigators have found that VPA is a more sensitive measure of sexual arousal than is VBV (e.g., Geer, Morokoff, & Greenwood, 1974; Heiman, 1977; Meston & Gorzalka, 1995, 1996; Osborn & Pollack, 1977), is influenced less by temperature changes (Beck, Sakheim, & Barlow, 1983), and is a superior measure in terms of convergent and divergent validity (Laan, Everaerd, & Evers, 1995). The photoplethysmograph was washed with Hibitane and sterilized by soaking in Cidex, 2% glutaraldehyde and 98% inert ingredients (long-life activated dialdehyde solution; Surgikose Canada, Peterborough, Ontario, Canada) for 10 hr between uses.

To minimize potential light and heating effects, we warmed the photoplethysmograph for 45-min before insertion, followed by a 10-min recorded adaptation period before the experiment began. The signal from the Geer gauge and module (Farrall Instruments, Grand Island, NE) was channeled through an optical isolator-power supply. The VPA and VBV signals were channeled and recorded on a Beckman (Scheller Park, IL) Model R612 dynagraph with a rectilinear pen system, and chart speed was set at 2.5 mm/s. VBV was transduced using a Beckman Type 9806AB coupler and amplified to yield 0.1 V/mm with the high-frequency response filter set at 22 Hz and the time constant set to direct

current. Pulse amplitude was transduced using a SensorMedics Type 9853A coupler and amplified to yield 10 mV/mm with the low-frequency response filter set at 5.3 Hz. The blood volume signal was recorded at a sampling rate of 5 times per second with a Data Translation (Marlborough, MA) analog-digital converter and the Labtech Acquire program (Laboratory Technologies Corporation, Wilmington, MA), installed on a Samtron SC-386 microcomputer. Heart rate was extracted from the pulse amplitude recordings. The software program timed the administration of the stimuli and used an audio trigger signal to mark all stimulus changeovers.

Subjective Measurement

Subjective sexual arousal was assessed using a self-report rating scale adapted from Heiman and Rowland (1983). Several studies have shown that this scale is a sensitive indicator of emotional reactions to erotic stimuli (e.g., Heiman, 1980; Heiman & Hatch, 1980; Heiman & Rowland, 1983; Morokoff & Heiman, 1980). The scale consists of 33 items: sexual arousal (1 item), perceptions of physical sexual change (4 items), autonomic arousal (5 items), anxiety (1 item), positive affect (11 items), and negative affect (11 items). Participants rated each of these items, depending on the degree to which they experienced the sensations, on a 7-point Likert scale ranging from *not at all* (1) to *intensely* (7). Subjective sexual arousal was defined by the first 5 items on the scale: sexually aroused, warmth in genitals, genital wetness or lubrication, genital pulsing or throbbing, and any genital feeling.

Procedure

The procedure consisted of three sessions: a 1-hr orientation screening and questionnaire session, a 45-min no-exercise experimental session; and a 1-hr exercise experimental session. The two experimental

sessions were scheduled at approximately 3-day intervals and excluded times during which the participants were menstruating. The phase of the menstrual cycle was not controlled because sexual arousability to erotic stimuli in laboratory situations, measured both subjectively and physiologically, is only minimally, if at all, influenced by the menstrual cycle (Hoon, Bruce, & Kinchloe, 1982; Meuwissen & Over, 1992). All respondents were requested to abstain from taking psychoactive drugs (including caffeine and alcohol) and from engaging in any strenuous physical activity for 24 hr before each experimental session.

Session 1 (Orientation)

During the orientation session, participants were individually shown the laboratory facilities and equipment, were given verbal instructions on the use of the photoplethysmograph, and were encouraged to ask any questions related to the experiment. To minimize a possible sense of coercion, participants were given the option of either participating in the first session that day or telephoning within a week regarding their decision to participate. All respondents chose to begin the study that day. After signing the standard consent form, they completed the DSFI, the OFQ, and the Physical Readiness Exam for Fitness Test in a private room. After completing the questionnaires, respondents were given a 10-min break and then began Session 2.

Sessions 2 and 3 (Experimental)

The second and third sessions were the two experimental conditions: exercise and no-exercise. The order of these two conditions was counterbalanced across participants, within each group (functional, low sexual desire, and anorgasmic). The order of presentation of film sequences (A then B or B then A) also was counterbalanced across participants within each group and experimental condition. Both experimental conditions were conducted inside the Sexual Psychophysiology Laboratory at the University of British Columbia. This laboratory had an adjoining, private, internally locked participant room that was kept at a constant 21.7 °C. An intercom system between the participant and experimenter rooms allowed for communication with participants at all times. A 41-cm color TV monitor was positioned 205 cm from the participant, a distance that allowed the participant to sit comfortably in a recliner with a full view of the screen. A bicycle ergometer was positioned in the rear of the room.

During the no-exercise condition, participants entered the room with the female experimenter. They were told that once the experimenter left the room, they were to sit in the chair and insert the photoplethysmograph to allow approximately a 2.5-cm distance between the end of the probe and the vaginal opening. To minimize potential movement artifacts, the experimenter asked them to remain as still as possible throughout the session. When participants notified the experimenter via the intercom system that they had finished inserting the plethysmograph, a 10-min adaptation recording was taken. After the adaptation period, participants viewed videotaped Sequence A or B. Each sequence consisted of the word *relax* (1 min), a neutral travelogue (3 min), and an erotic film (3 min). Immediately after the erotic film, participants were asked to fill out the subjective rating scale.

During the exercise condition, participants entered the room with the female experimenter and were informed of the experimental procedures, the same as in the no-exercise condition. They then were asked to cycle for 20 min on a stationary bicycle, during which time their heart rates were monitored continuously using a heart speedometer (Model 8719; Computer In-

struments Corporation, Westbury, NY). Participants were asked to cycle at a constant 70% of their maximum heart rate (HR_{max} ; HR_{max} was determined using the standardized formula, $HR_{max} = 220 - \text{age in years}$; Golding, Meyers, & Sinning, 1982). HR_{max} is an indirect assessment of the maximal volume of oxygen one can consume during exhausting work and is closely linked to aerobic fitness levels (e.g., Sutton, 1992). Respondents were given continual visual feedback on their heart rate levels and were asked to cycle faster or slower if their heart rate indicated that they were below or above the required exertion level. HR_{max} was used as a criterion for exercise intensity rather than an absolute criterion (e.g., a specific number of revolutions per minute) to ensure that participants of potentially different fitness levels exercised at comparable levels of exertion. Fitness levels were not assessed because Meston and Gorzalka (1995) reported no correlation between fitness levels and physiological measures of sexual arousal when participants exercised at equivalent relative levels of their HR_{max} .

When 1 min of cycling time remained, the experimenter left the room. Participants had been instructed to continue cycling until the timer signaled 20 min and then to sit in the chair, insert the plethysmograph, and notify the experimenter (via the intercom system) when they were ready. When the experimenter was notified, a 10-min adaptation recording was taken, followed immediately by one of the videotaped sequences (A or B). The total time from the cessation of exercise to the onset of the erotic stimulus was approximately 15 min (1 min to insert the plethysmograph, 10-min adaptation period, 1 min display of the word *relax*, 3-min neutral film) for all groups. Immediately after watching the erotic film, participants were asked to fill out the subjective rating scale. Except for the 20 min of cycling, all experimental procedures were identical to those used in the no-exercise condition.

After completing Session 3, participants were thoroughly debriefed, informed about the additional purposes and goals of the study, and given an opportunity to view the records of their vaginal responses. All participants were paid \$25 for their participation.

Data Sampling and Reduction

VPA. VPA was recorded throughout the entire 180 s of neutral film and 180 s of erotic film. The data were hand-scored from the polygraph recordings by a research assistant who did not know about the experimental manipulations. For each experimental condition, an average peak-to-peak amplitude was computed for both the neutral and erotic films by summing the amplitudes of each peak 80–100 s into the neutral or erotic film stimulus and dividing by the number of peaks per interval. Difference scores were computed for each experimental condition by subtracting the average VPA score during the neutral film from the average VPA score during the erotic film.

VBV. VBV was sampled during the last 80 s of the neutral film and during the entire 180 s of erotic stimuli. Because there is no absolute method of calibrating VBV and hence no zero point, the data were scored as 0.0001-mV units of blood volume deviation from a baseline reference level, defined as the mean of the last 80 s of the neutral stimulus.

Heart rate. Heart rate was scored from the pulse amplitude polygraph records by counting the number of beats across the entire 180 s of neutral film and 180 s of erotic film. The scores were averaged across each of the neutral and erotic films to yield two measures (beats per

minute) for each participant per experimental condition. This data reduction resulted in four mean heart rate measures per participant (exercise, neutral film; exercise erotic film; no-exercise neutral film; no-exercise erotic film). The data sampling and reduction procedures used for VBV, VPA, and heart rate were identical to those used by Meston and Gorzalka (1995, 1996), and Meston et al. (in press).

Results

Analyses of Group Differences in Sexual Functioning

To validate differences between sexually functional, low sexual desire, and anorgasmic groups, one-way analyses of variance (ANOVAs) were conducted on DSFI subscale scores, DSFI Drive subscale frequency rates, and OFQ scores. Because of accumulating Type I error on mean comparisons across the 18 variables, only mean differences of less than .003 were considered statistically reliable. As can be seen in Table 1, the groups differed significantly on measures of sexual drive and orgasmic ability. Newman-Keuls tests with significance set at the .05 level indicated significantly higher sexual drive scores among sexually functional than low sexual desire or anorgasmic participants. Newman-Keuls tests also indicated significantly higher sexual drive scores among anorgasmic women than low sexual desire women. Individual item analysis of DSFI Drive variables revealed significant differences between groups on frequency ratings of intercourse, masturbation, and ideal frequency of intercourse. With respect to orgasmic ability, those in the functional or low sexual desire groups were significantly more likely to achieve orgasm than were women in the anorgasmic group. Overall, these findings validate the designation of women in the current study as sexually functional, low sexual desire, and anorgasmic.

As also can be seen in Table 1, respondents in the sexually functional, low sexual desire, and anorgasmic groups did not differ significantly on measures of sexual experience, information, psychopathology, affect, gender role, fantasy, or body image and showed only marginally significant differences in ratings of sexual satisfaction. This suggests that group differences in sexual arousal are not likely attributable to differences in these variables.

Analyses of Physiological Sexual Arousal

VPA

A Condition (exercise vs. no-exercise) \times Group (functional vs. low sexual desire vs. anorgasmic) ANOVA was conducted on VPA difference scores (computed as the difference between average VPA scores during the neutral and erotic films). Mean VPA difference scores for the no-exercise and exercise conditions are presented in Figure 1. Results reveal a significant main effect of exercise, $F(1, 33) = 5.76, p = .022$, and a significant interaction between condition and group, $F(2, 33) = 7.19, p = .003$. A follow-up one-way ANOVA between VPA difference scores during the no-exercise conditions indicated no significant differences among the functional, low sexual desire, or anorgasmic groups ($F < 1$). A follow-up one-way ANOVA between VPA difference scores during the exercise conditions, however, revealed significant differences among the functional, low sexual desire, and anorgasmic groups, $F(2, 33) = 5.02, p =$

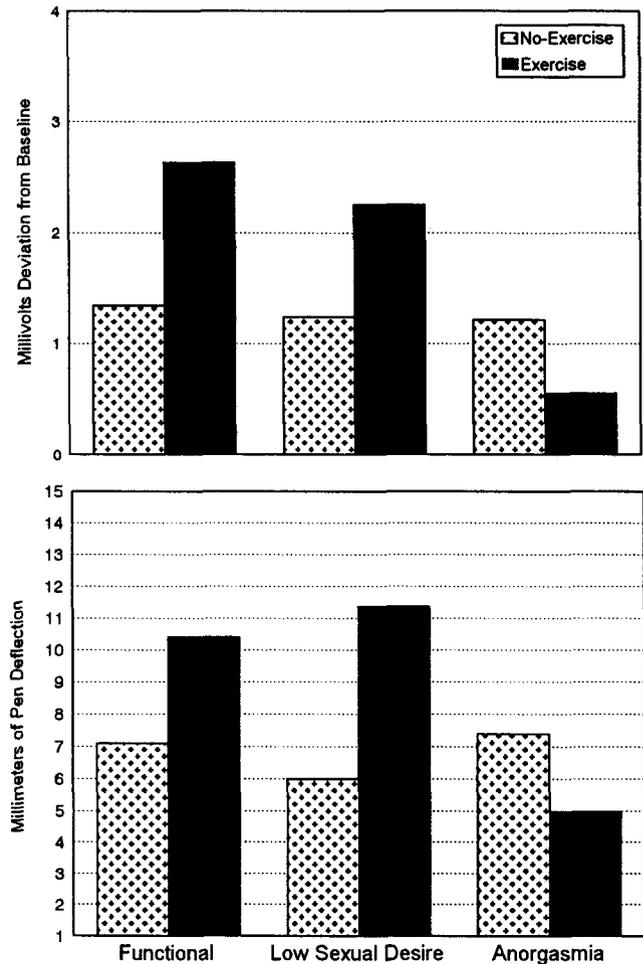


Figure 1. Mean vaginal pulse amplitude (millimeters of pen deflection between neutral and erotic films) and vaginal blood volume (millivolts deviation from baseline) responses for sexually functional, low sexual desire, and anorgasmic women during the no-exercise and exercise conditions.

.01. Newman-Keuls tests with significance set at the .05 level indicated a significant difference in VPA difference scores between the functional and anorgasmic groups and between the low sexual desire and anorgasmic groups. There was no significant difference in VPA difference scores between the sexually functional and low sexual desire groups. Planned follow-up t tests were conducted between the no-exercise and exercise conditions within each of the three groups. Results reveal a significant increase in VPA scores with exposure to exercise among sexually functional participants, $t(11) = -2.58, p = .026$, a significant increase with exposure to exercise among low sexual desire participants, $t(11) = -2.67, p = .022$, and a significant decrease with exposure to exercise among anorgasmic participants, $t(11) = 2.30, p = .042$.

To verify that the erotic films facilitated VPA responses, a Film (neutral vs. erotic) \times Group (functional, low sexual desire, anorgasmic) ANOVA was conducted on VPA raw scores within each experimental condition. Results reveal a significant increase in pulse amplitude responses with exposure to an

erotic film in both the no-exercise, $F(1, 33) = 63.30, p < .0001$, and exercise, $F(1, 33) = 130.93, p < .0001$, conditions. There was no significant main effect of group in either the no-exercise or exercise conditions ($F < 1$). These findings indicate that the experimental stimuli were effective in eliciting sexual arousal among all participant groups.

To determine whether order of experimental sessions influenced VPA responses, we conducted Condition (exercise vs. no-exercise) \times Order (exercise, no-exercise vs. no-exercise, exercise) ANOVAs on VPA difference scores within each group. There were no significant effects of order on VPA responses among either sexually functional, low sexual drive, or anorgasmic respondents and no significant interaction between condition and order for any group.

VBV

Deviation scores in VBV were compared using a Condition (exercise vs. no-exercise) \times Group (functional vs. low sexual desire vs. anorgasmic) ANOVA. Mean VBV deviation scores during the exercise and no-exercise conditions are presented in Figure 1. Results reveal a significant main effect of exercise, $F(1, 33) = 4.50, p = .042$, and a significant interaction between condition and group, $F(2, 33) = 5.70, p = .008$. Follow-up one-way ANOVAs revealed no significant differences in VBV deviation scores among the functional, low sexual desire, and anorgasmic groups during either the no-exercise ($F < 1$) or exercise, $F(2, 33) = 2.50, p = .097$, conditions. Planned follow-up t tests were conducted between the no-exercise and exercise conditions within each of the functional, low sexual desire, and anorgasmic groups. Results reveal a significant increase in VBV deviation scores with exposure to exercise among functional participants, $t(11) = -3.38, p = .006$; a significant increase among low sexual desire participants, $t(11) = -2.92, p = .014$; and no effect among anorgasmic participants, $t(11) = 1.17, p = .23$.

To verify that the erotic films facilitated VBV responses, we conducted paired samples t tests on VBV raw scores between neutral and erotic films within each experimental condition and group. Results reveal a significant increase in blood volume responses to the erotic film among functional participants in both the no-exercise, $t(11) = -7.61, p < .001$, and exercise, $t(11) = -5.82, p < .001$, conditions; among low sexual desire participants in the no-exercise, $t(11) = 3.60, p = .004$, and exercise, $t(11) = 4.33, p = .001$, conditions; and among anorgasmic participants in both the no-exercise, $t(11) = 4.41, p < .001$, and exercise, $t(11) = 4.15, p = .002$, conditions. These results further indicate that the experimental films were successful in eliciting sexual arousal among all groups.

To examine whether order of experimental sessions influenced VBV responses, we conducted Condition (exercise vs. no-exercise) \times Order (exercise, no-exercise vs. no-exercise, exercise) ANOVAs on VBV deviation scores within each group. There were no significant effects of order on VBV responses, and no significant interaction between condition and order for any group. The absence of order effects for both VBV and VPA measures suggested that familiarity with the experimental procedures or with viewing an erotic film had no significant influence on the participants' sexual responses.

To examine whether VBV responses changed across time

during presentation of each of the experimental films, we conducted Film (neutral vs. erotic) \times Condition (exercise vs. no-exercise) \times Time (eighteen 10-s time block means) multivariate analyses of variance (MANOVAs) within each group. There were no significant effects of time on VBV responses for any group.

Heart Rate

A condition (exercise vs. no-exercise) \times Film (neutral vs. erotic) \times Group (functional vs. low sexual desire vs. anorgasmic) MANOVA was computed to examine whether heart rate was altered with exposure to exercise, the erotic film, or both. Results reveal a significant main effect of condition, $F(1, 33) = 98.51, p < .0001$, indicating that exercise significantly increased heart rate among the three groups. There was no significant difference in heart rate between exposure to neutral and erotic films or between participant groups, and there were no significant interactions among condition, group, or film (all F s < 1). The finding that heart rate was significantly increased with exposure to exercise supports the notion that exercise elicited significant SNS activity. The fact that exercise did not differentially influence heart rate among functional, low sexual desire, or anorgasmic participants suggests that, as intended, levels of attained SNS activation were comparable across the three groups. Heart rate responses during assessment averaged 86–92 bpm for all groups. These rates were considerably lower than those attained by participants during peak exercise (approximate range = 125–140 bpm). These differences suggest that the increase in heart rate during assessment was, although stable, part of a return to baseline postexercise. Mean heart rate responses during the no-exercise neutral and erotic films and exercise neutral and erotic films were 68.27 ($SD = 8.53$), 74.66 ($SD = 21.61$), 92.13 ($SD = 8.43$), and 90.43 ($SD = 8.57$) for functional participants; 92.41 ($SD = 10.80$), 73.95 ($SD = 9.66$), 91.29 ($SD = 15.00$), and 92.07 ($SD = 16.46$) for low sexual desire participants; and 67.40 ($SD = 8.44$), 66.94 ($SD = 8.29$), 88.28 ($SD = 10.34$), and 86.56 ($SD = 10.98$) for anorgasmic participants, respectively.

Analyses of the Relationship Between VBV and VPA Responses

To determine the relationship between blood volume and pulse amplitude responses, we calculated Pearson product-moment correlation coefficients between VPA difference scores and VBV deviation scores of the middle 20s of erotic film, during both the no-exercise and exercise conditions (because of the small sample size, correlations were conducted across the three groups). There were no significant correlations at the .05 level between VBV and VPA responses during the exercise or no-exercise condition.

Analyses of Subjective Measures

Subjective ratings of sexual arousal, positive affect, negative affect, and anxiety in response to erotic stimuli were analyzed separately using 2×3 (Condition \times Group) ANOVAs. Mean subjective ratings are presented in Table 2. There were no sig-

Table 2
Group Differences in Subjective Ratings of Sexual Arousal, Positive Affect, Negative Affect, and Anxiety During the No-Exercise and Exercise Sessions

Group and condition	Sexual arousal		Positive affect		Negative affect		Anxiety	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Functional								
No exercise	4.65	1.64	3.30	1.76	1.23	0.28	1.17	0.40
Exercise	4.24	1.80	3.52	1.67	1.33	0.56	1.08	0.29
Low sexual desire								
No exercise	3.67	2.05	3.06	1.65	1.56	0.52	1.50	1.17
Exercise	4.30	1.57	3.21	1.10	1.43	0.45	1.42	1.0
Anorgasmic								
No exercise	3.35	1.83	2.81	1.23	1.40	0.22	1.50	0.91
Exercise	3.54	1.82	2.80	1.31	1.37	0.34	1.42	0.90

Note. Means are based on an item response format of low (1) to intense (7).

nificant effects of condition (no exercise vs. exercise) on measures of subjective sexual arousal, positive affect, negative affect, or anxiety (all $F_s < 1$). There were no significant effects of group (functional vs. low sexual desire vs. anorgasmic), and there were no significant interactions between condition and group for any of the subjective ratings (all $F_s < 1$).

Discussion

We examined the effects of heightened SNS activity on physiological and subjective sexual responding among sexually functional women, women with low sexual desire, and women with anorgasmia. The results indicate that SNS activation, induced via acute exercise, facilitates physiological sexual arousal among sexually functional women and women with low sexual desire. These effects include significant increases in VPA and VBV responses. The finding that SNS activation facilitated physiological sexual responses among functional women replicates Meston and Gorzalka's (1995, 1996) and Meston et al. (in press) findings of enhanced VPA and VBV responding after exposure to acute exercise and is consistent with reports of increased VBV with preexposure to anxiety-evoking films (Hoon, Wincze, & Hoon, 1977; Palace & Gorzalka, 1990). To the extent that VPA and VBV responses did not differ between sexually functional and low sexual desire participants with exposure to exercise, the results of our study do not support the prediction that differences in physiological sexual responses between functional and dysfunctional women may become apparent during conditions of heightened autonomic arousal. Although speculative, this suggests that an inhibition in sexual desire perhaps should be considered independent from an inhibition in physiological sexual responding. This is not to suggest, however, that differences in physiological sexual arousal would not emerge under real-life conditions of both heightened autonomic arousal and performance-related cognitions, as suggested by Barlow (1986). Given that functional and low sexual desire participants did not show changes in subjective ratings of anxiety, affect, or sexual arousal, one may assume that exercise approximated the nervous system changes that occur during the sexual act without approximating changes in cognitive processes.

In contrast to the facilitatory effects of exercise on VBV and

VPA responses in functional and low sexual desire participants, exercise significantly decreased VPA responses and had no effect on VBV responses among anorgasmic women. In other words, exercise-induced increased autonomic nervous system arousal differentiated physiological sexual responses among women with and without orgasmic dysfunction. These changes occurred despite the fact that, as with functional and low sexual desire participants, exercise had no apparent influence on cognitive processes. These findings suggest that physiological changes that occur during increased autonomic arousal may in themselves be detrimental to physiological sexual responding in women with orgasmic difficulties. That is, increased autonomic arousal may inhibit sexual responding among anorgasmic women not only through cognitive mechanisms (i.e., increased attention to performance cues; Barlow, 1986), but also through physiological (e.g., heart rate, blood pressure, muscle tension) processes. Although highly speculative, given that we did not examine the effects of varying levels of SNS activation on sexual arousal, one explanation for the finding that orgasmic and anorgasmic women differed in their response to SNS activation is that these groups have different "optimal levels" of SNS activation for facilitation of sexual arousal. Among sexually functional women, Meston and Gorzalka (1996) found that moderate and low levels of SNS activation significantly facilitated VPA responses and that intense levels inhibited VPA responses. It is possible that the moderate levels of SNS activation used in our study were either too high or too low to facilitate sexual responding among anorgasmic women. Future research is needed to examine the effects of low and high levels of intense exercise on sexual arousal in anorgasmic women.

The results of our study have implications for future research on sexual dysfunction in women. Only in the presence of increased autonomic arousal did physiological sexual responses between orgasmic and anorgasmic women differ. In the absence of exercise, there were no significant differences in VBV or VPA responses among the three groups. This latter finding is consistent with previous research (Morokoff & Heiman, 1980), which also has indicated no significant difference in VPA responses to an erotic film between sexually functional women and women with either low sexual arousal or anorgasmia. Fu-

ture studies that examine sexual responding among anorgasmic women may thus benefit from measuring sexual responses after increased SNS activation given that it may be only under situations of heightened autonomic activity that differences in physiological sexual responding become evident. The finding that exercise had no significant effect on subjective ratings of sexual arousal among either sexually functional, low sexual desire, or anorgasmic women replicates the results of Meston and Gorzalka (1995, 1996) and Meston et al. (in press) in sexually functional women and contrasts with reports that anxiety-evoking stimuli decrease subjective ratings of sexual arousal in sexually functional and dysfunctional women (Palace & Gorzalka, 1990). The fact that exercise also had no significant effect on subjective ratings of affect or anxiety similarly contrasts with reports that anxiety-evoking films significantly increase respondents' ratings of feeling "worried" (Palace & Gorzalka, 1990). These different influences of exercise and anxiety-evoking films on subjective ratings suggest that exercise may have less of an effect on cognitive processes than does a film of threatened amputation. Exercise, rather than anxiety-evoking films, may thereby provide a better means for examining the sexual effects of autonomic arousal in women given that interpretation of findings is not confounded by the possible contributory role of negative cognitions. Finally, the unexpected finding that low sexual desire and anorgasmic participants differed in their physiological sexual responses to SNS activation strongly suggests that future research on sexually dysfunctional women should consider low sexual desire and anorgasmic women as separate experimental groups. Categorization of women with a variety of sexual difficulties into one "sexually dysfunctional" group may disguise potentially important differences in response patterns between subgroups of women with sexual difficulties.

To our knowledge, our results provide the first empirical suggestion of a difference between orgasmic and anorgasmic women in physiological sexual responses to increased SNS activation. These findings also suggest that measurement of VBV and VPA responses to erotic stimuli under conditions of increased autonomic arousal potentially may provide an important means for assessing women with orgasmic difficulties. Given the small sample size used in our study, however, interpretation of the findings is preliminary and also is limited by the exclusive reliance on exercise to increase autonomic activity, heart rate to indirectly assess SNS activity, brief questionnaire data to screen for physical conditions that may influence sexual functioning, and the use of a contrived laboratory setting to examine a private emotional and physical experience. Most importantly, caution must be taken when generalizing our findings to clinically diagnosable cases of sexual dysfunction. To the extent that anorgasmic participants in the our study had either never experienced orgasm or experienced orgasm less than half of the time they engaged in any form of sexual activity, anorgasmic participants in our investigation may be comparable to those who meet the *DSM-IV* (American Psychiatric Association, 1994) criteria for female orgasmic disorder (302.73). However, classification of the anorgasmic participants in our study was made purely on the basis of brief verbal reports and questionnaire information that assessed orgasmic functioning and sexual experience and attempted to rule out psychopathology. To make a clinical diagnosis of female orgasmic disorder, a

detailed clinical interview would be necessary to ensure that the orgasmic difficulties were not attributable to inadequate sexual stimulation, that they caused "marked distress or interpersonal difficulty," and that they did not occur exclusively during the course of another Axis I disorder (*DSM-IV*; American Psychiatric Association, 1994).

Given the difficulties inherent in defining and diagnosing desire disorders (Leiblum & Rosen, 1988, 1989; Wincze & Carey, 1991), it is difficult to know how closely the low sexual desire participants in our study resemble clinical cases of hypoactive sexual desire disorder (302.71, *DSM-IV*; American Psychiatric Association, 1994). Participants in our study reported rates of intercourse and masturbation frequency not unlike those reported by women diagnosed with hypoactive sexual desire disorder (Schreiner-Engel & Schiavi, 1986). However, our participants were relatively young and single compared with most women who present themselves for clinical treatment (Leiblum & Rosen, 1988, 1989; Wincze & Carey, 1991). On one hand, these differences in age and marital status may limit the generalizability of our findings to clinical cases. On the other hand, one could argue that given their single status, participants in our study were likely to have volunteered because of "self-" versus "other-defined" symptoms of decreased sexual interest. This differs from clinical cases of hypoactive sexual desire disorder, in which many women present themselves for treatment simply because of marital discrepancies in the desire for sexual activity (Kilmann, Boland, Norton, Davidson, & Caid, 1986). Regardless, to clinically diagnose low sexual desire participants in our study, a detailed clinical interview would be necessary to better understand the individuals' characteristics, possible interpersonal determinants of the decrease in sexual interest, and the life context in which the disorder exists (*DSM-IV*; American Psychiatric Association, 1994). Our study represents a preliminary examination of the influence of increased SNS activation on sexual responding in sexually functional women and in women with desire and orgasmic difficulties. Future research is needed to assess such effects among women who meet clinically diagnosable criteria for female orgasmic disorder and hypoactive sexual desire disorder.

References

- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
- Barlow, D. H. (1986). Causes of sexual dysfunction: The role of anxiety and cognitive interference. *Journal of Consulting and Clinical Psychology, 54*, 140-148.
- Beck, J. G., Sakheim, D. K., & Barlow, D. H. (1983). Operating characteristics of the vaginal photoplethysmograph: Some implications for its use. *Archives of Sexual Behavior, 12*, 43-58.
- Derogatis, L. R. (1975). *The Brief Symptom Inventory*. Baltimore: Clinical Psychometrics Research.
- Derogatis, L. R. (1978). *Derogatis Sexual Functioning Inventory* (rev. ed.). Baltimore: Clinical Psychometrics Research.
- Derogatis, L. R., & Melisaratos, N. (1979). The DSFI: A multidimensional measure of sexual functioning. *Journal of Sex and Marital Therapy, 5*, 244-281.
- Geer, J. H., Morokoff, P., & Greenwood, P. (1974). Sexual arousal in women: The development of a measurement device for vaginal blood volume. *Archives of Sexual Behavior, 3*, 559-564.

- Golding, L. A., Meyers, C. R., & Sinning, W. E. (1982). *The Y's way to physical fitness* (2nd ed.). Chicago: National Board of YMCA.
- Hatch, J. P. (1979). Vaginal photoplethysmography: Methodological considerations. *Archives of Sexual Behavior*, 8, 357-374.
- Hawton, K., Salkovskis, P. M., Kirk, J., & Clark, D. M. (1991). *Cognitive behaviour therapy for psychiatric problems*. New York: Oxford University Press.
- Heiman, J. R. (1977). A psychophysiological exploration of sexual arousal patterns in females and males. *Psychophysiology*, 14, 266-274.
- Heiman, J. R. (1980). Female sexual response patterns: Interactions of physiological, affective and contextual cues. *Archives of General Psychiatry*, 37, 1311-1316.
- Heiman, J. R., & Hatch, J. P. (1980). Affective and physiological dimensions of male sexual response to erotica and fantasy. *Basic and Applied Social Psychology*, 1, 315-327.
- Heiman, J. R., & Rowland, D. L. (1983). Affective and physiological sexual response patterns: The effects of instructions on sexually functional and dysfunctional men. *Journal of Psychosomatic Research*, 27, 105-116.
- Hoon, P. W., Bruce, K., & Kinchloe, B. (1982). Does the menstrual cycle play a role in sexual arousal? *Society for Psychophysiological Research*, 19, 21-26.
- Hoon, P. W., Wincze, J. P., & Hoon, E. F. (1977). A test of reciprocal inhibition: Are anxiety and sexual arousal in women mutually inhibitory? *Journal of Abnormal Psychology*, 86, 65-74.
- Kilmann, P. R., Boland, J. P., Norton, S. P., Davidson, E., & Caid, C. (1986). Perspectives of sex therapy outcome: A survey of AASECT providers. *Journal of Sex and Marital Therapy*, 12, 116-138.
- Laan, E., Everaerd, W., & Evers, A. (1995). Assessment of female sexual arousal: Response specificity and construct validity. *Psychophysiology*, 32, 476-485.
- Leiblum, S. R., & Rosen, R. C. (1988). *Sexual desire disorders*. New York: Guilford Press.
- Leiblum, S. R., & Rosen, R. C. (1989). *Principles and practice of sex therapy: Update for the 1990's* (2nd ed.). New York: Guilford Press.
- Masters, W. H., & Johnson, V. E. (1966). *Human sexual response*. Boston: Little, Brown.
- Meston, C. M., & Gorzalka, B. B. (1995). The effects of sympathetic activation on physiological and subjective sexual arousal in women. *Behaviour Research and Therapy*, 33, 651-664.
- Meston, C. M., & Gorzalka, B. B. (1996). The effects of immediate, delayed, and residual sympathetic activation on sexual arousal in women. *Behaviour Research and Therapy*, 34, 143-148.
- Meston, C. M., Gorzalka, B. B., & Wright, J. M. (in press). Inhibition of physiological and subjective sexual arousal in women by clonidine. *Journal of Psychosomatic Medicine*.
- Meston, C. M., Jung, S., Hanson, L., & Gorzalka, B. B. (1993). *The Orgasmic Functioning Questionnaire (OFQ)*. Unpublished manuscript.
- Meston, C. M., Trapnell, P. D., & Gorzalka, B. B. (1996). Ethnic and gender differences in sexuality: Variations in sexual behavior between Asian and non-Asian university students. *Archives of Sexual Behavior*, 25, 33-72.
- Meuwissen, I., & Over, R. (1992). Sexual arousal across phases of the human menstrual cycle. *Archives of Sexual Behavior*, 21, 101-119.
- Morokoff, P. J., & Heiman, J. R. (1980). Effects of erotic stimuli on sexually functional and dysfunctional women: Multiple measures before and after sex therapy. *Behaviour Research and Therapy*, 18, 127-137.
- Nakamura, U., Yamamoto, Y., & Muraoka, I. (1993). Autonomic control of heart rate during physical exercise and fractal dimension of heart rate variability. *Journal of Applied Physiology*, 74, 875-881.
- Osborn, C. A., & Pollack, R. H. (1977). The effects of two types of erotic literature on physiological and verbal measures of female sexual arousal. *Journal of Sex Research*, 13, 250-256.
- Palace, E. M., & Gorzalka, B. B. (1990). The enhancing effects of anxiety on arousal in sexually dysfunctional and functional women. *Journal of Abnormal Psychology*, 99, 403-411.
- Palace, E. M., & Gorzalka, B. B. (1992). Differential patterns of arousal in sexually functional and dysfunctional women: Physiological and subjective components of sexual response. *Archives of Sexual Behavior*, 21, 135-159.
- Rachman, S. J., & Hodgson, R. (1974). Synchrony and desynchrony in fear and avoidance. *Behaviour Research and Therapy*, 12, 311-318.
- Rosen, R. C., & Beck, J. G. (1988). *Patterns of sexual arousal: Psychophysiological processes and clinical applications*. New York: Guilford Press.
- Schreiner-Engel, P., & Schiavi, R. C. (1986). Life psychopathology in individuals with low sexual desire. *Journal of Nervous and Mental Disease*, 174, 646-651.
- Sintchak, G., & Geer, J. H. (1975). A vaginal plethysmograph system. *Psychophysiology*, 12, 113-115.
- Steinman, D. L., Wincze, J. P., Sakheim, D. K., Barlow, D. H., & Mavissakalian, M. (1981). A comparison of male and female patterns of sexual arousal. *Archives of Sexual Behavior*, 10, 529-547.
- Sutton, J. R. (1992). VO_{2max} : New concepts on an old theme. *Medicine and Science in Sports and Exercise*, 24, 26-29.
- Wincze, J. P., & Carey, M. P. (1991). *Sexual dysfunction: A guide for assessment and treatment*. New York: Guilford Press.
- Wincze, J. P., Hoon, E. F., & Hoon, P. W. (1976). Physiological responsiveness of normal and sexually dysfunctional women during erotic stimulus exposure. *Journal of Psychosomatic Research*, 20, 445-451.
- Wincze, J. P., Hoon, E. F., & Hoon, P. W. (1978). Multiple measures analysis of women experiencing low sexual arousal. *Behaviour Research and Therapy*, 16, 43-49.
- Zingheim, P., & Sandman, C. (1978). Discriminative control of the vaginal vasomotor response. *Biofeedback and Self-Regulation*, 3, 29-41.

Received March 27, 1995

Revision received February 23, 1996

Accepted April 12, 1996 ■