# GENITAL AND SUBJECTIVE SEXUAL AROUSAL IN WOMEN: EFFECTS OF MENOPAUSE, SYMPATHETIC NERVOUS SYSTEM ACTIVATION, AND AROUSAL DISORDER

by

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE STUDIES

(Department of Psychology; Clinical)

We accept this thesis as conforming to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

March 2003

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0-612-85429-9

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Abstract

Despite three decades of psychophysiological research on female sexual arousal, inconsistencies in the literature with respect to the influence of age, menopause, sympathetic nervous system (SNS) activation, and sexual dysfunction leave clinicians and researchers with an incomplete picture of the female sexual response. The present investigation was aimed at increasing our understanding of female sexual arousal by exploring (1) the effects of age and menopause; (2) the effects of SNS activation on premenopausal, postmenopausal, and women with female sexual arousal disorder (FSAD); (3) the diagnostic utility of the vaginal photoplethysmograph (VPP); and (4) the relationship between laboratory-based and at-home sexual arousal. Experiment 1 found no significant differences in genital or subjective sexual arousal between 25 premenopausal, 25 postmenopausal, and 21 perimenopausal women age-matched to the postmenopausal group. SNS activation significantly increased genital sexual arousal in young women, but had no effect on subjective measures. In Experiments 2 and 3, genital and subjective sexual arousal were compared in 30 control and 31 women with FSAD. Three subtypes of FSAD emerged: "genital arousal disorder" characterized women with impaired genital arousal, "anhedonic arousal disorder" characterized women with impaired subjective sexual arousal, and "missed arousal disorder" characterized women who complained of both types of impairment, but who displayed normal VPP patterns. SNS activation significantly impaired genital arousal in women with anhedonic arousal disorder, near significantly increased it in women with genital arousal disorder, and had no effect in women with missed arousal disorder. No subjective measure was significantly affected. Experiment 4 examined the relationship between laboratory-based and at-home sexual arousal in control and FSAD groups. Using a detailed interview to assess at-home sexual arousal, these indices were found not to correlate with genital arousal assessed in the laboratory. Taken together, these results suggest that the genital arousal response is robust to the effects of age and menopause, but is significantly affected by SNS activation depending on diagnostic status. There is support for

putative subtypes of FSAD, and future clinical trials should investigate the efficacy of SNS activating techniques across such subtypes. Finally, female sexual arousal is a complex response involving unique contributions of subjective and genital arousal. Optimal assessment of sexual arousal in women would benefit from combining psychophysiological and self-report assessment techniques.

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# Preface

*Experiment 1 is published as follows:*

Brotto, L.A., & Gorzalka, B.B. (2002). Genital and subjective sexual arousal in postmenopausal women: Influence of laboratory-induced hyperventilation. *Journal of Sex and Marital Therapy, 28(suppl 1),* 39-53.

*Experiment 2 is currently under manuscript review as follows:*

Brotto, L. A., Basson, R., & Gorzalka, B.B. Female sexual arousal disorder and psychophysiological assessment: Implications for diagnostic subtypes.

*Experiment 4 has been presented as a paper presentation as follows:*

Brotto, L.A., Basson, R., & Gorzalka, B.B. Genital-subjective sexual arousal correlations in vaginal photoplethysmography: Implications for sex research and therapy. Paper presentation. Society for Sex Therapy and Research, Las Vegas, NV, USA, March 2002.

Acknowledgements

It is an exciting time to be launching a career within the field of female sexuality research. I have been impressed with the increasing number of scientific conferences, workshops, seminars, and scientific and general interest in women's sexual function and dysfunction. Without a doubt, several of the ideas raised within this dissertation have resulted from my numerous interactions with other researchers puzzled and intrigued by this field of study, as I am. As such, I would like to thank this growing field's leaders whom I have had the pleasure of meeting over the past few years, for inspiring me to devote my career to this work. In particular I would like to acknowledge and thank Dr. Rosemary Basson, with whom I have shared numerous discussions about the complexity of women's sexuality. She has provided the rich clinical data on which much of the current empirical findings are based. I would also like to thank her for being a continual source of support throughout my graduate years, and for modeling genuine interest and respect towards the women seeking her care. I would like to thank my research supervisor, Dr. Boris Gorzalka, for being a tremendous advocate for me during my graduate school career at the University of British Columbia. In particular, he trusted my independence, which allowed me to develop invaluable research and management skills that I might not have otherwise acquired. To my dissertation committee, Drs. Anita Delongis, Wolfgang Linden, Jim Enns, and Darrin Lehman, I would like to thank them for their very helpful comments and guidance which has helped shape this document. I would also like to thank them for their open-mindedness and patience in reading a dissertation topic slightly outside of their respective areas of expertise! To the many undergraduate students who have made working in the Sexual Psychophysiology Laboratory exciting and entertaining, and who devoted numerous hours to data collection, I would like to thank them with open arms. In particular, I would like to acknowledge Brooke Seal who, in addition to her impressive work ethic, shared many fascinating discussions with me on future research projects that needed to be explored in this area. To my family for

standing behind me, and believing in me for the past 22 years of my schooling history, I would like to dedicate this dissertation. In particular I would like to thank my father for passing his obsessive attention to detail, tenacious work ethic, and model of respect to me. And finally, to my husband, Ed Fontana, for being my foundation, and for sacrificing too many weekends and evenings while I focused on my research: Thank you Ed for your patience, support, encouragement, insight, and love. With excitement I conclude my studies at the University of British Columbia, and with anticipation I look forward to the next phase of my life.

# General Introduction

## *History of sex research*

The earliest documented descriptions of physiological events taking place during sexual arousal appear in medical textbooks of the early twentieth century, namely "Ideal Marriage" (Van de Velde, 1926) and "Human Sex Anatomy" (Dickinson, 1933). However, more detailed laboratory studies of the physiological changes during sexual arousal were published several years later with the ground breaking work of Kinsey et al. (Kinsey, Pomeroy, & Martin, 1948; Kinsey, Pomeroy, Martin, & Gebhard, 1953) followed by Masters and Johnson (1966). These pioneers of sexuality research paved the way for the formalized study of human sexuality. Kinsey provided the detail of some 20 different physiological events that take place during female sexual arousal (Kinsey et al., 1953), including central nervous system changes, increased blood pressure and peripheral blood flow, and higher respiration rates. The publication of their volume, "Human Sexual Response", documented detailed observations by Masters and Johnson of the anatomical and physiological events in reproductive tissues during sexual arousal in men and women (Masters & Johnson, 1966). The findings of these clinician-researchers were the first of their kind, and they provided the context that allowed the development of a new field of "sexual psychophysiology". Attention was paid to the laboratory investigation of sexual psychophysiology, which focused on the application of psychophysiological methods to the study of sexual arousal, with a special emphasis on the relationship between the cognitive and affective (i.e., subjective) features, and the physiological components of sexual arousal (Rosen & Beck, 1988). The observations of Masters and Johnson allowed them to formulate a four-stage sexual response cycle consisting of excitement, plateau, orgasm, and resolution (Masters & Johnson, 1966), which formed the basis for numerous other investigations in sexual psychophysiology. Excitement describes the initial response to the presence of effective sexual stimulation, and excitement increases as arousal increases. During the plateau phase, vasocongestion

reaches its peak and a relatively constant level of arousal is achieved. The orgasmic phase describes sexual climax following the plateau phase. During the subsequent resolution phase there is a loss of sexual tension and reinstatement of baseline levels of arousal. The model of Masters and Johnson (1966) postulates that the sexual response in men and women can be characterized by these four discrete, sequential stages, with specific physiological changes occurring at each phase. Though their descriptions of arousal were thorough and stimulated others to take an interest in sexual psychophysiology, Masters and Johnson neither quantified their observations in a manner that could be replicated by others, nor did they consider psychological factors during sexual arousal. Subsequently, the development of instruments to quantify sexual psychophysiological changes – the penile plethysmograph in men (Freund, 1963) and the vaginal photoplethysmograph in women (Sintchak & Geer, 1975) - allowed for a more thorough, objective, and methodologically rigorous study of genital sexual arousal. One might argue that the creation of the plethysmograph marked the true birth of the field of sexual psychophysiology.

*Assessment of sexual arousal in women*

Masters and Johnson provided exquisite detail of the genital and extragenital changes that take place during the sexual response cycle of women (Masters & Johnson, 1966). They claim of the vagina that

> *"to appreciate vaginal anatomy and physiology is to comprehend the fundamentals of the human female's primary means of sexual expression" (Masters & Johnson, 1966, p.68).*

Indeed the main focus of sexual psychophysiological investigations in women has been on vaginal sexual arousal. Estimates of female vaginal blood flow range from 5.5 – 19.6 ml/min in the non-aroused state to 21.5 – 45 ml/min during sexual arousal. Within 20 seconds of exposure to a visual and auditory erotic stimulus, vaginal blood flow increases and consequent vaginal lubrication increases in sexually functional, premenopausal women (Meston, 2000). Other physiological changes during sexual arousal include: altered heart rate, blood

pressure, peripheral blood flow, respiration rate, genital secretions, neuromuscular tension, and central nervous system excitement. Clitoral and labial engorgement also accompany vaginal vasocongestion during sexual arousal (Bancroft, 1989; Masters & Johnson, 1966), and instruments to detect these extra-vaginal physiological changes have been investigated (Deliganis, Maravilla, Heiman, Carter, Weisskoff, Garland, et al., 2000; Henson & Rubin, 1978; Khalife, Binik, Cohen, & Amsel, 2000). Measurement of clitoral arousal may compensate for some of the limitations involved in measuring vaginal vasocongestion (e.g., absence of absolute scale, susceptibility to movement artifact), and is currently the focus internationally in several research centers. The development of the vaginal photoplethysmograph (VPP) in 1975 allowed for the exploration of vaginal response patterns to a variety of erotic and non-erotic stimuli (Sintchak & Geer, 1975). To date, the most widely used stimuli consist of erotic film segments, usually with auditory accompaniment. A tampon-shaped acrylic probe (1.5 cm diameter, 4.5 cm length) which emits a pulse of infrared or incandescent light from a photo-emitting diode, is inserted into the vagina. Increases in blood volume within the vaginal blood vessels translate into more backscattered light from the vaginal probe (Levin, 1992). A photoelectric transducer within the probe detects these blood flow-induced changes (Sintchak & Geer, 1975) and transmits these messages to a filter and amplifier where the signal is adjusted. Two signals are derived from the VPP: one resulting from the dc current (vaginal blood volume) and the second from the ac current (vaginal pulse amplitude). Vaginal blood volume (VBV) is thought to represent slow changes in the overall pooling of blood within the vaginal wall (Hatch, 1979). Vaginal pulse amplitude (VPA) reflects the moment-to-moment changes within the peripheral vascular vessels of the vagina and is dependent on vaginal blood vessel pressure changes (Jennings, Tahmoush, & Redmont, 1980). The VPP provides an indirect index of genital engorgement that is highly sensitive and relatively specific to erotic stimuli (Hoon, Wincze, & Hoon, 1976). Compared to other psychophysiological measures such as skin conductance, systolic and diastolic blood pressure, heart rate, and forehead temperature, only the VPP

responds exclusively and most robustly to the visual presentation of erotic material (Hoon et al., 1976). While both VBV and VPA have been found to contribute unique variance to the assessment of genital sexual arousal (Hatch, 1979), VPA is consistently found to be the more sensitive measure (Geer, Morokoff, & Greenwood, 1974), is less vulnerable to movement artifacts (Laan, Everaerd, & Evers, 1995), is more closely related to self-report measures of arousal (Heiman, 1977), is more specific to erotic stimuli (Laan et al., 1995), and consequently is more widely used (Hatch, 1979).

*Genital and subjective sexual arousal assessment in women*

The overall experience of sexual arousal is composed of an intricate interaction between cognitive, physiological, and behavioural components, with each component representing a critical, yet separate aspect of the sexual arousal response (Barlow, 1986; Rosen & Beck, 1988). However, a clear understanding of the relationship between psychophysiological and subjective processes in female sexual arousal is lacking. Sexual psychophysiological investigations usually include measures of cognitive or affective (i.e., subjective) sexual arousal, typically in a self-report format. The most important measure of cognition and affect in the assessment of sexual arousal is measurement of the subjective experience of arousal (Heiman, 1998). Subjective sexual arousal reflects an estimate of the extent to which the subject is "mentally aroused" or "mentally aware of genital arousal", depending on how the question is posed. Subjective sexual arousal is most often assessed using a self-report Likert scale, which asks a variation on the question "how sexually aroused were you during the neutral/erotic film?" The question is varied so that it separately assesses the subject's perceptions of her genital sexual arousal, her mental sexual arousal, her perception of non-genital excitement such as heart rate and warmth, her positive and negative affect, and her level of anxiety (Heiman & Rowland, 1983). Others have employed a continuous measure of subjective sexual arousal by using a lever that can swing through a 90° arc (Wincze, Hoon, & Hoon, 1978). This method of continuous assessment of subjective arousal allows a subject to

assess her level of subjective arousal while still focusing on the erotic stimuli, and is useful in evaluating the correlation between genital and subjective sexual arousal using within-subject analyses. Use of this continuous assessment technique, however, does not yield higher correlations with genital vasocongestion (Wincze, Venditti, Barlow, & Mavissakalian, 1980). Moreover, because this method requires that the subject simultaneously attend to a film and to her own experience of arousal while making a lever rating, it is potentially distracting.

*Limitations of laboratory study of sexual arousal*

There exist some limitations in the use of the VPP that warrant careful consideration by the researcher employing this methodology. One issue is that because of the absence of a calibration method, the VPP measures relative rather than absolute levels of arousal, requiring implementation of a within-subjects design, in which genital responses to an erotic stimulus are compared to those of a neutral stimulus (Geer & Janssen, 2000). In other words, the VPP cannot be used to make raw-score comparisons between women. Additionally, there does not exist a sound theoretical basis for making interpretations about the physiology of the surrounding blood vessels based on the VPP signal (Levin, 1992), and it is unknown precisely where vasodilation occurs (Heiman, 1998). Because of its vulnerability to movement artifacts, the VPP is unsuitable for measurement of high levels of arousal and orgasm (Laan & Everaerd, 1998). Despite these limitations, the vaginal photoplethysmograph remains the most widely used instrument for the assessment of female sexual psychophysiology in the laboratory context, and it has the advantage of providing relative ease of use by the subject with minimal instructions from an investigator (Heiman, 1998).

Like most self-report instruments, the subjective assessment of sexual arousal is vulnerable to demand characteristics and reporting bias on the part of the subject. It has been suggested by some that self-report assessment strategies are less reliable than psychophysiological assessment measures because of factors such as subject dishonesty, and reliance on a subject's

memory to recall events clearly and accurately (Rowland, 1999). However, in the assessment of sexual dysfunction, where both the criteria of self-reported distress and impairment are necessary for diagnostic purposes, the assessment of subjective sexual arousal provides important information that is not captured by psychophysiological measurement.

*Desynchrony between genital and subjective sexual arousal in women*

In studies of sexual arousal where measurement of subjective and physiological processes have been combined, there is often no significant correlation between the two (Rosen & Beck, 1988). That is, these processes are desynchronous. The earliest documented description of this desynchrony occurred in 1977 when the presentation of "romantic" visual stimuli, which reliably elicited strong feelings of positive subjective arousal, produced little or no genital arousal in women (Heiman, 1977). It has been repeatedly demonstrated that although VBV and VPA increase with the presentation of "erotic" visual stimuli, they are not consistently correlated with subjective measures of arousal (Geer et al., 1974; Heiman, 1977; Laan et al., 1995, Laan, Everaerd, Van Bellen, & Hanewald, 1994; Meston & Gorzalka, 1995; 1996a; Palace & Gorzalka, 1990; Tuiten, Laan, Panhuysen, Everaerd, Haan, Koppeschaar et al., 1996; Wouda, Hartman, Bakker, Bakker, van de Wiel, & Weijmar Schultz, 1998). It has been suggested that this lack of correlation may be due to the "crudeness" of the subjective measure (Geer et al., 1974) in that it relies on retrospective recall of sexual feelings, permits only a restricted range of responses, and doesn't reflect fluctuations in arousal over the course of the session. However, even with continuous assessment of subjective sexual arousal using a lever, desynchrony between subjective and genital sexual arousal remains (Steinman, Wincze, Sakheim, Barlow, & Mavissakalian, 1981; Laan et al., 1995). Moreover, therapeutic techniques aimed at improving sexual arousal do not necessarily ameliorate both the subjective and the physiological components of the sexual arousal response. For example, women with hypothalamic amenorrhea who were found to display inhibited genital and subjective sexual arousal, responded

with increased VPA after testosterone treatment but failed to improve on subjective measures of arousal (Tuiten et al., 1996).

Several hypotheses have been put forward to explain why genital measures seem to correlate with subjective measures of sexual arousal in men, but not women (Heiman, 1977). It has been suggested that it is "socially acceptable" for males, but not females, to identify and express their sexual arousal (Gagnon & Simon, 1973). Others have suggested that the level of genital arousal produced by erotic visual stimuli is not sufficient to elicit subjective arousal (Heiman, 1976), and that perhaps under conditions of heightened genital arousal, self-reports of subjective arousal would correlate more strongly with genital excitement patterns. In support of this, Schreiner-Engel and colleagues have found that during the luteal phase of the menstrual cycle when genital arousal was highest, there were also the highest levels of subjective sexual arousal compared to the other phases of the menstrual cycle (Schreiner-Engel, Schiavi, Smith, & White, 1981). However, others have shown that even in the presence of relatively strong genital responses, the correlation between genital and subjective measures is quite poor (Laan et al., 1995). Another hypothesis to account for the genital-subjective desynchrony is that perhaps negative affect, induced by the "male-made" erotic films, blunts subjective, but not genital responses (Laan et al., 1994). These researchers speculated that the use of "female-made" erotica would increase positive affect, which in turn would increase ratings of subjective arousal, and subsequently increase correspondence between genital and subjective measures. However, while the female-made erotica did reliably increase ratings of subjective sexual arousal, the genital-subjective arousal correlation remained unchanged (Laan et al., 1994). Based on this literature one might conclude that women are estimating their level of subjective arousal independently of their genital excitement. In support of this, when women were told to focus on their genital blood flow, the correlation between genital and subjective measures increased (Korff & Geer, 1983). However, when "sexual mood" was induced by the use of jazz music and erotic fantasy before the laboratory presentation of an erotic film, neither

subjective sexual arousal nor the genital-subjective arousal correlation was affected (Laan, Everaerd, van Berlo, & Rijs, 1995). It has been speculated that psychophysiological assessment measures may not necessarily represent "true" sexual arousal as experienced by women, and as such should not be assumed to correlate with subjective sexual arousal. Clearly, more detailed studies that investigate the relationship between genital and subjective sexual arousal and subsequently relate these to the actual experience of sexual arousal in women are gravely needed.

*Effects of age and menopause on sexual arousal*

The use of the VPP over the past three decades has allowed for unprecedented advances in the understanding of female sexual arousal. However, our understanding of the psychophysiological sexual response patterns of aging and menopausal women is currently inadequate, despite ample literature demonstrating anatomical changes following menopause (Sherwin, 1991). Physiological changes during the menopause have been suggested to contribute to changes in sexual functioning, including reduced coital activity, reduced vaginal lubrication during arousal, and changes in subjective feelings of desire and sexual well-being (reviewed in Sherwin, 1991). However, to date only three published psychophysiological studies exist which have attempted to investigate the effects of menopause on genital and subjective sexual arousal in the laboratory setting. Unfortunately, these studies are conflicting; one reported significantly impaired genital arousal, as measured with the VPA signal of the vaginal photoplethysmograph, in post- compared to premenopausal women (Morrell, Dixen, Carter, & Davidson, 1984) whereas another found no differences in VPA in postmenopausal women receiving hormone replacement therapy compared to those that were not (Myers & Morokoff, 1986). In a recent, more extensive study, Laan and van Lunsen (1997) measured hormone levels (prolactin, total testosterone, free testosterone, $\alpha$-4-androstenedione, dehydroepiandrosterone, 17$\beta$-estradiol, and estrone) and VPA in postmenopausal women and in a small sample of younger, premenopausal

women. Postmenopausal women had significantly lower VPA responses than premenopausal women at baseline but these differences disappeared after exposure to an erotic stimulus. Though these authors attributed baseline differences in VPA to estrogen (Laan & van Lunsen, 1997), failure to conduct within-subjects analyses leaves these findings equivocal. The issue of genital-subjective desynchrony was addressed in two of these studies and the results were inconclusive in that both synchrony (Myers & Morokoff, 1986) and desynchrony (Morrell et al., 1984) emerged in postmenopausal women. One inconsistent methodological factor was the fact that only the Morrell et al. study included an age-matched sample of premenopausal women. Given the documented effects of aging on sexuality (Laumann, Paik & Rosen, 1999), an age-matched sample of premenopausal women would be necessary in order to attribute any findings to hormonal differences and not to age differences between groups. The results of such a study would shed light on the unresolved issue of age- and menopause-related changes in sexual functioning.

*Role of the sympathetic nervous system in sexual arousal*

It is generally accepted that the sympathetic and parasympathetic branches of the autonomic nervous system work together to mediate sexual arousal. Moreover, a growing body of evidence suggests that the sympathetic nervous system (SNS) may play an important role in facilitating the early stages of genital sexual arousal in women, contrary to expectations based on arousal in men. This conclusion stems from a creative line of studies employing intense physical exercise (Meston & Gorzalka, 1995; 1996a) and pharmacological agents that specifically enhance (Meston & Heiman, 1998) or reduce (Meston, Gorzalka, & Wright, 1997) SNS activity. Exercise, which significantly enhances SNS activity, increases VPA to an erotic stimulus, but has no effect in the absence of an erotic stimulus (Meston & Gorzalka, 1995; 1996a). Similarly, exercise is ineffective at increasing VPA in the presence of clonidine, an α–adrenergic agonist which reduces SNS activity (Meston et al., 1997).

This series of studies provides strong evidence that moderate levels of SNS activity facilitate genital arousal in healthy, young women; however, its effects on sexual arousal in aging or menopausal women have not been investigated. Given age-related differences in basal sympathetic nervous system activity (Matsukawa, Sugiyama, Watanabe, Kobayashi, & Mano, 1998), it is unknown if enhancing SNS arousal would facilitate sexual arousal in aging women. Moreover, the effects of diminished hormonal levels in postmenopausal women on SNS-enhanced sexual arousal are unknown and require further study. Such an investigation would allow researchers to generalize theories on the role of the autonomic nervous system to older and menopausal women.

*Genital and subjective sexual arousal in women with sexual dysfunction*

The literature examining psychophysiological sexual arousal in women with sexual dysfunction is limited, and equivocal in terms of providing any solid conclusions as to the VPP patterns in these women. In men, penile plethysmographyy has been used clinically to classify men with psychogenic erectile disorder (Janssen, Everaerd, van Lunsen, & Oerlemans, 1994). One might assume that given the VPP's ability to measure sexual arousal, it may be especially useful in the assessment of women with female sexual arousal disorder (FSAD). However, relatively few studies have explored genital arousal in women with sexual dysfunction, and only one published study has investigated women with FSAD.

The literature on this topic is mixed, with reports of differences in genital arousal using the VPP between women with and without mixed sexual dysfunction (Wincze, Hoon, & Hoon, 1976; Palace & Gorzalka, 1990) or dyspareunia (Wouda et al., 1998), although there have also been reports of no differences between groups (Meston & Gorzalka, 1996b). The VPP failed to differentiate women with FSAD from healthy controls (Morokoff & Heiman, 1980). Differences in methods used to classify women with sexual dysfunction may account for the disparate findings. Recruitment techniques range from newspaper advertisements to referrals made by physicians, and classification

into dysfunctional versus functional groups has been established either by self-report processes or clinical diagnoses. Moreover, classification systems for categorizing female sexual dysfunction have evolved (Basson et al., 2000; Leiblum, 2000), and it is possible that prior studies did not employ consistent diagnostic criteria when recruiting participants.

The recent reclassification, which separates genital from mental arousal impairment in FSAD (Basson et al., 2000), is based on clinical, but not empirical evidence. The genital arousal disorder subtype of FSAD describes women with a lack of genital vasocongestion and/or lubrication but unproblematic mental sexual excitement. Missed arousal disorder subtype, on the other hand, is expressed as impaired mental (i.e., subjective) sexual arousal despite adequate (i.e., missed) genital sexual arousal upon objective assessment. Nonetheless, women in this group often complain of absent genital arousal. This reclassification does not attempt to attribute mental arousal impairment to psychogenic causes and genital arousal impairment to organic causes. Instead, subtyping based on presumed etiological origin (organic, psychogenic, mixed, or unknown) is required in addition to diagnostic classification decisions. It has recently been speculated that the VPP may be valuable in separating women with FSAD due to organic etiology from those with FSAD due to psychogenic causes (Laan & van Lunsen, 2001), though published data on this topic do not exist. Thus, it is possible that the VPP may be useful in discriminating these recently described subtypes of FSAD. Such an investigation would represent an advance over the earlier report on genital arousal patterns in women with FSAD (Morokoff & Heiman, 1980) in that it does not amalgamate all types of arousal impairment into one heterogeneous group. Clearly the findings from such a study would have implications for the use of the VPP in clinical decision making.

Moreover, the role of the SNS in sexual arousal of women with sexual dysfunction has only been examined in a handful of studies. Following the presentation of anxiety-eliciting films to increase SNS activity, VBV was facilitated in a sample of women with mixed sexual dysfunction compared to responses observed during the baseline SNS phase (Palace & Gorzalka, 1990).

These authors hypothesized that anxiety, by facilitating SNS activity, may play a role in restoring genital arousal in sexually dysfunctional women. However, the large heterogeneity of the sexual dysfunctions included (e.g., primary and secondary arousal disorder, desire disorder, orgasmic disorder, dyspareunia, and sexual abuse) does not allow for the delineation of which sexual dysfunction may be related to aberrations in SNS activity. Using physical exercise as a method of eliciting SNS activity, Meston and Gorzalka (1996b) found that sexually functional and dysfunctional women without orgasmic difficulty responded with increased VPA whereas anorgasmic women responded with inhibited VPA after the presentation of an erotic stimulus. These authors speculated that impairments in autonomic nervous system functioning may play an etiological role in female orgasmic disorders and may have therapeutic implications (Meston & Gorzalka, 1996b). However, Meston and Gorzalka (1996b) did not use clinical instruments to categorize their subgroups of women. Studies that utilize updated diagnostic classification schemes and validated instruments to recruit women with sexual dysfunction are crucial if laboratory research is to be generalizable to sexual dysfunction outside of the laboratory setting. Such an investigation may allow for a more accurate exploration into the effects of heightened SNS activity on sexual arousal.

*The robustness of genital-subjective desynchrony*

It has been well established that genital and subjective sexual arousal rarely correlate in premenopausal, sexually healthy women. With respect to desynchrony in women with sexual dysfunction, only two studies have been performed. In one study, a significant relationship between VPA and subjective arousal was reported (Morokoff & Heiman, 1980), whereas the other failed to detect a correlation between VBV and subjective ratings of arousal (Palace & Gorzalka, 1990). It has been suggested that women in general do not attend to genital vasocongestion during the early stages of sexual arousal (Heiman, 1976; 1978) and that perhaps women with FSAD attend even less (Morokoff & Heiman, 1980), though the latter has not been empirically tested. A systematic

comparison of the degree of synchrony between genital and subjective sexual arousal between women with and without FSAD should help resolve this question of whether or not women with FSAD attend to or perceive genital excitement. It is possible that such findings may provide insight into the etiological factors in FSAD, and may provide an arena for therapeutic intervention.

No published studies exist on the relationship between laboratory genital arousal and mental sexual excitement during arousal outside of the laboratory. Heiman (1980) attempted to correlate laboratory genital arousal, using VPA, with women's self-reported level of sexual satisfaction outside of the laboratory. Contrary to her hypotheses, Heiman found that higher VPA responding in the laboratory was associated with lower enjoyment and frequency of intercourse (Heiman, 1980). Heiman concluded that laboratory arousal and non-laboratory sexual response are different phenomena. However, the Personal History Questionnaire (Harley, 1998) employed in the Heiman (1980) study was not designed for assessment of female sexual arousal, and as such, may not have accurately measured women's experiences of arousal. What is necessary in order to examine the relationship between laboratory genital arousal and real-life experience of arousal is an instrument that better captures women's experiences.

*Objectives of the current studies*

The following series of studies explored both genital and subjective sexual arousal in women in an attempt to address these major objectives: (1) to explore the effects of aging and menopause on genital and subjective sexual arousal; (2) to examine the influence of heightened sympathetic nervous system activity on genital and subjective sexual arousal in pre- and postmenopausal women; (3) to compare patterns of genital and subjective sexual arousal in women with and without female sexual arousal disorder; (4) to explore the discriminative ability of the VPP in differentiating women based on their subtype of arousal disorder, (5) to investigate the effects of heightened sympathetic nervous system activity in facilitating sexual arousal in women with female sexual arousal disorder; (6) to

explore the relationship between genital and subjective sexual arousal in women with different subtypes of FSAD in order to determine if desynchrony is a universal phenomenon, and (7) to explore the clinical utility of the VPP by determining the extent to which genital patterns of arousal correlate with detailed, self-report assessments of real-life sexual arousal. The following series of experiments represent the first in-depth, empirical exploration into the sexual psychophysiology of female sexual arousal disorder and the first detailed investigation into the potential clinical use of the VPP. It is probable that this comparison of genital and subjective sexual arousal in pre- and postmenopausal women, and between women with and without arousal disorder, yields significant novel findings that may lead to a clearer understanding of female sexual arousal in theoretical and methodological domains.

# Experiment 1: Sympathetic Nervous System Activity and Sexual Arousal in Pre- and Post-menopausal Women

*Menopause and sexual arousal*

The menopause is associated with significant physiological changes that may contribute to sexual functioning. For example, the gradual decline in ovarian estrogens has been linked to changes in skin and breast sensitivity, atrophy and loss of elasticity in the vagina, as well as atrophy of the internal reproductive structures (Sherwin, 1991). In addition, the decline in ovarian androgens has been suggested to play a role in changing sexual desire with age (Sarrel, 1999). Research into the effects of menopause on sexual functioning has yielded contradictory findings. For example, it's been reported that menopause is related to decreased sexual desire (Masters & Johnson, 1966) and subjective sexual arousal (Myers & Morokoff, 1986), no change in sexual desire (Olofsson & Collins, 2000), and even increased satisfaction with a sexual relationship (Hawton, Gath, & Day, 1994). Meta-analytic studies of sexual behaviour and menopause remain equivocal as to whether or not enjoyment and participation in sexual activity change with age and menopause (Myers, 1995). Moreover, age-related health problems, psychosocial stressors, and sexual dysfunction are strongly correlated in women (Laumann et al., 1999), and these health-related factors may exert more powerful effects than menopause per se on sexual functioning.

To date, there have been three published investigations examining the effects of menopause on sexual psychophysiological arousal using the vaginal photoplethysmograph (VPP). These have yielded conflicting findings. In the first study, 10 young premenopausal women, 8 older premenopausal women, and 11 older postmenopausal women were compared (Morrell et al., 1984). After exposure to an erotic visual stimulus, postmenopausal women displayed significantly lower vaginal pulse amplitude (VPA) than women in both premenopausal groups, but subjective sexual arousal did not differ between the groups, nor correlate with VPA. Although these authors concluded that ovarian

estrogen is necessary to maintain arousal to erotic stimuli, this conclusion was confounded by the fact that there was a significant age difference between the postmenopausal and older premenopausal women (i.e., 7 years). Another research team compared postmenopausal women receiving Hormone Replacement Therapy (HRT) to an age-matched control group (Myers & Morokoff, 1986). Given the apparent hormonal restoration in the former group, the authors argue that this group is similar to a group of premenopausal women, without the confounding effect of age. Although estrogen was a component of HRT, no group differences were found in either VPA or subjective sexual arousal (Myers & Morokoff, 1986). These researchers concluded that older women, with low estrogen levels, do not experience diminished vaginal vasocongestion. However, the HRT regimen employed does not reverse the non-estrogenic hormonal changes that accompany menopause, and therefore leaves the question of whether or not sexual psychophysiology is affected by menopause unanswered. In an attempt to take a more complete inventory of climacteric symptoms associated with menopause, Laan and van Lunsen (1997) measured hormones and VPA in postmenopausal women and a small sample of younger, premenopausal women. Postmenopausal women had significantly lower VPA scores than premenopausal women at baseline but these differences disappeared after exposure to an erotic stimulus. There was also a consistent positive correlation between VPA and a woman's self-reported estimate of lubrication, between estrone and sexual satisfaction, a negative correlation between estradiol and sexual desire, and no correlation between androgens and sexual functioning. These authors speculated that the baseline differences in VPA may be attributable to differences in estrogens (Laan & van Lunsen, 1997). No assessment was made of a potential correlation between VPA and subjective sexual arousal to the erotic stimulus. Because Laan and van Lunsen found no differences between pre- and postmenopausal VPA in response to an erotic stimulus, whereas Morrell et al. reported a lower VPA in postmenopausal women, it is still unclear whether menopause is associated with impaired genital responding. It would seem important that an age-matched sample of

premenopausal women be included in order to rule out the effects of age on this variable. In addition, the measurement of sexual and relationship satisfaction, age and erectile capacity of the partner, and living conditions – all of which have been suggested to contribute to the sexual changes associated with menopause (McCoy, 1998) – would seem critical to gauge. The findings from such a study would have implications for the potential benefit of HRT on measures of genital and subjective sexual arousal.

As reviewed in the General Introduction (pg. 8-10), genital and subjective sexual arousal are usually desynchronous in various subgroups of premenopausal women (Geer et al., 1974; Heiman, 1977; Laan et al., 1994; Laan et al., 1995, Meston & Gorzalka, 1995; 1996a; 1996b; Palace & Gorzalka, 1990; Tuiten et al., 1996; Wouda et al., 1998). The data on desynchrony in postmenopausal women are equivocal (Myers & Morokoff, 1986; Morrell et al., 1984). Given that individuals tend to develop more negative attitudes towards erotica as they age (Merritt, Gerstel, & LoSciuto, 1975), desynchrony between genital and subjective sexual arousal may be especially pronounced in older women. In light of these equivocal findings, this issue requires further exploration.

*Sympathetic nervous system activity and sexual arousal*

It is generally accepted that the sympathetic and parasympathetic branches of the autonomic nervous system work together to mediate sexual arousal. A growing body of evidence reveals that increased SNS activity in women may facilitate, rather than inhibit sexual arousal, contrary to expectations based on research in men. Hoon, Wincze and Hoon (1977) were the first to demonstrate a facilitatory effect of heightened SNS activity on sexual arousal by observing that women who watched an anxiety-evoking film prior to an erotic film exhibited greater VBV than those previously exposed to a neutral film (Hoon et al., 1977). Preexposure to an anxiety film, however, produced opposite effects on subjective sexual arousal (Palace & Gorzalka, 1990). Anxiety-evoking films, in addition to increasing SNS activity, have a cognitive component that may be

affecting sexual arousal scores. By employing other methods of increasing SNS activity, which have less direct effects on cognition, this component can be minimized. Based on evidence that intense, acute exercise significantly facilitates SNS activity, Meston and Gorzalka (1995) demonstrated that subjects who engaged in 20 minutes of intense, stationary cycling prior to watching an erotic film exhibited a higher VPA than women who did not cycle prior to the erotic film. Comparisons with responses to non-erotic films revealed that these effects were due specifically to the erotic component, and not simply to the passage of time (Meston & Gorzalka, 1995; 1996a). These findings are corroborated in investigations that have employed pharmacological means to enhance (Meston & Heiman, 1998) or inhibit (Meston et al., 1997) SNS activity. None of these effects on VPA occurred with presentation of neutral, non-erotic films. This series of studies provides strong evidence that moderate levels of SNS activity facilitate genital arousal in healthy, young women; however, there is no concurrent increase in subjective sexual arousal nor relationship between genital and subjective responses.

*Effects of menopause and heightened SNS activity*

To date, the effects of heightened SNS activity on sexual arousal have been investigated exclusively in young, healthy, premenopausal women. Prior methodologies (e.g., ephedrine use, intense stationary cycling) have precluded the participation of older women, in part because these procedures have greater risks in older women. It would seem desirable that the effects of heightened SNS activity in older, postmenopausal women be investigated, in order to assess the generalizability of prior studies to different female subgroups.

This study was designed to investigate the effects of menopause and heightened SNS activity on both genital and subjective sexual arousal in three groups of women: a young premenopausal group, an older postmenopausal group, and a premenopausal group age-matched to the postmenopausal group. A new method of enhancing SNS activity, namely laboratory-induced hyperventilation (LIH), was investigated in this regard. LIH involves rapid, deep

breathing, and is commonly used in the context of treatment for anxiety disorders (Barlow & Craske, 1994). LIH produces an imbalance between the partial pressure of carbon dioxide compared to oxygen, resulting in very low levels of carbon dioxide. The physiological events following LIH include hypoventilation to restore carbon dioxide stores, and a temporary state of hypoxemia (reduced oxygen availability to tissues of the body) lasting approximately 10 minutes (Achenbach-Ng, Siao, Mavroudakis, Chiappa, & Kiers, 1994). These changes produce increased cardiac output, pulmonary, muscle, and sympathetic nerve activity (Olsen, Christensen, Klausen, Fogh-Andersen, Plum, Kanstrup et al., 1998; St. Croix, Satoh, Morgan, Skatrud, & Dempsey, 1999), and appear to be mediated by a relative imbalance between sympathetic and parasympathetic nervous system activity. In particular, there appears to be a marked predominance of SNS activity following LIH (George, Nutt, Walker, Porges, Adinoff, & Linnoila, 1989). LIH was chosen for the present study as it avoids the undesirable side effects of other modes of SNS stimulation, may be suitable for older, or non-physically fit women, and is completely safe (Barlow & Craske, 1994). The aims of this experiment were to: (1) explore the effects of age and menopausal status on genital and subjective sexual arousal, (2) determine if LIH, a method of increasing SNS activity, has significant effects on genital and subjective measures of arousal in pre- and postmenopausal women, and (3) examine the correlation between genital and subjective sexual arousal in pre- and postmenopausal women.

## Methods

### *Participants*

A total of 71 women participated in this study. Twenty-five women were premenopausal and between the ages of 20-35, 21 women were premenopausal and between the ages of 44-53, and 25 women were postmenopausal, not receiving hormone replacement therapy, and between the ages of 46-64. Menopause was defined as "12 consecutive months without menses". Because the process of perimenopause involves gradual hormonal changes that may last

from 1 to 10 years, and because hormonal assays were not collected in the current study, it is possible that women in the older premenopausal group were in various stages of perimenopause. However, women who endorsed the presence of climacteric symptoms (e.g., hot flashes, night sweats, increased irritability and mood swings) were excluded from participation. Recruitment was conducted by posting advertisements in local and university newspapers, posting advertisements in hospitals and community centers in the Greater Vancouver area, and by advertising on a list-serve for administrators at Vancouver Hospital. All women were sexually functional, based on screening during a telephone interview, and later confirmed by scores on the Derogatis Sexual Functioning Inventory, a standardized self-report multidimensional test designed to measure the current level of sexual functioning (DSFI; Derogatis, 1978). Exclusion criteria were assessed during the initial telephone screening, and included: non-heterosexuality, current use of medications known to affect vascular or sexual functioning (e.g., antihypertensives, antidepressants), diabetes, hypertension, and lack of sexual experience. Subjects were told during the telephone screen that the purpose of the study was to examine the effects of aging and menopause on sexual arousal. Subjects who agreed to participate and who met inclusion criteria were asked to schedule a date for their first session.

*Procedure*

Each woman participated in two sessions, and a repeated measures design allowed each subject to serve as her own control. During session one, a female researcher oriented the subject to the laboratory equipment, obtained written consent, and provided a battery of questionnaires to be completed in a private room. Questionnaires included: the DSFI (Derogatis, 1978), the Beck Anxiety Inventory (Beck, 1993; to assess general levels of anxiety), the Golombok Rust Inventory of Sexual Satisfaction (GRISS; Rust and Golombok, 1985; to assess relationship and sexual satisfaction), and the Sexual Inventory (unpublished questionnaire; to assess the subject's perception of sexual arousal levels that would be attainable while viewing an erotic visual stimulus). This

questionnaire was included in order to assess the effects of arousal expectation on actual level of genital arousal in response to erotica. Demographic variables assessed included: age, age of menopause onset, ethnicity, education, health status, presence of medical conditions, age and sexual status of partner, and duration of relationship. Following completion of the questionnaires, each woman was seated comfortably in a reclining chair, and asked to insert the vaginal probe, with the aid of diagrammed instructions, after the female researcher had left the room. The vaginal probe has been shown to be safe, comfortable, and easy to put in place by the subject without the experimenter's assistance. A soft, plastic "placement device" ensures that once inserted the vaginal probe does not rotate, thus minimizing movement artifacts (Laan et al., 1995). The instrument was sterilized in a solution of Cydex-activated glutaraldehyde between uses. A TV monitor was placed on a high table so that subjects could comfortably recline on a couch with full view of the screen. They were provided with a light blanket and instructed to lie quietly for a 5-minute adaptation period before the onset of the video. Each film sequence included a 1-minute display of the word "relax", followed by a 3-minute neutral stimulus depicting a documentary of a geographical location (either glaciers or Stonehenge). Immediately following, a 3-minute erotic stimulus was presented, consisting of a nude heterosexual couple engaging in foreplay, mutual manual-genital and oral-genital stimulation, and intercourse. These film segments were chosen based on pilot work in our laboratory, and were shown to elicit positive sexual feelings and affect, and not to offend or induce feelings of disgust or guilt.

Psychophysiological testing was identical in sessions one and two, apart from different neutral and erotic film stimuli, presented in a counterbalanced fashion across sessions and groups. All women were randomized to take part in LIH prior to watching the video segments, in either the first or the second session. The LIH procedure has been described elsewhere (Clark & Hemsley, 1982), and consists of having subjects breathe along with a pre-recorded tape of paced respiration at a rate of 30 breaths/minute for two minutes. Subjects were instructed to breathe in as deeply as possible, through the mouth as well as the

nose, and breathe out, completely exhaling, according to the recorded breathing. Subjects were told to close their eyes during the LIH procedure to minimize feelings of light-headedness and confusion. Given prior reports of increased sensitivity to hyperventilation at the menstrual and premenstrual phases of the cycle (Damas-Mora, Davies, Taylor, & Jenner, 1980), all premenopausal women were assessed during the ovulation phase, which was estimated by asking subjects about the length of their cycle and number of days menstruating.

Immediately prior to and following the film, subjects completed a 34-item self-report questionnaire assessing autonomic arousal, perceptions of genital sexual arousal, mental sexual arousal, anxiety, positive affect, and negative affect (Heiman & Rowland, 1983). Each question was rated on a 7-point Likert scale from (1) not at all, to (7) intensely and a standardized scoring scheme was used to compute the score for each of these subscales. At the completion of session two, all subjects were debriefed and provided $20 for their participation. All procedures were approved by the University of British Columbia Behavioural Research Ethics Board.

*Psychophysiological recording*

VPA was monitored continuously during exposure to each film segment and recorded on a HP Vectra Celeron personal computer using the software program, AcqKnowledge III, Version 3.5 (BIOPAC Systems, Inc., Santa Barbara, CA) and a Model MP100WSW data acquisition unit (BIOPAC Systems, Inc.) for analog/digital conversion. A sampling rate of 200 samples/second was used for VPA throughout the 180 seconds of neutral and 180 seconds of erotic film exposure. The signal was band-pass filtered (0.5 - 30 Hz). Data were analyzed in 30 second segments, then averaged over the neutral and erotic segments separately, resulting in two data points per subject per session. Artifact detection following visual inspection of the data permitted the omission of the 30 second portion containing the artifact, and was replaced by the average of the 30 second intervals immediately preceding and following.

*Data analyses*

Analyses of variance (ANOVA) for repeated measures with group as the between subjects factor and session as the within subjects factor were used to investigate the effects of group (young-premenopausal, older-premenopausal, older-postmenopausal) and film (erotic, neutral) on VPA and subjective ratings of sexual arousal. In order to do so, repeated measures ANOVAs were run separately for the baseline SNS and heightened SNS conditions. A repeated measures ANOVA was subsequently used to investigate the effects of heightened SNS activity on genital and subjective arousal. Given that there is no absolute metric for VPA, change scores were calculated by dividing the average value during the erotic by the average value during the neutral stimulus, then multiplying by 100% (Heiman, 1980). Difference scores for subjective measures were computed by subtracting neutral stimulus values from erotic stimulus values for each subjective measure. Pearson product moment correlations were used to investigate the degree of association between genital and subjective measures of arousal for each of the baseline and heightened SNS conditions. Given that there does not exist a standardized protocol for how to conduct genital-subjective correlations, they were conducted in two ways: (1) difference between average VPA during erotic stimulus and average VPA during neutral stimulus, correlated with difference scores on subjective measures, and (2) difference between maximum 30-second VPA segment during erotic stimulus and average VPA during neutral stimulus, correlated with difference scores on subjective measures. In all conditions a p level of .05 was deemed significant.

## Results

*Demographic information*

Mean ages were 24.5 for the young premenopausal group, 47.8 for the older premenopausal group, and 56.0 for the postmenopausal group. Mean age significantly differed between groups, $F(2,69) = 341.37$, $p < .001$, with follow-up Tukey's multiple comparisons tests demonstrating that each group significantly

differed from each other, $p < .05$. Ethnic breakdown for each group appears in Table 1, with most participants being Caucasian. There was no significant difference in the proportion of Caucasian versus non-Caucasians across groups $\chi^2(8) = 14.12$, $p > .05$. Average highest level of education achieved was 15.5 years, and did not differ between the groups, $p > .05$. Postmenopausal women were an average of 10.26 years postmenopausal, and ranged from 1-27 years. There were no significant group differences in self-reported health status, $p > .05$, though the two groups of older women reported a significantly higher number of medical conditions than younger women, $\chi^2(2) = 8.79$, $p = .012$. About 60% of younger premenopausal (15/25), 71% of older, premenopausal (15/21), and 64% of postmenopausal (16/25) women were currently involved in a heterosexual relationship at the time of testing. Current relationship duration significantly differed between the groups, $F(2,66) = 16.61$, $p < .001$, with younger women having significantly shorter duration compared to the two older groups. Anxiety, as measured by the Beck Anxiety Inventory, and psychopathology, derived from the DSFI Brief Symptom Inventory subscale, were within the normal range, and did not differ between groups, $p > .05$. Although sexual frequency was lower in older compared to younger women, $F(2,68) = 5.36$, $p < .01$, and reports of vaginismus symptoms were higher in postmenopausal compared to premenopausal women, $F(2,65) = 2.49$, $p < .05$, overall relationship and sexual satisfaction did not differ between groups, $p > .05$. The groups did differ on their self-report of the highest level of sexual arousal that subjects believed they could ever experience, given sufficient stimulation, $F(2,69) = 4.24$, $p < .01$, with young, premenopausal women reporting higher levels than older women. However, self-report of actual level of sexual arousal ever achieved, and anticipated sexual arousal in response to an erotic film, did not differ between groups, $p > .05$. All demographic data are presented in Table 1.

Table 1

*Demographic information for participants in the young premenopausal; older premenopausal; and older postmenopausal groups. Data represent means (± standard error of the mean)*

| Measure | Young Premenopausal | Older Premenopausal | Older Postmenopausal |
|---|---|---|---|
| Age*** | 24.50 (0.94) | 47.8 (0.51) | 56.0 (1.09) |
| Ethnicity | | | |
| Caucasian | 76% | 95% | 92% |
| East Asian | 24% | - | 4% |
| First Nations | - | 5% | - |
| African-Canadian | - | - | 4% |
| Education (years) | 15.80 (0.33) | 15.32 (0.56) | 14.92 (0.75) |
| Months menopausal | - | - | 123.17 (17.43) |
| Number of medical conditions** | 0.12 (0.06) | 0.52 (0.11) | 0.40 (0.10) |
| Percentage in a relationship | 60% | 71% | 64% |
| Beck Anxiety Inventory | 6.40 (1.15) | 7.00 (1.48) | 5.59 (1.05) |
| DSFI – Brief Symptom Inventory | 0.49 (0.08) | 0.54 (0.09) | 0.38 (0.07) |
| DSFI – Information | 22.08 (0.40) | 21.52 (0.65) | 21.10 (0.51) |
| DSFI – Experience | 21.76 (0.42) | 20.18 (1.25) | 19.87 (0.78) |
| DSFI – Affect | 1.65 (0.20) | 1.64 (0.21) | 2.64 (0.90) |
| DSFI – Body image | 21.17 (1.44) | 21.90 (1.90) | 21.83 (1.71) |
| DSFI – Satisfaction | 7.76 (0.48) | 6.59 (0.62) | 7.00 (0.53) |
| GRISS – Infrequency** | 3.52 (0.42) | 5.43 (0.50) | 4.91 (0.45) |
| GRISS – Non-communication | 3.92 (0.36) | 4.31 (0.47) | 4.68 (0.47) |

| | | | |
|---|---|---|---|
| GRISS – Dissatisfaction | 2.60 (0.27) | 3.41 (0.42) | 3.62 (0.51) |
| GRISS – Avoidance | 3.28 (0.34) | 4.23 (0.52) | 3.33 (0.51) |
| GRISS – Non-sensuality | 2.84 (0.36) | 3.73 (0.48) | 3.82 (0.44) |
| GRISS – Vaginismus* | 3.12 (0.37) | 2.45 (0.39) | 3.84 (0.59) |
| GRISS – Anorgasmia | 3.40 (0.27) | 3.55 (0.36) | 3.18 (0.31) |
| Highest level of arousal thought possible** | 6.56 (0.12) | 5.86 (0.30) | 5.67 (0.28) |
| Highest level of arousal ever achieved | 6.00 (0.24) | 6.23 (0.22) | 6.42 (0.21) |
| Anticipated sexual arousal to erotica | 4.32 (0.27) | 4.23 (0.29) | 4.42 (0.21) |

*p < .05, **p < .01, ***p < .001 significant difference between groups

*Effects of group and film on genital sexual arousal*

Due to computer difficulties during data collection, psychophysiological data could not be collected for one young, premenopausal woman during the baseline and heightened SNS segments, for two older, premenopausal women during the heightened SNS segment, and for two postmenopausal women during the baseline and heightened SNS conditions. During the baseline SNS condition there was a significant main effect of film on VPA, $F(1,64) = 67.81$, $p < .001$, suggesting that the erotic film significantly facilitated genital arousal in all women, as illustrated in Figure 1. The main effect of group, $F(2,64) = 0.49$, $p > .05$, and the interaction between film and group, $F(2,64) = 0.01$, $p > .05$ were not statistically significant. These findings were paralleled in the heightened SNS condition, with a significant main effect of film, $F(1,63) = 53.42$, $p < .001$, as shown in Figure 2. There was no significant group effect, $F(2,63) = 0.46$, $p > .05$, nor an interaction between film and group for VPA, $F(2,63) = 2.48$, $p > .05$ during the heightened SNS condition. Whether or not subjects were currently involved in a heterosexual relationship did not affect these findings, $p > .05$.

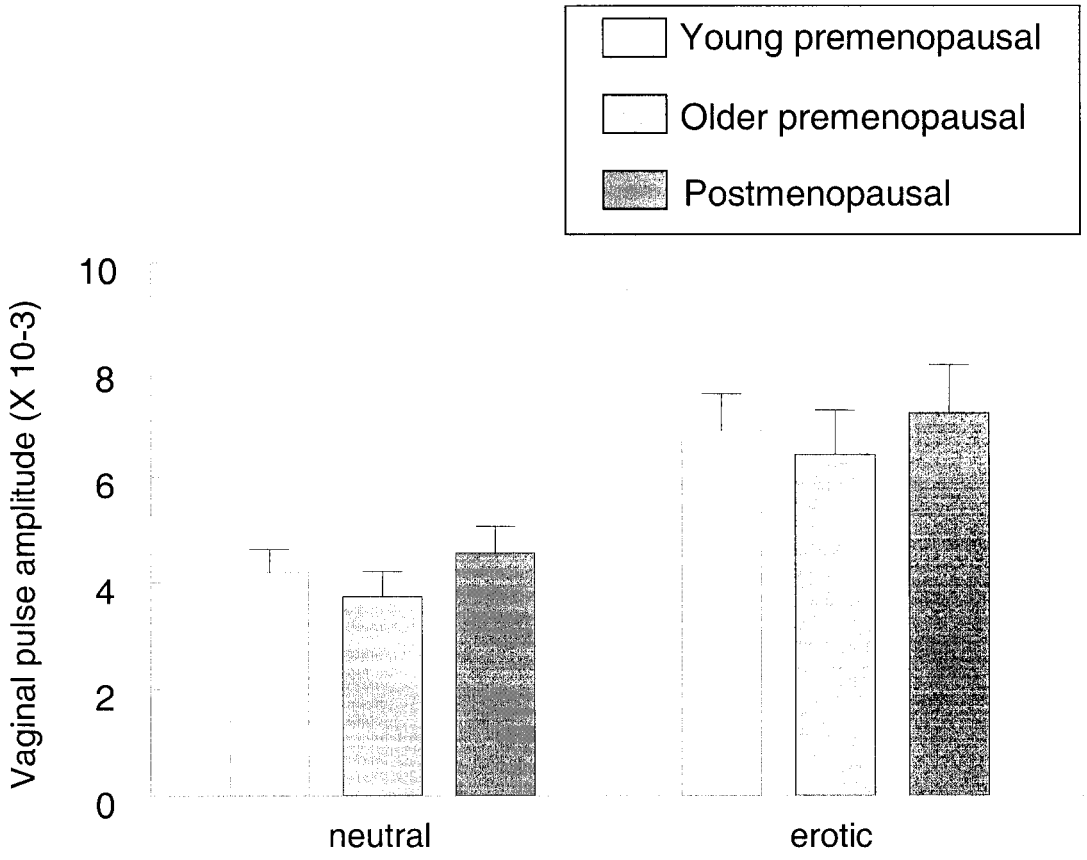


*Figure 1.* Effect of erotic stimulus on vaginal pulse amplitude in young premenopausal, older premenopausal, and postmenopausal women during a baseline sympathetic nervous system condition. Data represent means ± standard error of the mean.

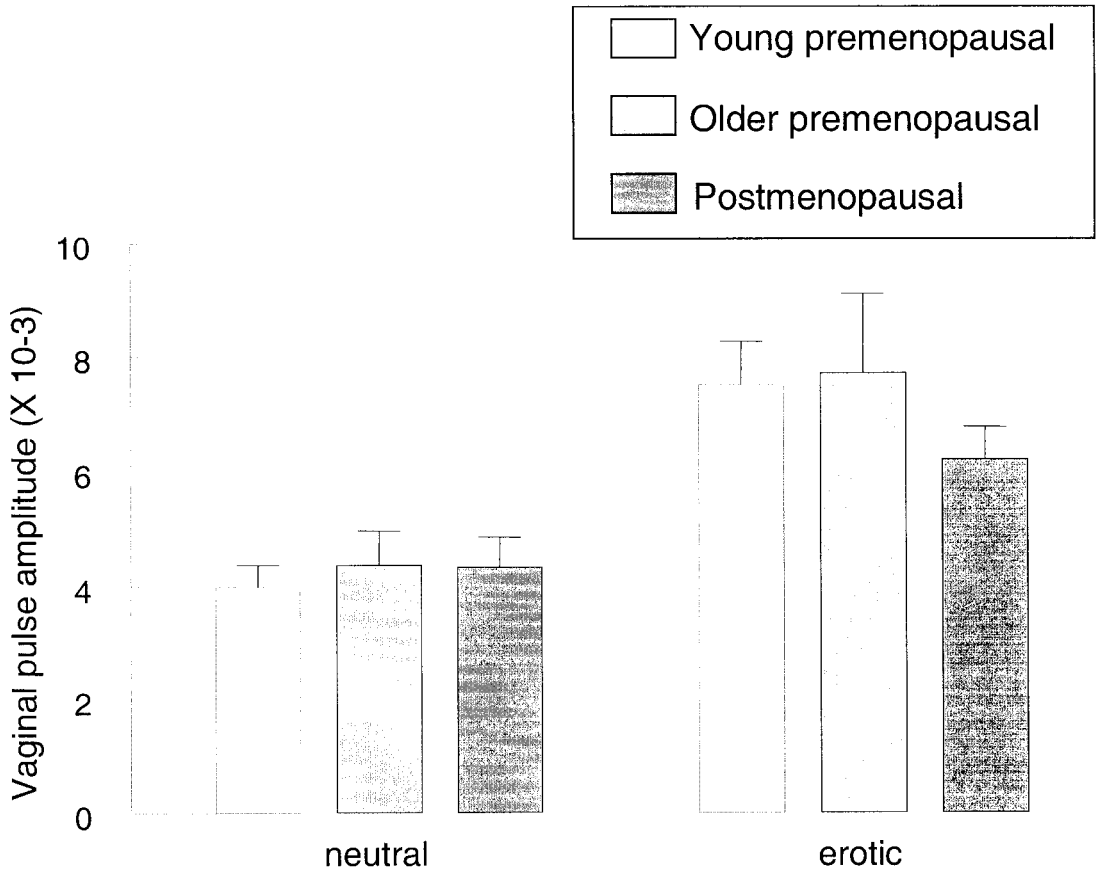


*Figure 2.* Effect of erotic stimulus on vaginal pulse amplitude in young premenopausal, older premenopausal, and postmenopausal women during a heightened sympathetic nervous system condition. Data represent means ± standard error of the mean.

*Effects of group and film on self-report measures*

With the presentation of the erotic stimulus, subjective autonomic arousal, $F(1,63) = 108.29$, $p < .001$, perception of genital arousal, $F(1,67) = 141.29$, $p < .001$, mental sexual arousal, $F(1,67) = 64.96$, $p < .001$, and positive affect, $F(1,66) = 71.51$, $p < .001$ significantly increased in all women, as indicated in Table 2. Negative affect was slightly increased for all women following the erotic stimulus, $F(1, 65) = 2.92$, $p = .092$, however this did not reach statistical significance. There were no significant group differences or interactions between group and film for any of these subjective measures, $p > .05$.

Patterns of subjective arousal during the heightened SNS condition were similar to those obtained during the baseline condition (Table 3) with autonomic arousal, $F(1,64) = 71.40$, $p < .001$, perception of genital arousal, $F(1,64) = 68.81$, $p < .001$, mental sexual arousal, $F(1,64) = 79.80$, $p < .001$, and positive affect, $F(1,64) = 76.61$, $p < .001$ significantly increasing in all women after the erotic stimulus. Negative affect significantly increased in all women following the erotic film, $F(1,62) = 4.63$, $p = .035$, and there was no effect of film on anxiety scores, $p > .05$. There were no significant group by film interactions, nor a main effect of group for any subjective measure during the heightened SNS condition, $p > .05$.

Table 2

*Effects of erotic stimulus on self-report measures of arousal during a baseline sympathetic nervous system condition for young premenopausal, older premenopausal, and older postmenopausal women. Data represent mean increases from a neutral film (± standard error of the mean).*

| | Young premenopausal | Older premenopausal | Older postmenopausal |
|---|---|---|---|
| Mental sexual arousal**** | 2.7 (0.5) | 2.4 (0.5) | 2.1 (0.5) |
| Perception of genital arousal**** | 10.0 (1.2) | 8.9 (1.2) | 8.8 (1.5) |
| Autonomic arousal**** | 6.2 (0.9) | 8.9 (1.4) | 6.9 (1.4) |
| Positive affect**** | 6.4 (1.2) | 5.8 (1.3) | 6.3 (1.3) |
| Negative affect | 0.9 (0.9) | 1.0 (1.2) | 1.2 (1.1) |
| Anxiety | -0.2 (0.2) | -0.5 (0.2) | 0.2 (0.2) |

*Note:* Data represent the difference between scores obtained in the neutral and erotic conditions, with positive values indicating an increase in that measure.

****$p < .0001$, main effect of erotic film

Table 3

*Effects of erotic stimulus on self-report measures of arousal during a heightened sympathetic nervous system condition for young premenopausal, older premenopausal, and older postmenopausal women. Data represent mean increases from a neutral film (± standard error of the mean).*

| | Young premenopausal | Older premenopausal | Older postmenopausal |
|---|---|---|---|
| Mental sexual arousal**** | 2.9 (0.5) | 2.2 (0.5) | 2.0 (0.4) |
| Perception of genital arousal**** | 9.4 (2.1) | 8.7 (2.0) | 10.0 (1.5) |
| Autonomic arousal**** | 7.7 (1.0) | 7.6 (1.7) | 6.0 (1.5) |
| Positive affect**** | 8.3 (1.2) | 8.0 (1.8) | 6.3 (1.4) |
| Negative affect* | -0.2 (0.6) | 1.1 (0.7) | 1.3 (0.6) |
| Anxiety | -0.2 (0.3) | -0.2 (0.2) | 0.1 (0.2) |

*Note:* Data represent the difference between scores obtained in the neutral and erotic conditions, with positive values indicating an increase in that measure.

*p < .05. ****p < .0001, main effect of erotic film

*Effects of heightened sympathetic nervous system activity on genital sexual arousal*

Examination of Figure 3 suggested that hyperventilation may have had specific effects only on the group of younger, premenopausal women. However, a repeated measures ANOVA, including all groups, did not reveal an overall group difference in VPA, $F(2,59) = 0.26$, $p > .05$, a main effect of heightened SNS activity, $F(1,59) = 0.83$, $p > .05$, nor an interaction between group and SNS condition, $F(2,59) = 1.32$, $p > .05$. Therefore, planned dependent t-tests were conducted on each group, and they demonstrated that indeed heightened SNS activity significantly facilitated VPA in younger, premenopausal women, $t(22) = -2.98$, $p = .007$, but had no effect in older premenopausal, $t(18) = 0.01$, $p > .05$, or in older postmenopausal women, $t(20) = -0.17$, $p > .05$.

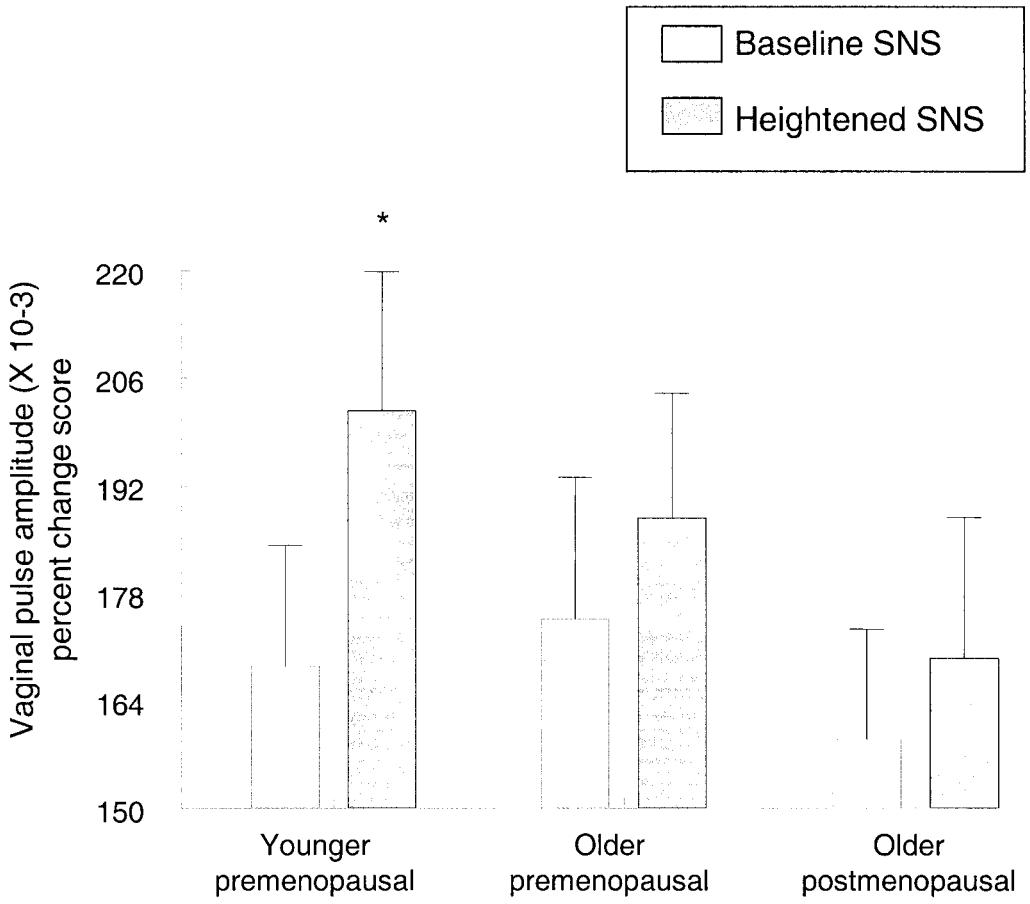


*Figure 3.* Effect of heightened sympathetic nervous system (SNS) activity on vaginal pulse amplitude in younger premenopausal, older premenopausal, and postmenopausal women. Data represent means ± standard error of the mean

*$p < .01$ significant difference in VPA increase following the erotic stimulus between baseline and heightened SNS

*Effects of heightened sympathetic nervous system activity on self-report measures*

There were no significant effects of heightened SNS activity on any difference score measure (from neutral to erotic conditions) of subjective arousal including: autonomic arousal, $F(1,59) = 0.27$; perception of genital arousal, $F(1,64) = 0.01$; anxiety, $F(1,66) = 0.24$; negative affect, $F(1,61) = 0.50$; positive affect, $F(1,63) = 1.90$; nor mental sexual arousal, $F(1,64) = 0.01$, $p > .05$ throughout, as shown in Table 4. The main effect of group was also not significant for any of these measures [autonomic arousal, $F(2,59) = 0.47$; perception of genital arousal, $F(2,64) = 0.05$; anxiety, $F(2,66) = 2.28$; negative affect, $F(2,61) = 0.80$; positive affect, $F(2,63) = 0.14$; nor mental sexual arousal, $F(2,64) = 0.59$, $p > .05$ throughout]. Moreover, no significant group by SNS interactions emerged for any of these subjective measures [autonomic arousal, $F(2,59) = 1.19$; perception of genital arousal, $F(2,64) = 0.23$; anxiety, $F(2,66) = 0.78$; negative affect, $F(2,61) = 0.40$; positive affect, $F(2,63) = 1.20$; nor mental sexual arousal, $F(2,64) = 0.34$, $p > .05$ throughout].

Table 4

*Effect of heightened sympathetic nervous system activity on self-report measures of mental sexual arousal, perception of genital arousal, autonomic arousal, positive affect, negative affect, and anxiety in young premenopausal, older premenopausal, and postmenopausal women. Data represent means (± standard error).*

| | Young premenopausal | Older premenopausal | Older postmenopausal |
|---|---|---|---|
| Mental sexual arousal | | | |
| Baseline SNS | 2.71 (0.48) | 2.38 (0.50) | 2.08 (0.54) |
| Heightened SNS | 2.91 (0.45) | 2.20 (0.54) | 2.00 (0.39) |
| Perception of genital arousal | | | |
| Baseline SNS | 10.04 (1.22) | 8.86 (1.25) | 8.80 (1.53) |
| Heightened SNS | 9.38 (2.14) | 8.68 (2.02) | 9.98 (1.52) |
| Autonomic arousal | | | |
| Baseline SNS | 6.20 (0.88) | 8.89 (1.43) | 6.91 (1.36) |
| Heightened SNS | 7.70 (1.04) | 7.55 (1.75) | 5.98 (1.46) |
| Positive affect | | | |
| Baseline SNS | 6.44 (1.17) | 5.76 (1.31) | 6.25 (1.34) |
| Heightened SNS | 8.29 (1.24) | 8.00 (1.77) | 6.33 (1.43) |
| Negative affect | | | |
| Baseline SNS | 0.92 (0.86) | 0.95 (1.17) | 1.17 (1.06) |
| Heightened SNS | -0.17 (0.59) | 1.10 (0.68) | 1.32 (0.66) |
| Anxiety | | | |
| Baseline SNS | -0.20 (0.17) | -0.48 (0.20) | 0.19 (0.18) |
| Heightened SNS | -0.21 (0.28) | -0.15 (0.20) | 0.08 (.17) |

*Note:* Data represent the difference between scores obtained in the neutral and erotic conditions, with positive values indicating an increase in that measure. This information also appears in Tables 2 and 3 for baseline and heightened SNS conditions, respectively.

The effects of heightened SNS activity on subjective arousal scores before presentation of the erotic stimuli were also compared across groups. There were no significant main effects of hyperventilation on pre-stimulus measures of autonomic arousal, $F(1,62) = 0.03$; perception of genital arousal, $F(1,65) = 1.55$; anxiety, $F(1,66) = 0.50$; negative affect, $(F1,63) = 1.43$, or mental sexual arousal, $F(1,66) = 0.09$, $p > .05$ throughout. Heightened SNS activity did significantly interact with group for positive affect, $F(2,66) = 3.21$, $p < .05$, such that positive affect decreased in premenopausal women (mean decrease: 2.41) but remained unchanged in postmenopausal women (mean increase: 0.16).

*Genital-subjective sexual arousal synchrony during baseline sympathetic nervous system activity*

Pearson product moment correlation analyses between VPA and (1) perception of genital arousal, and (2) mental sexual arousal, were initially conducted on all women as a group (Table 5). Average VPA neither correlated with perception of genital arousal ($r = .180$, $p > .05$) nor with mental sexual arousal ($r = .180$, $p > .05$). Maximum VPA response showed a similar pattern of results in that it, too, neither correlated with perception of genital arousal ($r = .001$, $p > .05$), nor with mental sexual arousal ($r = .052$, $p > .05$).

Genital-subjective correlations in young, premenopausal women failed to reveal any significant correlations between average VPA and perception of genital arousal ($r = -.199$, $p > .05$), between average VPA and mental sexual arousal ($r = -.114$, $p > .05$), between maximum VPA and perception of genital arousal ($r = -.235$, $p > .05$), nor between maximum VPA and mental sexual arousal ($r = -.158$, $p > .05$).

Older, premenopausal women showed a similar pattern of correlations to the younger women. Average VPA did not correlate with perception of genital arousal ($r = .226$, $p > .05$) nor with mental sexual arousal ($r = .060$, $p > .05$). The use of maximum instead of average VPA did not alter these findings. There were no significant correlations between maximum VPA and perception of genital

arousal ($r = .344$, $p > .05$) nor between maximum VPA and mental sexual arousal ($r = .143$, $p > .05$).

However, for postmenopausal women the correlation between average VPA and mental sexual arousal was statistically significant ($r = .552$, $p = .006$) as it also was with perception of genital arousal ($r = .507$, $p = .016$). Using maximum instead of average VPA, there was no longer a significant correlation with mental sexual arousal ($r = .114$, $p > .05$) nor with perception of genital arousal ($r = .001$, $p > .05$).

Table 5

*Correlations between (1) perception of genital arousal and average vaginal pulse amplitude (VPA), (2) perception of genital arousal and maximum VPA, (3) mental sexual arousal and average VPA, and (4) mental sexual arousal and maximum VPA, during baseline sympathetic nervous system activity.*

| | All women (N = 69) | Young pre-menopausal (N = 24) | Older pre-menopausal (N = 21) | Older post-menopausal (N = 24) |
|---|---|---|---|---|
| Perception of genital arousal with: | | | | |
| Average VPA | r = .180 | r = -.199 | r = .226 | r = .507* |
| Maximum VPA | r = .001 | r = -.235 | r = .344 | r = .001 |
| Mental sexual arousal with: | | | | |
| Average VPA | r = .180 | r = -.114 | r = .060 | r = .552** |
| Maximum VPA | r = .052 | r = -.158 | r = .143 | r = .114 |

*Note:* Values represent Pearson Product Moment Correlation Coefficients

*p < .05. **p < .01

*Genital-subjective sexual arousal synchrony during heightened sympathetic nervous system activity*

There was no significant correlation between average VPA responses and perception of genital arousal ($r = .116$, $p > .05$), though the correlation approached statistical significance with mental sexual arousal ($r = .219$, $p = .08$) when all women were examined as a group, as shown in Table 6. Using maximum VPA response instead of average VPA response did not significantly alter these findings: perception of genital arousal ($r = .144$, $p > .05$); mental sexual arousal ($r = .201$, $p > .05$).

When correlations were performed by group, there were no significant correlations for young premenopausal women: average VPA and perception of genital arousal ($r = -.164$, $p > .05$), average VPA and mental sexual arousal ($r = -.235$, $p > .05$), maximum VPA response and perception of genital arousal ($r = -.258$, $p > .05$), and maximum VPA and mental sexual arousal ($r = -.283$, $p > .05$).

Genital-subjective correlations for the group of older, premenopausal women were slightly different, as shown in Table 6. Average VPA response significantly correlated with mental sexual arousal ($r = .509$, $p = .026$) and the correlation approached significance with perception of genital arousal ($r = .431$, $p = .07$). The data were not markedly altered with the use of maximum VPA instead of average VPA: correlation with mental sexual arousal ($r = .509$, $p = .026$) and correlation with perception of genital arousal ($r = .438$, $p = .069$).

Genital-subjective correlations for postmenopausal women are also presented in Table 6. Average VPA did not correlate with perception of genital arousal ($r = .024$, $p > .05$) nor with mental sexual arousal ($r = .296$, $p > .05$). When maximal VPA was employed, the correlation with perception of genital arousal remained non-significant ($r = .239$, $p > .05$); however, the correlation with mental sexual arousal approached significance ($r = .375$, $p = .07$).

Table 6

*Correlations between (1) perception of genital arousal and average vaginal pulse amplitude (VPA), (2) perception of genital arousal and maximum VPA, (3) mental sexual arousal and average VPA, and (4) mental sexual arousal and maximum VPA, during heightened sympathetic nervous system activity.*

| | All women (N = 65) | Young pre-menopausal (N = 24) | Older pre-menopausal (N = 18) | Older post-menopausal (N = 23) |
|---|---|---|---|---|
| Perception of genital arousal with: | | | | |
| Average VPA | r = .116 | r = -.164 | r = .431 $^{t}$ | r = -.024 |
| Maximum VPA | r = .144 | r = -.258 | r = .438 $^{t}$ | r = .239 |
| Mental sexual arousal with: | | | | |
| Average VPA | r = .219 $^{t}$ | r = -.235 | r = .509* | r = .296 |
| Maximum VPA | r = .201 | r = -.283 | r = .509* | r = .375 $^{t}$ |

*Note:* Values represent Pearson Product Moment Correlation Coefficients

$^{t}$ $p \leq .08$. *$p < .05$

# Discussion

Results from this study indicate that the erotic film significantly facilitated genital responding in all women, regardless of age or menopausal status. These data corroborate the findings of Laan and van Lunsen (1997) and Myers and Morokoff (1986). However, they are inconsistent with the findings of Morrell and colleagues (1984) who found significantly lower VPA in postmenopausal compared to premenopausal women. It is possible that the differences in VPA in the study by Morrell (Morrell et al., 1984) were due to the type of erotic stimulus used. It has been demonstrated that the type of erotica employed, and in particular whether or not films are obtained from a commercially available or an educational source, can significantly influence the pattern of genital responding (Palace & Gorzalka, 1992). The current study employed commercially available contemporary erotica containing explicit sexual material, and may produce higher levels of genital arousal in all women compared to other forms of less intense erotic material.

Mental sexual arousal and perception of genital arousal increased in response to the erotic film, and did not differ between groups. Although findings from the current study are consistent with those of Morrell and colleagues (1984) who found no differences in subjective sexual arousal to the erotic stimulus between pre- and postmenopausal women, the overall magnitude of mental sexual arousal was higher in the current study (a 54% increase vs a 79% increase in the present study). Laan and van Lunsen (1997) also found that mental sexual arousal did not differ between pre- and postmenopausal women. However, Myers and Morokoff (1986) reported lower levels of erotica-induced mental sexual arousal in postmenopausal women. Given the current findings that positive affect increased in all women, this lends support to the notion that sexually explicit female-oriented material evokes high levels of genital and mental sexual arousal in all women, regardless of age or menopausal status. This is also supported by the current findings that negative affect was not induced by the erotic film in any groups. The current changes in affect to the

erotic film are inconsistent with the observation of Merritt and colleagues that womens' attitudes toward erotica become increasingly intolerant with age (Merritt et al., 1975). Based on the current data, it appears that the use of explicit female-oriented material is as effective at inducing arousal in younger as older women. The use of female-oriented erotic material in research has been common-practice for only the past decade, and may explain why studies published in the 1970s and 1980s, which employed male-oriented erotica, reported negative affective responses in older women (Merritt et al., 1975).

The laboratory-induced hyperventilation (LIH) technique employed in the current study has been shown to reliably lead to a state of SNS predominance (Olsen et al., 1998; St. Croix et al., 1999; George et al., 1989) for at least 7 minutes (Achebach-Ng et al., 1994). Given that onset of the erotic stimulus in the current study occurred 4 minutes following the cessation of hyperventilation (1 minute "relax" and 3 minute neutral film), it is reasonable to assume that physiological recording during the erotic film segment took place during a period of heightened SNS activity. This assumes that methodological precautions taken (i.e., paced audio recording, researcher remained with each subject during LIH) served to minimize individual differences in reactions to the LIH procedure. This is the first study to demonstrate an effect of LIH on sexual arousal as this technique is primarily used in the treatment of individuals with panic disorder (Barlow & Craske, 1994). The current findings suggest differential genital arousal in younger and older women to LIH-induced SNS activation. Specifically, it appears that younger women benefited from the LIH technique, whereas older women, regardless of menopausal status, did not.

The current findings suggest that SNS activation prior to an erotic visual stimulus may be a useful technique for discriminating subgroups of women. This is reminiscent of the findings of Meston and Gorzalka (1996b) who found that only in cases of heightened SNS activity could orgasmic and anorgasmic women be discriminated on genital sexual arousal. That older women, regardless of menopausal status, did not respond to heightened SNS activity with augmented VPA responding, whereas younger women did, is a novel finding. It is possible

that the LIH procedure did not produce an equivalent increase in SNS activity in older women. Because sympathetic nervous system activity increases with age (Dinenno, Jones, Seals, & Tanaka, 2000), it is possible that LIH effectively enhanced genital arousal in younger women with lower basal SNS activity, but that further increases in SNS activity in older women do not produce any additional effects. It would seem worthwhile to repeat the present study using other methods of increasing SNS activity to confirm the present finding of a general lack of effect of heightened SNS activity on genital arousal in older women. SNS activity was not directly measured in this study, and future studies should aim to directly measure SNS activity during erotic film exposure in order to reconcile the current finding. Alternatively, heightened SNS activity may have been more effective in younger, premenopausal women because of an interaction between normal levels of ovarian hormones and heightened SNS activity. It is likely that women in the older premenopausal group were in various stages of perimenopause, despite reporting normal frequency of menstruation. Therefore, it is possible that this group experienced declining hormone levels, but, given that hormonal assays were not taken, the extent to which the present findings are hormone-dependent is unclear and future studies should seek to explore this.

Synchrony between genital and subjective measures was examined during both control and hyperventilation conditions. Across all women, VPA was found not to correlate significantly with either perception of genital arousal or with mental sexual arousal during the baseline SNS condition, suggesting that although genital and subjective sexual arousal to the erotic stimulus increased in women, their patterns of increase were not similar. Of the three psychophysiological studies conducted on postmenopausal women, one did not attempt to correlate genital and subjective measures of arousal (Myers & Morokoff, 1986), one found no relationship (Morrell et al., 1984), and one found a significant negative correlation between VPA and self-reported arousal problems (Laan & van Lunsen, 1997). In both studies that compared genital to subjective arousal, pre- and postmenopausal women were examined as a group, thus

precluding an examination of desynchrony that might be age and/or menopause dependent. The current study aimed to address this issue by conducting correlations on each subgroup separately. Analyses revealed that during the baseline SNS condition, the correlation between VPA and perception of genital arousal and the correlation between VPA and mental sexual arousal were not statistically significant in younger and older premenopausal women. Interestingly, in postmenopausal women, both correlations were statistically significant, and this represents a novel finding. Given Cohen's moderate effect size of 0.30 based on a sample size of 85 (Cohen, 1992), this effect is likely to be particularly robust. Based on these findings, desynchrony between genital and subjective arousal appears to be characteristic only of premenopausal women. Although purely speculation, it is possible that older and postmenopausal women are more sensitive to the genital changes that accompany erotic stimuli exposure, and are perhaps more likely to perceive this genital arousal as a subjective sexual experience. The use of female-oriented erotica facilitated this synchrony and allowed positive sexual feelings to follow from increased physiological arousal. The finding that mental sexual arousal and positive affect increased in older women supports this idea.

It is possible that the observed desynchrony between genital and subjective sexual arousal found in the present study may reflect a lack of statistical significance due to insufficient power. Employing a conservative medium effect size of 0.30 (Cohen, 1992) and an alpha of .05, this would require an N of 85 in order to detect a significant correlation coefficient. The finding that significance was obtained for postmenopausal women during the baseline SNS condition and for older perimenopausal women during the heightened SNS condition suggests that these effects were robust. The lack of statistical significance for the other groups may be attributed to lack of power due to insufficient sample sizes. It is notable that the percentage of variance accounted for in the younger premenopausal women (i.e., $-0.199^2 = 0.04$) is 4%, and the percent of variance accounted for in the older group of women (i.e., $0.226^2 = 0.05$) is 5% indicating that there is a high degree of unexplained variance in these correlations between

genital and subjective sexual arousal. Future studies might benefit from examining the genital-subjective sexual arousal relationships in much larger groups of women in order to determine if the observed correlation coefficients represent true "desynchrony" or simply a lack of statistical significance.

The slightly different pattern of findings during the hyperventilation condition may help to explain these effects. SNS-induction caused the VPA-mental sexual arousal correlation in all women to approach statistical significance. Moreover, genital-subjective correlations in the older, premenopausal women achieved statistical significance. This suggests that the enhanced genital sensations due to LIH were also subjectively interpreted as being sexually arousing. Given that sexual and relationship satisfaction, and current involvement in a sexual relationship did not differ between the groups, it is unlikely that differences in current sexual activity account for the findings.

Another methodological issue concerns the slight differences in outcome depending on whether maximum or average VPA are used in correlations. In some cases the magnitude and the significance level of a correlation was drastically altered when maximum VPA was used. This reflects one problematic aspect in the use of vaginal photoplethysmography in that the absence of an absolute metric makes analyses between-subjects tenuous. It has been reported that analyses within subjects may more accurately capture genital-subjective correlations, if they exist (Merritt, Graham, & Janssen, 2001). However, this would necessitate the use of a continuous measure of subjective sexual arousal, which requires that women attend to their sexual arousal while simultaneously moving the lever and viewing the film (Laan & Everaerd, 1998). This is the first documented psychophysiological study to use both average and maximum VPA with genital-subjective correlations. Our findings encourage the standardization of study protocols involving female sexual psychophysiology if cross-study comparisons are to be made.

Overall, the data demonstrate no differences in genital or subjective sexual arousal in response to an erotic visual stimulus between pre- and postmenopausal women, or between younger and older women.

Hyperventilation differentiates genital arousal between younger and older women even though subjective arousal does not. These data provide support for the use of the LIH procedure as a feasible alternative to prior modes of eliciting SNS activity for the examination of genital arousal in women, and remain to be tested in women with female sexual arousal disorder who display impaired genital arousal. It is reasonable to assume that in this subgroup of women with sexual dysfunction, genital arousal may be enhanced with the use of LIH prior to an erotic stimulus. The current data also suggest that prior reports of desynchrony between genital and subjective measures may be true only for premenopausal women. In postmenopausal women, and under conditions of heightened SNS activity for older, premenopausal women, genital and subjective measures were synchronous.

## Experiment 2: Female Sexual Arousal Disorder and Psychophysiological Assessment: Implications for Diagnostic Subtypes

Sexual arousal in women is a poorly understood construct that has been conceptualized as a complex interaction between genital and subjective components (Everaerd, Laan, Both, & van der Velde, 2000; Rosen & Beck, 1988). Epidemiological data for the prevalence of Female Sexual Arousal Disorder (FSAD), defined by the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) as "an inability to attain or to maintain until completion of sexual activity, an adequate lubrication and/or swelling response" that causes distress (American Psychiatric Association, 1994) do not exist. However, population estimates suggest that the symptom of lubrication difficulty affects from 19% of women younger than 30, up to 27% of women aged 50-59 (Laumann et al., 1999), and may be as high as 75% for those women seeking routine gynecological care (Nusbaum, Gamble, Skinner, & Heiman, 2000). Lack of subjective sexual arousal during the sexual experience, especially when intercourse frequency is more tuned to the higher needs of the partner, is a more common complaint among women presenting clinically. Given the highly individual nature of subjective sexual arousal and the broad variability across women, determining when an ongoing lack of subjective sexual arousal constitutes a disorder is difficult. That both the World Health Organization International Classification of Diseases-10 (ICD-10; World Health Organization, 1992), and the DSM-IV (American Psychiatric Association, 1994), focus only on genital responding in their definitions of FSAD raises concern about effective management of such women.

Recently an international consensus conference consisting of multidisciplinary experts in the field of female sexual dysfunction convened to refine the current diagnostic criteria of the female sexual disorders. The results of this conference were published by the American Foundation of Urologic Disease (Basson et al., 2000). One feature of FSAD that was clarified was the recognition that it could be expressed as either a lack of subjective mental

excitement, or as a lack of genital lubrication/vasocongestion (Basson et al., 2000). This diagnostic modification encouraged more careful distinction between subjective arousal versus genital arousal impairment in empirical studies (Caruso, Intelisano, Lupo, & Agnello, 2001; Sipski, Alexander, & Rosen, 2001), with several further subtypes of FSAD described based on clinical experience (Basson 2000a, 2001a, 2001b; 2002a; 2002b), as shown in Table 7. One such subtype of FSAD is that which is described in the current DSM-IV for women who, despite retaining mental arousal in response to non-genital and non-physical sexual stimuli, mourn the loss of genital responsivity. This group has been described as experiencing "genital arousal disorder" (Basson, 2001b; 2002a; 2002b), and has been minimally represented in the psychophysiological literature. Another subtype of FSAD, not included in the current nosology, is described as "generalized sexual arousal disorder", and is characterized by absence of genital congestion in addition to a lack of mental sexual arousal in the presence of erotic stimuli. This subgroup has not been represented in the psychophysiological literature to date, and constitutes only a theoretical subtype in need of further investigation. The majority of women with self-reported lack of arousal studied in sexual psychophysiology laboratories show patterns of increased genital arousal in response to erotic stimuli comparable to those of sexually healthy women (Morokoff & Heiman, 1980). This is despite their reported lack of subjective arousal during the experience and occasional experience of negative emotions (Morokoff & Heiman, 1980). This subtype has been classified as "missed arousal disorder" since the women may miss or do not experience the subjective arousal that in sexually healthy women accompanies genital responding. Two other clinical forms of FSAD (dysphoric sexual arousal and anhedonic sexual arousal) are seen in women who report either a dysphoric reaction or no pleasurable subjective feelings to erotic stimuli, respectively, despite a normal vasocongestive response (Basson, 2001b; 2002a; 2002b). To date, epidemiological estimates for the prevalence of each of the subtypes of FSAD are unknown, and empirical research supporting these clinical subtypes does not yet exist.

Table 7

*Recently proposed clinical subtypes of female sexual arousal disorder (FSAD) according to Basson (2001b; 2002a; 2002b)*

| | genital arousal disorder | generalized arousal disorder | missed arousal disorder | dysphoric arousal disorder | anhedonic arousal disorder |
|---|---|---|---|---|---|
| Subjective Mental Excitement | Present | Absent | Absent | Absent | Absent |
| Genital vasocongestion/ Lubrication | Absent | Absent | Present | Present | Present |

The most widely used instrument to index sexual psychophysiological arousal in women is the vaginal photoplethysmograph. Vaginal photoplethysmography is not currently a component of routine assessment in the clinical setting, and this may be related to the lack of available data on its diagnostic utility. The literature on psychophysiological sexual arousal in women with sexual dysfunction is limited, and equivocal in terms of providing any solid conclusions as to their photoplethysmographic patterns. For example, genital vasocongestion to visual sexual stimuli was shown to be significantly lower in women seeking treatment for heterogeneous sexual complaints compared to sexually healthy women (Palace & Gorzalka, 1990; Wincze, Hoon, & Hoon, 1976) and in women with dyspareunia (Wouda et al., 1998), but was also found not to distinguish sexually healthy women from women with low sexual arousal (Morokoff & Heiman, 1980), or women with mixed sexual dysfunction that included impaired arousal (Meston & Gorzalka, 1996b). Several hypotheses emerge to account for these equivocal findings. It is possible that the use of film stimuli that are less explicit, the use of VBV versus VPA signals, and

experimental conditions that elicit variable demand characteristics (Palace & Gorzalka, 1992) account for some of the inconsistencies. Additionally, it is likely that there is variability in the methods used to classify or diagnose women with sexual dysfunction for inclusion. Recruitment techniques, which range from newspaper advertisements to referrals made by physicians, and varying methods of diagnostic classification, may have led to heterogeneous groups of women being investigated.

Because the aforementioned subtypes of FSAD have not been established by empirical means, but rather clinical observation, further clarification of these subtypes with an objective measure is especially warranted. This experiment sought to characterize, using psychophysiological and subjective measures of sexual arousal, the following groups of women: Group 1 - Healthy control women; Group 2 – Women reporting mental arousal from non-genital stimuli but acquired loss of awareness of genital responding, either directly (via genital throbbing, pulsing, or wetness) or indirectly (in terms of arousing sexual sensations from genital massage); Group 3 – Women reporting chronic lack of mental sexual arousal, but awareness of genital physiological responding; Group 4 – Women reporting neither genital responding nor mental arousal from any type of sexual stimulus during their sexual experience. An in-depth clinical interview will be used to classify women into the above groups.

Another aim of this study was to explore the degree of synchrony between genital vasocongestion and subjective sexual arousal in these subgroups of women. In general, psychophysiological studies show variable degrees of synchrony between genital and subjective sexual arousal in sexually healthy women (Everaerd et al., 2000; Rosen & Beck, 1988). Among those studies in which psychophysiological and subjective sexual arousal have been assessed in women with sexual dysfunction, one reported a statistically significant relationship between VPA and subjective arousal (Morokoff & Heiman, 1980), one found no correlation between VBV and subjective ratings (Palace & Gorzalka, 1990), and two did not examine synchrony in women with sexual dysfunction (Meston & Gorzalka, 1996b; Wincze et al., 1976). It has been

suggested that women in general do not attend to genital vasocongestion during the early stages of sexual arousal (Everaerd et al., 2000; Heiman, 1976; 1978) and that perhaps women with FSAD attend even less (Everaerd et al., 2000; Morokoff and Heiman, 1980). One might predict desynchrony in each of these FSAD subtypes given that either genital or subjective sexual arousal will be impaired, while the other may increase in a manner comparable to healthy controls. A systematic comparison of the degree of synchrony between genital and subjective sexual arousal across subtypes of FSAD compared to healthy controls may provide insights into the variable degree of genital arousal awareness, in the presence of actual genital vasocongestion, across diagnostic groups.

Thus the aims of this study were to: (1) compare genital and subjective sexual arousal responses in a sexually healthy control group to those of women who self-report sexual arousal difficulties, (2) examine genital and subjective sexual arousal differences between the subtypes of FSAD in an effort to evaluate the photoplethysmograph in diagnostic decision making, (3) examine the degree of synchrony between genital and subjective sexual arousal in sexually healthy control women compared to women with subtypes of FSAD, and (4) compare sexual attitudes and other sexual subscales in a healthy control group of women to those of women with various subtypes of FSAD.

## Method

### *Participants*

Sixty-one women participated in this experiment; thirty were free of sexual difficulty and between the ages of 18-39, and thirty-one women self-reported with clinically significant sexual arousal difficulties, and were between the ages of 21-45. Subject recruitment was conducted by posting flyers in Vancouver area community centers, hospitals, and colleges, and advertisements in local and university newspapers. Additionally, advertisements were posted at the BC Center for Sexual Medicine at Vancouver Hospital. The presence of arousal difficulties was initially screened during a telephone conversation in which the

following questions were asked: (1) Do you experience persistent inability to attain or to maintain until completion of sexual activity an adequate swelling or lubrication response in your genitals? (2) Do you experience persistent inability to attain or to maintain until completion of sexual activity an adequate level of mental sexual excitement? (3) Do you ever feel desire for sexual activity, experience fantasies or thoughts, either alone or with a partner, or are receptive to sexual activity? A positive endorsement of either question 1 or 2 served as the basis for inclusion into the FSAD group. Any woman who answered no to both questions 1 and 2 would be included in the sexually healthy group. All women in both the FSAD and control groups had to endorse question 3 positively in order to be included in the study. In other words, regardless of presence or absence of FSAD, women who met criteria for hypoactive sexual desire disorder (i.e., persistent or recurrent deficiency or absence of sexual fantasies/thoughts, or desire for, or receptivity to sexual activity) were excluded. These diagnostic groupings were later confirmed with a short interview and validated questionnaires during the laboratory session. Thus, there were four groups of women participating in the current study: (1) sexually healthy control women (n = 30), (2) FSAD characterized by a reported loss of awareness of genital responding (n = 7), (3) FSAD characterized by a reported lack of mental/subjective arousal despite normal genital responding (n = 8), and (4) FSAD characterized by both a reported impairment in genital and subjective sexual arousal (n = 16). All women were currently involved in a heterosexual relationship, and had a self-reported heterosexual orientation at the initial telephone screen. Exclusion criteria included: current diagnosis of dyspareunia (i.e., pain during intercourse), current use of medications known to affect vascular or sexual functioning (e.g., antidepressants, antihypertensive medications), diabetes, hypertension, lack of sexual experience, current active psychopathology, and surgical or natural menopause. Women who agreed to participate and who met inclusion criteria were asked to schedule a date for their session.

*Procedure*

The session was conducted by one of two female researchers and began by orienting the subject to the laboratory equipment, obtaining written consent, and answering any questions about the study protocol. Following a five-minute orientation to the study, each woman was seated comfortably in a reclining chair, and asked to insert the vaginal probe, with the aid of diagrammed instructions, after the female researcher had left the room. Information on the sterilization protocol for the probe, its placement vaginally, and testing room layout appear in the procedure section of Experiment 1.

Psychophysiological testing was identical in FSAD and control women. The film stimuli from Experiment 1 were employed given that they had been shown to elicit genital and subjective sexual arousal in pre- and postmenopausal women without sexual dysfunction, and were presented in a randomized counterbalanced fashion across groups. Immediately prior to and following the film, subjects completed a self-report questionnaire assessing autonomic arousal, perception of genital sexual arousal, mental sexual arousal, anxiety, positive affect, and negative affect (Heiman & Rowland, 1983). These items were rated on a 7-point Likert scale from (1) not at all, to (7) intensely.

Following psychophysiological testing, women completed a battery of questionnaires while remaining seated in the reclining chair. Questionnaires included: the DSFI (Derogatis, 1978; a standardized self-report multidimensional test designed to measure the current level of sexual functioning), the GRISS (Rust & Golombok, 1985; to assess relationship and sexual satisfaction), and the Sexual Inventory (unpublished questionnaire; to assess the subject's estimate of sexual arousal levels that would be attainable while viewing an erotic visual stimulus). To corroborate questionnaire data on arousal impairment, women were asked (1) if they experienced vaginal dryness during sexual activity, and if so (2) did this cause a problem during sexual intercourse. Following completion of the questionnaires, a detailed clinical interview to clarify the nature of the sexual arousal complaint was conducted. This 15-minute evaluation involved a series of structured questions about genital

and mental sexual excitement to a variety of direct and non-direct genital stimulations. This detailed assessment of arousal has recently been employed in clinical settings to characterize FSAD (Basson & Brotto, 2001).

At the completion of the session, women were debriefed and provided with information on resources for treatment of FSAD in the Greater Vancouver area. In addition, each woman was mailed a copy of her psychophysiological assessment with an accompanying description of the findings. All procedures were approved by the University of British Columbia Behavioural Research Ethics Board.

*Psychophysiological recording*

VPA was monitored continuously during exposure to the 180 seconds of neutral and 180 seconds of erotic film. All psychophysiological recording methods are identical to those reported for Experiment 1.

*Data analyses*

The initial analyses compared the control group to the three FSAD groups combined as a single group (FSAD unspecified). Subsequent analyses compared the three FSAD groups to each other and to the control group. Independent samples t-tests or the Welch's t-test were used to compare women with and without FSAD on demographic and psychological questionnaires. FSAD subtypes were subsequently compared on demographic variables using analyses of variance followed by Tukey's multiple comparisons tests. ANOVA for repeated measures with group as the between subjects factor (control and FSAD) and film as the within subjects factor (neutral and erotic) were used to investigate the effects of FSAD on VPA and subjective ratings of sexual arousal. In cases of a significant interaction, simple effects analyses, using a corrected error term were utilized to determine which groups or testing intervals significantly differed. Simple effects analyses were conducted within groups for analysis of psychophysiological data given the lack of an absolute metric in this instrument, and were conducted between groups for analyses of self-report data.

Pearson product moment correlations were used to investigate the degree of association between genital and subjective measures of arousal. Correlations were assessed in two ways: (1) difference between average VPA during erotic stimulus and average VPA during neutral stimulus, correlated with difference scores on subjective measures, and (2) difference between maximum 30-second VPA segment during erotic stimulus and average VPA during neutral stimulus, correlated with difference scores on subjective measures. Difference scores for subjective measures were computed by subtracting neutral values from erotic values for each subjective measure. In all conditions a p level of .05 was deemed significant.

## Results

*Demographic information*

Demographic information is presented in Table 8. The mean age for sexually healthy women was significantly lower than that for women reporting arousal difficulties, $t(59) = 1.62$, $p < .001$, (23.4 and 30.6 years old, respectively). There were no significant age differences between diagnostic groups, $p > .05$. Ethnic breakdown for each group appears in Table 8, with most participants being Caucasian. Women with impaired sexual arousal had a significantly higher level of education achieved, $t(38.2) = 2.38$, $p = .022$, than sexually healthy women (15.6 and 14.6 years of education, respectively), though this may be an artifact of the fact that women with impaired sexual arousal were on average older than women in the control group. The FSAD group reported significantly more medical conditions than control women, $t(44.1) = 2.26$, $p = .029$, although this was due to a statistically significant difference between the women in the control group and those with combined impairment of genital and subjective arousal, $p = .013$. There were also significantly more days of work missed by women with unspecified FSAD compared to controls, $t(37.8) = 2.65$, $p = .012$. All women were currently involved in a heterosexual relationship, though the duration for women with FSAD was significantly longer, $t(42.4) = 2.37$, $p = .023$ – again, likely due to the women with FSAD being significantly older.

Psychopathology, derived from the DSFI Brief Symptom Inventory subscale, was low and did not differ between groups, $p > .05$. There were no significant group differences on information about or attitudes towards sexuality, nor on diversity of sexual experiences, both $p > .05$, as measured by the DSFI subscales. Negative affect, $t(53) = 3.30$, $p = .002$ and negative body image, $t(59) = 2.28$, $p = .026$ were significantly higher in women with FSAD, though it was only the latter that was in the significant range of abnormality (i.e., two standard deviations from the mean). Women in the FSAD group reported difficulties with vaginal dryness during sexual activity significantly more than healthy control women, $\chi^2(3) = 25.23$, $p < .001$, specifically with those in the impaired genital arousal group as well as those in the combined genital and mental arousal impairment groups endorsing vaginal dryness significantly more than women complaining solely of impaired mental sexual arousal. The two former groups also reported that vaginal dryness was problematic during sexual intercourse, unlike sexually healthy control women or those only complaining of impaired mental arousal $\chi^2(3) = 33.89$, $p < .001$. All of the GRISS subscales were significantly higher in women with unspecified FSAD, including sexual infrequency, $t(54.4) = 4.51$, $p < .001$, sexual non-communication, $t(59) = 2.90$, $p = .005$, sexual dissatisfaction, $t(59) = 3.87$, $p < .001$, avoidance of sexual activity, $t(48.6) = 6.05$, $p < .001$, non-sensuality, $t(59) = 2.26$, $p = .028$, vaginismus symptoms, $t(59) = 2.79$, $p = .007$, and anorgasmia complaints, $t(55.8) = 4.08$, $p < .001$. Despite these significant differences, only the avoidance and anorgasmia subscales of the GRISS achieved levels indicative of clinically significant sexual complaints (i.e., scaled score higher than 5). As indicated in Table 8, GRISS infrequency was significantly higher in women reporting both impaired genital and mental sexual arousal compared to those reporting genital impairment only, $p = .042$. GRISS avoidance was significantly higher in those with impaired mental arousal only as well as those with combined mental and genital arousal impairment, compared to those with genital arousal impairment only, $p = .023$ and $p < .001$, respectively. Satisfaction with the sexual relationship was significantly lower in all women with FSAD, $t(59) = 6.63$, $p < .001$. There were also significant subtype differences on

this measure with women reporting both genital and subjective sexual arousal impairment having significantly lower sexual satisfaction than either women with impaired genital ($p = .048$) or impaired mental ($p = .010$) sexual arousal alone. Though women with FSAD reported significantly lower levels of estimated sexual arousal thought possible, $t(51.1) = 2.62$, $p = .012$, the groups did not differ on self-report of actual level of sexual arousal ever experienced, $p > .05$, or on estimated level of sexual arousal in response to erotica, $p > .05$, confirming that the diagnosis of FSAD was acquired, and not lifelong.

Table 8

*Demographic information on sexually healthy control women, in women with unspecified Female Sexual Arousal Disorder (FSAD), and across subgroups of FSAD depending on self-reported arousal impairment. Data represent means (± standard error of the mean)*

| MEASURE | CONTROL GROUP (N = 30) | UNSPECIFIED FSAD (N = 31) | GENITAL IMPAIRMENT ONLY (N = 7) | MENTAL AROUSAL IMPAIRMENT ONLY (N = 8) | COMBINED GENITAL AND MENTAL AROUSAL IMPAIRMENT (N = 16) |
|---|---|---|---|---|---|
| Age[c] | 23.40 (0.91) | 30.58 (1.24) | 28.14 (2.26) | 31.50 (2.83) | 31.19 (1.73) |
| Ethnicity | | | | | |
| Caucasian | 67% | 84% | - | - | - |
| East Asian | 20% | 6% | - | - | - |
| African-Canadian | 3% | 3% | - | - | - |
| Middle Eastern or East Indian | 7% | - | - | - | - |
| First Nations | 3% | - | - | - | - |
| Hispanic | - | 6% | - | - | - |
| Education (in years)[a] | 14.62 (0.38) | 15.61 (0.17) | 15.71 (0.29) | 15.5 (0.50) | 15.63 (0.18) |
| Medical conditions[g] | 0.17 (0.07) | 0.52 (0.14) | 0.29 (0.29) | 0.25 (0.25) | 0.75 (0.19) |
| Days of work missed[a] | 2.45 (0.52) | 5.97 (1.22) | 2.33 (1.20) | 7.31 (2.18) | 6.70 (1.95) |
| Relationship duration (in months)[a] | 22.95 (4.26) | 46.81 (9.13) | 24.29 (12.93) | 40.50 (8.31) | 59.81 (15.82) |
| DSFI – Brief Symptom Inventory | 45.00 (0.63) | 40.00(0.10) | 43.00 (0.10) | 43.00 (0.10) | 37.00 (0.10) |
| DSFI – Information | 48.00 (1.08) | 50.00 (1.00) | 57.00 (1.00) | 51.00 (1.00) | 46.00 (1.00) |
| DSFI – Experience | 51.00 (1.02) | 46.00 (1.55) | 46.00 (1.50) | 45.00 (1.50) | 47.00 (1.50) |
| DSFI – Affect[b] | 52.00 (3.82) | 43.00 (7.90) | 41.00 (12.40) | 49.00 (10.80) | 41.00 (14.50) |
| DSFI – Body image[a] | 43.00 (3.31) | 33.00 (2.33) | 42.00 (5.03) | 42.50 (5.50) | 32.00 (4.56) |
| DSFI – Satisfaction[b] | 51.00 (2.31) | 39.00 (3.24) | 41.00 (3.56) | 44.00 (4.56) | 32.50 (4.56) |
| GRISS – Infrequency[c, d] | 3.24 (0.31) | 5.58 (0.42) | 3.86 (0.70) | 5.75 (0.92) | 6.25 (0.52) |
| GRISS – Non- | 3.07 (0.34) | 4.45 (0.34) | 4.57 (0.84) | 3.50 (0.71) | 4.88 (0.40) |

| | | | | | |
|---|---|---|---|---|---|
| communication[b] | | | | | |
| GRISS – Dissatisfaction[c] | 2.30 (0.23) | 3.48 (0.20) | 4.00 (0.49) | 3.00 (0.27) | 3.50 (0.29) |
| GRISS – Avoidance[c, e, f] | 2.13 (0.27) | 5.27 (0.44) | 2.33 (0.80) | 5.00 (0.68) | 6.50 (0.44) |
| GRISS – Non-sensuality[a] | 3.07 (0.35) | 4.19 (0.35) | 3.71 (0.89) | 4.13 (0.74) | 4.44 (0.46) |
| GRISS – Vaginismus[b] | 2.63 (0.34) | 4.13 (0.41) | 4.42 (0.84) | 2.63 (0.60) | 4.75 (0.59) |
| GRISS – Anorgasmia[c] | 3.60 (0.34) | 5.90 (0.45) | 5.86 (0.86) | 5.38 (0.91) | 6.19 (0.67) |
| Highest level of arousal thought possible[a] | 6.40 (0.16) | 5.61 (0.25) | 6.43 (0.30) | 6.38 (0.26) | 4.88 (0.38) |
| Highest level of arousal ever achieved | 6.30 (0.17) | 5.74 (0.26) | 5.86 (0.40) | 6.25 (0.25) | 5.44 (0.46) |
| Anticipated sexual arousal to erotica | 4.53 (0.26) | 4.10 (0.22) | 3.86 (0.40) | 4.75 (0.41) | 3.88 (0.31) |

*Note*: The means for DSFI symptoms, information, experience, body image, and relationship satisfaction subscales are based on raw scores that were converted to established percentile rankings (t scores). Values for the GRISS subscales are presented in standard score units with a score greater than 5 indicating significant impairment.

Significant difference between control group and unspecified FSAD: $^{a}p < .05$, $^{b}p < .01$, $^{c}p < .001$

Significant difference between genital impairment only group and combined arousal impairment group: $^{d}p < .05$, $^{e}p < .001$

Significant difference between genital impairment only group and mental sexual arousal impairment only group: $^{f}p < .05$

Significant difference between control group and combined arousal impairment group: $^{g}p < .05$

*Effects of film and FSAD on genital sexual arousal*

Due to computer difficulties during data collection, psychophysiological data are not available for one sexually healthy woman and two women with FSAD. As suggested by Figure 4, the main effect of erotic film was significant, $F(1,55) = 34.50$, $p < .001$, indicating that women responded with increased VPA after erotic film exposure. The interaction between film and unspecified FSAD was not significant for VPA, $F(1,55) = 1.22$, $p > .05$, indicating that the groups did not differ on this measure. Analyses were then repeated looking at the different FSAD groups in comparison to sexually healthy women. Examination of the data in this manner revealed a significant film by FSAD subtype interaction, $F(3,53) = 6.73$, $p < .001$, which is presented in Figure 5 as percent change in VPA between neutral and erotic stimulus conditions. Simple effects analyses revealed that sexually healthy women, $F(1,53) = 15.06$, $p < .001$, women reporting impaired mental arousal only, $F(1,53) = 41.85$, $p < .001$, and women reporting combined impairment in mental and genital arousal, $F(1,53) = 6.946$, $p < .01$, experienced a significant increase in VPA following exposure to the erotic film whereas women reporting impaired genital sexual arousal alone did not experience such an increase, $F(1,53) = 0.931$, $p > .05$.

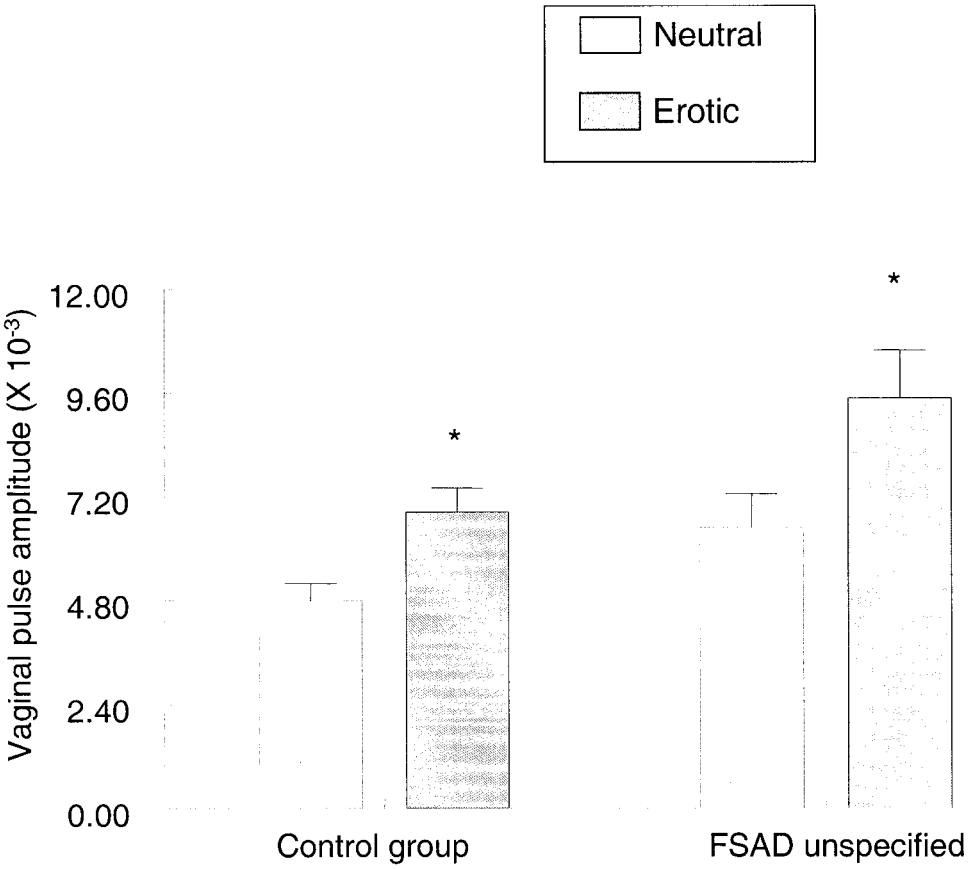


*Figure 4.* Effects of erotic stimulus on vaginal pulse amplitude in sexually healthy women and women with unspecified female sexual arousal disorder (FSAD). Data represent means (in millivolts) ± standard error of the mean.

*$p < .001$, main effect of erotic film

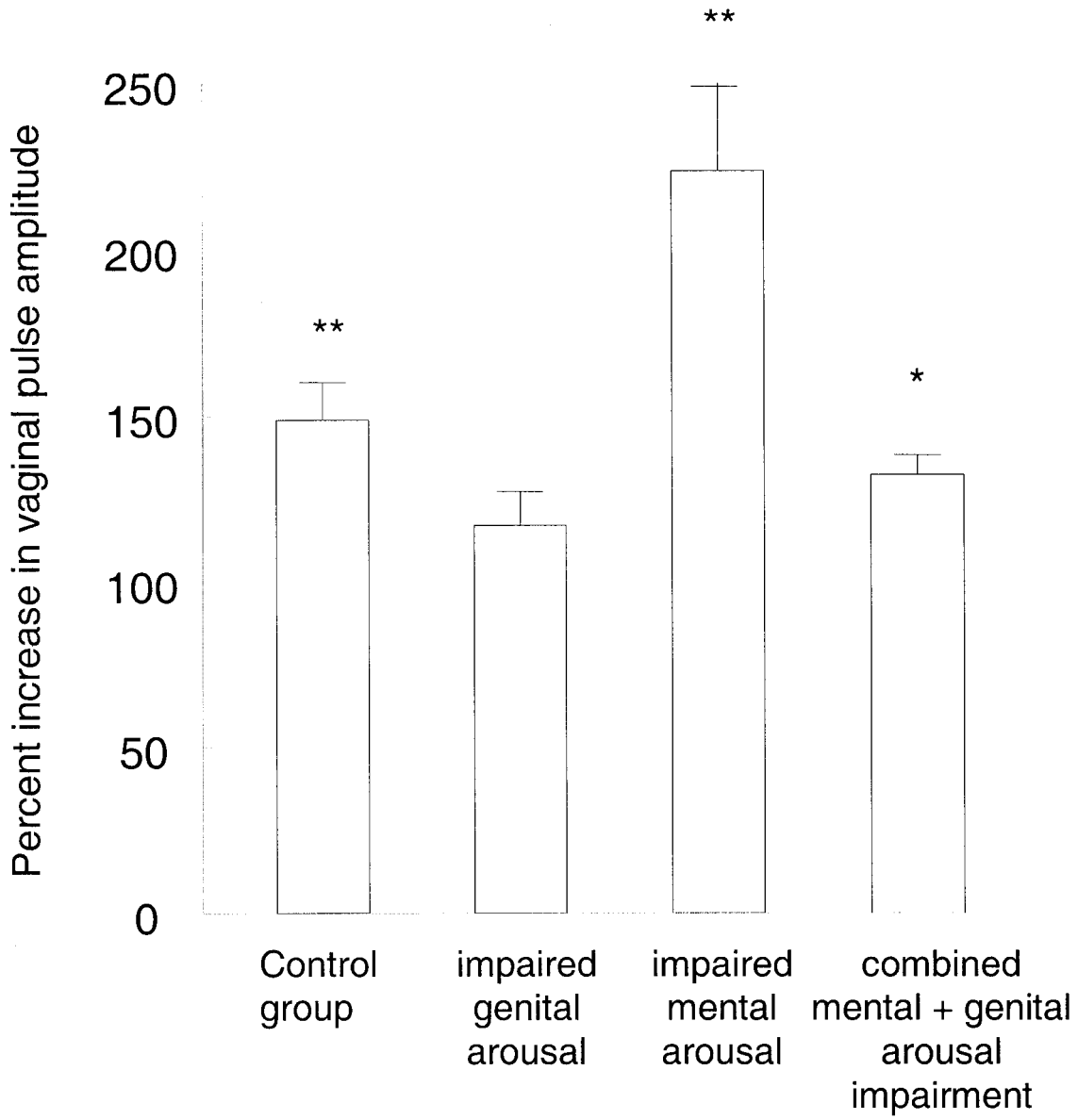


*Figure 5.* Effects of erotic stimulus on vaginal pulse amplitude in sexually healthy women, women with female sexual arousal disorder (FSAD) characterized by impaired genital arousal, with FSAD characterized by impaired mental arousal, and with FSAD characterized by combined impairment of mental and genital arousal. Data represent the mean percent increase from neutral to erotic stimulus conditions ± standard error.

*$p < .01$. **$p < .001$ denotes significant increase in vaginal pulse amplitude from neutral to erotic stimulus conditions

*Effects of film and FSAD on self-report measures*

The interaction between FSAD and erotic film was significant for perception of genital arousal, $F(1,59) = 9.96$, $p = .003$, and for positive affect, $F(1,58) = 5.88$, $p = .018$, but not for autonomic arousal, $F(1,58) = 2.94$, $p > .05$; mental sexual arousal, $F(1,59) = 0.09$, $p > .05$; anxiety, $F(1,59) = 0.07$, $p > .05$; nor negative affect, $F(1,56) = 2.05$, $p > .05$ (Figure 6). Simple effects analyses on each group revealed that for both perception of genital arousal and positive affect, the increase after the film was markedly higher in sexually healthy women than women with unspecified FSAD.

There was a main effect of erotic film such that autonomic arousal, $F(1,58) = 54.65$, $p < .001$, perception of genital arousal, $F(1,59) = 96.90$, $p < .001$, mental sexual arousal, $F(1,59) = 73.30$, $p < .001$, and positive affect, $F(1,58) = 53.64$, $p < .001$, were all significantly increased. The erotic film resulted in significantly reduced anxiety in all women, $F(1,59) = 6.36$, $p = .014$, and had no effect on negative affect, $F(1,56) = 0.77$, $p > .05$.

The control and unspecified FSAD groups significantly differed on: perception of genital arousal, $F(1,59) = 8.751$, $p = .004$, and on mental sexual arousal, $F(1,59) = 8.473$, $p = .005$, with lower scores being endorsed by the FSAD group. There were no differences for autonomic arousal, $F(1,58) = 0.04$, $p > .05$; anxiety, $F(1,59) = 1.59$, $p > .05$; and negative affect, $F(1,56) = 0.42$, $p > .05$. Positive affect showed a trend towards being lower in women with FSAD, $F(1,58) = 2.95$, $p = .091$, though this did not reach statistical significance.

Subjective measures were subsequently analyzed by type of arousal impairment reported using a repeated measures ANOVA. There was a main effect of group on perception of genital arousal, $F(3,57) = 3.75$, $p = .016$, and mental sexual arousal, $F(3,57) = 5.27$, $p = .003$. FSAD subtype and film significantly interacted for perception of genital arousal, $F(3,57) = 3.43$, $p = .023$. A follow-up simple effects analysis revealed that with exposure to the erotic film, women reporting genital arousal difficulties only ($p < .05$) and women reporting both mental and genital arousal difficulties ($p < .001$) had a significantly lower perception of genital arousal than sexually healthy women. Women with FSAD

characterized by impaired mental arousal only did not differ from control women on this variable, $p > .05$. Autonomic arousal, $F(3,56) = 1.26$, $p > .05$; mental sexual arousal, $F(3,57) = 0.17$, $p > .05$; anxiety, $F(3,57) = 0.88$, $p > .05$; negative affect, $F(3,54) = 1.54$, $p > .05$, and positive affect, $F(3,56) = 1.94$, $p > .05$, did not differ between these groups.

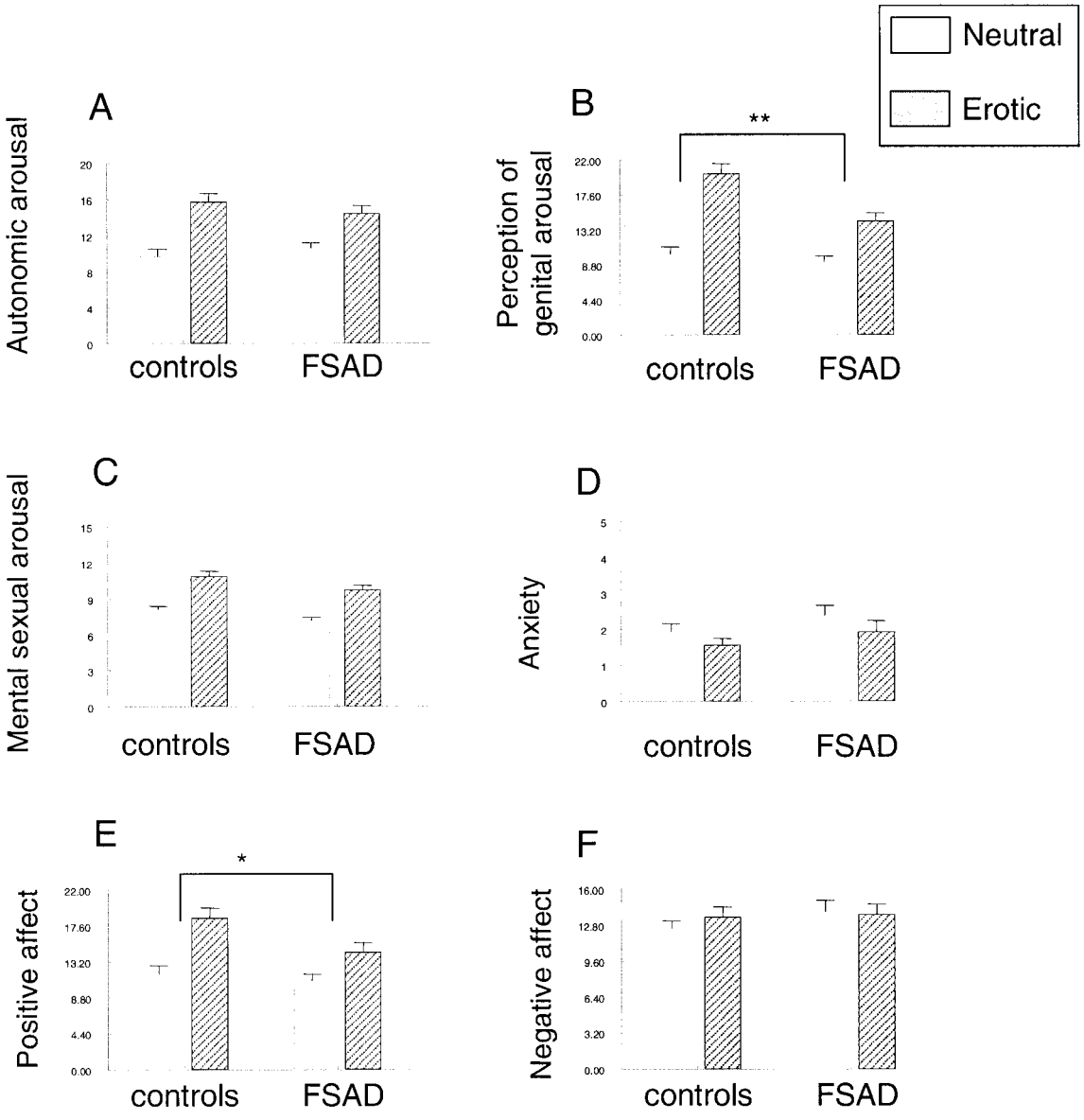


*Figure 6.* Effects of erotic film on A) autonomic arousal, B) perception of genital arousal, C) mental sexual arousal, D) anxiety, E) positive affect, and F) negative affect in sexually healthy women, and women with unspecified female sexual arousal disorder (FSAD). Data represent means ± standard error of the mean. *p < .05, **p < .01 denotes significant interaction between group (control vs. FSAD) and film (neutral vs. erotic)

*Genital-subjective sexual arousal synchrony*

Pearson product moment correlation analyses between VPA and (1) perception of genital arousal, and (2) mental sexual arousal, were conducted on sexually healthy and women with FSAD separately, as shown in Table 9. In sexually healthy women, the correlation between average VPA and perception of genital arousal was not significant ($r = -.221$, $p > .05$) though it was between average VPA and mental sexual arousal ($r = -.375$, $p = .045$). Employing maximum VPA instead of average VPA resulted in a lower correlation with mental sexual arousal ($r = -.243$, $p > .05$) and perception of genital arousal ($r = -.136$, $p > .05$). The unspecified FSAD group showed a slightly different pattern of correlations. Maximum VPA and mental sexual arousal showed a trend towards a significant positive correlation ($r = .331$, $p = .08$) though this trend was not apparent when average VPA was employed ($r = .166$, $p > .05$). Perception of genital arousal neither correlated with maximum VPA ($r = .037$, $p > .05$) nor with average VPA ($r = .077$, $p > .05$), as shown in Table 9.

Subsequently, genital-subjective correlations were conducted on each of the FSAD subgroups separately, though this reduced the number of subjects per group, and therefore, the probability of significance. Within the group of women reporting impaired genital arousal only, mental sexual arousal was significantly correlated with maximum VPA ($r = .884$, $p = .008$) and almost significantly correlated with average VPA ($r = .684$, $p = .09$). Perception of genital arousal did not correlate with maximum VPA ($r = .431$, $p > .05$) nor with average VPA ($r = .225$, $p > .05$) in this subgroup of women. Women in the impaired mental arousal only group did not show any significant correlations between mental sexual arousal and average VPA ($r = -.030$, $p > .05$) nor with maximum VPA ($r = -.011$, $p > .05$). Moreover, their perception of genital arousal did not correlate with either maximum VPA ($r = .101$, $p > .05$) nor with average VPA ($r = -.059$, $p > .05$). The same pattern of non-significant correlations was also found in the group of women with combined mental and genital arousal impairments. Mental sexual arousal did not correlate significantly with maximum VPA ($r = .084$, $p > .05$) nor with average VPA ($r = .185$, $p > .05$). Perception of genital arousal did not

correlate with maximum VPA ($r = -.212$, $p > .05$) nor with average VPA ($r = .119$, $p > .05$). It is noteworthy that all genital-subjective correlations for women in the control condition, regardless of their level of statistical significance, were in the negative direction. In contrast, in FSAD genital-subjective correlations were either near zero or positive, regardless of level of statistical significance.

Table 9

*Correlations between (1) average vaginal pulse amplitude (VPA) and perception of genital arousal, (2) maximum VPA and perception of genital arousal, (3) average VPA and mental sexual arousal, and (4) maximum VPA and mental sexual arousal in control group and women with unspecified female sexual arousal disorder (FSAD).*

| | CONTROL GROUP | UNSPECIFIED FSAD |
|---|---|---|
| Perception of genital arousal with: | | |
| Average VPA | r = -.221 | r = .077 |
| Maximum VPA | r = -.136 | r = .037 |
| Mental sexual arousal: | | |
| Average VPA | r = -.375* | r = .166 |
| Maximum VPA | r = -.243 | r = .331$^{t}$ |

*Note:* Values represent Pearson Product Moment Correlation Coefficients, $^{t}p = .08$, $^{*}p < .05$

# Discussion

Overall the data demonstrate that the erotic film was effective at increasing genital arousal, reducing self-reported anxiety and increasing self-reported autonomic arousal, perception of genital arousal, mental sexual arousal, and positive affect across all women. Moreover, there was no significant difference in genital arousal to the erotic film between the control group and an unspecified FSAD group. However, when women with unspecified FSAD were subsequently compared based on the subtype of arousal impairment experienced (i.e., genital impairment, mental arousal impairment, or both), differential VPA patterns emerged. Those women reporting impairment in genital responding only did not display an increase in VPA with exposure to the erotic film whereas all other groups did. Perception of genital arousal to the erotic film was significantly lower in the unspecified FSAD group compared to control women, and when this was analyzed further according to type of arousal impairment, it was found that those women reporting impaired genital responding as well as those reporting combined genital and mental arousal impairment had lower scores than the women only reporting mental arousal impairment.

The current psychophysiological findings indicate that as a group, women with unspecified FSAD do not differ from sexually healthy women on objective genital assessment. However, when this group was classified based on their self-reported arousal impairment, the data suggest that psychophysiological assessment may be valuable in discriminating among subgroups. Prior studies of psychophysiological responding in women with arousal dysfunction (Morokoff & Heiman, 1980; Palace & Gorzalka, 1990) have not characterized the likely deficient components of arousal. This may explain the discrepancies to date in prior studies which failed to distinguish between FSAD subtypes. Our finding that the undifferentiated FSAD women did not significantly differ on photoplethysmographic patterns from the control group is consistent with previous findings (Meston & Gorzalka, 1996b; Morokoff & Heiman,1980).

Using vaginal photoplethysmography, only women who self-reported with impairment in genital sexual arousal showed evidence of impaired genital vasocongestion on VPA, whereas women complaining of impaired mental arousal or both impaired genital and mental arousal displayed a robust VPA response to erotica, similar to sexually healthy women. The group of women classified based on their self-report of experiencing solely impaired genital arousal resembles the clinical FSAD subtype, genital arousal disorder, offered by Basson (2001b, 2002a; 2002b). The extent to which the psychophysiological features of this group are attributable to underlying genital organic factors is unknown. Emerging research is beginning to delineate the precise peripheral and central pathways involved in the genital arousal response (Giuliano, Rampin, & Allard, 2002), and there has been speculation that the photoplethysmograph may be useful in detecting arousal impairment due to organic genital etiology (Laan & van Lunsen, 2001). That those with genital arousal disorder differ from women in the other FSAD subgroups as well as from sexually healthy women supports the strong possibility of an underlying organic etiology in the genital arousal disorder group.

Women complaining solely of mental arousal difficulties resemble women diagnosed as the FSAD subtype, anhedonic arousal disorder, in terms of clinical descriptions (Basson 2001b, 2002a; 2002b). These women displayed a normal vaginal vasocongestive response to sexual stimuli similar to that of sexually healthy control women, and significantly different from the subtype classified as having genital arousal disorder. In response to sexual stimuli, their perception of genital sexual arousal did not significantly differ from that of control women. However, it is unclear why under laboratory conditions their mental sexual arousal was similar to that of control women. That an erotic video was arousing to women complaining of persistent lack of such arousal in their sexual lives is interesting. However, the sexual stimulus employed may have been insufficient to allow differences between these groups to be reached. Alternatively the sexual stimuli or contexts in their lives may have been problematic. Clearly further

research, employing more naturalistic sexual stimuli, is necessary in order to explore differences in mental sexual arousal between these groups.

The lack of a difference in psychophysiological patterns between a control group and women reporting combined impairment of mental and genital arousal was not unexpected. These women were classified based on their self-reported impairment in both subjective and genital arousal, but the literature to date confirms healthy psychophysiological responding in the majority of such women (Everaerd et al., 2000). These findings of normal VPA despite a self-reported lack of perceived genital arousal to the erotic film supports the classification of these women into the FSAD subtype, missed arousal disorder, characterized by missing subjective arousal, despite genital vasocongestion that is indeed occurring. It is also possible that genital arousal was in fact impaired in this sample, but it was undetectable by the photoplethysmograph. Levin (1997) warns against making inferences about the underlying vaginal vasculature based on VPA and VBV given that these two signals can change in opposite directions. Perhaps the use of VBV in women presenting with impaired genital and mental sexual would have revealed different patterns. Although clinical experience suggests that women frequently report a complete lack of both genital and mental sexual arousal, given the literature to date and the findings from this study, it is likely that women historically classified as experiencing neither mental nor genital sexual arousal in fact fit into the FSAD missed arousal disorder subtype, and that psychophysiological assessment is necessary in order to make this differential diagnosis. Indeed their description of dysfunction suggests they should fit a "generalized arousal disorder" subtype, but there is no psychophysiological data to support this theoretical subtype.

The findings on self-reported arousal in response to the erotic film suggest that across all women there was a significant increase in mental sexual arousal and perception of genital arousal with exposure to erotica. This significant increase was affected by the presence of FSAD such that women with unspecified FSAD experienced significantly lower increases in these measures compared to sexually healthy control women. When self-report measures were

further investigated based on the FSAD subtypes just described, women with genital arousal disorder and those with missed arousal disorder had significantly lower perception of genital arousal than women with anhedonic arousal disorder or the control group. These data are in contrast to the findings of Palace and Gorzalka (1990) and Meston and Gorzalka (1996b) who found no differences in mental sexual arousal between a mixed sexual dysfunction group and control women, or between women with low desire or orgasmic dysfunction and control women, respectively. The current findings are consistent with those of Morokoff and Heiman (1980) in that women with unspecified FSAD had significantly lower perception of genital arousal and mental sexual arousal to erotica. The present findings, by demonstrating that the pattern of subjective response is dependent on the subtype of FSAD, may reconcile these inconsistencies in the earlier literature.

Some models of sexual arousal presume that during sexual excitement genital and subjective sexual arousal increase and decrease to the same degree (Barlow, 1986). However, desynchrony between genital and subjective sexual arousal is a hallmark feature of this research in women (Rosen & Beck, 1988). In the current study, genital-subjective desynchrony was apparent in sexually healthy women but was not in women with FSAD. Specifically, mental sexual arousal and VPA were negatively correlated in sexually healthy women, but showed a trend towards being positively correlated in women with unspecified FSAD. It appeared as though the positive correlation between VPA and mental sexual arousal was characteristic only of women with genital arousal disorder subtype – women with missed and anhedonic arousal subtypes did not show synchrony. The literature on genital-subjective correlations in women with sexual dysfunction is inconsistent, with reports of desynchrony between mental sexual arousal and VBV in women with mixed sexual dysfunction (Palace & Gorzalka, 1990), synchrony in mental arousal and VBV in anorgasmic women (Wincze et al., 1976), and desynchrony between VPA and mental arousal in women with FSAD (Morokoff & Heiman, 1980). That significant synchrony between mental arousal and VPA was found only in women with genital arousal disorder

suggests that this group may be relying on their somatic cues to label sexual arousal whereas sexually healthy women and women with the other two FSAD subtypes may be relying more on cognitive information (Pennebaker & Roberts, 1992) or contextual factors (Dekker, Everaerd, & Verhelst, 1985) to label their subjective state. It is also possible that women with anhedonic and missed arousal disorder subtypes felt inhibited to report arousal that was indeed occurring. It is interesting that among sexually healthy women a significant negative correlation between mental sexual arousal and VPA existed, despite the finding that positive affect increased and negative affect was unchanged. Morokoff and Heiman (1980) discovered negative correlations between genital and subjective sexual arousal when women were presented with an audiotape, a significant positive correlation when allowed to fantasize, and no correlation when women with FSAD were shown an audiovisual film. It remains speculative that different methods of erotic stimulus exposure may evoke different patterns of synchrony across subtypes of FSAD.

One factor that may account for inconsistencies across prior studies is the method used to recruit and classify subjects. In particular, results differ depending on whether brief, self-report assessments of sexual dysfunction (Meston & Gorzalka, 1996b) or standardized questionnaires and/or clinical interviews (Morokoff & Heiman, 1980) are used to recruit subjects. In the current study, women were recruited from community advertisements and not a sex therapy clinic; however, detailed telephone and in-person interviews by a doctoral-level clinical psychology student experienced in the assessment of sexual dysfunction were employed. The extent to which the current sample of women with FSAD is representative of women typically presenting to sex therapy clinics is unknown. Given that women in the current study responded to an advertisement that stated "Do you experience significant impairment with sexual arousal", and later self-reported significant distress and interference in their interpersonal relationship during the telephone screen along with a desire for information on treatment resources, it is likely that the current sample resembles

women presenting to sex therapy clinics with complaints of FSAD. Thus, the generalizability of the current findings is probable.

Questionnaire data revealed that on average women with FSAD were significantly older than women in the control group. The extent to which this is attributable to a selection bias versus reflective of actual prevalence of FSAD is unknown. Given the findings from Experiment 1 which find no significant effect of age, per se, on genital or subjective sexual arousal, age was not included as a covariant in the current analyses. To date epidemiological data on subtypes of FSAD do not exist, and the available data on lubrication difficulty with age suggests that there is no change in prevalence from age 18-40 (Laumann et al., 1999). Women with FSAD reported significantly more medical problems than women in the control group, though levels of psychopathology were low and did not differ between groups. The extent to which the documented higher levels of poor body image in women with FSAD are related to their arousal complaints is worthy of future investigation. It is possible that heightened attention to the body during sexual activity may distract from attending to sexual cues, and have a negative impact on sexual arousal. On the other hand, it may be that a negative experience of sexual arousal may lead to feelings of poor body image. It is not surprising that avoidance of sexual activity and anorgasmia were significantly elevated in women with FSAD compared to control women given that arousal impairment can lead to reduced sexual satisfaction and hence a reduced motivation to be sexual. In addition, sexual arousal and orgasm complaints are often highly comorbid, as was seen in the present study.

The possibility of incorporating psychophysiological assessment into clinical assessments of women with sexual dysfunction is an old issue (Hatch, 1981; Heiman, 1976) that has yet to be definitively resolved. Whereas penile plethysmographyy has been suggested to provide useful information for discriminating psychogenic from organic erectile dysfunction (Janssen et al., 1994), definitive conclusions and analogous studies have yet to be presented for vaginal photoplethysmography.

Heiman (1976) has cautioned that as a laboratory procedure, psychophysiological assessment may not accurately reflect sexual arousal patterns in a person's natural environment. The finding that genital and mental sexual arousal to erotica were desynchronous in women with anhedonic sexual arousal and missed sexual arousal subtypes, and were negatively related in sexually healthy controls supports this caveat. However, one cannot rule out the possibility that sexual arousal experienced in the laboratory setting parallels that experienced in the real-life setting for women with genital arousal disorder subtype given the presence of genital-subjective synchrony. The degree of correlation between laboratory-based measures and real-life sexual arousal will be the focus of Experiment 4.

The current findings reinforce the notion that the diagnostic group, FSAD, is a heterogeneous category comprised of subgroups that differ on self-report and psychophysiological assessment. Recent reclassifications provide empirical support for the delineation of genital versus subjective arousal impairment in FSAD (Basson et al., 2000), and for the subtyping of FSAD based on the pattern of genital versus mental arousal impairment (Basson, 2001a; 2001b; 2002a; 2002b). A better understanding of the relationship between the photoplethysmographic signal and the underlying vaginal vasculature is essential before the current findings can be related to anatomical or biochemical events that differ between women with FSAD subtypes and women without sexual arousal difficulty. The current findings may have implications for the treatment of arousal problems, which has proven difficult to date. There is preliminary evidence that such subtyping of FSAD may allow for the positive effects of therapeutic agents to emerge (Brotto & Basson, 2002; Caruso et al., 2001) whereas studies lacking FSAD subtyping showed no benefit (Basson, McInnes, Smith, Hodgson, Spain, & Koppiker, 2002). The current findings support careful delineation of FSAD subtypes in future studies to allow the beneficial effects of an intervention to emerge.

## Experiment 3: Heightened Sympathetic Nervous System Activity and Female Sexual Arousal Disorder (FSAD): Differential Effects on FSAD Subtypes

Effective treatments for female sexual dysfunction lag behind the repertoire of effective treatments for male sexual dysfunction (Riley, 1998; Wincze & Carey, 2001). To date, the only female sexual dysfunction for which efficacious treatment, defined by the American Psychological Association (1995) Task Force on the Promotion and Dissemination of Psychological Procedures as "studies conducted by different investigators in which a treatment is shown to be superior to another treatment or placebo" exists, is Female Orgasmic Disorder. There are no published investigations on the effects of psychotherapy for FSAD and pharmacotherapy trials for this condition are only beginning to emerge. Only one U.S. Food and Drug Administration approved product for FSAD exists. This EROS Clitoral Therapy Device (UroMetrics, Inc., St. Paul, MN) has been found to significantly increase several domains of sexual response, including arousal (Billups, Berman, Berman, Metz, Glennon, & Goldstein, 2001), though anecdotal claims of its efficacy are cause for scepticism. The current unsatisfactory status of effective treatments for FSAD may partially be attributed to historically less research attention to female as compared to male sexual dysfunction. Another factor may be that the complexity of female sexuality makes it difficult to delineate a treatment that works well for all women with a particular type of sexual dysfunction (Heiman, 2002; Leiblum & Wiegel, 2002). Even in cases for which an identified organic explanation may account for the acquired sexual difficulty (e.g., as in the case of spinal cord injury), the precise biological, psychological, and socio-cultural interactions that play a role in sexual dysfunction, which subsequently dictate the corresponding treatment, vary across women, and within women across situations. Stemming from the recent success of vasoactive products in treating male sexual dysfunction, there is heightened awareness of the "medicalization" of the field of female sexual dysfunction (Moynihan, 2003) and caution against the excitement over using pharmaceutical interventions for all varieties of sexual dysfunction (Tiefer, 2001).

Patterns of female sexual responding do not parallel those for men (Laan & Everaerd, 1995), thus precluding any straightforward adaptation of treatments for male sexual dysfunction to women.

There is an accumulating body of literature supporting the role of sympathetic nervous system activation in female sexual arousal. Plasma norepinephrine has been shown to correlate with increases in female sexual arousal, reaching a peak during orgasm (Exton, Bindert, Kruger, Scheller, Hartmann, & Schedlowski, 1999). The vaginal photoplethysmograph has been used to examine the effects of heightened SNS activity on vaginal vasocongestion via pharmacological (Meston & Heiman, 1998; Meston & Worcel, 2002; Rosen, Phillips, Gendrano, & Ferguson, 1999; Rubio-Aurioles, Lopez, Lipezker, Lara, Ramirez, Rampazzo, et al., 2002) and non-pharmacological means (Experiment 1; Meston & Gorzalka, 1995; 1996a; 1996b; Palace & Gorzalka, 1990). The VPP has been shown to be sensitive to the vasocongestive effects of these manipulations, even in cases where subjective sexual arousal is not significantly affected (e.g., Meston & Heiman, 1998; Meston & Gorzalka, 1995; 1996a; 1996b; Meston & Worcel, 2002; Palace & Gorzalka, 1990).

There exist few published investigations in which the effects of heightened SNS activity on genital and subjective sexual arousal have been examined in women with sexual dysfunction. VBV, but not VPA, significantly increased after visual sexual stimulation following exposure to an anxiety-eliciting film in a sample of women with mixed sexual dysfunction (Palace & Gorzalka, 1990). Sexual dysfunction in this study included primary and secondary orgasmic disorder, hypoactive sexual desire disorder, arousal disorder, and dyspareunia, with two women reporting a history of sexual abuse. The authors found that neutral films were ineffective and hypothesized that anxiety-eliciting film stimuli, by facilitating SNS activity, may play a role in restoring genital arousal in women with sexual dysfunction. In contrast, using physical exercise as a method of eliciting SNS activity, Meston and Gorzalka (1996b) found that sexually functional and dysfunctional women without orgasmic difficulty responded with increased

VPA whereas anorgasmic women responded with inhibited VPA after the presentation of an erotic stimulus. These authors speculated that impairments in autonomic nervous system functioning may play an etiological role in female orgasmic disorders and that this may have therapeutic implications (Meston & Gorzalka, 1996b). The same group of authors found that clonidine, a selective $\alpha_2$-adrenergic agonist which inhibits SNS activity, inhibited genital arousal (Meston et al., 1997). While each of these studies (Meston & Gorzalka, 1996b; Palace & Gorzalka, 1990) provide a rationale for the use of SNS-enhancing agents in some women with sexual dysfunction, the large heterogeneity of the samples employed and the lack of consistent findings across them precludes any general conclusions.

There have been three studies that have investigated SNS-enhancing agents in women with FSAD. A small pilot study found support for a facilitatory effect of phentolamine mesylate, a non-selective $\alpha_1$- and $\alpha_2$-adrenergic antagonist, on VPA in women with undifferentiated FSAD (Rosen et al., 1999). In a larger sample of women with FSAD, Rubio-Aurioles et al. found a significant facilitatory effect of phentolamine mesylate on VPA in postmenopausal women receiving hormone replacement, and a trend towards significance for women not receiving hormones (Rubio-Aurioles et al., 2002), whereas Meston and Worcel failed to find an effect of the $\alpha_2$-adrenergic antagonist, yohimbine, on genital or subjective sexual arousal in a sample of women with specifically genital arousal disorder (Meston & Worcel, 2002). However, in the presence of the vasodilator, L-arginine glutamate, this SNS-enhancing drug significantly facilitated VPA (Meston & Worcel, 2002). Given that there was no group receiving L-arginine glutamate only, and that a mixed sample of women both receiving and not receiving hormone replacement were included, it is difficult to make implications with respect to the role of the SNS in this study. Taken together, there is some pharmacological support for a facilitatory effect of heightened SNS activity on genital arousal in women with FSAD.

The recent reclassification of female sexual dysfunction by the American Foundation for Urologic Disease (Basson, Berman, Burnett, Derogatis, Ferguson,

Fourcroy et al., 2000) has resulted in more careful specification of psychological versus biological underpinnings of the female sexual disorders. The diagnostic category of FSAD was further clarified by introducing the delineation of mental from genital impairment. Moreover, the findings from Experiment 2 suggest psychophysiological support for the differentiation of subtypes of FSAD that were previously described only in the clinical literature (Basson, 2001b; 2002a; 2002b). Specifically, the results of Experiment 2 provide support for the differentiation of genital arousal disorder, missed arousal disorder, and anhedonic arousal disorder based on a combination of clinical self-reports and psychophysiological testing. Dysphoric arousal disorder and generalized arousal disorder are two other theoretical subtypes of FSAD that have been described clinically, but which require future research attention, and as a result, were likely not observed in Experiment 2. The delineation of these clinical subtypes of FSAD bears important implications on the choice of intervention employed. It has been suggested that women with genital arousal disorder may benefit from vasocongestive interventions, whereas those without evidence of impaired genital congestion may not (Basson, 2002a; 2002b; Everaerd & Laan, 2000). To date the effect of an intervention across subtypes of FSAD has not been investigated.

Based on the literature that (1) heightened SNS activity significantly facilitates genital arousal in sexually healthy premenopausal women (Experiment 1; Meston & Gorzalka, 1995; 1996a) and in premenopausal women with low desire (Meston & Gorzalka, 1996b), (2) pharmacotherapeutic agents which enhance SNS activity increase genital arousal in women with FSAD (Meston & Worcel, 2002; Rosen et al., 1999; Rubio-Aurioles et al., 2002), and (3) agents which decrease SNS activity result in inhibited genital arousal in sexually healthy women (Meston et al., 1997), there appears to be support for using heightened SNS activity as a method of facilitating genital arousal in women with FSAD. Moreover, the finding that the VPP may be useful in differentiating genital arousal disorder from other subtypes of FSAD (Experiment 2) suggests that further separation may be possible with enhanced SNS activity across the subtypes of

FSAD. Therefore, this study sought to examine the effects of heightened SNS activity in both an undifferentiated group of women with FSAD, as well as across the different subtypes of FSAD in comparison to a normal control group. Laboratory-induced hyperventilation (LIH), a technique that reliably facilitates sympathetic nervous system activity (George et al., 1989; Olsen et al., 1998; St. Croix et al., 1999) was used to enhance SNS activity. Thus, another objective of this study was to replicate the findings from Experiment 1 that LIH is an effective way of facilitating genital sexual arousal in sexually healthy premenopausal women. The results from this study will help to clarify the therapeutic utility of SNS-enhancing agents in women with FSAD, and should help to elucidate in which, if any, subtype of FSAD these beneficial effects are apparent.

## Methods

### *Participants*

Sixty-one women participated in this experiment, and were recruited through advertisements in local newspapers, throughout the Vancouver community, and across campus at the University of British Columbia. Participants had also taken part in Experiment 2, an examination of the diagnostic utility of the vaginal photoplethysmograph. The current study took place during the same laboratory session as that in Experiment 2. Based on the findings from Experiment 2 that the VPP can be used to classify women according to the theoretical subtypes described in the clinical literature (Basson 2001a; 2001b; 2002a; 2002b), the women, who had previously been categorized according to their self-reported arousal impairment, were labelled according to the published FSAD subtypes in this experiment. Women were divided into one of four such diagnostic categories: (1) sexually healthy control group, (2) genital arousal disorder (i.e., impaired genital arousal only), (3) anhedonic arousal disorder (i.e., impaired mental sexual arousal only), or (4) missed arousal disorder (i.e., self-reported impairment in both genital and mental sexual arousal with normal vaginal vasocongestion in laboratory testing).

*Procedure*

Each woman participated in one session. A between-within repeated measures design allowed for the comparison between FSAD and control groups, between baseline and heightened SNS conditions, and also within groups to compare the effects of the erotic stimulus with a neutral stimulus. The session was conducted by one of two female researchers and began by orienting the subject to the laboratory equipment, obtaining written consent, and answering any questions about the study protocol. Following this brief orientation, each woman was seated comfortably in a reclining chair, and asked to insert the vaginal probe, with the aid of diagrammed instructions, after the female researcher had left the room. Details on the sterilization protocol, placement of the vaginal probe, and testing room set-up appear in the methods section of Experiment 1. The same film stimuli employed in Experiment 1 were used given that they elicited genital and subjective sexual arousal in pre- and postmenopausal women without sexual dysfunction.

Psychophysiological testing took place twice over the course of the 90-minute session – once after five minutes and again after 75 minutes. Different neutral and erotic film stimuli, presented in a randomized counterbalanced fashion across groups (control and FSAD) and across testing segments (time 1 and 2) were utilized. Women from each group were randomized to receive LIH prior to watching the film stimuli in either the first or the second testing segment. The LIH protocol employed in the current experiment was identical to that in Experiment 1, and involved two minutes of rapid, deep breathing at a rate of 30 breaths/minute. Subjects breathed along with a pre-recorded audiocassette of paced respiration and were asked to breathe in and out as deeply as possible. They were also instructed to close their eyes during LIH in order to minimize feelings of light-headedness. The female investigator remained in the room with the subject during the LIH procedure and left prior to the onset of the film. Immediately prior to the neutral, and following the erotic film, participants completed a self-report questionnaire assessing autonomic arousal, perception of genital sexual arousal, mental sexual arousal, anxiety, positive affect, and

negative affect (Heiman & Rowland, 1983). These items were rated on a 7-point Likert scale from (1) not at all, to (7) intensely.

Questionnaire completion occurred during Experiment 2. Following completion of the questionnaires, the subject notified the investigator, via an intercom, to return to the private testing room. At this time, a different film was placed into the VCR. If women were randomized to receive LIH at this time, the investigator remained in the room during this procedure. If the woman had already received LIH before the first film, then the investigator left the room after changing the video. The investigator instructed the subject, via the intercom, to relax for 5 minutes, and subsequently alerted the subject when to operate the remote control device to turn on the film.

At the completion of the session, women were debriefed and provided information on resources for treatment of female sexual arousal disorder in the Greater Vancouver area. They were also informed of the study hypotheses and given information on prior studies that have examined the effects of heightened SNS activity on arousal. In addition, each woman was mailed a copy of her psychophysiological assessment with an accompanying description of the findings. All procedures were approved by the University of British Columbia Behavioural Research Ethics Board.

*Psychophysiological recording*

VPA was monitored continuously during exposure to the 180 seconds of neutral and 180 seconds of erotic film during both the baseline and heightened SNS conditions. All psychophysiological recording methods are identical to those reported for Experiment 1.

*Data analyses*

Data on genital and subjective sexual arousal during a baseline SNS condition were collected during Experiment 2 and are included in the current analyses to examine the effects of heightened SNS activity. All analyses were conducted initially between control versus the three combined FSAD groups

(FSAD unspecified), and subsequently the three FSAD groups were compared to each other and to the control group. Analyses of variance for repeated measures were used for these comparisons to examine the effects of the erotic stimulus, diagnostic group, and heightened SNS activity on genital and subjective sexual arousal. Simple effects analyses were conducted in cases of a significant interaction. Within group follow-up analyses were conducted for psychophysiological data given the lack of an absolute metric in this instrument. Between group follow-up analyses were run at each condition on self-report data. Pearson product moment correlation coefficients were used to investigate the degree of synchrony between genital and subjective sexual arousal during the heightened SNS condition, across groups of women. Correlations were assessed in two ways: (1) difference between average VPA during erotic stimulus and average VPA during neutral stimulus, correlated with difference scores on subjective measures, and (2) difference between maximum 30-second VPA segment during erotic stimulus and average VPA during neutral stimulus, correlated with difference scores on subjective measures. Difference scores for subjective measures were computed by subtracting neutral values from erotic values for each subjective measure. Correlations were analyzed in this manner given the findings from Experiments 1 and 2 that the method of VPA analysis can affect the pattern of genital-subjective correlations. Percent increase scores for VPA, calculated by dividing the mean VPA response during the erotic film by the mean VPA response during the neutral film and multiplying by 100% (Heiman, 1980) were used to examine the effects of heightened SNS activity. In all cases a p level of .05 was deemed statistically significant.

## Results

### *Demographic information*

Demographic information for women participating in this study is presented in the results section of Experiment 2.

*Effects of film and FSAD on genital sexual arousal during a heightened sympathetic nervous system condition*

Due to computer difficulties during data collection, psychophysiological data could not be collected for one sexually healthy woman, and for one woman with FSAD during the heightened SNS condition. There was a significant main effect of film, $F(1,57) = 62.32$, $p < .001$, with all women displaying increased VPA after presentation of the erotic film, as illustrated in Figure 7. The interaction of group (control vs unspecified FSAD) and film (neutral vs erotic) was not statistically significant, $F(1,57) = 0.23$, $p > .05$. Subsequently, analyses were repeated looking at the different FSAD groups in comparison to sexually healthy women. The interaction between FSAD subtype and film remained non-significant, $F(1,57) = 0.232$, $p > .05$, suggesting that all women, regardless of FSAD subtype, responded to the erotic film with increased VPA.

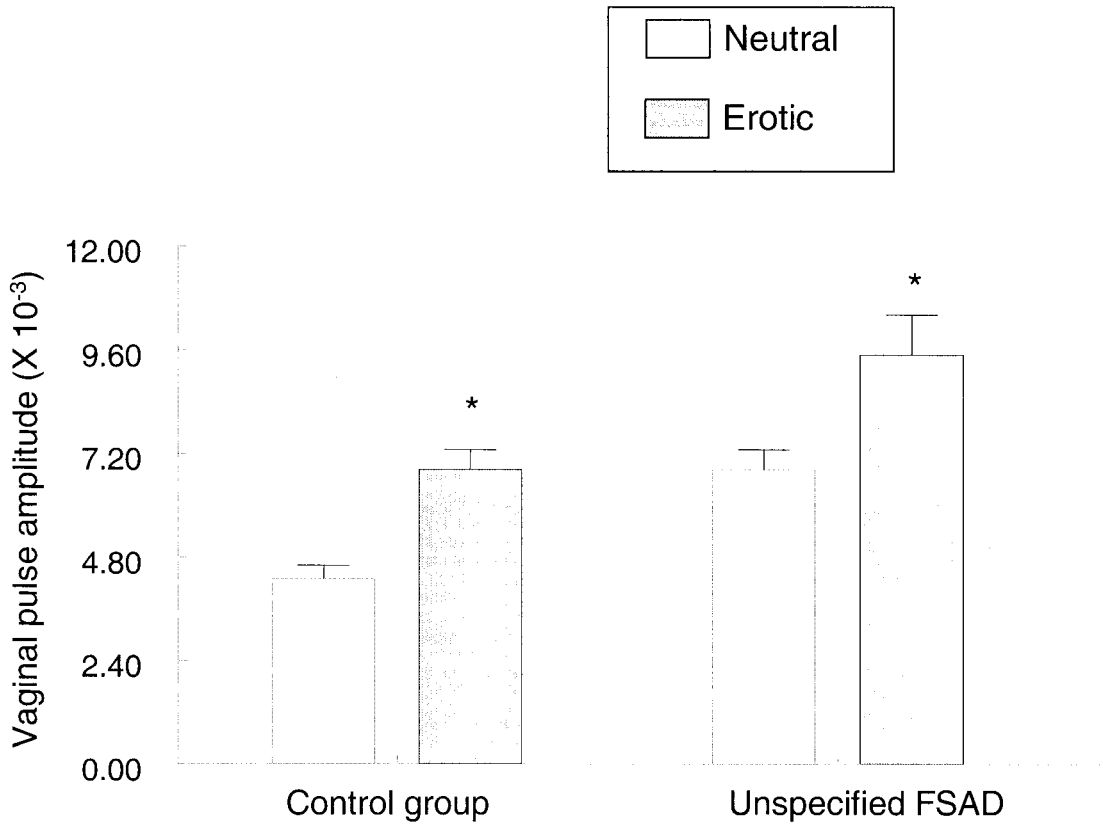


*Figure 7.* Effects of erotic stimulus on vaginal pulse amplitude during a heightened sympathetic nervous system condition in a control group and women with unspecified female sexual arousal disorder (FSAD). Data represent means (in millivolts) ± standard error of the mean.

*p < .001, significant main effect of erotic film

*Effects of film and FSAD on self-report measures during a heightened sympathetic nervous system condition*

Self-report data during the heightened SNS condition are presented in Figure 8. The main effect of erotic stimulus was significant for autonomic arousal, $F(1,59) = 56.38$, $p < .001$; perception of genital arousal, $F(1,58) = 97.96$, $p < .001$; mental sexual arousal, $F(1,59) = 91.96$, $p < .001$; anxiety, $F(1,59) = 13.76$, $p < .001$; and positive affect, $F(1,59) = 47.99$, $p < .001$. As illustrated in Figure 8, each of these self-report scores increased, except for anxiety, which decreased, in response to the erotic stimulus. The main effect of film on negative affect was not significant, $F(1,59) = 0.51$, $p > .05$. The control and unspecified FSAD groups significantly differed on perception of genital arousal, $F(1,58) = 7.58$, $p = .008$; mental sexual arousal, $F(1,59) = 10.16$, $p = .002$; and positive affect, $F(1,59) = 8.66$, $p = .005$, but not on autonomic arousal, $F(1,59) = 0.406$, $p > .05$; anxiety, $F(1,59) = 0.69$, $p > .05$; or negative affect, $F(1,59) = 0.67$, $p > .05$. Women without FSAD had a heightened perception of genital arousal, mental sexual arousal, and positive affect overall compared to women with unspecified FSAD. Film and unspecified FSAD approached a statistically significant interaction for autonomic arousal, $F(1,59) = 3.70$, $p = .059$ and positive affect, $F(1,59) = 3.31$, $p = .07$, and attained significance for perception of genital arousal, $F(1,58) = 6.24$, $p = .015$. There was no significant interaction for mental sexual arousal, $F(1,59) = 0.38$, $p > .05$; anxiety, $F(1,59) = 1.45$, $p > .05$; nor negative affect, $F(1,59) = 2.42$, $p > .05$. Simple effects analyses revealed that sexually healthy women experienced a significantly greater perception of genital arousal with the erotic stimuli than women with FSAD, $p < .01$. Although only marginally significant, interaction effects for autonomic arousal and positive affect were followed up with simple effects analyses. Such analyses revealed that sexually healthy control women had higher levels of perceived autonomic activity in response to the erotic film compared to women with FSAD, $p < .01$. Follow-up analyses for positive affect revealed that during both the neutral ($p < .05$) and the erotic stimulus conditions ($p < .001$), positive affect was comparably higher for

sexually healthy women, and that following exposure to the erotic film, the increase in positive affect was greater for control group women.

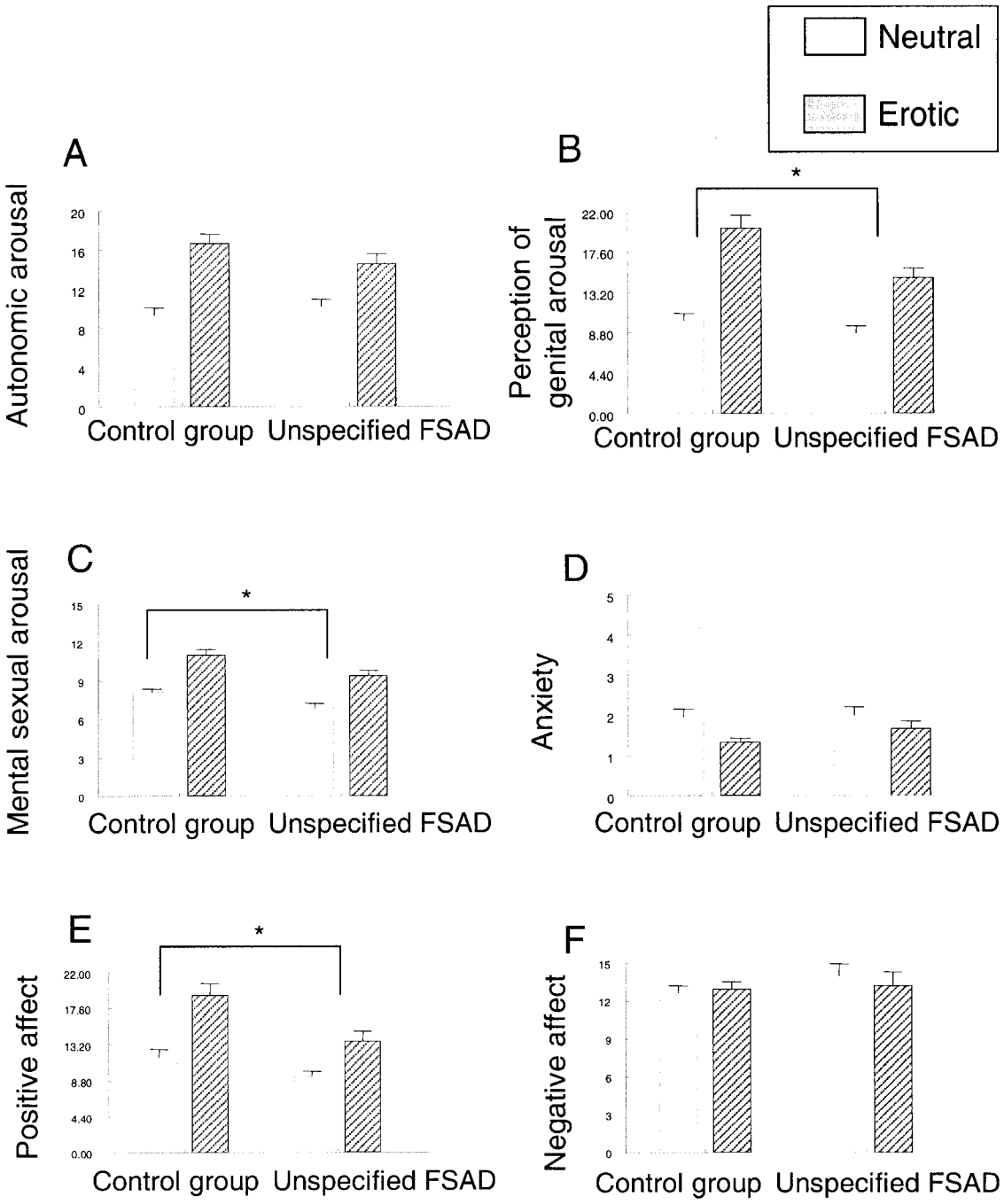


*Figure 8.* Effects of erotic stimuli on A) autonomic arousal, B) perception of genital arousal, C) mental sexual arousal, D) anxiety, E) positive affect, and F) negative affect in a control group and women with unspecified female sexual arousal disorder (FSAD) during heightened sympathetic nervous system (SNS) activity. Data represent means ± standard error of the mean.

*$p < .01$, significant main effect of group (control vs unspecified FSAD)

*Effects of heightened sympathetic nervous system activity on genital sexual arousal*

The interaction between SNS (baseline and heightened conditions) and group (control and unspecified FSAD) approached but did not reach statistical significance, $F(1,55) = 2.87$, $p = .09$, with neither the main effect of SNS, $F(1,55) = 2.49$, $p > .05$, nor the main effect of group, $F(1,55) = 0.30$, $p > .05$, being statistically significant, as illustrated in Figure 9. Reanalysis of these data employing the separate subtypes of FSAD (genital, anhedonic, and missed arousal disorder subtypes) with a repeated measures analysis of variance revealed a significant SNS by FSAD subtype interaction, $F(3,53) = 4.37$, $p = .008$, as shown in Figure 10. Subsequent simple effects analyses performed on each FSAD subtype, across baseline and heightened SNS conditions, revealed a significant increase in VPA percent change in the control group, $p < .05$, and a significant reduction in VPA percent change among women with anhedonic arousal, $p < .01$. The VPA percent change from baseline to heightened SNS condition were: 149% and 169% for the control group, and 223% and 179% in the anhedonic arousal subtype. Although Figure 10 suggests that the VPA percent increase was enhanced with heightened SNS activity in women with genital arousal disorder, simple effects analyses failed to detect a significant increase in this group, $p > .05$. The increase in VPA for women with genital arousal disorder was 117% during the baseline and 136% during the heightened SNS condition. The VPA increase for women with missed arousal subtype, was 132% during baseline and 143% during heightened SNS condition, was not statistically significant, $p > .05$.

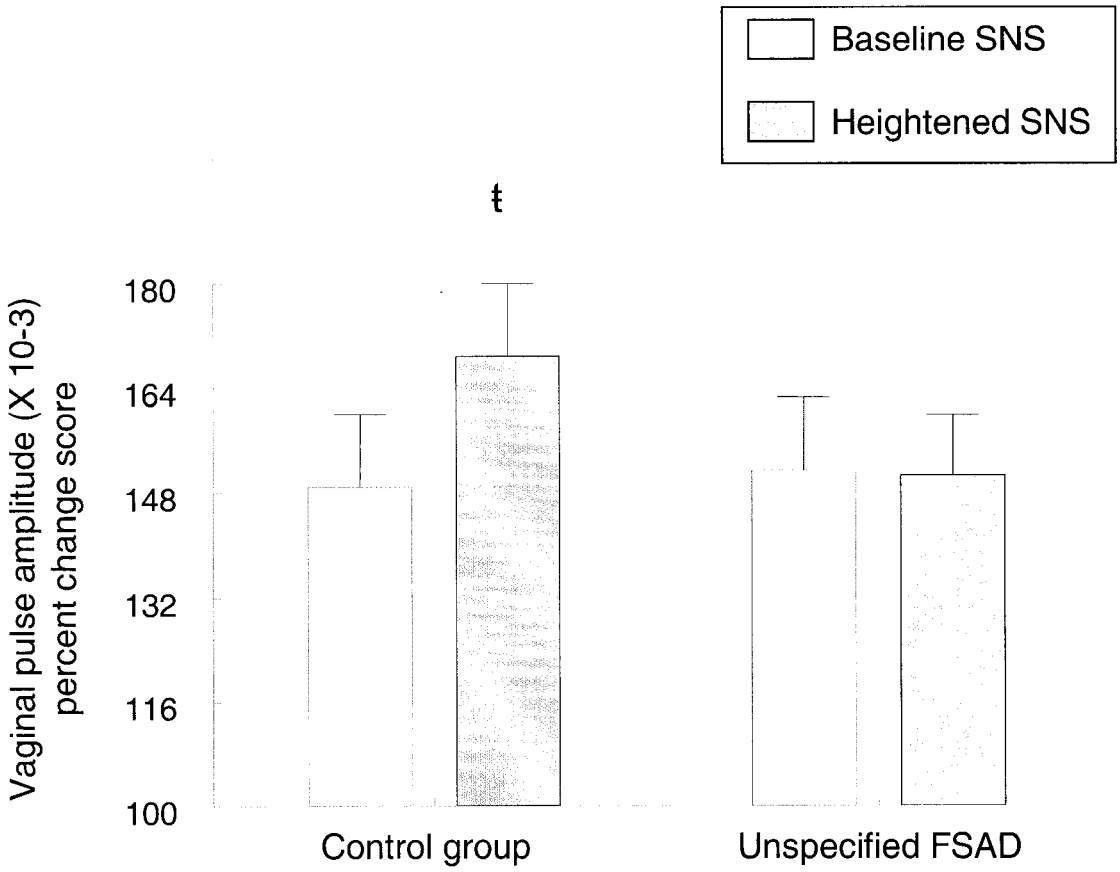


*Figure 9.* Effect of heightened sympathetic nervous system (SNS) activity on vaginal pulse amplitude percent change scores (erotic/neutral) in a control group and women with unspecified female sexual arousal disorder (FSAD). Data represent means ± standard error.

†$p = .09$, trend towards a difference in percentage VPA increase between baseline and heightened SNS activity

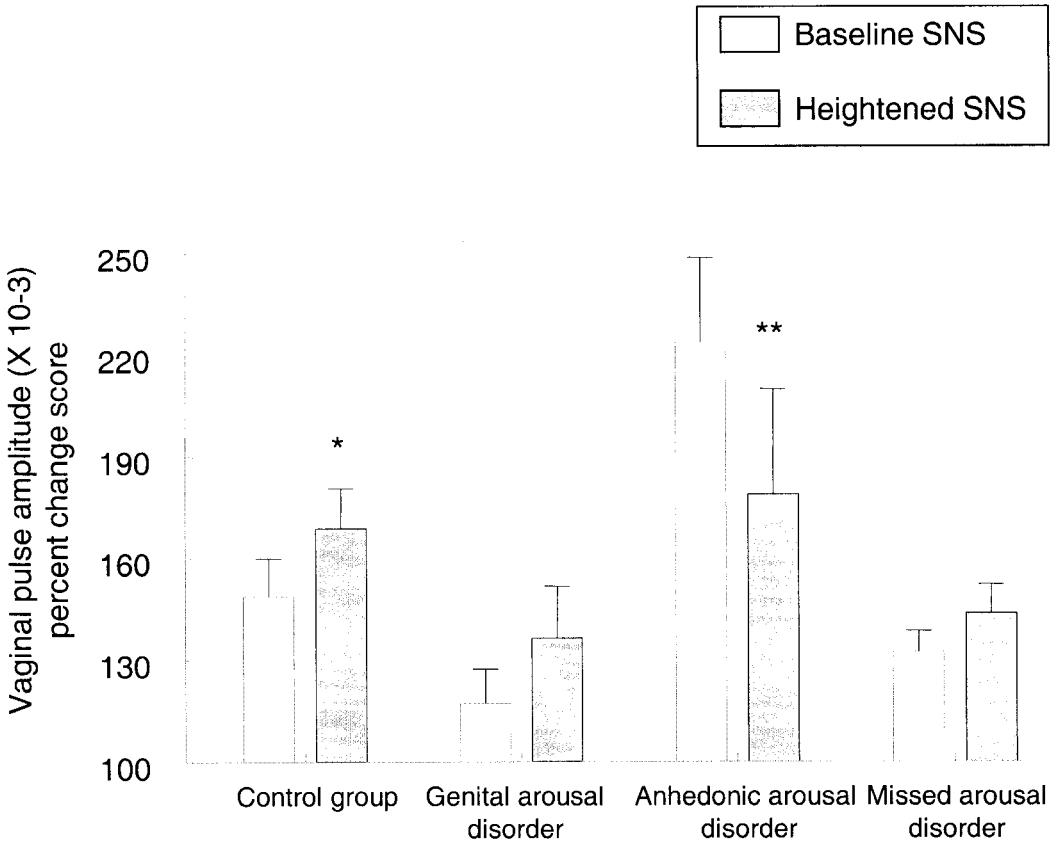


*Figure 10.* Effect of heightened sympathetic nervous system activity on vaginal pulse amplitude percent change scores (erotic/neutral) in a control group, women with genital arousal disorder subtype, women with anhedonic arousal subtype, and women with missed arousal subtype. Data represent means ± standard error.

*p < .05. **p < .01, significant difference in percentage VPA increase between baseline and heightened SNS activity

*Effects of heightened sympathetic nervous system activity on self-report measures*

The main effect of group was significant for autonomic arousal, $F(1,58) = 4.14$, $p = .047$, and perception of genital arousal, $F(1,58) = 9.15$, $p = .004$, and approached significance for negative affect, $F(1,56) = 3.68$, $p = .060$. The main effect of group was not significant for mental sexual arousal, $F(1,59) = 0.27$; anxiety, $F(1,59) = 0.31$; and positive affect, $F(1,59) = 0.59$, $p > .05$. Inspection of Table 10 reveals that negative affect and autonomic arousal were higher but perception of genital arousal was lower in women with unspecified FSAD compared to sexually healthy control women. The main effect of heightened SNS activity was not significant for any subjective measure including: autonomic arousal, $F(1,58) = 0.28$; perception of genital arousal, $F(1,58) = 0.38$; mental sexual arousal, $F(1,59) = 0.03$; anxiety, $F(1,59) = 0.75$; negative affect, $F(1,56) = 0.25$; or positive affect, $F(1,59) = 0.63$, $p > .05$ throughout, as shown in Table 10. There were no significant interactions between FSAD and SNS on any self-report measure [autonomic arousal, $F(1,58) = 0.71$; perception of genital arousal, $F(1,58) = 0.70$; mental sexual arousal, $F(1,59) = 0.07$; anxiety, $F(1,59) = 0.87$; negative affect, $F(1,56) = 0.01$; and positive affect, $F(1,59) = 0.75$, $p > .05$ throughout]. Reanalysis of the data based on FSAD subtype failed to reveal significant interactions between FSAD subtype and SNS for autonomic arousal, $F(3,56) = 8.15$; perception of genital activity, $F(3,56) = 0.38$; mental sexual arousal, $F(3,57) = 0.04$; anxiety, $F(3,57) = 0.50$; positive affect, $F(3,57) = 2.13$; or negative affect, $F(3,54) = 0.39$, $p > .05$ throughout.

Table 10

*Effect of heightened sympathetic nervous system activity on self-report measures of mental sexual arousal, perception of genital arousal, autonomic arousal, positive affect, negative affect, and anxiety in a control group and in women with unspecified female sexual arousal disorder ( FSAD). Data represent mean differences (± standard error).*

| | CONTROL GROUP | UNSPECIFIED FSAD |
|---|---|---|
| Mental sexual arousal | | |
| Baseline SNS | 2.76 (0.48) | 2.58 (0.40) |
| Heightened SNS | 2.90 (0.42) | 2.55 (0.38) |
| Perception of genital arousal* | | |
| Baseline SNS | 9.76 (1.30) | 5.16 (0.84) |
| Heightened SNS | 10.10 (1.46) | 6.03 (0.79) |
| Autonomic arousal* | | |
| Baseline SNS | 6.10 (1.04) | 3.81 (0.86) |
| Heightened SNS | 7.17 (1.19) | 4.32 (0.99) |
| Positive affect | | |
| Baseline SNS | 6.77 (1.09) | 6.52 (3.22) |
| Heightened SNS | 7.40 (1.50) | 4.32 (0.81) |
| Negative affect | | |
| Baseline SNS | 1.07 (0.61) | -0.25 (0.69) |
| Heightened SNS | 0.48 (0.45) | -0.81 (0.55) |
| Anxiety | | |
| Baseline SNS | -0.37 (0.20) | -0.45 (0.25) |
| Heightened SNS | -0.63 (0.18) | -0.32 (0.18) |

*Note:* Data represent the difference between neutral and erotic scores for each of the baseline and heightened SNS conditions, with positive values indicating an increase in that subjective measure following exposure to the erotic film.

*$p < .05$, significant main effect of group (control vs unspecified FSAD groups)

*Effects of heightened sympathetic nervous system activity on genital-subjective sexual arousal correlations*

Correlations were conducted on women in the control group and women with unspecified FSAD separately. Among sexually healthy women, there were no significant correlations between average VPA and mental sexual arousal ($r = -0.016$, $p > .05$), or between average VPA and perception of genital arousal ($r = -0.072$, $p > .05$). Likewise the use of maximum VPA instead of average VPA did not affect the correlation with mental sexual arousal ($r = -0.061$, $p > .05$) or the correlation with perception of genital arousal ($r = -0.095$, $p > .05$). Genital-subjective correlations were subsequently conducted for women with unspecified FSAD. The correlations between average VPA and mental sexual arousal ($r = 0.346$, $p = .06$), and between average VPA and perception of genital arousal ($r = 0.313$, $p = .09$) approached statistical significance. The use of maximum VPA instead of average VPA reduced the correlation with mental sexual arousal ($r = 0.261$, $p > .05$) and with perception of genital arousal ($r = 0.241$, $p > .05$).

Correlations were subsequently analyzed by FSAD subtype, as presented in Table 11. Among women with genital arousal disorder subtype, correlations between mental sexual arousal and both average VPA ($r = 0.679$, $p = .09$) and maximum VPA ($r = 0.692$, $p = .08$) approached statistical significance. Among these women, however, neither average VPA nor maximum VPA correlated with perception of genital arousal, $p > .05$. Among women with anhedonic arousal disorder, the correlation between average VPA and mental sexual arousal ($r = 0.734$, $p = .06$) and between average VPA and perception of genital arousal ($r = 0.744$, $p = .055$) approached statistical significance. Using maximum VPA instead of average VPA reduced these correlations to non-significant levels, $p > .05$. There were no significant genital-subjective correlations among women with missed arousal subtype using either average VPA, $p > .05$, or maximum VPA, $p > .05$.

Table 11

*Correlations between (1) perception of genital arousal and average vaginal pulse amplitude (VPA), (2) perception of genital arousal and maximum VPA, (3) mental sexual arousal and average VPA, and (4) mental sexual arousal and maximum VPA, during the heightened sympathetic nervous system condition.*

| | CONTROL GROUP | UNSPECIFIED FSAD | GENITAL AROUSAL DISORDER | ANHEDONIC AROUSAL DISORDER | MISSED AROUSAL DISORDER |
|---|---|---|---|---|---|
| Perception of genital arousal with: | | | | | |
| Average VPA | r = -0.072 | r = 0.313† | r = 0.043 | r = 0.744† | r = 0.138 |
| Maximum VPA | r = -0.095 | r = 0.241 | r = -0.084 | r = 0.627 | r = 0.133 |
| Mental sexual arousal with: | | | | | |
| Average VPA | r = -0.016 | r = 0.346 † | r = 0.679 † | r = 0.734 † | r = -0.059 |
| Maximum VPA | r = -0.061 | r = 0.261 | r = 0.692 † | r = 0.463 | r = -0.146 |

*Note:* Values represent Pearson Product Moment Correlation Coefficients, † $p \leq .09$.

# Discussion

The erotic film significantly increased VPA and self-report measures including perception of genital activity, mental sexual arousal, and positive affect, and significantly reduced anxiety in all women during a condition of heightened sympathetic nervous system activity. The finding of a near significant interaction between film and FSAD for positive affect and for autonomic activity suggests more positive affect to the film and higher levels of perceived autonomic activity (i.e., faster heart rate) are experienced in women without as compared to with FSAD.

This replicates the findings from Experiments 1 and 2 that female-made, female-focused erotic stimuli effectively increase sexual arousal and positive affect in women. The lack of a significant interaction between film and FSAD during the heightened SNS condition contrasts with the findings from Experiment 2 in a baseline SNS condition, in that it appears as though all women, regardless of FSAD subtype, experienced increased VPA to the erotic film during the heightened SNS state. The significant interaction between film and FSAD for perception of genital activity was identical to that seen in Experiment 2, during a baseline SNS condition, in that perception of genital activity increased in all women, but to a significantly greater degree in sexually healthy as compared to women with unspecified FSAD.

An examination of the effects of heightened SNS activity on VPA revealed differential effects depending on the subtype of sexual arousal disorder. Sexually healthy women showed enhanced VPA to heightened SNS activity. In contrast, women with anhedonic arousal subtype experienced a significant reduction in VPA percent increase after the heightened SNS manipulation. Women with genital arousal disorder subtype showed a marginal, but non-significant, increase in VPA, and women with missed arousal disorder showed no change in VPA percent increase.

That the findings replicated those in Experiment 1 for sexually healthy women suggests that laboratory-induced hyperventilation, by significantly

enhancing SNS activity, potentiates the genital arousal response to erotic stimuli. Heightened SNS activity did not increase VPA overall, but rather exerted its effects only after exposure to the erotic stimulus. This is consistent with the findings of Meston and colleagues (Meston and Gorzalka, 1995; 1996a; 1996b; Meston et al., 1997; Meston and Heiman, 1998) who used acute, intense exercise as a method of enhancing SNS activity. These studies found that exercise significantly facilitated VPA only in the presence of erotic stimuli and had no effect on its own.

Women in the current study who self-reported with subjective sexual arousal difficulties only (i.e., anhedonic arousal disorder) showed a significantly reduced VPA response to erotica during the heightened SNS compared to the baseline condition. Heightened SNS activity had no effect on subjective arousal in this group of women, suggesting that the effects of SNS manipulation occurred at a physiological, and not cognitive level. These findings are reminiscent of the findings of Meston and Gorzalka (1996b) who found that women with orgasmic difficulty experienced a similar response to exercise-induced increases in SNS activity, whereas orgasmic women showed patterns similar to the sexually healthy control group in the current experiment. The authors suggested that perhaps the physiological events taking place during heightened SNS activity are detrimental to the sexual response in anorgasmic women. This explanation may be extended to the current sample of women with anhedonic arousal subtype. Accumulating clinical experience with women complaining of anhedonic sexual arousal disorder suggests that this subgroup would not benefit from vasoactive medication designed to increase genital vasocongestion (Basson, 2002a; 2002b), given that there is no evidence of impaired genital vasocongestion in this group. The current findings that enhanced SNS activity reduced VPA supports this view, and implies that agents designed to increase SNS activity may in fact impair genital arousal. The extent to which the SNS plays a role in the anhedonic response to sexual arousal in this sample of women can only be speculated at this point. It is possible that cognitive distraction, related to heightened SNS activity, may contribute to impaired mental sexual arousal in this

group of women. Excitation transfer theory posits that individuals experiencing heightened activity followed by a sexual stimulus will report significantly lower levels of sexual arousal if they perceive residual effects from the prior activity (Cantor, Zillmann, & Bryant, 1975). A second explanation for the reduced VPA response to heightened SNS activity for women with anhedonic arousal is that the SNS manipulation may have elicited distraction from attending to their genital activity. Techniques that draw attention away from genital excitement indeed have been shown to significantly reduce the actual level of genital sexual arousal (Sakheim, Barlow, Beck, & Abrahamson, 1984). Barlow's (1986) cognitive interference model of sexual dysfunction posits that psychogenic sexual dysfunction may result when a cognitive interference process interacts with anxiety. Instead, sexually functional subjects may benefit from the arousal-enhancing effects of anxiety since they process and focus on erotic cues without difficulty. Still another possibility, for which there is no empirical evidence as yet, is that the anhedonic arousal subtype may already be functioning at a higher level of SNS activity than the other FSAD groups and that it is possible that the addition of the SNS manipulation functioned to reduce VPA. According to the Yerkes-Dodson Law of arousal and performance (Yerkes & Dodson, 1908), there is an optimal level of arousal below and above which performance is significantly impaired. If the facilitatory effect of SNS activity on VPA indeed follows such an inverted-U pattern, this would provide support for this speculation. Future studies should aim to directly assess levels of SNS activity during baseline and following SNS manipulations in order to test this hypothesis.

Such a model may account for the differences between the genital arousal and anhedonic arousal disorder groups if one considers these dysfunctions as having primarily organic versus primarily psychogenic etiologies, respectively. Heightened SNS activity produced a non-significant increase in VPA for women with genital FSAD. This corroborates the findings in postmenopausal women with FSAD, in which the SNS-enhancing agent, phentolamine mesylate led to increased VPA responses. The lack of significance in the current study may therefore be attributable to low sample sizes and future studies should aim to

investigate this potential effect of SNS in larger samples of premenopausal women with genital FSAD. That this sample did not show increased VPA during a baseline SNS condition (Experiment 2) but did show increased VPA to erotic stimuli during a heightened SNS state (Experiment 3) provides support for the notion that enhanced SNS activity may improve genital arousal in this subgroup of women. The lack of significance in this increase may be attributable to an inability of laboratory-induced hyperventilation to evoke sufficient levels of SNS activity that would subsequently facilitate genital sexual arousal. Meston and Gorzalka (1996b) employed intense, acute exercise which has been found to lead to significantly elevated levels of SNS activity for up to 40 minutes following cessation of exercise and to lead to changes in levels of testosterone, cortisol, and prolactin. In an effort to employ a technique that did not preclude the participation of women who are not physically capable of intense exercise for 20 minutes, we used laboratory-induced hyperventilation which has been shown to lead to SNS predominance for 7 minutes (Achenbach-Ng, et al., 1994). It is possible that the use of exercise instead of hyperventilation would have allowed the facilitation in VPA response in women with genital arousal subtype to reach statistical significance. It is also possible that a pharmacological intervention (e.g., phentolamine mesylate) would have been more effective at enhancing VPA, though the potential side effects of such a manipulation must be considered.

In contrast, women with missed arousal disorder subtype did not show differential patterns of VPA during the baseline and heightened SNS conditions. Notably, this group was characterized by self-reported impairments in both genital and subjective sexual arousal, though impaired vaginal vasocongestion was not apparent during laboratory testing. Clinically this group is differentiated from anhedonic arousal subtype in that the former is unaware whereas the latter is aware of genital congestion (Basson, 2002b). Moreover, the current data suggest that in the presence of heightened SNS activity, these two subtypes can be differentiated.

Synchrony between genital and subjective sexual arousal during a condition of heightened SNS activity was not apparent in sexually healthy women, regardless of whether maximum or average VPA was used. Of the studies which have examined genital sexual arousal following heightened SNS activity in sexually functional women (Experiment 1; Hoon et al., 1977; Meston & Gorzalka, 1996b; Palace & Gorzalka, 1990), only two explored potential correlations between genital and subjective sexual arousal during the heightened SNS condition. Palace and Gorzalka (1990) reported no correlation between VBV and self-report measures of arousal. Similarly, the results of Experiment 1 revealed desynchrony between VPA and perception of genital arousal for premenopausal women; however, the relationship between VPA and mental sexual arousal approached significance. It remains unknown, therefore, if heightened SNS activity leads to synchrony between VPA and self-reported sexual arousal in premenopausal women given these conflicting findings. Premenopausal women participating in the current study do not appear to differ appreciably on demographic variables from those employed in Experiment 1. In contrast, there was a near significant positive correlation between VPA and subjective sexual arousal, but not perception of genital arousal in women with genital arousal disorder subtype. Synchrony in this sample of women has never been previously examined. Moreover, given the low sample size, and the fact that a medium effect size would require a sample of 85 subjects to be statistically detected (Cohen, 1992), this suggests that this positive correlation is quite robust. It is possible that the synchrony with mental sexual arousal but desynchrony with perception of genital arousal in this subsample reflects the finding that women with genital arousal disorder did experience an increase in VPA with the erotic film during the heightened SNS condition, though their perceptions of genital arousal were not affected. This parallels the findings for this group during the baseline SNS condition of Experiment 2. That the correlation between subjective sexual arousal and actual genital sexual arousal approached statistical significance has clinical implications for this group. Perhaps it may be of therapeutic value to teach women with genital arousal

disorder subtype to increase their focus on genital excitement during sexual events. It must be kept in mind, however, that the desynchrony present with perception of genital arousal may be related to this scale being a less valid or less sensitive indicator of affect.

In women with anhedonic arousal subtype, average VPA approached significance for a positive correlation with both mental sexual arousal and perception of genital arousal; the use of maximum VPA reduced these near significant correlations. It is possible that this group accounts for the near significant positive correlations seen in the unspecified FSAD group given that the other subgroups experienced desynchrony between genital and subjective measures. It is possible that in this subgroup of women, the experience of genital vasocongestion influences self-reported sexual arousal, or vice versa, to a greater degree than in the other subgroups of women. In terms of therapeutic implications, it is possible that this subgroup who experience impaired mental sexual arousal, may benefit from drawing attention to their "normal" vasocongestive patterns and pointing out its influence on their mental sexual arousal. Clearly further research which investigates the relationship between response to treatment and genital-subjective synchrony would help to elucidate the validity of this speculation. Similar to women in the control group, those labelled as missed arousal disorder subtype experienced desynchrony between VPA, either maximum or average, and mental sexual arousal and perception of genital arousal. Comparison of these findings to those obtained in Experiment 2 suggests that heightened SNS activity does not affect genital-subjective desynchrony in women with missed arousal disorder subtype.

Overall the findings from Experiment 3 suggest that heightened SNS activity effectively facilitates genital vasocongestion in sexually healthy women, and shows promise for enhancing VPA in premenopausal women with genital arousal disorder. Moreover, the current results suggest that heightened SNS activity may play a detrimental role in the genital arousal patterns of women with anhedonic arousal subtype. It is unclear, based on the current findings, whether or not women diagnosed with missed arousal disorder would benefit from

enhanced SNS activity. These data suggest that SNS-enhancing drugs, such as phentolamine mesylate, may be effective specifically for women with genital arousal disorder if those women with anhedonic arousal subtype are excluded. It is possible that the marginally significant effect of phentolamine mesylate in postmenopausal women with FSAD not receiving hormone replacement (Rubio-Aurioles et al., 2002) would have been magnified if women with anhedonic arousal subtype were excluded. Given that no self-report measure of sexual arousal or affect was influenced by the current SNS manipulation, the current findings suggest that any observable effect of heightened SNS activity on genital arousal is occurring at physiological, and not at cognitive levels.

Importantly, the current findings have implications for the diagnostic category FSAD. Considerable research has demonstrated the elusive nature and complexity of FSAD (Basson 2000a, 2001a, 2001b, 2002a, 2002b) and has argued against the current DSM-IV classification which necessitates lubrication difficulties in order for a diagnosis of FSAD to be met. The current findings indicate that not only can women with FSAD be subtyped according to genital versus subjective sexual arousal impairment, but this classification is further supported by their differential responses to heightened SNS activity. Future studies should aim to further elucidate the role of the SNS in the development, maintenance, and treatment of FSAD and its subtypes.

## Experiment 4: Genital-subjective Sexual Arousal Correlations in Laboratory and At-home Settings: Effects of Female Sexual Arousal Disorder subtypes

Investigations that assess female sexual arousal consistently fail to find synchrony between objective psychophysiological (i.e., genital) patterns and subjective responses to an erotic stimulus in the laboratory (Everaerd et al., 2000; Rosen & Beck, 1988). This discordance between subjective and genital measures is seen in various subgroups of premenopausal (Experiment 1; Geer et al., 1974; Heiman, 1977; Laan et al., 1994; Laan et al., 1995, Meston & Gorzalka, 1995; 1996a; Tuiten et al., 1996) and postmenopausal (Experiment 1; Morrell et al., 1984) women, in women with sexual dysfunction (Experiment 2 and 3; Meston & Gorzalka, 1996b; Palace & Gorzalka, 1990), and in women with chronic dyspareunia (Wouda et al., 1998). The typical profile of desychrony manifests as increased genital sexual arousal accompanied by less, little, or no increase in subjective sexual arousal following exposure to an erotic stimulus (Laan et al., 1994). Although numerous explanations to account for such desynchrony in women have been put forth and empirically tested (see pages 8-10, General Introduction), it remains puzzling as to why genital and subjective sexual arousal are desynchronous in women but not men (Hall, Binik, & DiTomasso, 1985; for a review see Everaerd et al., 2000). It has recently been speculated that the genital arousal response in women may represent an automatized process that is adaptive from an evolutionary perspective (Laan, 2002).

Whereas the assessment of subjective sexual arousal in the laboratory context does not consistently correlate with genital arousal, the extent to which the latter correlates with sexual arousal in the "real-life", non-laboratory setting is unknown. In contrast to laboratory studies of men (Janssen, Carpenter, & Graham, 2002) it is possible that erotic stimuli employed in studies of women are insufficient to evoke subjective sexual arousal and may be seen as artificial by women in the laboratory setting. In particular, it has been argued that although genital arousal contributes somewhat to the subjective experience of sexual

arousal, external, situational cues may be more important in determining the subjective experience for women (Everaerd et al., 2000; Laan & Everaerd, 1995). Heiman (1980) attempted to correlate laboratory genital arousal, using the VPA signal of the VPP, with women's self-reported level of sexual arousal and satisfaction outside of the laboratory setting. Contrary to her hypotheses, Heiman found that higher VPA responding in the laboratory was associated with less arousal, lower enjoyment, and lower frequency of intercourse (Heiman, 1980). Heiman concluded that laboratory sexual arousal and real-life sexual arousal are different phenomena. How women were conceptualizing their at-home sexual arousal is unknown given that the Personal History Questionnaire employed does not separate the experience of genital from mental sexual arousal (Harley, 1998). The explicit delineation between mental and genital sexual arousal impairment in women with sexual dysfunction is a recent addition to the literature (Basson et al., 2000) from a previous nosology that strictly focused on lubrication difficulties (American Psychiatric Association, 1994). Thus, that laboratory-based VPA and at-home sexual arousal were not correlated (Heiman, 1980) still leaves open the possibility laboratory-based VPA is related to other aspects of the sexual arousal experience, and that more detailed delineation with respect to what aspect of sexual arousal is assessed is necessary in order to explore this relationship. The current study will seek to correlate VPA with assessment of various components of the sexual arousal experience in order to clarify these findings.

It is possible that increases in vaginal vasocongestion, as measured by the VPP, are not experienced as pleasurable by women. Clinical experience strongly suggests that pleasure evoked from direct stimulation of sexually responsive genital areas may provide an indirect measure of genital congestion (Basson, 2002a). Erectile tissue in the bulb of the vestibule has broader anatomical boundaries than previously thought (O'Connell, Hutson, Anderson, & Plenter, 1998), and may be stimulated in intercourse. Although women may not be aware that their erectile tissue is tumescent, their experience of subjective arousal is increased if these structures are skillfully stimulated (Basson, 2000b;

2002a). The underlying neurophysiology of vulvar engorgement may be different from that of the vaginal capillary beds, and that of the vaginal smooth muscle (Giuliano et al., 2002). Moreover, the clitoris has been suggested to play a major role during sexual activity because of the pleasurable sensations experienced by its stimulation. Researchers exploring the construct of genital-subjective sexual arousal desynchrony have yet to include assessment of perceived vulvar or clitoral arousal in their assessment of synchrony. Based on clinical evidence, one might speculate that the correlation between self-reported pleasure from direct genital stimulation of engorging tissue and mental sexual arousal in the laboratory may be positive in cases where VPA and mental sexual arousal are desynchronous, particularly if this pleasure from direct stimulation is important in contributing to women's experience of sexual arousal. To date, the hypothesis that pleasure from direct genital stimulation is more related to mental sexual arousal than laboratory-based VPA is has never been empirically tested.

The results of Experiment 2 suggest that subtypes of FSAD may be differentiated on the basis of laboratory psychophysiological patterns, and on correlations between genital and subjective sexual arousal. Specifically, women complaining solely of impaired genital arousal (i.e., genital arousal disorder) showed a positive correlation between VPA and mental sexual arousal, whereas this correlation was not significant in women with anhedonic or missed sexual arousal disorder, and was significantly negative in the sexually healthy group. It is possible that the use of an indirect measure of genital arousal, pleasure from direct genital stimulation, may lead to different patterns of synchrony in these FSAD subtypes.

It has been argued that women do not attend to genital changes during sexual arousal, and that genital congestion contributes little to a woman's overall experience of sexual arousal. Laan, Everaerd, van der Velde, and Geer (1995) found that the subjective report of sexual arousal is dependent on detection of changes in genital arousal (i.e., change from medium to high VPA), whereas the actual intensity of genital arousal (i.e., absolute level of VPA) contributes very little, if anything, to women's subjective report of mental sexual arousal. To date,

these data have been collected only among sexually healthy women. Anecdotal reports among clinical cases of FSAD suggest that women with genital arousal disorder do not derive pleasure from direct stimulation of engorging genital tissue, unlike sexually healthy women where this stimulation may affect a woman's self-reported level of sexual arousal (Basson, 2002a). Women with anhedonic and missed sexual arousal disorder have yet to be assessed for the relative balance between awareness of genital excitement versus mental sexual arousal. However, it can be hypothesized that women with anhedonic sexual arousal disorder would experience significantly less mental sexual excitement relative to genital excitement, whereas those with missed sexual arousal disorder, who report impairment in mental and genital excitement, would show low levels of both genital and subjective arousal, and therefore, they would be relatively balanced. Through the use of composite scores, this study will attempt to compare women with FSAD subtypes and sexually healthy women on the relative balance between awareness of genital excitement versus mental sexual arousal through the use of composite scores.

The assessment of real-life sexual arousal was conducted using a semi-structured interview commonly used clinically in the assessment of women with FSAD (Basson & Brotto, 2001). This detailed assessment interview includes assessment of mental sexual arousal, awareness of vaginal wetness/pulsing/throbbing, and pleasure from direct stimulation of engorging genital tissues, all in the at-home setting. Thus, the objectives of this experiment were as follows: (1) to compare VPA to three different components of subjective sexual arousal assessed in reference to the at-home setting; (2) to use self-reported pleasure from direct genital stimulation as an indirect measure of genital congestion, and to correlate it with laboratory-based subjective sexual arousal; (3) to compare the relative balance between mental sexual excitement and awareness of genital excitement; and (4) to compare women with FSAD subtypes and a control group of women on each of the preceding analyses.

## Methods

*Participants*

Sixty-one women participated in this experiment, and were recruited through advertisements in local newspapers, throughout the Vancouver community, and across campus at the University of British Columbia. Participants had also taken part in Experiments 2 and 3. Thirty women were free of sexual difficulties, 16 were categorized as missed arousal disorder, 7 as genital arousal disorder, and 8 as anhedonic arousal disorder.

*Procedure*

The detailed structured interview took place following genital arousal assessment (conducted for Experiments 2 and 3). This interview was conducted in a private testing room by the same investigator who conducted that participant's session for Experiments 2 and 3. The structured interview employed had been developed for another investigation, and is commonly used in the assessment of women with FSAD in the clinical setting (Basson & Brotto, 2001). This "Detailed Interview Assessment of Real-Life Sexual Arousal" (see Appendix) assesses a woman's experience of sexual arousal in her real-life sexual setting, and includes assessment of: (1) intensity of mental sexual excitement in response to direct and indirect sexual stimulation, (2) awareness of genital arousal (i.e., throbbing, wetness) in response to direct and indirect sexual stimulation, and (3) intensity of pleasant sexual genital sensations in response to direct sexual stimulation (i.e., pleasure from touching female erectile tissue). Components 1 and 2 were assessed in response to several forms of non-direct [i.e., viewing erotic films; touching, holding, or non-deep kissing; deep-mouth kissing; breast stimulation] and direct [i.e., manual-genital contact; oral-genital contact; penile-vulval contact; vaginal intercourse; masturbation] sexual contact. By definition, component 3 was only assessed in response to direct genital contact (manual or genital). Women were asked to give a response on a 7-point Likert scale ranging from 1 (not at all arousing/not at all aware) to 7 (intensely arousing/intensely aware). Procedures were identical for all women.

Responses were then recorded by the female investigator. At the completion of the session, women were debriefed and provided with information on resources for treatment of FSAD in the Greater Vancouver area.

*Data analyses*

The Detailed Interview Assessment of Real-Life Sexual Arousal was scored by tallying each of the nine responses in components 1 and 2, and the five responses in component 3, and dividing by the number of items endorsed, resulting in a mean response for that component. Sum totals were not used because there were instances in which an individual did not engage in one of the sexual acts (e.g., oral sex). Sexually healthy women were initially compared to all women with FSAD (FSAD unspecified) on the results from the Detailed Interview Assessment of Real-Life Sexual Arousal using Independent Samples t-tests. Subsequently, diagnostic groups were compared using ANOVAs with each of the 3 interview components as the dependent variables. The fixed factor in these analyses was FSAD subtype (i.e., sexually healthy women, and genital arousal disorder, anhedonic arousal disorder, or missed arousal disorder subtypes). Multiple ANOVAs, instead of the multivariate ANOVA (MANOVA) approach were preferred because each of the three components of the detailed assessment were deemed to be conceptually independent (Huberty & Morris, 1989) based on the empirical literature as well as our clinical experience with women with FSAD. In other words, women's experience of mental sexual excitement is a separate component of sexual arousal than is her awareness of genital throbbing/wetness. Although published data do not exist, our clinical experience with women strongly suggests that the experience of pleasure from direct genital stimulation is distinct from a woman's awareness of genital throbbing/wetness. In cases of a significant overall ANOVA, pairwise comparisons between diagnostic groups using Tukey's test were conducted. A new composite variable was computed that reflected the difference between detailed assessment component 1 (i.e., mental sexual excitement) and detailed assessment component 2 (i.e., awareness of genital throbbing/pulsing/wetness).

The relative difference between awareness of mental versus genital excitement in the real-life sexual setting was then compared across diagnostic groups using Planned Orthogonal Contrasts. A priori predictions that: (1) women with missed and anhedonic arousal disorder subtypes would display a significantly lower difference between mental and genital sexual awareness compared to a control group of women or those with genital arousal disorder subtype, and (2) women with genital arousal disorder may have a larger difference between mental and genital arousal compared to sexually healthy women or those with missed and anhedonic arousal disorder subtypes, permitted these analyses. Pearson product moment correlations were used to investigate the degree of association between data from the photoplethysmographic results and each of the three components of at-home sexual arousal. Such correlations were conducted on FSAD and control groups separately utilizing average VPA as well as the 30-second interval of maximum VPA separately. In all conditions, a p level of .05 was deemed significant.

## Results

### *Demographic information*

Thirty sexually healthy and 31 women with FSAD completed the Detailed Interview Assessment of Real-Life Sexual Arousal. Psychophysiological data were available for 29 sexually healthy and 28 women with FSAD. The demographic characteristics of the sample can be found in the results section of Experiment 2.

### *Effects of FSAD on detailed assessment responses*

Independent samples t-tests comparing women in the control group to women with unspecified FSAD revealed that those with FSAD scored significantly lower on interview component 1 (i.e., real-life mental sexual excitement), $t(59) = 5.90$, $p < .001$, lower on interview component 2 (i.e., awareness of genital arousal), $t(59) = 4.65$, $p < .001$, and lower on interview component 3 (i.e., pleasant sexual genital sensation from direct genital touch),

$t(49.9) = 4.68$, $p < .001$. Analyses were subsequently conducted comparing scores from each of the FSAD subtypes (genital, anhedonic, and missed arousal disorder subtypes) and scores of women in the control group on each of the components of the Detailed Interview Assessment of Real-Life Sexual Arousal. A one-way ANOVA was significant for component 1 (i.e., mental sexual excitement), $F(3,57) = 17.52$, $p < .001$, with Tukey's multiple comparisons test revealing that both the anhedonic subtype ($p = .005$) and the missed arousal subtype ($p < .001$) differed significantly from the sexually healthy group (Figure 11A). Specifically, scores in these subtypes were significantly lower than those of women in the control group. Scores were also significantly lower in women with missed arousal subtype compared to those with genital arousal subtype ($p = .008$).

Significant group differences for component 2 (i.e., awareness of genital throbbing, wetness, and pulsing) emerged, $F(3,57) = 9.98$, $p < .001$. Women classified as missed arousal subtype scored significantly lower than sexually healthy control women ($p < .001$). There was a trend towards significance with the genital arousal disorder subtype scoring lower than the control group ($p = .06$), as shown in Figure 11B. There was also a trend towards significance for the missed arousal subtype scoring lower than the anhedonic arousal subtype ($p = .06$).

Interview component 3 (i.e., experience of pleasant sexual genital sensations) significantly differed between diagnostic groups, $F(3,57) = 10.39$, $p < .001$. Women with missed arousal subtype scored significantly lower than the control group ($p < .001$) and significantly lower than women with anhedonic arousal subtype ($p < .05$), as illustrated in Figure 11C. Though women with genital arousal disorder scored lower than those in the control group (Figure 11C), this only approached statistical significance ($p = .09$).

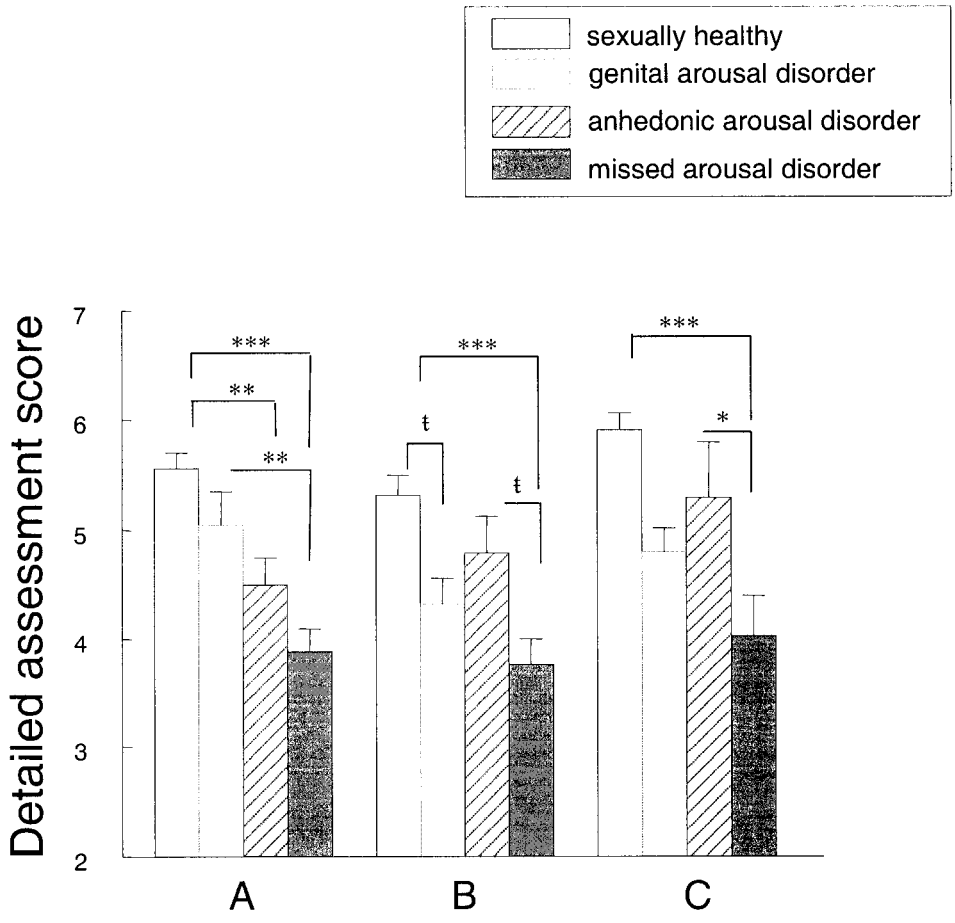


*Figure 11.* Detailed Interview Assessment of Real-Life Sexual Arousal including A) awareness of mental sexual excitement, B) awareness of genital throbbing, wetness, and pulsing, and C) pleasant sexual genital sensations in response to direct genital stimulation. Data are presented separately for women in the control group (N = 30), those with genital arousal disorder (N = 7), anhedonic arousal disorder (N = 8), and missed arousal disorder (N = 16) subtypes of female sexual arousal disorder (FSAD).

*Note:* Maximum value is 7.00 for all components.

***$p < .001$, **$p < .01$, *$p < .05$, $^{t}p = .06$

*Correlations between genital and subjective sexual arousal using laboratory-based VPA and at-home mental sexual excitement in women with and without FSAD*

The correlation between VPA and mental sexual excitement (interview component 1) in sexually healthy women was not significant with either average VPA ($r = 0.003$, $p > .05$) or maximum VPA ($r = 0.110$, $p > .05$). Similarly there were no significant correlations in women with unspecified FSAD using either average VPA ($r = 0.178$, $p > .05$) or maximum VPA ($r = 0.144$, $p > .05$). When subtypes of FSAD were investigated separately, the correlation with either average ($r = -.48$, $p > .05$) or maximum VPA ($r = -.27$, $p > .05$) remained nonsignificant in women with genital arousal disorder. In women with anhedonic arousal subtype, there was similarly no significant correlation with average ($r = .41$, $p > .05$) or maximum VPA ($r = .23$, $p > .05$). There were no significant correlations with either average ($r = .45$, $p > .05$) or maximum VPA ($r = .19$, $p > .05$) among women with missed arousal disorder (see Table 12).

Table 12

*Correlations between maximum vaginal pulse amplitude (VPA) and average VPA with the Detailed Interview Assessment of Real-Life Sexual Arousal components: mental sexual excitement; awareness of genital throbbing, wetness, or pulsing; and experience of pleasant sexual genital sensations in sexually healthy control women (N = 29) and women with genital arousal disorder (N = 7), anhedonic arousal disorder (N = 7) and women with missed arousal disorder (N = 14).*

| | Mental sexual excitement | Awareness of genital sexual arousal | Pleasant sexual genital sensations |
|---|---|---|---|
| **Control Group** | | | |
| Average VPA | r = 0.003 | r = 0.034 | r = -0.203 |
| Maximum VPA | r = 0.110 | r = 0.097 | r = -0.212 |
| **Unspecified FSAD** | | | |
| Average VPA | r = 0.178 | r = 0.347$^{t}$ | r = 0.281 |
| Maximum VPA | r = 0.144 | r = 0.364* | r = 0.278 |
| **Genital arousal disorder** | | | |
| Average VPA | r = -0.477 | r = 0.224 | r = -0.018 |
| Maximum VPA | r = -0.273 | r = 0.337 | r = 0.084 |
| **Anhedonic arousal disorder** | | | |
| Average VPA | r = 0.410 | r = 0.178 | r = 0.169 |
| Maximum VPA | r = 0.234 | r = 0.168 | r = 0.050 |
| **Missed arousal disorder** | | | |
| Average VPA | r = 0.452 | r = 0.309 | r = 0.368 |
| Maximum VPA | r = 0.183 | r = 0.212 | r = 0.322 |

*$p < .05$, $^{t}p = .07$

*Correlations between genital and subjective sexual arousal using laboratory-based VPA and at-home awareness of genital throbbing, wetness, or pulsing in women with and without FSAD*

Among sexually healthy control women, the correlation between awareness of genital throbbing, wetness, or pulsing (interview component 2) and average VPA was not significant, $r = 0.034$, $p > .05$. Similarly, the correlation with maximum VPA was not significant, $r = 0.097$, $p > .05$. Among women with unspecified FSAD, however, there was a significant correlation between this measure and maximum VPA, $r = 0.364$, $p < .05$, and a marginally significant correlation when average VPA was used, $r = 0.347$, $p = .070$, as illustrated in Table 12. When only those with genital arousal disorder were examined, there were no significant correlations with average ($r = .22$, $p > .05$) or maximum VPA ($r = .34$, $p > .05$). In women with anhedonic arousal subtype, the correlations with average ($r = .18$, $p > .05$) and maximum VPA ($r = .17$, $p > .05$) were not statistically significant. There were also no significant correlations in women with missed arousal disorder with either average ($r = .31$, $p > .05$) or maximum VPA ($r = .21$, $p > .05$).

*Correlations between genital and subjective sexual arousal using laboratory-based VPA and at-home experience of pleasant sexual genital sensations, in women with and without FSAD*

Interview component 3 (i.e., pleasant sexual genital sensations) did not correlate with average VPA ($r = -0.203$, $p > .05$) nor with maximum VPA ($r = -0.212$, $p > .05$) in sexually healthy women. Similarly, no significant correlations were found in women with unspecified FSAD: correlation with average VPA ($r = 0.281$, $p > .05$) and correlation with maximum VPA ($r = 0.278$, $p > .05$). In women with genital arousal disorder, there was no significant correlation with either average ($r = -.018$, $p > .05$) or maximum VPA ($r = .084$, $p > .05$). No significant correlation was found in women with anhedonic arousal subtype with either average ($r = .169$, $p > .05$) or maximum VPA ($r = .050$, $p > .05$). Women

with missed arousal subtype also failed to show synchrony in either average ($r = .368$, $p > .05$) or maximum ($r = .322$, $p > .05$) VPA, as shown in Table 12.

*Mental sexual arousal versus awareness of genital sexual excitement across diagnostic groups*

A composite score for each woman, calculated by subtracting the woman's average response to detailed assessment component 2 (i.e., awareness of genital sexual arousal) from her average response to detailed assessment component 1 (i.e., mental sexual excitement) was obtained and compared between the subtypes of FSAD and sexually healthy control women. Planned Orthogonal Contrasts revealed a significant difference between the genital arousal disorder and anhedonic arousal subtypes on this variable with the latter showing a significantly lower difference, $t(57) = -2.28$, $p = .026$, as shown in Figure 12. Though the other planned contrasts did not reach statistical significance, Figure 12 suggests a difference between the genital arousal subtype and control group with the former showing much greater mental versus awareness of genital arousal. Low sample sizes likely account for this lack of statistically significant difference.

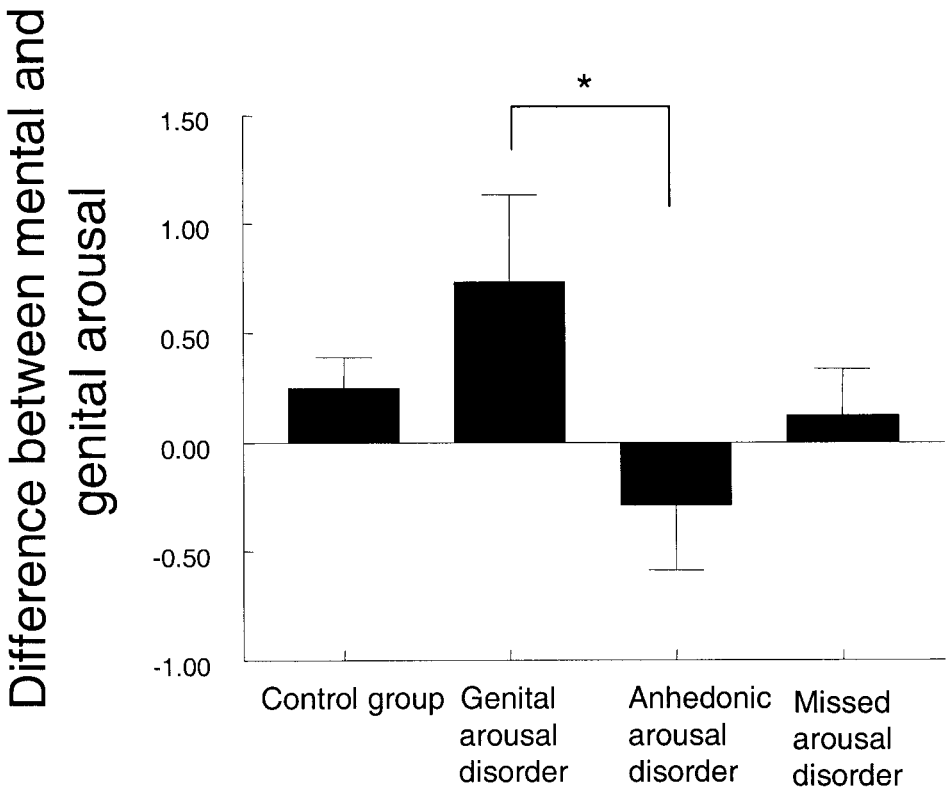


*Figure 12.* Difference between mental sexual arousal and awareness of genital excitement composite in sexually healthy control women (N = 29), women with genital arousal disorder (N = 7), women with anhedonic arousal disorder (N = 8), and women with missed arousal disorder (N = 16) subtypes of female sexual arousal disorder.

Note: y-axis represents average on mental sexual excitement component (maximum = 7.0) minus average on awareness of genital arousal component (maximum = 7.0). *$p < .05$, significant group difference using Planned Orthogonal Contrasts

*Relationship between pleasant genital sensations and laboratory-based subjective sexual arousal*

Correlations between pleasant genital sensation from direct stimulation (i.e., interview component 3) and laboratory-based subjective sexual arousal are presented in Table 13. Among sexually healthy women, this indirect measure of genital congestion was significantly correlated with subjective sexual arousal, $r = .387$, $p = .035$. Such correlational analyses did not reach statistical significance for women with genital arousal disorder ($r = .320$, $p > .05$), for women with anhedonic arousal disorder ($r = .224$, $p > .05$), or for women with missed arousal disorder ($r = -.136$, $p > .05$).

Table 13

*Correlations between pleasant sexual genital sensations (interview component 3) and laboratory-based subjective sexual arousal in sexually healthy control women (N = 29) and women with genital arousal disorder (N = 7), anhedonic arousal disorder (N = 8) and women with missed arousal disorder (N = 16) subtypes of female sexual arousal disorder.*

| | correlation |
|---|---|
| **Control group** | r = 0.387* |
| **Genital arousal disorder** | r = 0.320 |
| **Anhedonic arousal disorder** | r = 0.224 |
| **Missed arousal disorder** | r = -0.136 |

*p < .05

# Discussion

Overall the data reveal that women with unspecified FSAD reported significantly lower mental sexual excitement, reduced awareness of genital pulsing/throbbing/wetness, and reduced pleasure from direct genital stimulation in the real-life sexual setting compared to sexually healthy women. A re-analysis based on FSAD subtype helped to further clarify these findings. Specifically, women with the missed and anhedonic arousal subtypes reported significantly lower mental sexual excitement than women in the control group and women with genital arousal disorder, whereas there were no differences between the latter two groups. Awareness of genital excitement (e.g., throbbing, pulsing, or wetness) was significantly lower in women with missed arousal disorder, and showed a trend towards being significantly lower in women with genital arousal disorder ($p = .06$) compared to the control group. Women with missed arousal disorder had significantly lower perception from direct genital stimulation than those in the control group and than women with dysphoric arousal disorder. Whereas women in the genital arousal disorder subgroup showed lower responses than the control group, this effect did not reach statistical significance. These data suggest that the Detailed Interview Assessment of Real-life Sexual Arousal is helpful in differentiating subtypes of FSAD based on the presence of genital versus mental sexual arousal difficulties.

When genital arousal, as assessed by the vaginal photoplethysmograph, was correlated with various domains of at-home subjective sexual arousal, an interesting pattern of findings emerged. VPA was not significantly correlated with at-home mental sexual excitement in any of the FSAD subtypes, nor in sexually healthy women. The correlation between VPA and at-home awareness of genital excitement was significantly positive when all women with FSAD were combined, though this effect disappeared when each subtype was examined independently. It is likely that this can be attributed to small sample sizes given that a medium effect size would require a correlation of $r = 0.30$ and a sample size of 85 to detect statistical significance. Given that the current sample sizes were much

lower than this cut-off, this lends support for a sample-size artefact. Across sexually healthy women as well as across subtypes of FSAD, there were no significant correlations between VPA and at-home experiences of pleasure from direct genital stimulation.

The above correlations using laboratory-based VPA and various measures of at-home subjective sexual arousal suggest that VPA correlates poorly with the subjective experience, both inside and outside of the laboratory setting. Both in the clinical (Basson, 2002a) and in the laboratory setting (Laan, Everaerd, van der Velde, and Geer, 1995), women report that their sense of "arousal" stems only minimally from awareness of vaginal vasocongestion. Instead, women describe arousal more as subjective mental excitement that may or may not be accompanied by awareness of genital congestion. That self-reported awareness of at-home lubrication correlated with VPA whereas at-home mental excitement did not suggests that the VPP may be a useful index of lubrication in women with unspecified FSAD. However, there does not seem to be support for the use of the VPP in predicting subjective sexual arousal for women, even if their subjective report relates to genital arousal.

When the experience of pleasant sexual sensations from direct genital touch was used in place of laboratory VPA, a significant correlation with subjective sexual arousal emerged for sexually healthy women. As predicted this correlation was not statistically significant for women with genital arousal disorder, and relates to the diagnostic features of this condition which necessitate the absence of pleasant genital sensation in response to stimulation. Similarly, the correlation was absent among women with missed and anhedonic arousal disorder, and in these subtypes the findings are likely attributable to absent subjective sexual arousal in the laboratory, thus leading to no significant correlations. The finding among sexually healthy women supports the clinical observation (Basson, 2000b; 2002a) that sexually healthy women report awareness of and pleasure from direct stimulation of engorging tissue.

A comparison of the relative balance between mental sexual excitement and awareness of genital excitement across groups of women revealed that this

composite score reliably differentiates FSAD subtypes from women in the control group. Specifically, women with anhedonic arousal disorder had a significantly lower difference between mental and genital sexual arousal than women with genital arousal disorder. In other words, women self-reporting clinically with impaired subjective sexual arousal indeed show low levels of mental compared to genital sexual arousal whereas in women reporting with impaired genital arousal only, their self-reported mental arousal is much greater than their reported genital excitement. Although both groups appeared to have differed from the control group (Figure 12), these differences did not reach statistical significance. Given the low sample sizes in these two subgroups (n = 8 and n = 7, respectively), these lack of statistically significant effects are not surprising.

In the current climate of emerging pharmaceutical products to treat female sexual dysfunction, the vaginal photoplethysmograph is increasingly used in outcome studies to assess treatment response (Laan, van Lunsen, Everaerd, Riley, Scott, & Boolell, 2002; Meston & Worcel, 2002; Rosen et al., 1999; Rubio-Aurioles, et al., 2002; Sipski, Rosen, Alexander, & Hamer, 2000). However, such studies do not consistently find an improvement in subjective sexual arousal despite increased vaginal vasocongestion in the laboratory setting (Laan et al., 2002; Meston & Worcel, 2002). Moreover, the consistent finding of desynchrony between genital and subjective sexual arousal in laboratory studies suggests that any improvement in vaginal vasocongestion should not necessarily be interpreted as indicating a significant increase in overall sexual arousal. This also raises concern as to the use of vaginal vasocongestion as a therapeutic endpoint in clinical trials for women with FSAD (Everaerd & Laan, 2000). It is unclear how such vasocongestive changes are interpreted in the real-life sexual setting, and if this perception varies with the clinical subtype of FSAD.

The current findings suggest that laboratory-based VPA correlates with women's self-reported awareness of genital throbbing/lubrication/wetness, but not with women's self-reported mental sexual excitement in their at-home setting. To the extent that this instrument is used to predict genital engorgement and lubrication, it may be a useful test in clinical trials for sexual dysfunction. This

study suggests that vaginal vasocongestion, as assessed by the VPP, represents a unique component of the sexual arousal response that is not likely accessible by subjective assessment. Desynchrony between psychophysiological and subjective measures is found in other areas of psychological functioning (e.g., Hoehn-Saric & McLeod, 2000; McLeod, Hoehn-Saric, & Stefan, 1986) and has been attributed to mediating psychological factors, such as expectations and attention. In order to better understand the nature of the unique contribution of the VPP in capturing important features of the sexual arousal response, basic science aimed at investigating the vaginal vasculature and how it changes during the process of arousal, is critical. Investigations aimed at exploring such processes in animal models are currently underway (e.g., Giuliano, Allard, Compagnie, Alexandre, Droupy, & Bernabe, 2001; Min, Kim, McAuley, Stankowicz, Goldstein, & Traish, 2000).

Taken together, the data from this experiment suggests that our understanding of the components of and factors which influence sexual arousal in women is complex and poorly understood. Importantly, this study found different patterns based on FSAD subtype. Future studies should aim to further clarify the genital-subjective sexual arousal relationship by conducting large-scale investigations in which women with subtypes of FSAD are compared to each other and to sexually healthy women.

# General Discussion

There are a number of important conclusions that can be drawn from this series of experiments. First, the results of Experiments 1 and 3 provide additional support for the role of the sympathetic nervous system in female sexual arousal and demonstrate a novel, non-pharmacological means of increasing genital arousal by increased SNS activity. A comparison of Experiments 1 and 3 also support the notion that the effects of SNS activity on VPA may function differentially depending on the age and/or hormonal status of the woman, and depending on her clinical presentation of sexual arousal complaints. Second, Experiments 2, 3, and 4 together suggest that the diagnostic category, FSAD, represents a heterogeneous class comprised of separate subtypes that differ on subjective and psychophysiological sexual arousal. Third, the investigations support the clinical observation that response to intervention may differ across such diagnostic subtypes. The finding that the vaginal photoplethysmograph was necessary in making these diagnostic and treatment response distinctions is a novel and important finding. Fourth, the results of Experiments 2, 3, and 4 provide important implications for the use of the VPP in clinical settings. That the VPP was necessary to document the presence of vaginal vasocongestion in women who reported impairment (i.e., missed arousal disorder) has important treatment implications that will be discussed. Fifth, the findings across all four experiments for genital-subjective desynchrony raise some important conceptual and theoretical issues that must be taken into account when designing clinical trials for treatments of female sexual dysfunction, and when making speculations as to the significance of a particular VPA signal. There are some methodological issues worthy of mention that warrant future investigation. For example, the finding across Experiments 1 to 4 that the use of average versus maximum VPA in analyses of desynchrony may lead to widely disparate correlations is a troubling issue. Additionally, there does not exist a standardized way for conducting sexual psychophysiological studies in women, and it is disconcerting to suppose that cross-study aberrations

in methodology may lead to equivocal findings. Finally, this series of experiments provides a framework from which future investigations aimed at better understanding sexual arousal in women may follow.

The findings from the current experiments contribute to the existing literature supporting sympathetic nervous system activation in genital sexual arousal in women. The extent to which these effects are mediated by hormone levels is unknown, and it is possible that hormonal factors account for the lack of effect of heightened SNS activity on genital sexual arousal in older women (Experiment 1). Future studies, in which sympathetic nervous system activity and hormone levels are assessed in tandem will help to explain any relationship between these systems in affecting genital sexual arousal. Unlike pharmacological interventions which directly increase SNS activity, LIH may provide a safe, nonpharmacological alternative to treatments which may prove to have as yet undetermined side effects. However, given the speculated lack of vested interest from pharmaceutical sponsors, it is possible that such a technique would not receive popular media or industry-funded research attention. It is well-accepted that a relative balance between sympathetic and parasympathetic nervous system activity contribute to sexual response. Our finding that heightened SNS activity, presumably enhanced by the LIH manipulation, contributed to inhibited VPA in women with anhedonic arousal disorder may be explained by a closer investigation into the parasympathetic-sympathetic balance. If facilitation of SNS activity indeed contributes to impaired genital arousal in women, this has therapeutic implications for this subtype of FSAD. Future investigations may aim to explore the effects of manipulations designed to decrease SNS activity. At a minimum, our efforts should not be spent on developing pharmacological or behavioural treatments with pro-SNS activity effects for this group. Future investigations may also benefit from more directly assessing the involvement of sympathetic versus parasympathetic nervous system involvement during sexual arousal.

The results from Experiments 2, 3, and 4 suggest that the diagnostic category, FSAD, is a heterogeneous class comprised of distinct subtypes. To

date these subtypes have only been described clinically, whereas the current experiments provide empirical support for the future delineation of these FSAD subtypes into our diagnostic nosology. The finding that only after sexual psychophysiological assessment were women complaining of both impaired genital and mental sexual arousal classified into the "missed arousal disorder" category suggests that the VPP may be useful in diagnostic decision making for FSAD. The missed arousal disorder subtype represents a puzzle for both assessment and treatment. Such women clearly complain of impaired genital sensation and lubrication, though objective evidence of vaginal vasocongestion suggests otherwise. Perhaps women in this subcategory may benefit from treatments focused on detecting genital excitement that is indeed occurring. To date, neither psychological nor pharmacological interventions have been compared across subtypes of FSAD. Future investigations will help to better understand this perplexing condition. These findings not only bear important clinical, but also research implications. It is possible that prior inconsistencies in the literature may be related to combining several subtypes of FSAD into one heterogeneous group. Future studies in which subtypes of FSAD are compared with each other should lead to a better understanding of the mechanisms involved in the etiology of each condition. As our classification system becomes more refined, such recruitment errors should be remedied.

The vaginal photoplethysmograph remains the most widely used index of genital vasocongestion despite a literature documenting its shortcomings (Levin, 1997). The current experiments indicate that the VPP was helpful in classifying FSAD subtypes and in detecting responses to SNS activation. The finding that pleasure evoked from direct stimulation of engorging tissue significantly correlated with subjective sexual arousal whereas VPA did not is an interesting, novel finding. This suggests that subjective perception of genital congestion may occur independent of actual vaginal vasocongestion. The precise neural mechanisms involved in the female genital response are currently being explored. Basic science research aimed at delineating the underlying vascular changes that occur during detection of a VPA signal may shed light into the

meaning of the VPA signal. At present, this instrument remains useful only for within-subjects designs (Geer & Janssen, 2000) due to the absence of an absolute scale, which necessitates statistical manipulations in order to make between-subject comparisons.

The findings on genital-subjective desynchrony were interesting. Sympathetic nervous system activation was found to lead to synchrony in older premenopausal women, and to desynchrony in postmenopausal women. SNS activation also had the effect of reducing the positive correlation between VPA and mental sexual arousal in women with genital arousal disorder. These are the first data to show an effect of SNS activity on genital-subjective correlations, and as such, highlight the importance of replication. It was surprising that sexually healthy premenopausal women showed no relationship between genital and subjective sexual arousal in Experiment 1, whereas these constructs were found to be negatively correlated in a similar sample in Experiment 2. It is possible that slight differences in methodological design account for these differences. It is also possible that these inconsistencies reflect widely varying individual differences in the relationship between genital and subjective sexual arousal in women. One must not lose sight of the fact that desynchrony represents a clinical description of genital and subjective processes not correlating. However, such a clinical description is based, essentially, on the lack of a statistically significant correlation between genital and subjective sexual arousal measures. Given Cohen's medium effect size of 0.30, he recommends that a sample size of 85 would be needed to detect statistical significance. Obviously if alpha is relaxed to 0.10, the required sample size would be only 68 to detect a medium effect size. Given that the current sample sizes did not meet these mimimum cut-off scores, the extent to which the current findings represent "true desynchrony between these measures as opposed to a statistical null is unknown. Given the prior literature which has employed similar sample sizes, and occasionally found synchrony while at other times desychrony, it is possible that the current null findings reflect the fact that these two processes indeed do not correlate in women. This would be consistent with our clinical impression of

women's self-reports of sexual arousal. Future large-scale studies in which methodological confounds are held constant, but in which factors presumed to influence genital-subjective desynchrony can be explored, are gravely needed.

Findings of desynchrony raise the theoretical issue of whether the VPA signal reflects the "proper" physiological measure of arousal. Whereas Freud's exclusive focus on the importance of the vaginal orgasm, and assumption that clitoral arousal and orgasm reflected fixation at an immature stage, Masters and Johnson provided evidence for the importance of clitoral arousal and orgasm. They noted that orgasm achieved through masturbation (typically clitoral) led to a more intense physiological experience than those achieved vaginally through intercourse. Similarly, sophisticated instruments (e.g., Duplex Doppler ultrasonography, fMRI) are currently the focus of physiological investigations of clitoral arousal in women following several decades of exclusive focus on vaginal vasocongestion. This is partially motivated by the finding of high concentrations of nitric oxide in clitoral erectile tissue, and comparably lower levels in the vagina (Giuliano et al., 2002). The significance of the difference between vaginal versus clitoral arousal in accounting for women's experience of sexual arousal will likely prove to be an increasing focus within the growing field of sexual psychophysiology. By integrating the findings from Experiments 1, 2, and 3, which support the use of the VPP in diagnostic and treatment decisions, together with the finding from Experiment 4 which suggests that the VPP signal may reflect a unique component of the sexual arousal response that is not captured by subjective assessment, we are left to conclude that sexual arousal in women is a highly complex response that may be optimally measured using multiple assessment techniques. Moreover, one might conclude that without such a multi-modal assessment, an incomplete picture of sexual arousal is obtained, leading to significant diagnostic and treatment implications. Future studies might aim to explore the unique contributions of psychophysiological, affective, and cognitive aspects of sexual arousal in sexually healthy and sexually dysfunctional women, across both laboratory and clinical settings, in order to better understand the inter-relationships among these constructs as they influence sexual arousal.

An important aspect of women's sexuality that has received little attention in this series of investigations is the role of the interpersonal relationship. Sex usually involves two individuals, and therefore, the influence of one's partner on the female sexual response cannot be ignored. Masters and Johnson's four-stage sexual response cycle has been criticized for ignoring the role of sexual desire, as well as non-genital factors such as closeness, intimacy, and sensuality in the sexual response (Leiblum, 2000). Increasing attention has been placed on the importance of motivations for being sexual, as well as the role of affect (e.g., fear, anger, resentment) in preventing the effectiveness of sexual stimuli in triggering sexual desire and/or arousal (Basson, 2000a). Women experiencing sexual difficulties commonly report dissatisfaction with the nonsexual aspects of the relationship (McCabe & Cobain, 1998). Although the focus of this investigation was on the genital aspect of sexual arousal, this author recognizes the equal, if not greater, importance of the interpersonal aspects of the sexual relationship on sexual arousal. In parallel with the pharmaceutical race to detect an effective drug to treat impaired genital sexual arousal, there should be an equivalent effort aimed at uncovering interpersonal facets that might influence sexual desire and arousability.

There are a number of methodological shortcomings that limit the generalizability of the current findings. First of all, it is possible that lack of statistical significance may have been attributable to low sample size in several analyses. By employing a medium effect size of 0.30, Cohen would encourage a sample size of 85 in order to detect significance at the 0.05 alpha level. By relaxing alpha to 0.10, a lower sample size of 68 would be required. In terms of the current findings which were based on a much smaller sample size, this suggests that any cases in which a significant negative or positive correlation coefficient was obtained, this would represent a robust effect. The lack of statistical significance in genital-subjective correlations found in Experiments 2, 3, and 4 may be attributed to a "true" state of desynchrony between the measures, or be reflective of a lack of statistical power. The consistent finding in the genital-subjective sexual arousal correlations was the relatively low level of

significant variance accounted for. This suggests that there is a high degree of unexplained variance in genital-subjective relationships across most of the subgroups examined. Future studies would benefit from examining genital-subjective sexual arousal correlations in sample sizes of at least 85 in order to detect a medium effect size and clarify whether the current findings represent true "desynchrony" or statistical artifacts. Second, despite the use of a placement device used to ensure proper depth of insertion of the vaginal probe, individual differences in genital anatomy may have led to inconsistent placement of the vaginal probe across subjects. Although data have yet to be collected, it has been suggested that slight aberrations in placement of the vaginal probe may lead to disparate effects. Third, the generalizability of the findings, which are based on samples of women who agreed to volunteer for a study on sexuality, is limited by the fact that not all women feel comfortable taking part in such a study. Although efforts were made to ensure a professional atmosphere with well trained investigators, discussing sexuality remains a topic of embarrassment for many women. Finally, the generalizability of the findings from Experiments 1, 2, and 3 to the at-home sexual setting is unknown. Experiment 4, which focused on the relationship between laboratory and at-home sexual arousal, suggested that VPA correlated rather poorly with three different at-home measures of sexual arousal. The importance of context in the sexual experience has received much attention, and remains a difficult issue for translating laboratory-based findings into real-world experience.

More generally, one must consider the generalizability of laboratory studies of sexual arousal given the possibility for a volunteer bias to exist. Males are more likely than females to participate in studies involving sexual psychophysiological assessment (Plaud, Gaiter, Hegstad, Rowan, & Devitt, 1999), and females tend to give emotional rather than pragmatic reasons more often than men for choosing not to volunteer (Plaud et al., 1999). Females who do participate in sexual psychophysiological studies are less likely to object to viewing sexually explicit films and are exposed to commercially available erotica more often than non-volunteers (Wolchik, Spencer, & Lisi, 1983). Male and

female volunteers for sexual psychophysiological studies tend to report significantly more sexual experience, have more sexual partners, and have higher levels of sex guilt than non-volunteers (Plaud et al., 1999), whereas in general volunteers for sexuality studies have more positive attitudes towards sexuality than non-volunteers (Strassberg & Lowe, 1995). Other issues to consider are individual differences in the subject's familiarity/experience with erotica, individual differences in sexual arousability to erotica, individual differences in preference for different types of erotica, the level of comfort with invasive genital instruments, and the subject's willingness to share information about personal material honestly. Rowland raises the issue of the considerable amount of time necessary to participate in laboratory studies of sexual arousal (Rowland, 1999); this factor may also be contributing to selection of a unique, highly motivated sample of individuals willing to undergo laboratory testing, often for several hours. Finally, the extent to which laboratory-based assessments generalize to at-home sexual behaviour and arousal is unclear and requires further exploration. The sex researcher must take these methodological issues into consideration when designing studies, and must make every effort to control for such confounding issues during analysis.

More broadly, one must consider the current climate within which female sexuality research is being conducted. Industry-sponsored research, conference meetings, and reclassification committees, undoubtedly affect, and possibly bias, both the focus and the results of our efforts (Moynihan, 2003). With increasing pharmaceutical attention aimed towards medications that might ameliorate female sexual complaints, it is possible that important issues related to the definition and experience of sexuality are overlooked. Moreover, there is a danger that medicalization might lead to a scarcity of research funds aimed at understanding the sociocultural and political influences on women's sexuality. To safeguard against these efforts, researchers from mental health must ally with those from medical professions, and strive towards conceptualizing research on female sexual dysfunction within a biopsychosocial framework. Additionally, non-

industry affiliated granting agencies must increase the resources available for funding sexuality research.

The preceding series of experiments provide novel, important findings for the field of women's sexuality. Moreover, they offer a framework from which numerous investigations may follow. For example, a more comprehensive comparison between younger and older, as well as pre- and postmenopausal women on genital and subjective sexual arousal may benefit from inclusion of hormonal assays in order to explore the relationship between hormone levels and sexual arousal. The effects of sympathetic nervous system activation on sexual arousal might be explored more directly by including a measure of SNS activity. Such a measure would allow for exploration for the possibility of an inverted-U relationship between SNS activation and sexual arousal across subtypes of FSAD. In addition, other behavioural techniques (e.g., exercise) which result in a more pronounced level of SNS activity might be explored as a therapeutic intervention for women with genital arousal disorder. The utility of diagnostic subtypes within FSAD might be explored with future large-scaled clinical trials on women reporting with significant impairment in sexual arousal. Comprehensive assessment including vaginal photoplethysmography, subjective assessment of arousal both in the laboratory and in the naturalistic setting, and detailed interviews would help to elucidate more definitively the characteristics of these putative FSAD subtypes. Following from there, clinical trials aimed at exploring the effects of pharmacotherapeutic and psychological interventions across these FSAD subtypes would allow for an exploration of the effects of matching to treatment. Clearly, the field of female sexual psychophysiology is still in its infancy. With the advent of more sophisticated instruments to measure the genital arousal response in women, combined with a surge of clinical investigations exploring the DSM-IV constructs of female sexual response, the next few decades will be a productive and exciting time leading to a better understanding of women's sexuality.

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# Appendix

## Detailed interview assessment of real-life sexual arousal

Sexual arousal means different things to different women – there is mental excitement, pleasant "sexual" changes in your body including breathing, temperature, muscle tension. Some women are quite aware of genital tingling, throbbing, or wetness. Some will become aware of genital changes only when stimulated directly around the labia and clitoris by fingers, partner's body, orally, with a vibrator, etc., or with a partner's penis stimulating from the inside of the vagina (often far less sensitive).

1. On a scale from 1-7 where: 1 = low, 4 = average, 7 = extremely intense, how mentally excited would you be for each of the following types of stimulation:

| | Low | | Average | | | | Intense |
|---|---|---|---|---|---|---|---|
| a) verbal/visual/written sexual stimuli | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| b) physical, hugging, holding, nondeep kissing | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| c) breast stimulation | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| d) deep-mouth kissing | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| e) manual-genital stimulation | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| f) oral-genital stimulation | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| g) penile-vulval contact | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| h) vaginal intercourse | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| i) self-stimulation | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

2. On a scale from 1-7 where: 1 = low, 4 = average, 7 = extremely intense, how much awareness of genital tingling, throbbing, or wetness would you experience for each of the following types of stimulation:

| | Low | | Average | | | | Intense |
|---|---|---|---|---|---|---|---|
| a) verbal/visual/written sexual stimuli | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| b) physical, hugging, holding, nondeep kissing | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| c) breast stimulation | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| d) deep-mouth kissing | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| e) manual-genital stimulation | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| f) oral-genital stimulation | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| g) penile-vulval contact | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| h) vaginal intercourse | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| i) self-stimulation | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

3. On a scale from 1-7 where: 1 = low, 4 = average, 7 = extremely intense, how much pleasant sexual genital sensations and increasing urge to receive more stimulation would you experience from each of the following types of stimulation:

| | Low | | | Average | | | Intense |
|---|---|---|---|---|---|---|---|
| a) manual-genital stimulation | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| b) oral-genital stimulation | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| c) penile-vulval contact | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| d) vaginal intercourse | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| e) self-stimulation | 1 | 2 | 3 | 4 | 5 | 6 | 7 |