

**AN EXPLORATION OF
GENITAL AROUSAL CATEGORY-SPECIFICITY
AND
SEXUAL CONCORDANCE IN MEN AND WOMEN**

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DEDICATION

To my family, for all of their contributions that have allowed me to reach this goal.

ABSTRACT

There are substantial differences between the sexual arousal patterns of men and women. Men's genital and subjective sexual arousal are *category-specific*; different sexual stimuli elicit different degrees of arousal. Women's subjective sexual arousal is also category-specific, but their genital arousal is *category-nonspecific*; different sexual stimuli produce similar arousal. Men also exhibit a high *concordance* or correlation between their genital and subjective arousal, whereas women exhibit much lower sexual concordance. I conducted five studies with 219 participants to further explore these sex differences and test different explanations for their occurrence. The results confirm the existence and stability of sex differences in arousal patterns, provide support for a functional explanation of the sex difference in genital category-specificity, provide mixed support for an information-processing model of sexual arousal in relation to sexual concordance, and provide no support for the notion that sexual concordance is another manifestation of sex differences in interoception.

PREFACE

This dissertation comprises five empirical studies that are presented as scientific reports in separate chapters, along with introductory and concluding chapters. Versions of these reports are either published elsewhere or currently under review for publication. Chapter Two has been published in *Psychological Science* and Chapter Five is currently in press in *Archives of Sexual Behavior*. The remaining empirical manuscripts are currently under review. The references below provide the relevant publication information. The format of scientific reports in psychology, with references, tables, and figures provided at the end of the reports, has been maintained.

All of the scientific reports in this dissertation have co-authors. Martin Lalumière provided conceptual and editorial assistance for all reports. Meredith Chivers provided one of the datasets, as well as conceptual, statistical, and editorial assistance for Chapter Three.

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Chapter Three:

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Chapter Four:

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CHAPTER ONE

Introduction

Men's and women's sexualities differ in several ways. Men's sex drive or sexual motivation is higher than women's (Baumeister, Catanese, & Vohs, 2001): Men masturbate more frequently (Oliver & Hyde, 1993; Petersen & Hyde, 2010), report fantasizing more frequently and about more varied content (Leitenberg & Henning, 1995), and seek out erotic material more often and starting at a younger age (Buzzell, 2005; Hald, 2006; Oliver & Hyde, 1993; Petersen & Hyde, 2010). Men's sexuality, as measured by their sexual behaviours and general opinions, is also more stable and less influenced by sociocultural factors relative to women's (Baumeister, 2000). Diamond (2003; 2008) has reported that sexual minority women's sexual partner preferences and sexual identities can change over time. Men's and women's sexual interests also differ: Men are more likely than women to have sexual interests involving atypical objects, activities, or partners (Bannerman, Dawson, & Lalumière, 2011; Långström & Seto, 2006). The purpose of the research presented in this dissertation is to investigate another intriguing difference between men's and women's sexualities, that is, sex differences in sexual arousal patterns.

Men's Sexual Arousal Patterns

Chivers (2005) defined sexual arousal as a complex state composed of several interacting components, including physiological changes, emotional responses, and motivated behaviour. Two of these components, physiological changes and emotional responses, have been studied extensively in laboratory settings with men. Men's physiological sexual arousal is most commonly measured with penile plethysmography, the

direct or indirect measurement of blood flow in the penis. Penile plethysmography measures changes in the penis during an erection in two different ways. Volumetric plethysmography involves placing a plastic cylinder on a man's penis; the cylinder is connected to a piece of tubing which is itself connected to a pressure transducer. Changes in the size of the penis result in air displacement that is detected by the pressure transducer (Freund, 1963). Circumferential plethysmography measures changes in the width or circumference of the penis using a strain gauge, which is a thin rubber band filled with mercury (Fisher, Gross, & Zuch, 1965). An erection produces a stretch in the rubber band, causing changes in electrical conductance within the rubber band. Physiological responses are often measured in combination with emotional responses. Emotional responses may be recorded continuously throughout a stimulus presentation or at different times within or following a stimulus presentation. Individuals may be asked to report their overall feelings of sexual arousal or their perceptions of genital arousal.

Early research on men's sexual arousal focused on determining the stimulus cues that best elicit a physiological and emotional response. Research conducted by Kurt Freund, the creator of penile plethysmography, as well as other researchers, yielded clear and consistent results regarding men's sexual arousal patterns: Men in these studies showed different genital and subjective sexual arousal to different sexual cues, such that their sexual arousal corresponded with stimulus cues depicting their self-reported preferences. Men's differential arousal has been observed in response to the sex of the persons depicted (Freund, 1963; Freund, 1965; Freund, Langevin, Cibiri, & Zajac, 1973; Mavissakalian, Blanchard, Abel, & Barlow, 1975) and the age of the persons depicted (Freund & Blanchard, 1989; Freund & Watson, 1991). These early results have also been supported by more recent research (e.g.,

Blanchard, Klassen, Dickey, Kuban, & Blak, 2001; Chivers, Rieger, Latty, & Bailey, 2004; Chivers & Bailey, 2005; Chivers, Seto, & Blanchard, 2007; Seto, Lalumière, & Blanchard, 2000; Suschinsky, Lalumière, & Chivers, 2009). Recent research also indicates that men's sexual arousal patterns vary with the sexual activities depicted, as studied in rapists (Lalumière & Quinsey, 1994), sadistic men (Seto, Lalumière, Harris, & Chivers, 2009), and men who prefer consensual non-violent sex (Fairweather & Lalumière, 2009). Given that men's genital and subjective sexual arousal responses typically vary in the same direction as a function of sexual stimulus content, men's sexual arousal (both genital and subjective) is said to be *category-specific*. Men also exhibit a high degree of *sexual concordance*, or a strong relationship between their genital and subjective sexual arousal, though there are instances when men's genital and subjective arousal do not correspond, such as in sex offenders (Quinsey, Steinman, Bergersen, & Holmes, 1975).

Women's Sexual Arousal Patterns

The advent of devices to study men's sexual arousal was followed relatively quickly by the development of similar devices for women (reviewed by Janssen, Prause, & Geer, 2007). Despite the development of devices for measuring physiological arousal in women, sex research remained androcentric for decades. There may be several reasons for the disproportionate focus on men's sexual arousal, including historical, legal, and practical reasons. From a historical perspective, the social, cultural, and political climate of sex research was male-biased. The vast majority of scientists conducting research were men, focused on understanding men's sexual problems. Also, the second wave of modern feminism was in its infancy; the need for understanding women and women's issues was still not fully appreciated, and thus studying women's sexuality may have been viewed as simply

unnecessary. From a legal perspective, the scientific focus on men's sexual arousal was somewhat justified, given the fact that more men are incarcerated for sexual offences than women (e.g., Moulden, Firestone, & Wexler, 2007). Research is obviously needed to better understand the motivations behind sexual offenses and atypical sexual interests in general, in order to reduce harm to victims and promote more appropriate sexual outlets or interests for men.

Practically speaking, women's genital arousal also proved to be more difficult to assess in laboratory settings than men's genital arousal. Early devices included measures of vaginal pH (Shapiro, Cohen, DiBianco, & Rosen, 1968) and uterine contractions (Bardwick & Behrman, 1967; Jovanovich, 1971); these devices were intrusive and often painful for participants. The development of vaginal photoplethysmography (Hoon, Wincze, & Hoon, 1976; Palti & Bercovici, 1967; Sintchak & Geer, 1975), a less intrusive measure of genital arousal in women, led to increased research on women's sexual arousal. Vaginal photoplethysmography is now the most commonly used measure of genital arousal in women. It consists of a clear tampon-shaped plastic probe that contains both a light source and a light detector. The light source is used to illuminate the capillary bed of the vaginal wall and the blood circulating within it. The amount of backscattered light serves as an indirect measurement of vasocongestion or swelling of the vaginal wall, as the amount of reflected light varies in relation to the transparency of vaginal tissue.

Interest in women's sexual arousal patterns has increased dramatically in recent years. Unlike early studies of men's sexual arousal, early studies of women's sexual arousal did not focus on determining the kind of stimuli that would elicit a genital or subjective response. Women were rarely presented with a variety of sexual stimuli (but see Steinman,

Wincze, Sakheim, Barlow, & Mavissakalian, 1981); the varied stimuli most often depicted sexual and non-sexual scenes to determine the validity of vaginal photoplethysmography as a measure of sexual arousal (Geer, Morokoff, & Greenwood, 1974; Hoon et al., 1976; Laan, Everaerd, & Evers, 1995; see Suschinsky et al., 2009 for a critique of this early research) or different kinds of stimuli to assess women's arousal to purely sexual versus romantic sexual stimuli (Heiman, 1977; Osborn & Pollack, 1977). Researchers were also interested in better understanding women's sexual arousal across the menstrual cycle (Hoon, Bruce, & Kinchloe, 1982; Schreiner-Engel, Schiavi, Smith, & White, 1981; Slob, Bax, Hop, Rowland, & Ven der Werff ten Bosch, 1996), and more research is currently taking place (Bossio, 2011). Another early focus of women's sexual arousal research, which has continued to the present, is sexual functioning (e.g., Brotto, Basson, & Gorzalka, 2004; Brotto, Basson, & Luria, 2008; Brotto et al., 2008). Early research on women's sexual functioning examined the impact of therapy (Morokoff & Heiman, 1980), mastectomy (Gerard, 1982), diabetes (Slob, Koster, Radder, & van der Werff ten Bosch, 1990), hormone replacement therapy (Myers & Morokoff, 1986), biofeedback (Cerny, 1978; Hoon, 1980), and Kegel exercises (Messé & Geer, 1985) on women's sexual arousal.

Men's and women's sexual arousal responses were rarely compared within the same study; those few researchers who did assess both men and women, however, aptly and quickly noted that men and women tended to show different patterns of sexual arousal. Heiman (1977) and Steinman et al. (1981) were among the first to report that women's genital and subjective sexual arousal were less correlated or concordant with each other. Chivers, Seto, Lalumière, Laan, and Grimbos (2010) recently confirmed the significant sex

difference in sexual concordance with a meta-analysis of over 100 studies that assessed genital and subjective sexual arousal.

More recent research has focused on determining the type of stimuli that elicit a genital or subjective sexual response in women; these studies provide further evidence that women's sexual arousal is complex. There is a relatively clear and consistent pattern for women's subjective sexual arousal: Women's subjective arousal, much like men's, tends to be category-specific and correspond with their stated sexual preferences or interests (Chivers et al., 2004; Chivers & Bailey, 2005; Chivers et al., 2007; Suschinsky et al., 2009). Women's genital arousal, however, is not category-specific and does not occur only in the presence of stimuli that correspond with their stated sexual preferences or interests, with respect to the sex of the actors depicted (Chivers et al., 2004; Chivers & Bailey, 2005; Chivers et al., 2007; Laan, Sonderman, & Janssen, 1995; Suschinsky et al., 2009; but see Steinman et al., 1981). Women even show significant genital arousal to nonhuman sexual stimuli (Chivers & Bailey, 2005; Chivers et al., 2007). In other words, women's subjective sexual arousal is category-specific, but their genital arousal is category-nonspecific.

The Current State of Sexual Arousal Research

The sex differences in sexual arousal patterns are well-established in some respects. There is substantial evidence that men's sexual arousal (both genital and subjective) is category-specific with respect to the age of the persons, the sex of the persons, and the activity depicted within a stimulus, across a variety of stimulus modalities. Similarly, there is substantial evidence that women's genital arousal is category-nonspecific with respect to the sex of the persons depicted in audio-visual sexual stimuli. There is also considerable

evidence that men's sexual concordance is significantly higher than women's sexual concordance.

Although it is clear that men's and women's sexual arousal patterns differ in some respects, the reasons for these differences are currently unknown. The studies described in this dissertation were conducted to further investigate men's and women's sexual arousal patterns by evaluating different explanations for the sex differences in genital category-specificity and sexual concordance. Chapter Two tests a functional explanation for women's category-nonspecific genital arousal. The *preparation hypothesis* suggests that women's genital responses, as measured by changes in vaginal blood flow, should occur in the presence of any sexual stimulus, functioning to prepare a woman for a sexual encounter. The study described in Chapter Two also extends previous category-specificity research in two unique ways. I investigated whether women's genital arousal is nonspecific in response to a cue other than the sex of human actors: The stimuli depicted different partnered sexual activities of similar intensities between a man and a woman. Likewise, it is the first published study to investigate nonspecific genital arousal in response to audio stimuli.

Chapter Three describes two studies that test an information-processing model of sexual arousal. Laan and Janssen's (2007) information-processing model of sexual arousal suggests that men and women derive their subjective experience of sexual arousal from different sources: Men derive their subjective arousal primarily from their genitals, whereas women derive their subjective arousal from the memories or meanings that a sexual stimulus triggers. These studies are the first to empirically test Laan and Janssen's model, and do so using second-by-second sexual arousal data for calculating sexual concordance.

Chapter Four describes a study that investigates the stability of the sex differences in sexual arousal patterns. Although the sex differences in genital category-specificity and sexual concordance have been reported by different researchers in different studies, little to no research has been conducted to assess the stability of these differences within the same participants over time. We do have some reasons to suspect that women's sexual arousal patterns may change with experience or time. Women with previous experience with erotic materials report stronger feelings of overall sexual arousal and more genital sensations in response to sexual films presented in the laboratory (Pearson & Pollack, 1997). Given that women have less experience with both erotic materials and their genitals (Oliver & Hyde, 1993; Petersen & Hyde, 2010), it is possible that their sexual arousal patterns may change with experience. If sexual arousal patterns are consistent across testing sessions, their validity would be further supported and even less likely to be the result of extraneous factors. If sexual arousal patterns are not consistent across testing sessions, and especially if the sex differences decrease over testing sessions, researchers must question the validity of these sex differences and possibly alter their experimental methodologies to incorporate multiple testing sessions.

Chapters Five and Six describe novel studies that investigated the relationship between sexual concordance and awareness of non-sexual physiological states, or *interoception*. In laboratory settings, men are more accurate than women at detecting and reporting both their sexual and non-sexual physiological states. Given the consistent sex difference for both sexual and non-sexual awareness, it is possible that men's higher sexual concordance is simply related to their higher interoceptive awareness. If the sex difference in sexual concordance is related to general awareness of physiological states, then the focus of

research must shift from sexuality-specific hypotheses to broader hypotheses regarding emotional processing. I investigated the relationship between sexual concordance and interoceptive awareness by conducting two studies: The first study (Chapter Five) involved a sample of men and women, and the second study (Chapter Six) involved a sample of women, a subset of which were recruited because of their increased likelihood to have high interoceptive abilities.

A summary of the results reported in this dissertation, as well as some implications and suggestions for future research are provided in Chapter Seven. Generally speaking, the findings reported in this dissertation indicate that the sex differences in sexual arousal patterns are valid phenomena and not simply the result of methodological issues. Overall, the results provide support for a functional explanation of the sex difference in genital category-specificity, offer mixed support for an information-processing model of sexual arousal in relation to sexual concordance, confirm the existence and stability of sex differences in sexual arousal patterns at the group level, and provide no evidence to suggest that sexual concordance is another manifestation of sex differences in interoception. These results have important implications for sex therapy and assessing sexual preferences in women.

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CHAPTER TWO

Testing a Functional Explanation for the Sex Difference in

Genital Arousal Category-Specificity

Abstract

Men's genital arousal occurs in response to a limited number of sexual stimuli, whereas women's genital arousal occurs in response to a wide range of sexual stimuli, including those depicting nonpreferred cues. Researchers have hypothesized that women's nonspecific pattern of genital arousal prepares the body for sexual activity, thus functioning to protect the genital organs against injury. If this hypothesis is correct, women should show genital responses to any cues suggesting sexual activity, even unappealing cues that involve nonconsensual sex and extreme violence. Fifteen men and 15 women listened to fourteen 2-min audiotaped narratives that depicted an interaction between a man and a woman and that varied factorially according to the presence of consent, violence, and sexual activity. The results support the preparation hypothesis: Men showed the greatest genital arousal in response to narratives depicting consensual, nonviolent sex, whereas women showed similar responses to all the narratives involving sexual activities, including those describing a sexual assault.

Introduction

Recent research has revealed a reliable sex difference in genital response patterns. Men's genital responses are *category-specific*, in that men tend to exhibit high responses to only certain stimulus categories. For example, self-identified heterosexual men exhibit large genital responses to sexual stimuli depicting adult women and no response to adult men (Lykins et al., 2010). In contrast, women's genital responses are typically *category-nonspecific*: women tend to exhibit similar responses to a variety of sexual stimuli. For example, self-identified heterosexual women show similar responses to stimuli that depict heterosexual, gay, or lesbian sex (Chivers, Rieger, Latty, & Bailey, 2004). In this study, we tested a functional hypothesis for women's category-nonspecific genital responses: that women's genital responses function to prepare the body for sexual intercourse, whether it is wanted or not.

Men's genital arousal is often assessed with penile plethysmography, using mercury-in-rubber strain gauges to measure changes in the circumference of the penis during the presentation of stimuli. Women's genital arousal is typically assessed with vaginal photoplethysmography, which measures changes in vaginal blood flow via changes in light reflectance. Using these devices, researchers have found that men's genital responses typically occur in the presence of stimulus cues that match their sexual interests. Women's genital responses, however, are less connected than men's to their sexual interests (Chivers, Seto, Lalumière, Laan, & Grimbos, 2010). Women even show some genital responses to nonhuman primates copulating, whereas men do not (Chivers & Bailey, 2005).

This well-replicated sex difference is not caused by poor validity of vaginal photoplethysmography as a measure of sexual arousal. Women, like men, exhibit genital

responses only in the presence of sexual stimuli (Suschinsky, Lalumière, & Chivers, 2009). Also, photoplethysmography can detect category-specific response patterns in the neovagina of postoperative male-to-female transsexuals (Chivers et al., 2004). Furthermore, women's genital responses, like men's, are affected by the intensity of sexual stimuli: More intense stimuli (e.g., two nude persons having sex) generate larger responses than less intense stimuli (e.g., one nude person masturbating; Chivers, Seto, & Blanchard, 2007).

Women's genital responses tend to be automatic. They occur shortly after the onset of a sexual stimulus and before self-report of feeling sexually aroused (Laan, 1994; Suschinsky, Chivers, & Lalumière, 2007). Genital responses occur in the presence of sexual stimuli even among women who report sexual arousal dysfunctions (Brotto, Klein, & Gorzalka, 2009). Evidence also indicates that women respond genitally to sexual stimuli even when not aware of their presence (Ponseti & Bosinski, 2010).

The Preparation Hypothesis

Some researchers have suggested a functional hypothesis for the nonspecificity and automaticity of female genital arousal. Because increased vaginal blood flow is a precursor to vaginal lubrication (Levin, 2003), nonspecific and automatic genital responses in women may serve a protective or preparatory function, readying women for sexual intercourse whether it is desired or not (Chivers, 2005; Laan, 1994; Laan & Janssen, 2007; Suschinsky et al., 2009; van Lunsen & Laan, 2004).

Substantial ethnographic, historical, and comparative evidence suggests that the threat of unwanted sexual activity has been considerable over human evolutionary history (Lalumière, Harris, Quinsey, & Rice, 2005). Therefore, there would have been strong selection pressure on women to avoid unwanted sex, or to minimize its costs should it occur

(Smuts, 1992). The social and metabolic costs of nonspecific genital responses in women (i.e., increased vaginal blood flow and lubrication) are not known but are probably low. Women's genital responses, unlike men's, are not easily observed. Also, because women's genital arousal is likely restricted to sexual cues, there is no need to maintain a constant state of lubrication and preparedness.

Conversely, the benefits of nonspecific and automatic genital responses are probably high. Increased vaginal blood flow and lubrication facilitate sexual activity and protect the genital tract from injury. Penile penetration, whether consensual or nonconsensual, can result in injuries in women, such as tears and ecchymoses (Anderson, McLain, & Riviello, 2006), although nonconsensual penetration produces a larger number of injuries than consensual sex (Anderson et al., 2006; Slaughter, Brown, Crowley, & Peck, 1997). Lack of a genital response during sexual activity may have had important negative reproductive consequences for women; for example, injuries to the reproductive tract increase the likelihood of contracting infections, which can result in infertility (e.g., pelvic inflammatory disease) or death (e.g., syphilis).

Some evidence already supports the preparation hypothesis. For instance, some women report experiencing lubrication during unwanted sexual activity (for a review, see Levin & van Berlo, 2004). Postmenopausal women, who typically lubricate less than premenopausal women during sexual activity, are more likely to sustain injuries during sexual assault (for a review, see Poulos & Sheridan, 2008). Also, women show some genital responses to stimuli that depict sexual threat or nonconsensual sexual activity (Laan, Everaerd, & Evers, 1995; Suschinsky et al., 2009).

Previous studies have typically shown that women's genital responses to sexually threatening cues are lower than their responses to consensual sexual cues, a pattern of results inconsistent with the preparation hypothesis. The sexual threat stimuli in prior studies, however, were qualitatively different from the consensual stimuli in terms of the intensity of sexual activity and the amount of nudity. No study has examined women's responses to stimuli depicting nonconsensual sexual interactions that are otherwise identical to stimuli depicting consensual sexual interactions.

If nonspecific genital responding functions to prepare women for a possible sexual encounter, women should exhibit a genital response to any stimulus that contains sexual content, regardless of the presence or absence of consent or violence, and regardless of whether they find the stimulus subjectively arousing or not. On the basis of previous research (Lalumière, Quinsey, Harris, Rice, & Trautrimas, 2003), we predicted that men would show their highest genital responses to stimuli depicting consensual, nonviolent sexual activity. We also expected women and men to report little subjective sexual arousal in response to stimuli depicting violent or nonconsensual sexual activity. Because we expected women to show genital arousal, but little subjective sexual arousal, to most of the stimuli, we predicted that women, relative to men, would exhibit low correlations between genital and subjective sexual arousal. More specifically, we predicted a stronger negative relationship between rated unpleasantness of the sexual stimuli and genital responses among men than among women.

Method

Participants

Thirty-six participants were recruited from a university campus. All reported that they were between 18 and 28 years old, involved in a dating relationship, nulliparous, heterosexual, sexually experienced, and free from mental illnesses and sexual dysfunctions. Data from one man were excluded because he exhibited his highest genital response to the neutral stimuli, and data from five women could not be used because of movement artifacts. Of the remaining participants, the mean age for men ($n = 15$) was 23.2 years ($SD = 2.8$), and the mean age for women ($n = 15$) was 21.5 years ($SD = 2.5$).

Materials and Measures

The stimuli consisted of audio recordings of 2-min narratives previously designed to investigate the relative importance of cues of consent, violence, and sex for men's genital arousal (Harris, Lalumière, Seto, & Rice, 2008). Narratives were read by a woman from her point of view and followed a standard format: a few sentences to set the scene, a description of the initial contact between a man and the woman, the woman's reaction, the man's response, the woman's experience, the man's final acts, and the woman's final condition. The narratives varied factorially on three elements: *consent* (female consent and enjoyment vs. refusal and displeasure), *violence* (injury and suffering vs. none), and *sexual content* (sexual acts and nudity vs. none). Of the eight resulting combinations, one (no consent, no violence, no sex) was not used. For each category, five narratives were available, and two were randomly selected for each participant. Two other narratives, a neutral interaction (consent, no violence, no sex) and a consensual, nonviolent sexual interaction, were presented before the experimental session to acquaint the participant with the procedure. The 14 experimental narratives were presented in a quasirandom order for each participant, such that no participant heard two narratives from the same stimulus category consecutively.

All genital and continuous subjective data were sampled using the same procedure in our previous study (Suschinsky et al., 2009). Participants continuously rated how sexually aroused they felt during each narrative by pushing a button on a computer keypad. When participants pushed the button to signal increased or decreased arousal, a vertical bar would appear on a computer monitor situated 5 ft in front of participants. Changes in subjective arousal were depicted as changes in the height of the bar. Following each narrative, six questions were presented on the monitor one at a time, and participants responded using the keypad. The questions addressed participants' overall sexual arousal and genital arousal, how calm and anxious they felt, and how pleasant and unpleasant the narrative was. The rating scale ranged from 1 (*emotion not present*) to 9 (*emotion definitely present*).

Procedure

Participants were assessed individually and were left alone in a dimly lit private room to apply the genital gauge. The narratives (presented with headphones) were separated by interstimulus intervals lasting (30 to 300 s), during which time participants answered the poststimulus questions. After listening to all the narratives, participants completed a biographical questionnaire. The University of Lethbridge human ethics committee approved the procedure.

Scores for genital and continuous subjective responses were calculated by subtracting the baseline response (at the start of the trial) from the peak response (during the trial), separately for each narrative. The genital responses were then transformed into z scores (within-subjects) because the response outputs for men and women are not on the same scale. Responses to the two narratives within a stimulus category were averaged to produce a mean score for each category.

Results

Figure 2.1 presents the standardized genital responses for men and women. A 2 (participant's sex) \times 7 (stimulus category) analysis of variance (ANOVA) revealed that men and women showed different patterns of genital arousal, $F(6, 168) = 3.88, p = .001, \eta^2 = .12$. Men's genital responses were largest for the consensual, nonviolent sexual stimuli and lower for all other stimulus categories, whereas women's genital responses tended to be more evenly distributed across the stimulus categories. Planned contrasts revealed that men exhibited significantly higher genital responses to the consensual, nonviolent sexual narratives than to all other categories of narratives ($ps < .002, ds = 1.79\text{--}4.32$). Women's genital responses to the consensual, nonviolent sexual narratives were significantly higher than their responses to the three nonsexual stimulus categories and only one sexual category, nonconsensual, nonviolent sex ($ps < .03, ds = 0.96\text{--}2.48$).

Next, we performed a Kolmogorov-Smirnov test for each participant in order to compare the distribution of responses to all nonneutral stimuli against a theoretical uniform (i.e., flat) response distribution. A higher Z score indicates that the response pattern differed to a greater extent from a uniform distribution. An independent-samples t test of these scores showed that men's genital response patterns ($M = 1.56, SD = 0.42$) were significantly less uniform than women's ($M = 1.16, SD = 0.51$), $t(28) = 2.31, p = .029, d = 0.86$.

Figure 2.2 presents the raw mean scores for continuous subjective sexual arousal. A 2 (participant's sex) \times 7 (stimulus category) ANOVA revealed that men and women showed different patterns of subjective arousal, $F(6, 168) = 3.45, p = .003, \eta^2 = .11$. However, planned contrasts indicated that men and women exhibited similar patterns of subjective sexual responses because both men and women showed significantly higher responses to the

consensual, nonviolent sexual narratives than to all the other narrative categories ($ps < .001$). Men ($M = 29.4, SD = 18.1$), however, reported significantly more sexual arousal in response to the consensual, violent sexual narratives than women did ($M = 15.7, SD = 14.4$), $t(28) = 2.30, p = .029, d = 0.84$, causing the significant interaction between participant's sex and stimulus category.

A Kolmogorov-Smirnov test was performed for each participant's continuous subjective sexual arousal. The results from an independent-samples t test of the Z scores indicate that men's ($M = 1.63, SD = 0.55$) and women's ($M = 1.75, SD = 0.74$) patterns of subjective sexual arousal did not differ significantly, $t(27) = -0.48, p = .63, d = -0.18$.

Table 2.1 presents the mean poststimulus ratings. Independent-samples t tests revealed no significant sex differences for any question for any stimulus category. Men and women rated the consensual, nonviolent sexual stimuli as the most sexually arousing. Both sexes rated the neutral stimuli and the consensual, nonviolent sexual stimuli as most pleasant, whereas the remaining stimulus categories were all rated as unpleasant. Similarly, both sexes felt most calm and least anxious during the neutral stimuli and the consensual, nonviolent sexual stimuli.

Following the method we used previously (Suschinsky et al., 2009), we calculated a nonparametric (Spearman rank correlation coefficient) correlation to examine sex differences in the relationship between genital arousal and self-reported sexual arousal (i.e., sexual concordance). Individual concordance scores were calculated for each participant using the data for the eight sexual narratives (for a total of eight pairs of data). Following Chivers et al. (2010), we used post-stimulus self-reported sexual arousal for our concordance calculations. An independent-samples t test revealed that men were significantly more sexually

concordant ($Mean r_s = .77$) than women were ($Mean r_s = .18$), $t(27) = 4.54$, $p < .001$. Men also exhibited a significantly stronger negative correlation between their genital arousal in response to sexual stimuli and the reported degree of stimulus unpleasantness ($Mean r_s = -.54$) than women did ($Mean r_s = -.15$), $t(28) = -2.77$, $p = .01$.

Discussion

The results support the preparation hypothesis for the low category-specificity of women's genital arousal. Men's genital responses were directed toward stimuli that depicted their preferred activity—consensual, nonviolent sex—whereas women showed similar genital arousal to most sexual stimuli. Similarly, men's genital responses were more likely than women's to differ from a uniform distribution, a pattern indicating that men's genital responses were more discriminating. Men's and women's subjective sexual-arousal responses were similar (with one exception): Both sexes reported their highest sexual arousal in response to consensual, nonviolent sex. Men were more sexually concordant than women, and genital arousal was more negatively correlated with unpleasantness ratings in men than in women. Both sexes reported that they found narratives involving violence or nonconsent to be highly unpleasant and somewhat anxiety provoking.

Notably, women did show elevated genital responses to the stimuli depicting nonsexual consensual violence. Although narratives in this category included no sexual cues, it is possible that participants perceived the narratives as sexual, because the narrator described the characters as receiving much pleasure from the activities—the kind of pleasure that is usually associated with sexual activities. It is also notable that one sexual stimulus category (nonconsensual, nonviolent sex) unexpectedly evoked lower genital responses than the consensual, nonviolent sex category in women, although it still produced much higher

responses than the neutral category ($d = 1.48$). In addition, the size of the difference in arousal between the nonconsensual, nonviolent sexual narratives and the consensual, nonviolent sexual narratives was much smaller for women ($d = 0.97$) than for men ($d = 2.06$). These results are consistent with the results of the Kolmogorov-Smirnov analyses and show that women produce less discriminating responses than men do.

Although the results of this study support the preparation hypothesis, there are methodological limitations that must be noted. All narratives were told from a woman's perspective and read by a woman, and it is possible these narratives prompted women to imagine themselves as the female character in the story, whereas the men may have felt less connected with the male character. Narratives that use a woman's perspective, however, are known to increase men's arousal, even for rape stimuli (Lalumière et al., 2003). Participants were relatively young and in sexual relationships, and our results cannot necessarily be generalized to other groups. Also, individuals willing to participate in sexual-arousal studies typically are more sexually experienced and report less sex guilt than individuals who are not willing to participate in such studies (Strassberg & Lowe, 1995). We recommend that this study be replicated with a larger and more diverse sample.

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Tables and Figures

Table 2.1.

Mean post-stimulus ratings.

Question and sex of participant	Non-sexual stimulus categories		
	Neutral <i>M (SD)</i>	Violence, No Consent <i>M (SD)</i>	Violence, Consent <i>M (SD)</i>
Sexual arousal			
Men	1.2 (0.5)	1.1 (0.3)	2.0 (1.4)
Women	1.1 (0.3)	1.1 (0.3)	1.7 (0.8)
Genital arousal			
Men	1.1 (0.2)	1.2 (0.4)	1.9 (1.4)
Women	1.2 (0.4)	1.3 (0.5)	1.9 (0.9)
Pleasant			
Men	6.5 (1.9)	1.1 (0.4)	1.8 (1.0)
Women	5.5 (1.9)	1.1 (0.3)	1.7 (0.8)
Unpleasant			
Men	2.0 (2.2)	8.3 (1.4)	7.2 (1.2)
Women	1.7 (1.4)	8.3 (0.9)	6.5 (2.0)
Calm			
Men	7.4 (1.5)	2.6 (2.1)	3.6 (2.0)
Women	6.4 (2.0)	2.3 (1.0)	2.7 (1.5)
Anxious			
Men	2.2 (1.8)	5.7 (2.7)	4.7 (1.8)
Women	1.7 (1.1)	5.7 (2.2)	4.4 (2.2)

Sexual stimulus categories				
Question and sex of participant	Violence, No Consent <i>M (SD)</i>	Violence, Consent <i>M (SD)</i>	No Violence, No Consent <i>M (SD)</i>	No Violence, Consent <i>M (SD)</i>
Sexual arousal				
Men	1.8 (1.0)	3.7 (1.8)	2.2 (1.2)	6.5 (1.8)
Women	1.8 (1.0)	2.7 (1.5)	2.5 (1.5)	5.5 (1.5)
Genital arousal				
Men	2.0 (1.3)	3.6 (1.9)	2.2 (1.2)	5.8 (1.9)
Women	2.1 (1.2)	3.0 (1.6)	3.1 (1.5)	5.1 (1.6)
Pleasant				
Men	1.7 (1.1)	3.2 (1.6)	1.7 (1.0)	7.1 (1.9)
Women	1.6 (1.0)	2.6 (1.1)	2.2 (1.3)	6.3 (1.7)
Unpleasant				
Men	7.4 (1.5)	5.8 (1.8)	7.6 (1.5)	1.7 (1.9)
Women	7.7 (1.7)	5.6 (1.9)	6.8 (2.0)	1.8 (0.8)
Calm				
Men	3.1 (1.7)	4.1 (1.8)	3.3 (2.3)	6.0 (1.4)
Women	2.3 (1.4)	3.4 (1.9)	2.8 (1.5)	5.7 (2.0)
Anxious				
Men	5.1 (2.7)	4.6 (1.7)	5.1 (2.5)	2.9 (1.8)
Women	5.5 (2.1)	4.2 (2.0)	4.9 (1.9)	2.5 (1.5)

Note: Ratings were provided on a scale from 1 (*emotion not present*) to 9 (*emotion definitely present*). Standard deviations are given in parentheses.

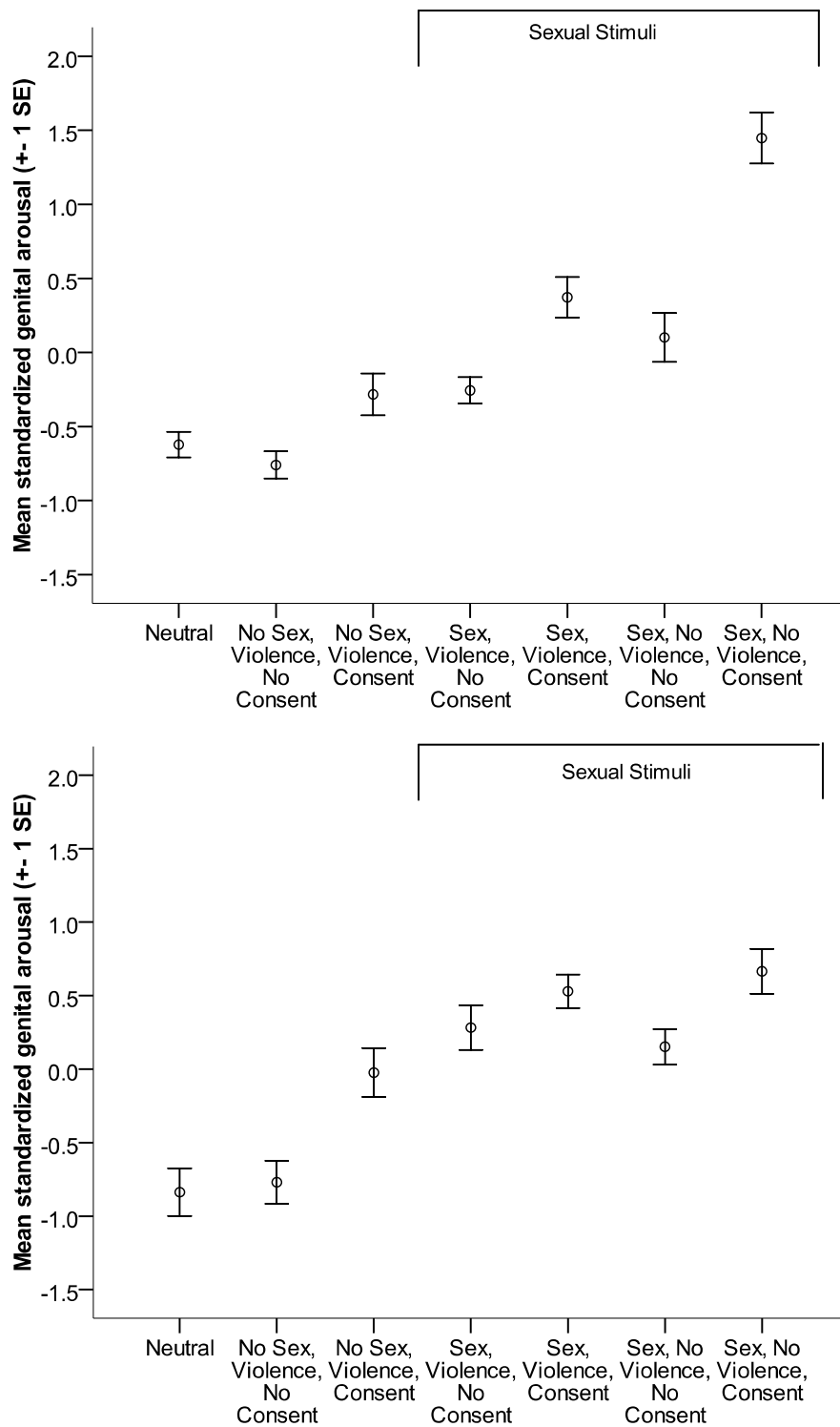


Figure 2.1.

Standardized mean genital responses in men (top) and women (bottom).

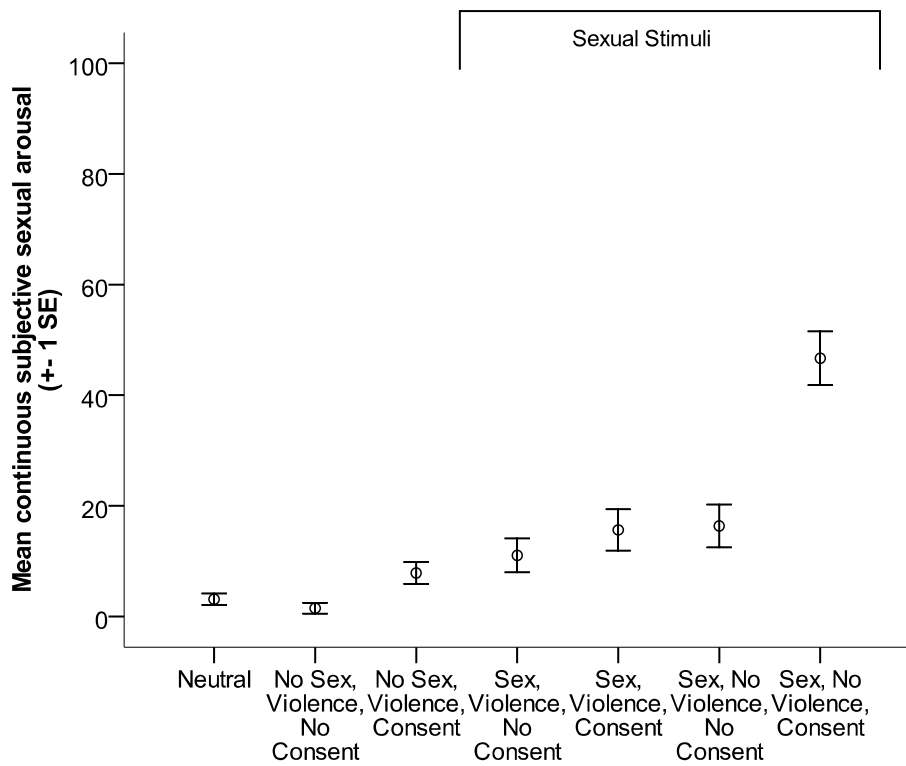
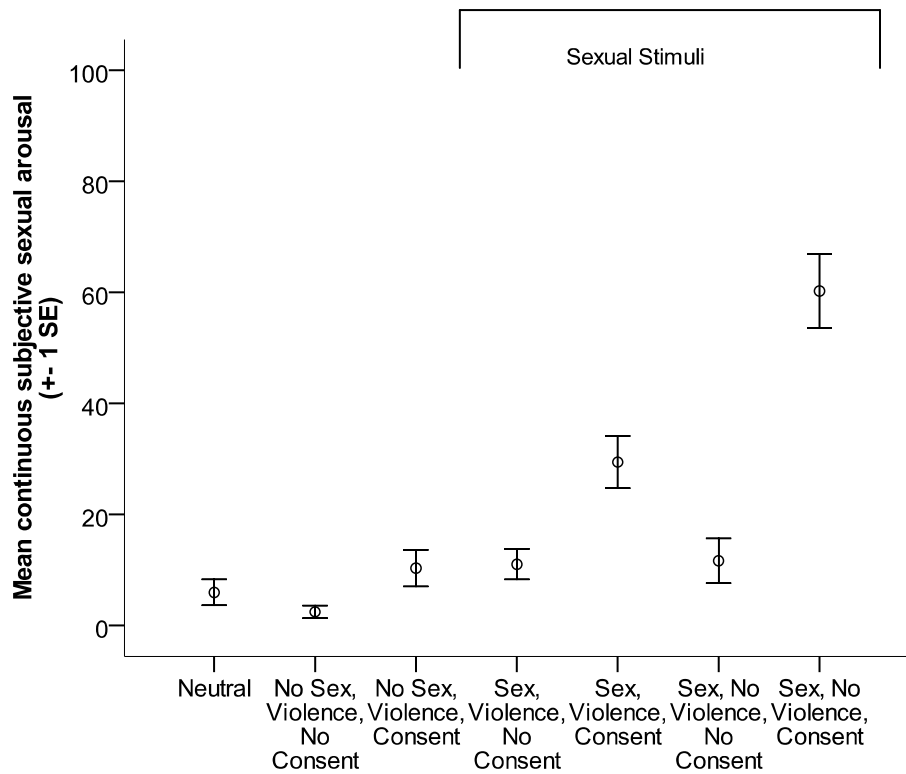


Figure 2.2.

Mean continuous subjective sexual arousal responses in men (top) and women (bottom).

CHAPTER THREE

Testing an Information-Processing Model of Sexual Arousal and Sexual Concordance

Abstract

Sexual concordance, or the relationship between genital and self-reported sexual arousal, is consistently higher in men than in women. Laan and Janssen (2007) proposed an information-processing model to explain this sex difference, arguing that men and women derive their experience of arousal from different sources. The purpose of the current study was to test this model using data from 40 heterosexual men and 40 heterosexual women from previously published studies (Suschinsky et al., 2009; Chivers et al., 2007). We used second-by-second data to examine sexual concordance, the timing of genital and subjective responses, and the effect of stimulus content. Men had significantly higher sexual concordance scores than women, regardless of the method used to calculate concordance and for most stimuli. Laan and Janssen's model received some support: Men were more likely than women to report being sexually aroused at their peak genital response, and a genital response was usually present at the time of peak subjective responses in both sexes. Unexpectedly, men's genital responses did not precede their subjective arousal, and women's sexual concordance scores were less influenced by stimulus content than men's. The results are discussed in the context of previous research and we offer directions for future research.

Introduction

The human sexual response involves physiological, emotional, and cognitive processes (Geer & Janssen, 2000; Rosen & Beck, 1988). It may seem intuitive that the outcomes of these processes should occur in a relatively coordinated fashion. For instance, when a man exhibits a penile response, we expect that he also feels sexually aroused and is thinking sexual thoughts. Similarly, when a woman is expressing her desire to engage in sexual activity we expect that, in the absence of a sexual dysfunction, she is also displaying signs of physiological arousal, such as vaginal lubrication or labial swelling.

Sexual concordance refers to the relationship between physiological and self-reported (i.e., emotional) sexual arousal. The relationship between genital arousal and self-reported sexual arousal in men is consistently high. Women's genital and self-reported sexual arousal are less strongly connected. Although the relationship in women is typically positive (Pearson $r = .26$; in a meta-analysis by Chivers, Seto, Lalumière, Laan, & Grimbos, 2010), it is significantly much lower than that seen in men (Pearson $r = .66$; Chivers et al., 2010).

Low sexual concordance in women is not a newly discovered phenomenon. Thirty-four years ago, Heiman (1977) found that fewer women (58%) than men (100%) reported feeling sexually aroused during their highest genital response, as measured by vaginal blood volume and changes in penile circumference, respectively. Steinman, Wincze, Sakheim, Barlow, and Mavissakalian (1981) reported fewer significant correlations between genital and self-reported arousal in women (63%) relative to men (100%). More recently, Suschinsky and Lalumière (2011) reported that men exhibited significantly higher sexual concordance in response to audio-taped sexual narratives ($r = .77$) relative to women ($r = .18$). Although the sex difference in sexual concordance has been reported in different

fashions for several decades and has been confirmed in Chivers et al.'s (2010) meta-analysis, investigations into the sources of lower sexual concordance in women have only recently begun.

Factors Associated with Lower Sexual Concordance in Women

Methodological factors. Chivers et al. (2010) noted that the sex difference in sexual concordance may be the result of methodological factors that spuriously enhance sexual concordance in men or decrease sexual concordance in women. In their meta-analysis of 132 studies examining genital and self-reported sexual arousal, they investigated several methodological aspects of psychophysiological studies of sexual concordance. The results suggest that the sex difference in sexual concordance is in fact robust to many methodological factors, including stimulus characteristics (e.g., stimulus length, modality of presentation, male- versus female-centered content, and number of trials), sample characteristics (e.g., age and hormonal contraceptive use in women), statistical factors (e.g., type of correlation computed), and type of vaginal photoplethysmography component used (i.e., vaginal blood volume or vaginal pulse amplitude).

Suschinsky, Lalumière, and Chivers (2009) investigated the possibility that lower sexual concordance in women is the result of poor measurement of their genital arousal. The most commonly used measure of genital arousal in women is vaginal blood flow, as assessed by vaginal photoplethysmography (Sintchak & Geer, 1975). Because vaginal photoplethysmography had not been subjected to the same rigorous testing as phallometry, it was plausible that women's lower sexual concordance may be simply related to poorer measurement validity of one of the measures used in the calculation of sexual concordance: If vaginal blood flow changes in response to both non-sexual and sexual stimuli, lower

sexual concordance in women would not be surprising, because women would likely not be reporting increased feelings of sexual arousal in response to stimuli they perceive as non-sexual. Suschinsky et al.'s results were consistent with earlier investigations of vaginal photoplethysmography's validity (e.g., Laan, Everaerd, & Evers, 1995) and suggested that vaginal blood flow is specific to sexual stimuli. Just like men, women exhibited their greatest genital arousal in response to the sexual stimuli, and minimal genital arousal in response to non-sexual but emotionally-charged stimuli of either positive or negative valence.

There might be other genital arousal measures that produce higher sexual concordance in women. Henson, Rubin, and Henson (1979) suggested that temperature changes of the external genitalia measured by a labial thermistor or thermography are more perceptible to women than changes in vaginal vasocongestion measured by vaginal photoplethysmography. Chivers et al. (2010) compared temperature and blood flow measures of genital arousal, and found that thermography does indeed yield higher correlations with subjective arousal in women when compared to vaginal photoplethysmography. Chivers et al., however, also noted the limited number of studies that have reported temperature measurements ($K = 6$) relative to blood flow measurements ($K = 49$), and were hesitant to suggest that temperature measurements consistently produce more valid concordance scores than blood flow measurements. Recent research using thermal imaging cameras suggests that at least some women still show low sexual concordance; 40% of the women in Kukkonen, Binik, Amsel, and Carrier's (2010) study had a sexual concordance score less than or equal to zero, whereas all of the men had positive sexual concordance scores.

Another factor that may influence sexual concordance involves the method used to calculate sexual concordance scores. Researchers have often assessed subjective arousal with a single Likert scale item or computed a mean score based on several items. Rellini, McCall, Randall, and Meston (2005) argued that these methods reduce the richness of the data, and preclude determining how changes in one measure may relate to changes in the other measure. Rellini et al. calculated sexual concordance in 22 women using hierarchical linear modeling (HLM), a statistical method designed to assess between- and within-participants factors while retaining resolution to examine individual differences. Genital arousal was assessed with vaginal photoplethysmography and subjective arousal was assessed continuously during a neutral and a sexual film. Rellini et al. found that 16 of 22 women exhibited a significant correlation between their genital and subjective sexual arousal ($r \geq .37$).

Although Rellini et al.'s (2005) results indicate that there is indeed a significant correlation between genital and subjective arousal in women, there are two important issues to consider. First, Rellini et al. included data collected during the neutral film in their analyses. Including non-sexual stimuli in sexual concordance calculations results in higher sexual concordance (Suschinsky et al., 2009); non-sexual stimuli do not elicit a genital or subjective sexual response, thus spuriously increasing variation in both responses. Second, Rellini et al. did not include a male comparison group. The question of interest is not simply whether women are sexually concordant – we know that women exhibit positive sexual concordance (Chivers et al., 2010) – but rather *why* women's sexual concordance is lower than men's sexual concordance.

Although researchers have used different statistical analyses for assessing sexual concordance, most previous sexual concordance research has focused on using peak or mean responses to a given stimulus, that is, a single pair of data for each stimulus, for calculating correlations (e.g., Suschinsky et al., 2009). Rellini et al. (2005), as well as other researchers (e.g., Korff & Geer, 1983; Laan, Everaerd, van Bellen, & Hanewald, 1994) have considered the dynamic nature of sexual arousal when calculating sexual concordance by comparing genital and subjective arousal data over varying time periods within a given stimulus. Although comparing points within a stimulus allows for a more dynamic measure of concordance by taking into account periodic changes, the data are still reduced to a few points per stimulus. For example, Rellini et al. averaged their genital and subjective arousal data over 10-second intervals for their 10 minute film. Laan et al. took measurements every 30 seconds during an 11 minute film. Korff and Geer assessed arousal at three different points during a slide presentation. To our knowledge, no one has assessed sexual concordance using second-by-second data from vaginal blood flow measures of genital arousal.

Sexual experience. Perhaps the difference between men's and women's sexual concordance can be attributed to their different experiences across the lifespan. Chivers et al. (2010) suggested that there are three potential sources of differential experiences. The first is the fact that the penis provides men with an obvious external cue to their genital arousal, whereas women's genital arousal is less obvious and hidden from view. Second, many women are presented with negative images of female genitalia and menstruation, and thus some women may associate genital sensations with shame and disgust (Steiner-Adair, 1990). Lastly, women have less experience with their genitals and sexual responses because they

masturbate much less frequently than men on average (Oliver & Hyde, 1993; Petersen & Hyde, 2010).

Although men and women clearly have different experiences with their genitals and undergo different socialization regarding sexuality, it does not appear that lower sexual concordance in women is a function of these differential experiences. One would expect that older women would be more sexually concordant, given the fact that older women would have had more opportunities to explore their bodies or to experience sexual arousal. Chivers et al. (2010) did not find a significant correlation between average sample age and sexual concordance in women, but did find a significant correlation in men. Similarly, one would expect individuals with little experience with their genitals, such as recent post-operative male-to-female transsexuals, to be less sexually concordant than individuals with more experience with their genitals, such as natal women, but Chivers, Rieger, Latty, and Bailey (2004) found in fact that post-operative male-to-female transsexuals showed higher correlations between their genital and self-reported sexual arousal than natal women.

One might also expect women to show higher sexual concordance if they were asked to focus on their physical sensations because they would be paying more attention to their arousal. Chivers et al. (2010) examined studies that assessed self-reported sexual arousal in two different ways: subjective arousal (i.e., emotional feelings of sexual arousal) and perception of genital arousal (i.e., reporting how sexually aroused one's genitals feel). Chivers et al. found that women's sexual concordance was actually slightly lower ($r = .23$) when using perception of genital arousal as the method of self-report, relative to subjective arousal ($r = .26$).

Social desirability. Laan and Janssen (2007) noted that lower sexual concordance in women is likely not the result of social desirability. Although women often under-report their sexual experiences to conform to gender-role expectations (Alexander & Fisher, 2003), Laan and Janssen suggested that it is unlikely that lower sexual concordance in women is a function of women attempting to minimize their sexual arousal. Past research has suggested that women who volunteer to participate in sexuality research are more sexually experienced (e.g., have more experience with less common sexual practices, more masturbation experience, and more non-coital sexual experience) and less sexually inhibited (Morokoff, 1986). In addition, women often report some sexual arousal in response to sexual stimuli that evoke negative emotional reactions, including male-oriented erotica (Laan et al., 1994) and non-consensual sexual activities (Laan et al., 1995; Suschinsky et al., 2009), making it unlikely that women would be unwilling to report arousal in response to stimuli depicting consensual sexual activities. More to the point, Brody, Laan, and van Lunsen (2003) did not find a difference in sexual concordance between women who scored high on a measure of social desirability and women who had lower social desirability scores.

Other factors. There is a second sex difference in patterns of sexual arousal that may be related to the sex difference in sexual concordance. Men's genital arousal is *category-specific*, such that men typically exhibit their largest genital response when presented with stimuli depicting certain features, such as the sex of the people in the stimuli (Chivers et al., 2004; Chivers & Bailey, 2005; Chivers, Seto, & Blanchard, 2007; Suschinsky et al., 2009) or the age of the actors depicted (Blanchard, Klassen, Dickey, Kuban, & Blak, 2001; Seto & Lalumière, 2001). Heterosexual women's genital arousal is much less category-specific, in that women's genital arousal increases to stimuli depicting both preferred and non-preferred

features (Chivers et al., 2004; Laan, Sonderman, & Janssen, 1995; Suschinsky et al., 2009; Suschinsky & Lalumière, 2011). Lesser category-specificity in genital arousal would of course lead to lower correlations between genital and self-reported arousal, because a genital response would be present for most sexual stimuli and a subjective response would be less frequent. Women's category-nonspecific genital arousal cannot be the sole explanation for the sex difference in sexual concordance, however, because even when heterosexual men and women are presented with only stimuli that depict their preferred sex partners (i.e., sexual interactions between one man and one woman), men still exhibit significantly higher correlations between their genital and self-reported arousal relative to women (Harte, Adkins, Rand, & Meston, 2007; Wincze, Venditti, Barlow, & Mavissakalian, 1980).

Chivers et al. (2010) did report a few factors that significantly influenced sexual concordance. These factors decreased sexual concordance in men or spuriously increased sexual concordance in women. There was no significant difference between men's and women's sexual concordance when participants were asked to continuously rate their sexual arousal, because men's sexual concordance decreased under that condition. Likewise, there was no significant sex difference when participants were presented with sexual stimuli that varied by content or modality. Because greater variety in sexual stimuli can lead to more variability in responses, the likelihood of detecting correlations increases. It is important to note that although the sex difference in sexual concordance was not significantly different when assessing continuous subjective sexual arousal and when the stimuli varied by content or modality, women's average sexual concordance ($r = .30$ and $r = .49$, respectively) was still lower than men's ($r = .44$ and $r = .60$, respectively).

Based on the recent findings outlined above, it is clear that there is a robust difference between men's and women's sexual concordance. Although many factors have been ruled out as possible influences on sexual concordance, the source of lower sexual concordance in women still remains unknown. Because investigations of primarily external factors (e.g., methodological issues or social desirability) have not elucidated the source of lower sexual concordance in women, it may be appropriate to pursue more personal factors that may influence sexual concordance in women, such as cognitions.

An Information-Processing Model of Sexual Arousal

Janssen, Everaerd, Spiering, and Janssen (2000) proposed an information-processing model of sexual arousal. According to this model, there are two pathways involved in sexual arousal: one pathway involves appraisal of the sexual stimulus and automatic response generation and the other involves attention and regulation. Sexual arousal begins with the activation of sexual meanings in memory after the presentation of a sexual stimulus. A physiological response follows this initial activation, which in turn directs attention to the sexual stimulus, thereby maintaining focus on the stimulus and maintaining the physiological response. This continued focus on the stimulus, and potentially the genital response, allows the individual to review the meanings of memories (i.e., sexual or non-sexual, positive or negative) associated with the stimulus. Although the genital response has been activated by the sexual meanings, the emotional experience of sexual arousal is determined by the combination of both the sexual and non-sexual meanings. Lower sexual concordance, according to this model, occurs when the sexual stimulus elicits non-sexual meanings, specifically negative non-sexual meanings, in addition to sexual meanings.

Recently, Laan and Janssen (2007) adapted this model to explain the sex difference in sexual concordance. They suggested that the information-processing model proposed by Janssen et al. (2000) applies to both men and women, in that sexual meanings will result in a genital response in both men and women. The factors that influence the emotional or subjective aspect of sexual arousal, however, differ between men and women. Laan and Janssen argued that there are two sources of emotional experience: the automatic genital response and the meanings produced by the sexual stimulus. Men's experience of sexual arousal depends heavily on the automatic component of sexual arousal (i.e., the appraisal of a stimulus as sexual and the genital response), whereas women's experience of sexual arousal depends less on the genital response and more on the meanings they attribute to a sexual stimulus that are stored in their memory. The meanings that are associated with sexual stimuli can be positive, negative, or both (Peterson & Janssen, 2007). Laan and Janssen postulated that men and women may rely on different sources of information for their subjective experience of sexual arousal because of sex differences in anatomy that provide more feedback to men during sexual arousal, sex differences in neural sensitivity to feedback from genital arousal, or sex differences in explicit memory for emotional stimuli.

The explanation that is best supported seems to involve sex differences in explicit memory for emotional stimuli. Canli, Desmond, Zhao, and Gabrieli (2002) found that women have better memory for intensely negative non-sexual images after a three-week period. When presented with the most emotionally arousing stimuli, only women showed activation in their hippocampus, a brain region involved in explicit memory, at the three-week follow-up. Laan and Janssen noted that these results must be replicated with sexual stimuli in order to support their hypothesis that women are more affected by the meanings

derived from sexual stimuli. To date, however, no one has directly tested Laan and Janssen's model of sexual arousal in relation to sexual concordance.

The Current Study

Using Laan and Janssen's (2007) model of sexual response, we made several hypotheses about the nature of sexual concordance in men and women. (a) Overall, men were expected to be more sexually concordant than women. We tested this hypothesis using a novel approach that takes into account minute changes in arousal during a given stimulus presentation using second-by-second data. (b) If men rely more heavily on their genital responses to infer their emotional sexual arousal than women, they should be more likely to report feeling sexually aroused at their peak genital response to a sexual stimulus relative to women. (c) If the genital response is somewhat automatic and responsible for directing attention to the stimulus, which is in turn necessary for an individual to assess the meanings associated with the stimulus in both men and women, then men and women should be equally likely to exhibit a genital response at their peak self-reported arousal to a sexual stimulus. (d) The genital response should therefore precede self-reported sexual arousal in both men and women. (e) If men rely more heavily on their genital responses and less on the meanings generated by the sexual stimuli to determine their emotional experience, men should show similar sexual concordance scores across different types of sexual stimuli, regardless of whether the stimulus is rated as pleasant or elicits anxiety. If women rely more heavily on the meanings generated by sexual stimuli to determine their emotional experience, however, they should show lower sexual concordance for stimuli they consider unpleasant or that elicit anxiety.

Method

The hypotheses described above were tested using data from two previously published studies; data from Suschinsky et al. (2009) will be reported as Study A and data from Chivers et al. (2007) will be reported as Study B.

Study A

Participants. Suschinsky et al.'s (2009) sample consisted of 20 male and 20 female participants. Participants were required to be between 18 and 28 years of age, mostly or exclusively attracted to members of the opposite sex, in an intimate relationship for six months or longer, sexually experienced (i.e., must have engaged in sexual intercourse before participating and been previously exposed to erotic material), free from a history of sexual dysfunctions, mental illness, substance abuse, and sexually transmitted diseases, as well as not using medications for high blood pressure or mental illnesses. Women also were required to be nulliparous and report a regular menstrual cycle. Women using hormonal contraceptives (56%) were included. For the purposes of the current study, data from three participants were excluded for one of the following reasons: failure to exhibit a genital response (defined as 25% of their maximum peak minus baseline genital response and greater than their maximum peak minus baseline response to a neutral stimulus) to at least two sexual stimuli (one woman), or failure to report any change in subjective sexual arousal to at least two sexual stimuli (one man and one woman). The final sample included in the current study consisted of 19 men (*mean age* = 21.9, *SD* = 2.5) and 18 women (*mean age* = 22.2, *SD* = 2.9). Most men (84%) and all women were Caucasian. Most of the men (79%) and women (83%) reported that they were currently completing or had completed post-secondary education. All men and women reported their sexual orientation as heterosexual.

Materials and Measures.

Audio-visual stimuli. Participants were presented with two exemplars from a variety of sexual (low-intensity male-female, male-female sexual aggression, male-male, female-female, and male-female) and non-sexual films (neutral, happy, sad, exhilarating, anxiety-inducing) with sound (90 s each). The low-intensity male-female stimuli depicted a partially clothed man and woman kissing and caressing each other. The male-female sexual aggression stimuli depicted scenes with either a single man or multiple men explicitly forcing a woman to engage in sexual activity. The remaining sexual stimuli depicted consensual oral or penetrative sexual activity between nude individuals. Data from the five sexual stimulus categories were used in data analyses for the current study.

Genital measures. All psychophysiological data (i.e., genital arousal and continuous subjective arousal) were sampled continuously throughout each film using a Limestone Technologies Inc. (Kingston, ON) DataPac_USB and Preftest software. Women's genital arousal was assessed with changes in vaginal pulse amplitude (VPA) using a vaginal photoplethysmograph. The photoplethysmograph signal was sampled at a rate of 10 samples/s, band-pass filtered (.5 Hz to 10 Hz), and digitized (40 Hz). Baseline was captured during the one second preceding each stimulus and the peak response corresponded to the largest peak-to-trough distance during the stimulus presentation. A placement device made of flexible silicone was attached to the cable of the vaginal gauge and placed at a distance of 5 cm from the phototransistor (i.e., light detector). The placement device was used to control the depth and the orientation of the gauge (Laan et al., 1995). Movement artifacts were detected through visual inspection of the waveforms and removed prior to data analysis; the experimenter was blind to the stimulus category when removing artifacts.

Men's genital arousal was measured using mercury-in-rubber strain gauges. The

signal was sampled at a rate of 10 samples/s, low-pass filtered (to .5 Hz), and digitized (40 Hz). The signal was transformed into millimeters of circumference. Baseline was captured at the beginning of each stimulus and the peak response corresponded to the highest circumference value during the stimulus presentation. The gauges were calibrated over six 5-mm steps for each participant. Movement artifacts were detected through visual inspection of the response curves and removed prior to data analysis; the experimenter was blind to the stimulus category when removing artifacts.

Subjective arousal measures. During the presentation of each film, participants were instructed to continuously rate how sexually aroused they felt, defined as “how turned on you are feeling” on a scale of 0% (i.e., no sexual arousal) to 100% (i.e., sexual arousal associated with the feeling right before reaching an orgasm). Participants rated their subjective sexual arousal by pressing a button on a keypad that would raise or lower a bar that represented their sexual arousal that was displayed on the same monitor as the films.

Post-stimulus questions. After each film had ended, participants were asked several questions about their sexual and emotional responses. They were asked to rate how pleasant, unpleasant, and intense the films were, as well as how sexually aroused, happy, exhilarated, sad, anxious, and calm they felt during each film. Participants answered these questions using a scale of 1 (i.e., the emotion was definitely not present) to 9 (the emotion was definitely present).

Procedure. Participants who met the eligibility criteria for the study participated individually. They attached or inserted the genital gauge in private, while fully reclined in a comfortable chair. Participants watched the films on a computer monitor in a dimly lit room and wore headphones to listen to the sound that accompanied the films. During the

presentation of the films, participants used a keypad on the arm of the chair to continuously rate their subjective sexual arousal by raising or lowering the electronic bar on the computer monitor. After each film, participants answered several questions about their sexual and emotional reactions to the film by using a keypad. They were required to answer these questions before the next film could begin. Each stimulus presentation was followed by a return-to-baseline interval to allow genital responses to return to a pretrial level of response. After all of the films had been presented, participants removed the gauge and were then debriefed by the experimenter. For more details on the experimental procedure, see Suschinsky et al. (2009).

Study B

Participants. A total of 47 men and 49 women participated in the study reported by Chivers et al. (2007). Participants were required to be between 18 and 40 years of age, able to read and write English fluently, not currently using medications or contraceptives believed to influence sexual functioning, and free from active sexually transmitted diseases, sexual dysfunctions, mental illness, or substance abuse. Women had regular menstrual cycles and were not pregnant.

To ensure that the participants from the two studies were similar in terms of sexual orientation, only participants who reported their sexual attractions as mostly or exclusively directed toward members of the opposite sex were included in analyses for the current study. This eliminated 18 men and 22 women. For the purposes of the current study, data from 13 additional participants were excluded for one of the following reasons: unreliable genital response data because of muscle contractions (two women), failure to exhibit a genital response (defined as 25% of their maximum peak minus baseline genital response and

greater than their maximum peak minus baseline response to a neutral stimulus) to at least two sexual stimuli (four men and one woman), failure to report any change in subjective sexual arousal to at least two sexual stimuli (two women), and having incomplete data (i.e., having only continuous subjective arousal but not post-stimulus subjective arousal ratings; four men).

The final sample used in the current study consisted of 21 men and 22 women. The mean age for men was 24.1 years ($SD = 3.7$; range = 19-35) and for women it was 22.0 years ($SD = 2.0$; range = 18-26). Most of the men and women reported that they were either Caucasian (33% and 27%, respectively) or Asian (29% and 45%, respectively). The majority of men (81%) and women (95%) were either currently in university completing an undergraduate degree or had already completed their degree. All of the men and all but one woman self-identified as heterosexual (the remaining woman identified herself as “sexual”). Most of the men (76%) and women (90%) were single.

Materials and Measures.

Audio-visual stimuli. Participants were presented with several 90 s films depicting solitary non-sexual activity (a nude person exercising), solitary sexual activity (masturbation), partnered human sexual activity (either a man and a woman, two men, or two women engaging in sexual activities), partnered non-human sexual activity (bonobo chimpanzees engaging in sexual intercourse), and neutral stimuli (landscapes). There were two exemplars from each stimulus category. For the purpose of this study, data collected for stimuli depicting human sexual activity were used to test the hypotheses.

Genital measures. The genital measures and the sampling of all psychophysiological data were identical to Study A, with the exception of the baseline period: Baseline was

captured during the pre-stimulus question period.

Subjective arousal measures. During the presentation of each film, participants were instructed to continuously rate how sexually aroused they felt, defined as their “state of mental or emotional sexual arousal” on a scale of 0% (i.e., no sexual arousal) to 100% (i.e., most sexual arousal ever felt, sexual arousal associated with orgasm). Similar to Study A, participants rated their subjective sexual arousal by pressing a button on a keypad that would raise or lower a visual representation of their sexual arousal (i.e., a bar) displayed on the same monitor as the film.

Pre- and post-stimulus questions. Participants were asked several questions about their physical (e.g., genital sensations) and emotional (e.g., desire for contact with a sexual partner) sexual arousal before and after each film. The questions appeared on the same screen that the film appeared on. Participants answered the questions on a scale of 0 (*no sexual arousal*) to 9 (*high sexual arousal*) using a computer keypad. To be consistent with Study A, we report data based on participants’ overall sexual arousal.

Procedure. The procedure was similar to Study A. For a complete description of the procedure, see Chivers et al. (2007).

Results

The Sex Difference in Sexual Concordance

Separate peak minus baseline scores were calculated for genital arousal and continuous subjective arousal for each stimulus presented (including those not used in the current study). These scores were then standardized within-subjects (i.e., transformed into z-scores) because men’s and women’s genital arousal is measured on different scales. To test the sex difference in sexual concordance in hypothesis one, sexual concordance was

calculated in three different ways. The first two sexual concordance scores were calculated following procedures reported elsewhere (e.g., Suschinsky et al., 2009). These scores were based on correlations between the standardized peak minus baseline scores for genital arousal and the two measures of subjective sexual arousal (i.e., continuous subjective arousal and post-stimulus subjective arousal). Each participant's sexual concordance score (Pearson r) was based on the 10 pairs of data obtained for the sexual stimuli used in each study. Mean sexual concordance scores were then computed for each sex.

The third sexual concordance score was calculated using a form of data never before reported in the literature with respect to vaginal blood flow measurements: correlations for individual stimuli using second-by-second data. This procedure was used on unstandardized data based on three-point moving averages. Three-point moving averages were computed to smooth out sudden changes in genital or subjective response that were not considered to be movement artifacts. The moving averages were based on the response at any given second, in addition to the two seconds that immediately followed. Each stimulus in the present two studies was 90 s long, thus each stimulus correlation consisted of 88 data points. There were 10 samples/s for the continuous data (both genital and subjective sexual arousal); for each second, we took the maximum value of the 10 samples that corresponded to that particular second. Figure 3.1 depicts the continuous genital and subjective sexual arousal data from a single trial for a male and female participant.

The correlations for each stimulus were then averaged within each participant to compute an overall concordance score; the number of scores used to compute an individual's average concordance score varied, because concordance could not be calculated for stimuli that did not elicit any change in subjective sexual arousal. The number of stimuli that did not

produce a concordance score did not differ significantly between men ($M = 3.0$ stimuli, $SD = 1.6$) and women ($M = 2.5$ stimuli, $SD = 1.8$), $t(35) = 0.98$, $p = .33$. The sex difference in concordance was examined for each method using independent samples t -tests.

Table 3.1 shows the mean sexual concordance scores for men and women for the three concordance calculations for Study A and Study B. In Study A, men exhibited significantly higher sexual concordance than women for all of the different concordance scores, $ps \leq .003$. A 3 (concordance calculation) X 2 (sex) mixed ANOVA revealed that the different calculations used to compute the concordance scores yielded similar concordance scores. There was no main effect of concordance calculation type, $F(2, 70) = 1.16$, $p = .32$, and no interaction between concordance calculation type and sex, $F(2, 70) = 2.55$, $p = .085$. Supporting the results of the independent samples t -tests reported in Table 3.1, there was a main effect of sex, $F(1, 35) = 28.21$, $p < .001$.

The results were similar for Study B. Men had significantly higher sexual concordance than women for all of the different concordance scores, $ps < .001$. As with Study A, concordance scores were similar to each other, regardless of the calculation used to compute sexual concordance. There was no main effect of concordance calculation type, $F(2, 82) = 2.75$, $p = .070$, and no interaction between concordance calculation type and sex, $F(2, 82) = 1.73$, $p = .18$. There was a main effect of sex, $F(1, 41) = 44.65$, $p < .001$. Overall, then, men exhibited significantly higher sexual concordance than women, regardless of the method used to calculate sexual concordance in both studies.

Were Participants Subjectively Aroused At Their Peak Genital Response?

For data to be included in the analyses for the second hypothesis (i.e., at peak genital response, men would be more likely than women to report feeling sexually aroused), the

stimulus must have elicited a clear genital response. A genital response was considered to have definitely occurred for a particular stimulus if the participant's genital response reached 25% of her or his maximum raw peak minus baseline score to a sexual stimulus during the session and was higher than her or his maximum genital response to a neutral stimulus. A subjective sexual response was considered to be any response above baseline. The presence of a subjective response at the initial peak of genital arousal was coded as yes or no; the results of this coding were then subjected to a chi square analysis. The actual value of the subjective arousal at peak genital arousal was also recorded to determine if the magnitude of subjective arousal differed between men and women.

For Study A, a genital response occurred in 57.4% of men's trials (109 of a possible 190 trials) and in 68.8% of women's trials (124 of a possible 180 trials). There was no significant difference in the number of stimuli (out of 10) that elicited a genital response in men ($M = 5.7$ stimuli, $SD = 2.4$, range = 2 – 10) and women ($M = 6.8$ stimuli, $SD = 2.4$, range = 2 – 10), $t(35) = -1.43$, $p = .16$. The results of the chi square analysis revealed that men were significantly more likely than women to report being sexually aroused at their peak genital response than women, $\chi^2(1, N = 233) = 4.62$, $p = .032$. Within subjects, men had a significantly higher proportion of trials during which they reported being sexually aroused at their peak genital response ($M = 0.88$, $SD = 0.15$) relative to women ($M = 0.65$, $SD = 0.20$), $t(35) = 3.87$, $p < .001$, $d = 1.15$. At their peak genital response, men's average subjective sexual arousal ($M = 40.6$, $SD = 16.6$) was significantly higher than women's average subjective sexual arousal ($M = 16.2$, $SD = 11.2$), $t(35) = 5.22$, $p < .001$, $d = 1.76$.

For Study B, a genital response occurred in 58.6% of men's trials (123 of a possible 210 trials) and in 73.6% of women's trials (162 of a possible 220 trials). Women exhibited a

genital response to significantly more stimuli ($M = 8.0$ stimuli, $SD = 2.8$, range = 2 – 10) than men ($M = 5.4$ stimuli, $SD = 1.6$, range = 2 – 9), $t(40) = 3.65$, $p = .001$. Similar to Study A, men were significantly more likely than women to report being sexually aroused at their peak genital response than women, $\chi^2(1, N = 285) = 4.44$, $p = .035$. Men also had a significantly higher proportion of trials for which they reported being sexually aroused at their peak genital response ($M = 0.94$, $SD = 0.12$) relative to women ($M = 0.80$, $SD = 0.24$), $t(41) = 2.34$, $p = .024$, $d = 0.78$. At their peak genital response, men's average subjective sexual arousal ($M = 41.9$, $SD = 15.4$) was significantly higher than women's average subjective sexual arousal ($M = 25.2$, $SD = 21.6$), $t(41) = 2.90$, $p = .006$, $d = 0.90$. In both studies, then, men were more likely than women to report being subjectively aroused at their peak genital response.

Were Participants Genitally Aroused At Their Peak Subjective Response?

For data to be included in the analyses for the third hypothesis (i.e., that men and women would be equally likely to exhibit a genital response at their peak subjective arousal), participants had to report that they were subjectively aroused. We considered the participant to be definitely subjectively aroused if he or she reported a subjective arousal level of at least 25 points higher than baseline. A genital response was said to have occurred at the peak subjective response if the participant's genital arousal was 10% of her or his maximum peak minus baseline genital response for the testing session and higher than their maximum peak minus baseline genital response to a neutral stimulus.

For Study A, a subjective response occurred in 39.4% of men's trials (75 of a possible 190 trials) and in 32.3% of women's trials (58 of a possible 180 trials). Three women failed to report a subjective response to any sexual stimulus; there was, however, no

significant difference in the overall number of stimuli that elicited a subjective response in men ($M = 3.9$ stimuli, $SD = 1.2$, range = 2 – 6) and women ($M = 3.2$ stimuli, $SD = 2.7$, range = 0 – 9), $t(35) = 1.05$, $p = .30$. The results of the chi square analysis revealed that men were not significantly more likely than women to exhibit a genital response at their peak subjective response, $\chi^2(1, N = 133) = 1.86$, $p = .17$. Similarly, the proportion of trials during which participants exhibited a genital response at their peak subjective response was very high, and did not differ significantly between men ($M = 0.97$, $SD = 0.7$) and women ($M = 0.92$, $SD = 0.20$), $t(32) = 1.01$, $p = .32$, $d = 0.11$. Because men's and women's genital arousal is recorded on different scales, their average genital arousal at peak subjective response could not be compared. Men's average peak subjective sexual arousal ($M = 53.2$, $SD = 11.7$) was significantly higher than women's average peak subjective sexual arousal ($M = 43.5$, $SD = 11.9$), $t(32) = 2.38$, $p = .023$, $d = 0.82$.

The results from Study B were somewhat different. A subjective response occurred in 44.2% of men's trials (93 of a possible 210 trials) and in 54.5% of women's trials (120 of a possible 220 trials). Four women failed to report a subjective response to any sexual stimulus, but there was no significant difference in the overall number of stimuli that elicited a subjective response in men ($M = 4.4$ stimuli, $SD = 1.6$, range = 1 - 8) and women ($M = 5.0$ stimuli, $SD = 3.8$, range = 0 – 10), $t(41) = -0.62$, $p = .53$. The results of the chi square analysis revealed that men were significantly more likely than women to exhibit a genital response at their peak subjective response, $\chi^2(1, N = 210) = 11.34$, $p < .001$. The proportion of trials for which a genital response was present at peak subjective response, however, was very high and not significantly larger for men ($M = 1.00$, $SD = .00$), relative to women ($M = 0.91$, $SD = .21$), $t(37) = 1.89$, $p = .066$, $d = 0.86$. Men ($M = 51.0$, $SD = 13.3$) and women's

($M = 51.6$, $SD = 14.4$) average peak subjective sexual arousal did not significantly differ, $t(37) = -0.14$, $p = .88$, $d = -0.04$. Overall, then, the proportion of trials during which a genital response occurred at a participant's peak subjective response was very high for both men and women in both studies. Men were more likely than women to be genitally aroused at their peak subjective arousal, though this difference was only significant for Study B.

The Timing of Genital and Subjective Sexual Arousal

In order for data to be included in analyses for the fourth hypothesis (i.e., a genital response should precede the subjective response in both sexes), participants must have exhibited a subjective response in that trial. For the purposes of this analysis, a subjective response was defined as any response that was higher than baseline level of subjective arousal that was either constant or increasing over a period of 10 seconds. A genital response was considered to be 10% of the participant's maximum peak minus baseline genital response in the session, over the baseline value for each trial. For example, if a participant's maximum peak minus baseline response was 20 mm and his baseline genital arousal was 85 mm, he would need to reach a genital response of 87 mm (i.e., 2 mm or 10% of his maximum overall genital response above the baseline value for that stimulus). The time at which a genital response began was subtracted from the time at which a subjective response began; positive numbers indicated that the genital response preceded the subjective response. These values were then subjected to an independent samples t -test to compare the timing of the sexual responses between men and women.

For Study A, a subjective response occurred in 69.4% of men's trials (132 of a possible 190) and 75.0% of women's trials (135 of a possible 180 trials). Of the trials that elicited a subjective response, a genital response occurred in 87.8% of men's trials and

99.2% of women's trials. The mean number of stimuli that produced a subjective response did not differ significantly between men ($M = 6.9$ stimuli, $SD = 1.6$) and women ($M = 7.5$ stimuli, $SD = 1.8$), $t(35) = -0.98$, $p = .33$. Similarly, the mean number of stimuli that produced a genital response did not differ significantly between men ($M = 5.2$ stimuli, $SD = 1.5$) and women ($M = 5.4$ stimuli, $SD = 2.2$), $t(35) = -0.38$, $p = .71$. Men's genital sexual arousal was significantly less likely to precede their subjective sexual arousal ($M = -15.2$ s, $SD = 20.9$) relative to women's ($M = 16.1$ s, $SD = 20.3$), $t(246) = 11.96$, $p < .001$, $d = -1.52$. On average, men's genital responses occurred significantly later ($M = 29.6$ s, $SD = 20.8$) within the sexual stimuli relative to women's genital responses ($M = 3.9$ s, $SD = 8.8$), $t(248) = 12.97$, $p < .001$, $d = 1.73$. There was a non-significant tendency for men's subjective responses ($M = 15.8$ s, $SD = 14.8$) to begin earlier in the stimuli relative to women's ($M = 19.7$ s, $SD = 18.0$), $t(265) = -1.95$, $p = .052$, $d = -0.23$.

For Study B, a subjective response occurred in 68.0% of men's trials (143 of a possible 210) and 86.3% of women's trials (190 of a possible 220). Of the trials that elicited a subjective response, a genital response occurred in 95.1% of men's trials and 100% of women's trials. The mean number of stimuli that produced a subjective response was significantly higher in women ($M = 8.9$ stimuli, $SD = 1.8$) than men ($M = 7.8$ stimuli, $SD = 1.6$), $t(41) = 2.14$, $p = .038$. The mean number of stimuli that elicited a genital response did not differ significantly between men ($M = 6.4$ stimuli, $SD = 1.4$) and women ($M = 6.5$, $SD = 1.7$), $t(41) = -0.14$, $p = .88$. Men's genital sexual arousal was significantly less likely to precede their subjective sexual arousal ($M = -16.2$ s, $SD = 22.0$) than women's ($M = 14.5$ s, $SD = 19.9$), $t(324) = -13.14$, $p < .001$, $d = -1.46$. Men's genital responses occurred significantly later ($M = 32.6$ s, $SD = 20.4$) within the sexual stimuli relative to women's

genital responses ($M = 3.9$ s, $SD = 6.0$), $t(331) = 18.33$, $p < .001$, $d = 2.17$. The onset of men ($M = 16.8$ s, $SD = 16.7$) and women's ($M = 18.4$ s, $SD = 19.1$) subjective sexual responses did not significantly differ, $t(331) = -0.84$, $p = .401$, $d = -0.09$. Overall, then, across both studies, men's genital responses occurred later in the sexual stimuli and were less likely to precede their subjective responses than women's. Women's genital responses began quickly after a sexual stimulus began. Men's and women's subjective responses began at similar times in both studies.

Sexual Concordance as a Function of Stimulus Category

For Study A, a 2 (sex) X 5 (stimulus category) mixed design ANOVA was used to assess whether men's and women's sexual concordance varied as a function of stimulus category and whether affective responses (i.e., unpleasantness and anxious ratings) influenced the effect of stimulus category on sexual concordance. Pleasant ratings were reverse scored and then summed with the unpleasant ratings for each stimulus; higher scores indicated higher overall unpleasantness ratings. Calmness ratings were reverse scored and then summed with anxious ratings for each stimulus; higher scores indicated higher anxiety ratings. There were 20 missing concordance values for men and 13 missing values for women, because these participants did not report any change in subjective sexual arousal for a given stimulus category. Missing values were replaced by imputing the mean for each stimulus category for the appropriate sex. The mean sexual concordance scores as a function of stimulus category are presented in Figure 3.2. The results indicate the sexual concordance indeed varied as a function of stimulus category. There was a main effect of stimulus category, $F(4, 140) = 35.76$, $p < .001$, as well as a significant interaction between stimulus category and participant sex, $F(4, 140) = 6.48$, $p < .001$. There was also a significant main

effect of participant sex, $F(1, 35) = 19.56, p < .001$. The results remained the same when unpleasantness or anxious ratings were added as covariates, except that the main effect of stimulus category was eliminated. Figure 3.3 shows the mean unpleasantness and anxious ratings as a function of stimulus category.

Simple effects were examined separately for men and women. There was a main effect of stimulus category for both men, $F(4, 90) = 26.54, p < .001$, and women, $F(4, 85) = 9.92, p < .001$. Men showed significantly greater sexual concordance in response to female-female, male-female, and low intensity male-female sexual stimuli relative to male-male and sexual aggression stimuli (all $ps \leq .006$). Women showed significantly greater sexual concordance in response to female-female sexual stimuli relative to male-female low intensity and sexual aggression stimuli ($ps \leq .039$). Women also showed significantly greater sexual concordance in response to male-female sexual stimuli relative to male-male, male-female low intensity, and sexual aggression stimuli (all $ps \leq .032$). When comparing the sexes, one-way ANOVAs revealed that men had significantly higher sexual concordance than women in response to the female-female, male-female, and male-female low intensity sexual stimuli (all $ps \leq .014$). There was no significant sex difference in sexual concordance for male-male and sexual aggression stimuli ($ps \geq .23$).

To further investigate the relationship between sexual concordance and affective ratings we calculated within-subjects correlations based on the 10 experimental stimuli. More men (42%) than women (11%) had a significant negative correlation between sexual concordance and unpleasantness ratings, $\chi^2(1, N = 37) = 4.50, p = .034$. There was, however, no significant difference between men's correlations ($M = -.54, SD = .46$) and women's correlations ($M = -.37, SD = .35$) for sexual concordance and unpleasantness ratings, $t(35) =$

-1.23, $p = .22$, $d = -0.41$. There was no significant difference in the number of men (21%) and women (11%) with significant correlations between their sexual concordance scores and anxious ratings, $\chi^2(1, N = 37) = 0.67$, $p = .41$. There was, however, a non-significant tendency for men's sexual concordance scores and anxious ratings to be more correlated ($r = -.26$) than women's ($r = .08$), $t(35) = -2.07$, $p = .052$, $d = -0.68$.

We also used a 2 (sex) X 5 (stimulus category) mixed design ANOVA to assess whether men's and women's sexual concordance varied as a function of stimulus category in Study B; no covariate was used because we did not have affective response ratings for this dataset. There were 15 missing values for men and 4 missing values for women. Missing values were replaced by imputing the mean for the appropriate sex and stimulus category. The results were similar to Study A and are depicted in Figure 3.4. There was a significant main effect of stimulus category, $F(4, 164) = 13.96$, $p < .001$, and a significant interaction between participant sex and stimulus category, $F(4, 164) = 5.81$, $p < .001$. There was also a significant main effect of participant sex, $F(1, 41) = 27.72$, $p < .001$.

Simple effects were examined separately for men and women. There was a main effect of stimulus category for men, $F(4, 104) = 16.99$, $p < .001$, but not for women, $F(1, 105) = 1.44$, $p = .22$. Men showed significantly higher sexual concordance in response to female masturbation, male-female, and female-female sexual stimuli relative to male-male and male masturbation stimuli. Men exhibited significantly higher sexual concordance relative to women in response to female masturbation, male-female, and female-female sexual stimuli (all $ps \leq .001$). Though men's sexual concordance was higher than women's for both the male-male and male masturbation stimuli, there was no significant difference. Overall, then, men's sexual concordance was higher than women's sexual concordance for

the majority of sexual stimuli in both studies. Men's sexual concordance varied across stimulus categories in both studies, but women's sexual concordance varied across stimulus categories only in Study A. Affective ratings, if anything, only affected men's sexual concordance scores.

We also compared men's and women's sexual concordance scores for the stimulus categories that were consistent across both studies by conducting a 2 (Sex) X 2 (Study) X 3 (Stimulus Category) ANOVA. The results indicate that the two studies produced similar concordance scores, as there was no main effect of study, $F(1, 76) = 0.002, p = .96$, and study did not interact with stimulus category, participant sex, or stimulus category and participant sex combined (all $ps \geq .15$). Consistent with the ANOVAs performed on the individual study data, there was a main effect of stimulus category, $F(2, 152) = 39.49, p < .001$, a main effect of participant sex, $F(1, 76) = 34.57, p < .001$, and significant interaction between stimulus category and participant sex, $F(2, 152) = 5.78, p = .004$. Overall, these results indicate that sexual concordance scores varied as a function of stimulus category in a similar fashion across the two studies.

Discussion

The results are consistent with previous research indicating that men's and women's sexual concordance significantly differs (Chivers et al., 2010): Men had significantly higher sexual concordance when sexual concordance was calculated using a single data point per stimulus and when it was calculated using continuous second-by-second data. Consistent with Laan and Janssen's (2007) model, men were significantly more likely than women to report feeling sexually aroused at their peak genital responses. Men were also more likely to exhibit a genital response at their peak subjective sexual response, though this difference was

only significant for one dataset. Unexpectedly, there was a sex difference regarding the timing of genital and subjective sexual arousal: Men's genital arousal was significantly less likely to precede their subjective sexual arousal than women's and occurred significantly later within sexual stimuli relative to women's. Also unexpectedly, men's sexual concordance was influenced by stimulus content. Women's sexual concordance differed significantly across stimulus categories in only one dataset; generally, women's sexual concordance scores followed a similar pattern, with male-female, female-female, and male-male sexual stimuli eliciting a similar degree of sexual concordance, except in Study A, where women showed significantly lower sexual concordance in response to male-male sexual stimuli. With the exception of one stimulus category, men's sexual concordance was always higher than women's.

Calculating Sexual Concordance in Men and Women

Sexual concordance scores were similar within each sex, regardless of the method used to calculate them. This result contrasts with Chivers et al.'s (2010) finding that sexual concordance based on continuous measures of subjective sexual arousal resulted in decreased sexual concordance in men, thereby eliminating the sex difference in sexual concordance. Chivers et al. suggested that continuous measures of subjective sexual arousal in men may reduce penile, but not subjective, responses through distraction, and recommended using post-stimulus ratings of subjective sexual arousal in men in future research.

Our results support the use of post-stimulus ratings of subjective sexual arousal in men and women, but also the use of continuous measures of subjective sexual arousal for both sexes. All three of our sexual concordance calculation methods yielded similar degrees of sexual concordance within men and women. Although the effect sizes for the sex

difference were smaller when sexual concordance was calculated using a continuous measure of subjective arousal in Study A (Table 3.1), they are still considered to be very large sex differences, as Cohen (1988) suggested effect sizes of 0.80 and higher to be considered as large. The sexual concordance effect sizes obtained in the current study ($d = 1.06$ to 2.13) are among the largest effect sizes reported for sex differences in sexuality, as well as the general psychology literature. For example, one of the most consistent sex differences in sexuality is masturbation frequency, such that men report masturbating more frequently than women; Oliver and Hyde (1993) reported an effect size of 0.96, and a more recent meta-analysis of sex differences in sexuality revealed that masturbation frequency again yielded one of the largest sex differences ($d = 0.53$; Petersen & Hyde, 2010). Another consistent sex difference involves masculinity and femininity: Men and women differ significantly in terms of their self-ascribed masculinity or femininity ($d = 1.21$) and preferences for male- or female-typical occupations ($d = 1.39$; Lippa, 2008). Hyde (2005) noted that the magnitude of sex differences can vary significantly, and reported that a mere 8% of the effect sizes obtained from 46 meta-analyses on psychological sex differences (i.e., cognitive variables, communication, social and personality variables, psychological well-being, and motor skills) were above 0.66.

We speculate that our measure of continuous subjective arousal may be less distracting than previous measures of continuous subjective arousal. Participants in both Study A and B used a button on a small computer keyboard to manipulate a bar on the screen that presented the sexual stimuli. Most previous research that has involved assessing genital and subjective sexual arousal simultaneously has involved more intrusive and possibly more distracting measures. For example, Wincze et al.'s (1980) participants reported that they had

problems with the lever they were instructed to use to indicate their subjective sexual arousal: Several participants reported that the lever moved to the maximum position too quickly and that they were not used to the range of the lever or how much to move the lever once they felt a change in arousal. Given that most of the participants in the current study were students and likely experienced with computers and that the visual output of their arousal was in the same place as the sexual stimuli, there was likely less distraction than in previous research.

An Information-Processing Model of Sexual Arousal and Sexual Concordance

Our results show some support of Laan and Janssen's (2007) adapted information-processing model of sexual arousal, which suggests that men and women may derive their subjective experience of sexual arousal from different sources. Consistent with Laan and Janssen's model, men were more likely than women to report being sexually aroused at their peak genital response. Men were more likely than women to exhibit a genital response at their peak subjective response, though this difference was only significant for one dataset. Although men were more likely to exhibit a genital response at their peak subjective response, our results are still consistent with Laan and Janssen's model because a genital response was almost always present at time of peak subjective response in both men and women.

Laan and Janssen (2007) suggested that subjective arousal is experienced after an individual recognizes a genital response and positively evaluates a given sexual stimulus. Consistent with their model, we found that women's genital responses preceded their subjective responses. This result is also consistent with the *preparation hypothesis* of genital arousal in women (Laan, 1994; Chivers, 2005; Suschinsky and Lalumière, 2011). Laan and

Everaerd (1995a) noted that women's genital responses occur shortly after the onset of a sexual stimulus and hypothesized that the seemingly automatic nature of increased vaginal blood flow may serve to prepare women for sexual activity, given that increased vaginal blood flow is the precursor to vaginal lubrication (Levin, 2003). Consistent with the preparation hypothesis and Laan and Everaerd's observations, our results confirm that women's genital responses occur very shortly after the onset of sexual stimuli (about three seconds in our samples), and well before the onset of a subjective sexual response.

Unexpectedly, however, we found that men's genital responses did not precede their subjective experience; in fact, our results indicated that men's genital responses occurred later than their subjective responses, and later than women's genital responses. This result must be interpreted with caution, however. We used circumferential phallometry (i.e., penile strain gauges) to assess men's genital arousal. Although circumferential phallometry is a valid measure of genital arousal, volumetric phallometry is more accurate at low levels of arousal (i.e., less than 2.5 mm circumference; Kuban, Barbaree, & Blanchard, 1999). The difference in validity at low levels of arousal is likely the result of physiological changes in the penis during arousal. The penis actually decreases in girth but increases in length at initial arousal (Earls & Marshall, 1983; McConaghy, 1974). Volumetric phallometry detects the increase in penile length, but circumferential phallometry cannot. Volumetric phallometry should be employed in the future to better assess the timing of genital arousal and initial changes in genital arousal in men.

Laan and Janssen (2007) suggested that lower sexual concordance occurs when a sexual stimulus elicits both positive and negative meanings, which may interfere with one's subjective experience of sexual arousal. We tested this hypothesis by assessing sexual

concordance across a variety of stimulus categories that elicited different unpleasantness and anxious ratings. Our results suggest that sexual concordance varies in men as a function of stimulus category and that men's sexual concordance is somewhat correlated with affective responses. The results are less clear for women. Women's sexual concordance did significantly differ across stimulus categories in Study A. Although women's sexual concordance differed across stimulus categories in Study A, there was a consistent trend in both studies: The difference between the highest mean concordance score and the lowest mean concordance score was greater in men than in women in both Study A (Cohen's $d = 2.64$ and $d = 1.88$, for men and women, respectively) and Study B ($d = 2.00$ and $d = 0.66$, respectively). Similarly, the correlations between sexual concordance scores and affective responses were lower in women than in men in both studies. Taken together, these results suggest that women's sexual concordance is less influenced by stimulus content than men's.

Our finding that women's sexual concordance was less influenced by content and affective ratings may not be consistent with Laan and Janssen's (2007) model, but it is consistent with Chivers et al.'s (2010) meta-analytic results. Chivers et al. did not find that female-centered sexual stimuli produced higher sexual concordance than male-centered sexual stimuli in women. Given that female-centered sexual stimuli elicit more positive affective responses and higher subjective sexual arousal in women relative to male-centered sexual stimuli (Laan et al., 1994), one would expect that sexual concordance would be higher in response to these stimuli. It is possible, however, that the unpleasantness and anxiety ratings in our study may not be the most appropriate or accurate affective response to assess. Peterson and Janssen (2007) found that positive affect, as measured by self-reports of emotional terms including pleasant, interested, sensual, and passionate, was strongly and

positively related to men's and women's subjective sexual arousal; they did not specifically assess sexual concordance in relation to affective responses. Future research could better investigate the role of affective responses in relation to sexual concordance by asking about a variety of positive and negative affective responses or by measuring physiological affective responses via facial muscle activity (e.g., Laan & Everaerd, 1995b).

Sexual Concordance and Stimulus Content

Chivers et al. (2010) reported that studies that included varied sexual stimuli resulted in significantly higher positive sexual concordance for women only. Women's increased sexual concordance in these studies eliminated the sex difference in sexual concordance, though women's sexual concordance never exceeded that of men's. Although we presented participants with a variety of sexual stimuli in the current study, we still found that men showed significantly higher sexual concordance than women. We also found that men's sexual concordance was higher than women's sexual concordance, regardless of stimulus category (with the exception of the sexual aggression category, which produced slightly, but not significantly, higher sexual concordance in women).

The fact that sexual concordance in men and possibly women (albeit to a lesser extent) varies as a function of sexual stimulus category is a novel finding. To our knowledge, no one has reported sexual concordance based on within-subjects correlations for individual sexual stimulus categories in both men and women. For example, Adams, Wright, and Lohr's (1996) reported that men's penile responses were less consistent with their subjective arousal when they were presented with a male-male sexual stimulus, relative to a female-female or male-female sexual stimulus; women were not included in the study. Terry, Suschinsky, Lalumière, and Vasey (in press) found that both men and women reported

subjective sexual arousal in the absence of a genital response to non-sexual feeding stories, suggesting, again, that some stimulus categories produce low sexual concordance.

Current sexual psychophysiological research often involves the presentation of a single heterosexual stimulus (e.g., Brotto & Gorzalka, 2002; Meston & Gorzalka, 1995; Rellini et al., 2005). When varied sexual stimuli have been presented, sexual concordance has not been calculated for each individual stimulus category, but rather as the mean across all relevant stimulus categories (e.g., Chivers et al., 2007; Suschinsky et al., 2009; Suschinsky & Lalumière, 2011; Wincze, Hoon, & Hoon, 1977; Wincze & Qualls, 1984; Wincze et al., 1980). Our results indicate the importance of assessing sexual concordance across a variety of sexual stimuli.

We suspect that some stimulus categories elicit lower sexual concordance in both men and women, thereby eliminating the sex difference in sexual concordance, for three potentially related reasons: social desirability, negative affect, and low response variation. One of the stimulus categories that elicited the lowest sexual concordance depicted inappropriate sexual acts (sexual aggression films). The other two stimulus categories depicted sexual activities among individuals who are often stigmatized; heterosexual individuals, and heterosexual men in particular, hold more negative attitudes toward male same-sex sexuality and sexual behaviours relative to female same-sex sexuality and sexual behaviours (Herek, 2002). These three categories also produced high unpleasantness and anxious ratings (Figure 3.3). As a result of attempting to respond in a socially desirable fashion, or simply disliking the stimuli, the range of subjective sexual arousal responses may be restricted for these stimuli, thus precluding strong correlations from being detected. Indeed, the stimuli that elicited lower sexual concordance in both Study A and Study B had

lower mean subjective sexual arousal ratings than the stimuli that elicited higher sexual concordance (Figure 1 in Suschinsky et al., 2009 and Figures 3 and 4 in Chivers et al., 2007, respectively). Although these three factors cannot account for variations in sexual concordance as a result of participants' reporting subjective arousal when a genital response not recorded (Terry et al., in press), they likely account for the variation in sexual concordance across stimulus categories in the present study.

Why is there a Sex Difference in Sexual Concordance?

Given that men showed higher sexual concordance than women, regardless of the method used to calculate sexual concordance and regardless of stimulus category (with one exception that is likely the result of response manipulation), we are still left to consider why women show lower sexual concordance than men. Women's lower sexual concordance does not seem to be the result of simply failing to report their subjective sexual arousal. In fact, the results from the current study indicate that women may be equally subjectively aroused as men: Women's average peak subjective sexual arousal value did not significantly differ from men's average peak subjective sexual arousal value in Study B. Although the women in Study A reported significantly lower subjective arousal than men, their mean peak subjective arousal level was still relatively high.

It is unclear whether women's lower sexual concordance is the result of sex differences in information-processing, though it is still possible. Contrary to Laan and Janssen's (2007) model, men's genital responses occurred after their subjective sexual arousal began, though this may be the result of the genital arousal measure we used for men. Also inconsistent with the model is our finding that affective responses, as measured by unpleasantness and anxious ratings, seemed to impact men's sexual concordance more than

women's. As noted above, however, our measure of affective responses was somewhat limited, and future research should continue to investigate whether affective responses influence sexual concordance.

Although the sex difference in sexual concordance may be the result of sex differences in information-processing, it is possible that the sex difference in sexual concordance may be an extension of a broader sex difference in awareness of one's physiological states, or *interoception*. Men have significantly higher interoceptive awareness than women in laboratory settings, as evidenced by men's increased accuracy at detecting or reporting their heart rate (Brener & Jones, 1974; Katkin, Blascovich, & Goldband, 1981; Van der Does, Antony, Ehlers, & Barsky, 2000; Whitehead, Drescher, Heiman, & Blackwell, 1977), respiratory resistance (Harver, Katkin, & Bloch, 1993), blood glucose levels (Cox et al., 1985), blood pressure (Pennebaker & Watson, 1988), and stomach contractions (Whitehead & Drescher, 1980). Based on the fact that men, on average, are more accurate at detecting and reporting both their sexual and non-sexual states and that women, on average, are less accurate at detecting and reporting their sexual and non-sexual states (Chivers et al., 2010), it is possible that sexual concordance is part of general interoceptive awareness. Future studies should investigate the relationship between sexual and non-sexual interoceptive awareness.

Limitations

We have already addressed some of the limitations of the current study above, including our measurement of genital arousal in men. We noted that circumferential phallometry may not be sensitive enough at low levels of arousal to detect the initial stages of genital arousal in men (Kuban et al., 1999). The device that we used to measure women's

genital arousal, a vaginal photoplethysmograph, is a valid measure of sexual arousal in women, in that vaginal blood flow only increases in response to sexual stimuli (Laan et al., 1995; Suschinsky et al., 2009) and sexual stimuli of different intensities elicit different amounts of genital arousal (Chivers et al., 2007; Suschinsky et al., 2009). The photoplethysmograph signal can be filtered into two related, but unique, components: vaginal blood volume (VBV), which reflects slower changes in blood pooled within the vaginal walls and vaginal pulse amplitude (VPA), which reflects changes in vaginal blood flow with each heart beat (Hatch, 1979). We measured VPA in the current study.

Given that VPA changes with each heart beat, the output can involve sudden and momentary increases in vaginal blood flow that may not always correlate well with subjective arousal, but that may have met the minimum criteria we set for genital responses. Figure 3.1 shows that VPA does not produce as smooth a response curve as phallometry does for men's, even when using a three-point moving average. Chivers et al. (2010) noted that VBV produced slightly (but not significantly) higher correlations with subjective arousal than VPA; given that VBV reflects slower changes in women's genital arousal, it may be a more appropriate measure of genital arousal, when assessing the timing of genital responses. Chivers et al. also noted, however, that VBV increases in the presence of anxiety-inducing non-sexual stimuli, and thus has poorer psychometric properties than VPA.

Future research could also involve the use of thermal imaging cameras or clitoral photoplethysmography. Kukkonen, Binik, Amsel, and Carrier (2007) noted that there was no significant difference in the average length of time to peak genital temperature between men and women who were exposed to an erotic film. Temperature measurements of genital arousal suffer from their own limitations, however, because changes in genital temperature

are slow to occur. For instance, Kukkonen et al.'s male and female participants reached their peak genital temperature after approximately 11 and 12 min, respectively. It is unclear whether temperature measurements of genital arousal would be more accurate (or faster) at detecting initial genital arousal. The advantage of temperature measures, however, is that the same physiological endpoint is used for both sexes.

Clitoral blood volume, as measured by clitoral photoplethysmography, may also be a valid measure of genital arousal in women. Gerritsen et al. (2009) found a negative correlation between vaginal pulse amplitude and clitoral blood volume when women were presented with sexual stimuli, suggesting that increases in clitoral blood volume may be less automatic than increases in vaginal pulse amplitude. Given that the clitoris and the penis are homologous structures, increases in clitoral blood volume are more similar to increases in penile circumference or volume, and thus, clitoral photoplethysmography may be a more comparable measure of genital arousal in women. Limited research has been conducted on the validity of the clitoral photoplethysmography, and future research must investigate its validity and the correlation between clitoral blood volume and self-reported sexual arousal.

Sexual psychophysiology studies are often criticized for their selection biases; individuals who are willing to participate in sexual psychophysiology research are typically more sexually experienced and report less sex guilt than individuals who are not willing to participate (e.g., Strassberg & Lowe, 1995). It is unclear whether this selection bias affected the results in the current study. Although the participants in the current study may differ from the general population, the results of the current study remain fairly consistent across the two datasets, despite the fact that the data were collected in two different settings: a relatively small city and a large metropolitan city. The high consistency of our results across the two

datasets suggests that our findings are valid. Similarly, the results are consistent with Chivers et al.'s (2010) meta-analysis. The high correspondence of results from Study A with the meta-analysis is particularly important, because the data from Study A were not included in the meta-analysis, and thus provide an independent confirmation of the meta-analytic results.

The stimuli used in the current study differed across the two datasets. Although three stimulus categories were consistent across the two datasets and showed similar activity (male-female, female-female, and male-male sexual activity), the stimuli were not identical across the two datasets. Interestingly though, the results remained fairly consistent across the two datasets, indicating that the sex difference in sexual concordance and timing of genital and subjective responses across stimulus categories is a robust finding.

Conclusions and Future Research Questions

The sex difference in sexual concordance is one of the largest and most consistent sex differences reported in the psychological literature. It is robust to many methodological influences: Men's sexual concordance is higher than women's sexual concordance, regardless of the method used to calculate sexual concordance and the stimuli used to elicit sexual arousal. The results from the current study show some support for Laan and Janssen's (2007) information-processing model of sexual arousal, in that men were more likely to report being subjectively aroused at their peak genital response, a genital response was almost always present at both men's and women's peak subjective arousal, and women's genital arousal preceded their subjective arousal. Inconsistent with the information-processing model is our finding that men's subjective sexual arousal preceded their genital arousal, and that women's affective responses were not significantly related to sexual concordance.

The current study was the first to empirically test an information-processing model of sexual arousal in relation to sexual concordance, and further research is needed. If the sex difference in sexual concordance is the result of sex differences in information-processing, future research questions will focus on the different sources that contribute to men's and women's subjective experiences of sexual arousal and how sexual concordance may influence other aspects of an individual's sexuality, such as sexual functioning. Alternatively, sexual concordance may be an extension of a broader sex difference in *interoception*, or awareness of physiological states and responses. If sexual concordance is related to interoceptive awareness, then we would have to shift our research focus from sexuality-specific explanations to broader non-sexual explanations.

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Tables and Figures

Table 3.1.

Mean correlations (Pearson r) between genital arousal and subjective sexual arousal for men and women for Study A (top) and Study B (bottom).

Type of Correlation	Study A			
	Men	Women	$t(35)$	Cohen's d
Genital-Continuous Subjective*	0.72	0.36	3.16	1.06
Genital-Post Subjective**	0.83	0.36	6.26	2.13
Second-by-Second**	0.68	0.40	4.91	1.60
Type of Correlation	Study B			
	Men	Women	$t(41)$	Cohen's d
Genital-Continuous Subjective**	0.82	0.36	5.58	1.92
Genital-Post Subjective**	0.86	0.38	5.36	1.92
Second-by-Second**	0.71	0.36	6.09	2.00

Note: Significant sex difference, * $p < .005$, ** $p < .001$

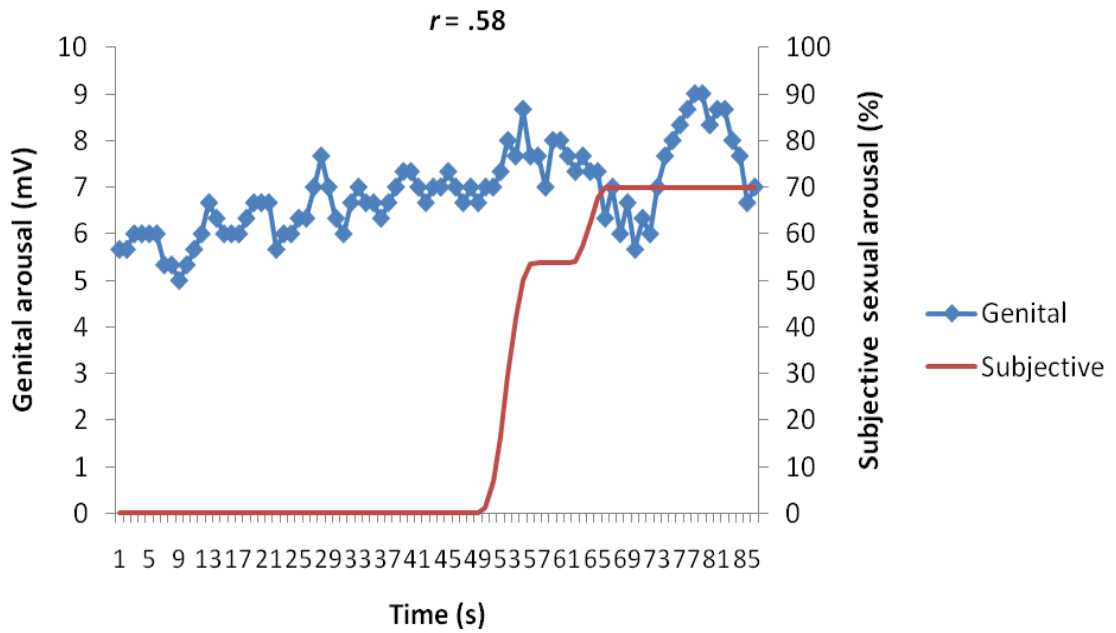
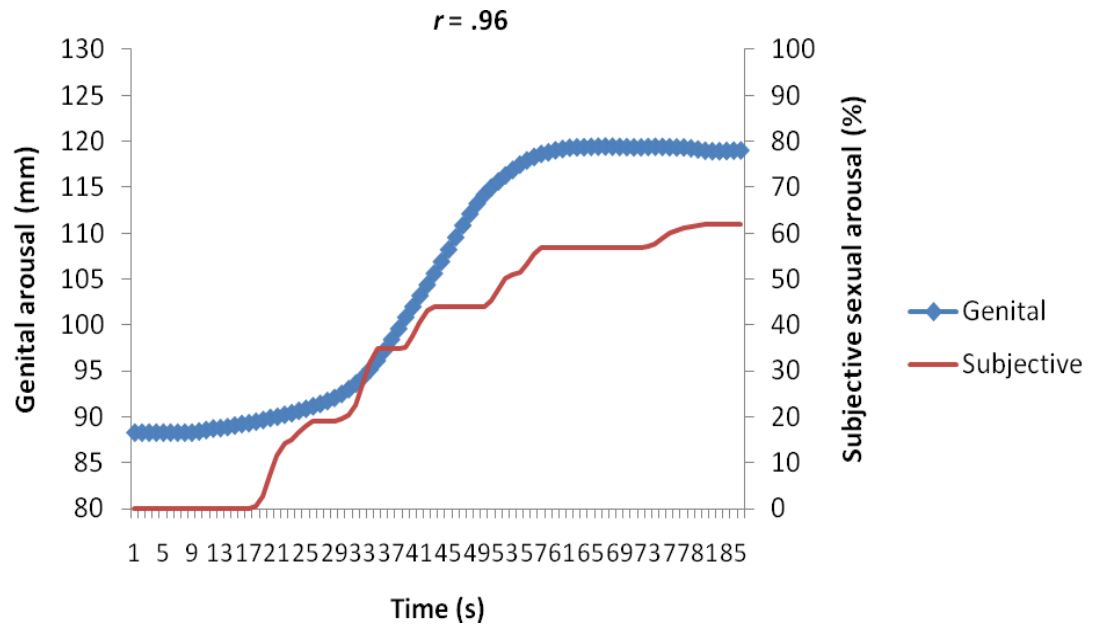


Figure 3.1.

Example of a graph depicting second-by-second sexual arousal data for a male (top) and female (bottom) participant for the same male-female film.

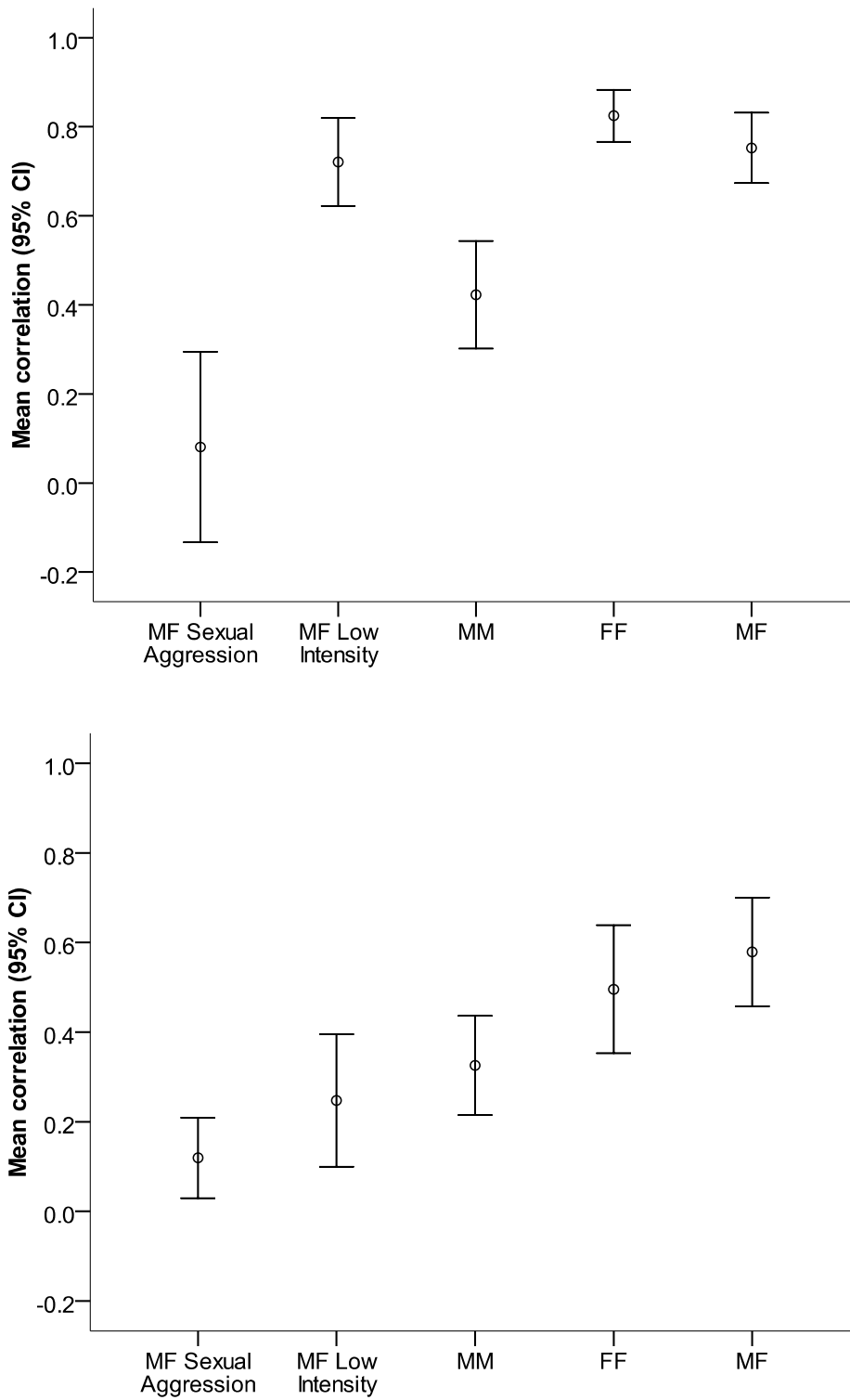


Figure 3.2.

Sexual concordance in men (top) and women (bottom) as a function of stimulus category for Study A.

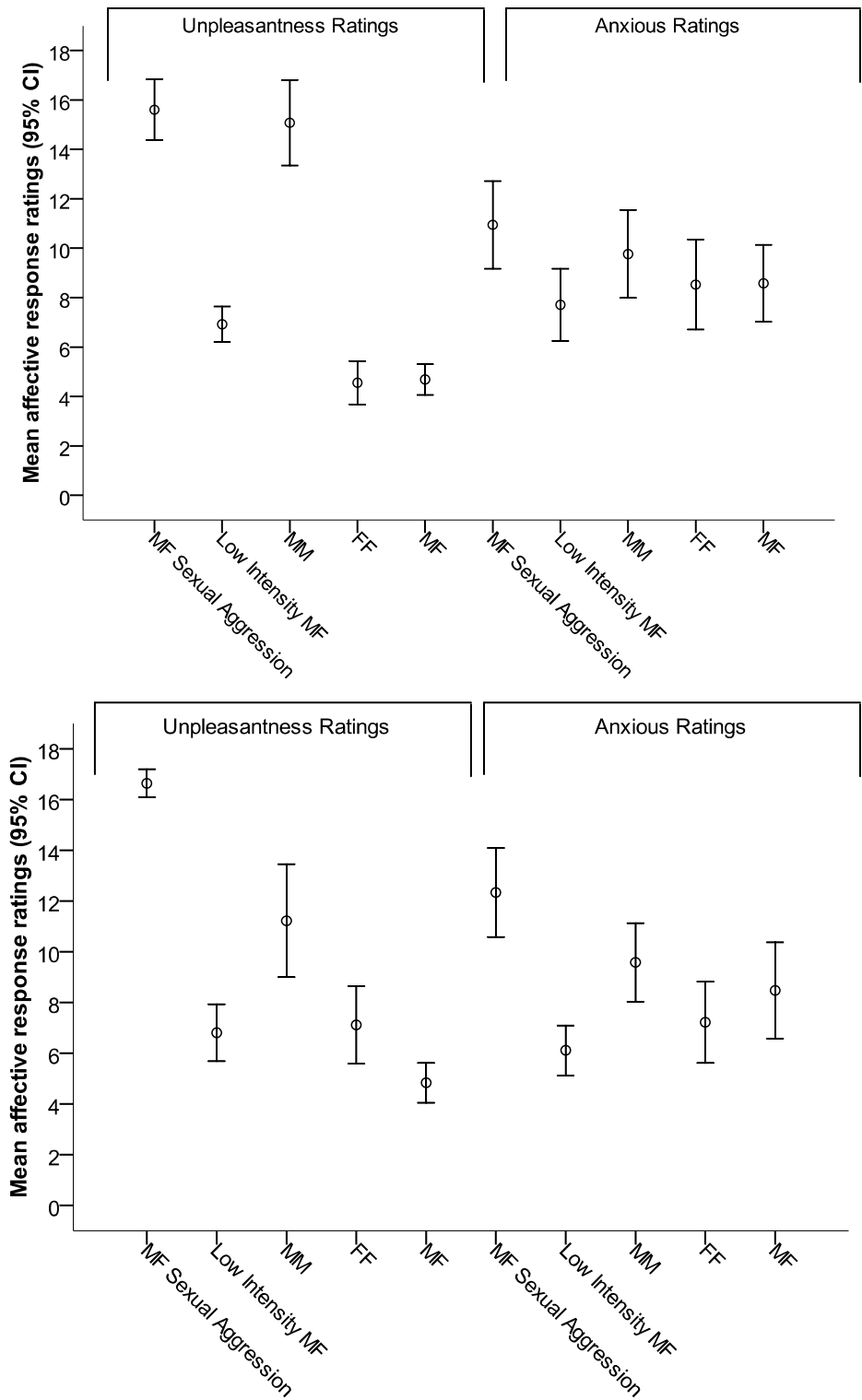


Figure 3.3.

Mean unpleasantness and anxious ratings in men (top) and women (bottom) as a function of stimulus category in Study A.

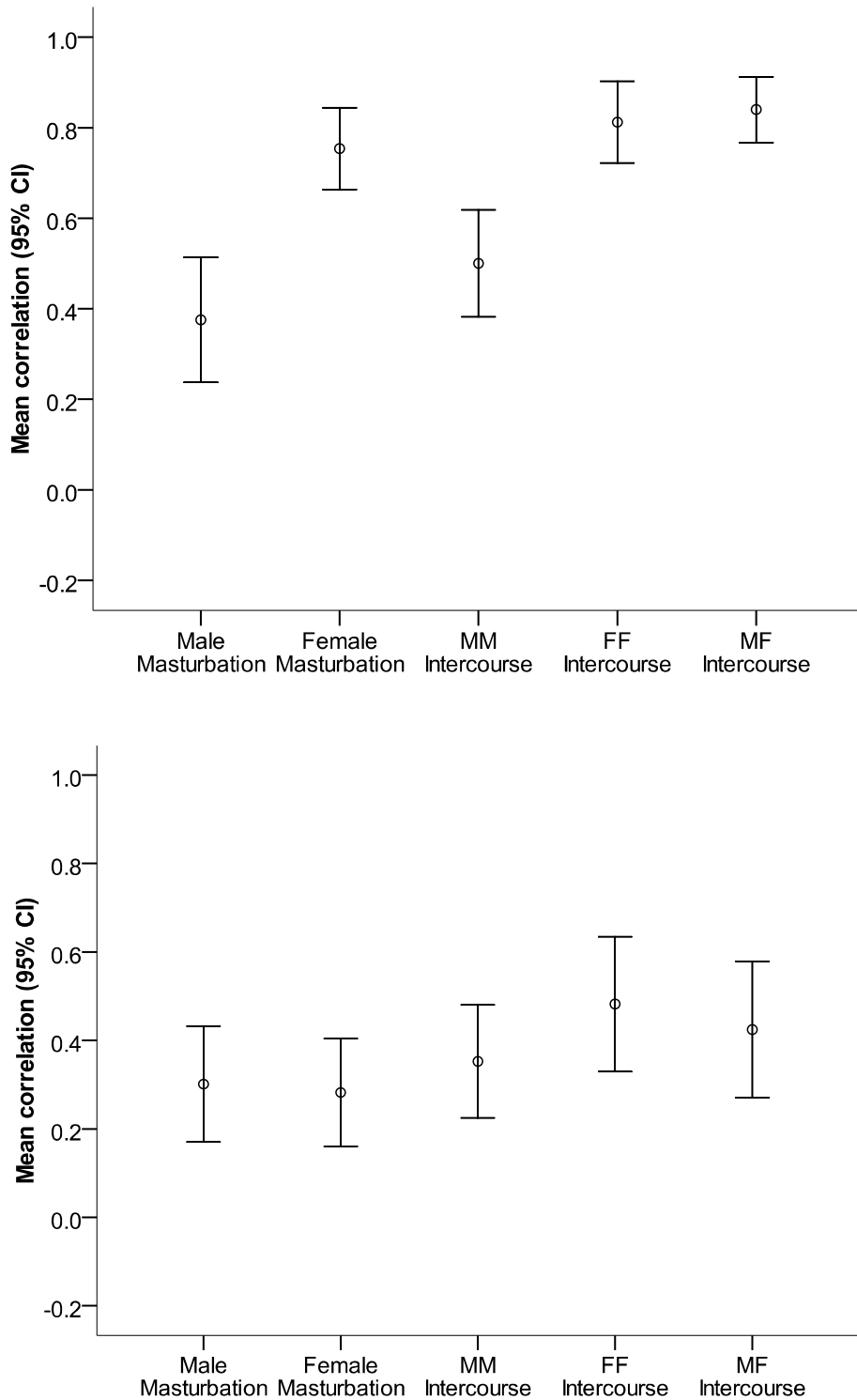


Figure 3.4.

Sexual concordance in men (top) and women (bottom) as a function of stimulus category for Study B.

CHAPTER FOUR

Examining the Stability of Sex Differences in Sexual Arousal Patterns

Abstract

The sexual arousal patterns of men and women differ in two ways. First, men's genital and self-reported sexual arousal are *category-specific*, such that different stimuli elicit different degrees of arousal. Women's self-reported sexual arousal is, like men's, category-specific, but their genital arousal is *category-nonspecific*, because they show similar genital responses to different sexual stimuli. Second, men's *sexual concordance*, or the relationship between genital and self-reported sexual arousal, is higher than women's. Although these differences are consistent across studies, limited research has assessed the stability of these differences within the same sample. Twenty men and 18 women participated in two experimental sessions one month apart, in which they listened to 14 sexual and nonsexual audiotaped narratives while their genital arousal and subjective arousal were measured. The expected sex differences were found in both sessions: Men's genital arousal was more category-specific than women's, and their sexual concordance was higher than women's. Men and women showed an equivalent degree of category-specific self-reported sexual arousal in both sessions. Correlational analyses revealed little stability for genital arousal category-specificity and sexual concordance at the individual level for women. Overall, the results suggest that the sex differences in sexual arousal patterns are stable across testing sessions, thus lending additional support to their validity, but that further research is required to better understand the stability of sexual arousal patterns at the individual level.

Introduction

There are several features of a sexual stimulus that elicit genital arousal, self-reported sexual arousal, or both. Some of these features include those associated with the sex of persons depicted, the age of persons depicted, and the kind of sexual activity depicted in a sexual stimulus. Men's genital responses tend to be differentially affected by these features, whereas women's genital responses tend not to be. Thus, men exhibit a *category-specific* pattern of genital arousal and women exhibit a *category-nonspecific* pattern of genital arousal. For example, gynephilic men (i.e., men with a sexual preference for women) show the most genital arousal to stimuli that depict women (e.g., Suschinsky, Lalumière, & Chivers, 2009), and androphilic men (i.e., men with a sexual preference for men) show the most genital arousal to stimuli that depict men (e.g., Chivers, Rieger, Latty, & Bailey, 2004). Similarly, men without a history of sexual activity with children exhibit their highest genital arousal to stimuli involving adults, whereas men with a history of sexual activity with multiple children show their highest genital arousal to stimuli depicting children (e.g., Blanchard, Klassen, Dickey, Kuban, & Blak, 2001).

The sex of persons depicted in a sexual stimulus does not have much influence on women's genital responses. For example, androphilic women show relatively equal genital arousal to stimuli depicting men and women (e.g., Chivers et al., 2004). Gynephilic women display somewhat category-specific genital responses to low intensity sexual stimuli, in that they exhibit higher genital arousal to stimuli depicting a nude female exercising or a nude female masturbating relative to the equivalent male stimuli. Gynephilic women, however, show similar genital arousal to high intensity partnered sexual interactions between two men, two women, or a man and a woman. No one has assessed women's genital responses to

stimuli depicting persons in different age categories (with the exception of one case study of a woman with multiple paraphilias who had a category-nonspecific genital arousal pattern; Cooper, Swaminath, Baxter, & Poulin, 1990).

Men's genital responses also vary depending on the type of sexual activity that is depicted. Men without a history of sexual aggression exhibit their highest genital responses to stimuli that depict consensual sexual activity and much less genital arousal to stimuli that depict non-consensual sexual activity (Lalumière & Quinsey, 1994). Men with a history of sexual aggression exhibit, on average, similar genital arousal to stimuli that depict consensual and non-consensual sexual activity, but there are some sexually aggressive men who show the most arousal to non-consensual sexual stimuli (Lalumière & Quinsey, 1993).

Only one published study has specifically investigated women's genital arousal in response to different partnered sexual activities of similar intensities. This study differed from other studies that have assessed sexual arousal to different partnered sexual activities (Laan, Everaerd, & Evers, 1995; Suschinsky et al., 2009) by holding the number of actors depicted and the amount of sexual content described constant across stimuli. Suschinsky and Lalumière (2011) presented men and women with a variety of audio-stories while their genital arousal was assessed with penile plethysmography (via penile strain gauges) and vaginal photoplethysmography (via a probe that measures changes in the colour of the vaginal wall). The audio-stories described interactions between a man and a woman and varied based on three factors: expression of consent or non-consent on the part of the woman, presence or absence of sexual activity, and presence or absence of violence and injury to the woman. Unlike the men, the women showed relatively high and relatively equal

genital arousal to the stimulus categories that contained sexual content, regardless of the presence of violence and injury or non-consent.

In contrast to genital arousal, both men and women exhibit a category-specific pattern of subjective or self-reported sexual arousal, in that they report different degrees of sexual arousal to different sexual stimuli. Men and women typically report their highest sexual arousal in response to stimuli that depict sexual partners who match their sexual preferences (e.g., Chivers et al., 2004). Although men and women do not exhibit different patterns of self-reported sexual arousal, they do exhibit different degrees of *sexual concordance*, with men having high correlations between their genital and self-reported sexual arousal, and women having positive, but significantly lower, correlations between their genital and self-reported sexual arousal (Chivers, Seto, Lalumière, Laan, & Grimbos, 2010). Women's lower sexual concordance is not simply the result of their lower genital category-specificity—if women exhibit genital arousal to all sexual stimuli, but only report sexual arousal in response to some sexual stimuli, low correlations between genital and self-reported sexual arousal would be inevitable. Women still exhibit lower sexual concordance than men when presented with sexual stimuli that they find sexually appealing (Suschinsky, Chivers, & Lalumière, 2011; Wincze, Venditti, Barlow, & Mavissakalian, 1980). Women also show significantly lower sexual concordance than men when asked to report their feelings of genital arousal, rather than overall subjective feelings of sexual arousal (Chivers et al., 2010).

How Stable are Sexual Arousal Patterns?

The sex differences in genital category-specificity and sexual concordance appear to be valid phenomena in need of explanation, and not the result of measurement error. The

validity of penile plethysmography has been well-established for quite some time (for reviews, see Rosen & Beck, 1988; Janssen, Prause, & Geer, 2007; Zuckerman, 1971), and the validity of vaginal photoplethysmography has been established recently (Laan et al., 1995; Suschinsky et al., 2009). Increases in penile circumference (or volume) and in vaginal blood flow are only observed in response to sexual stimuli (Laan et al., 1995; Suschinsky et al., 2009; Zuckerman, 1971). Similarly, higher intensity sexual stimuli depicting partnered copulation elicit higher genital arousal in men and women than lower intensity sexual stimuli depicting solitary masturbation or two clothed people kissing and caressing each other (Chivers, Seto, & Blanchard, 2007; Suschinsky et al., 2009).

Although the sex differences in sexual arousal patterns appear to be valid, little to no research has examined their stability or consistency. If the sex differences are consistent across testing sessions, their validity would be further supported and less likely to be the result of extraneous factors, such as experience with erotica, experience with sexual arousal, or comfort with the testing session. If these sex differences are not consistent across testing sessions and especially if the sex differences decrease over testing sessions, researchers must question their validity and possibly alter their experimental methodologies to incorporate multiple testing sessions.

The limited research that has assessed sexual arousal over more than one testing session has focused on the test-retest reliability of phallometry in men (Eccles, Marshall, & Barbaree, 1988; Farkas et al., 1979) and the effect of the menstrual cycle on women's sexual arousability (Hoon, Bruce, & Kinchloe, 1982; Meuwissen & Over, 1992; Schreiner-Engel, Schiavi, Smith, & White, 1981; Slob, Bax, Hop, Rowland, & Ven der Werff ten Bosch, 1996). Some research suggests that men's sexual arousal patterns may actually become more

discriminating over testing sessions. For example, Barbaree, Baxter, and Marshall (1989) presented 41 male university students and 60 incarcerated rapists with audio-stories of consensual and non-consensual sexual interactions over two testing sessions that took place at least 48 hours (but not more than a month) apart. A rape index (i.e., the summed penile responses to non-consensual stimuli divided by the summed penile responses to consensual stimuli) was calculated for each participant for each testing session. Barbaree et al. found that the rapists' rape indices were moderately correlated across testing sessions (Pearson $r = .44$), but that the students' rape indices were less correlated across testing sessions (Pearson $r = .29$). They noted that the students exhibited a greater degree of discrimination between the consensual and non-consensual stimuli during the second testing session, by showing greater arousal to consensual stories. To our knowledge, an equivalent study in women has not been conducted.

Sexual concordance has been assessed across testing sessions in men and women. Wormith (1986) presented 36 incarcerated male sex offenders and non-sex offenders with a variety of slides depicting nude individuals of different ages and heterosexual couples engaging in sexual activity while their genital and self-reported arousal were assessed during two testing sessions separated by one week. Wormith reported a near significant between-session correlation for sexual concordance of 0.23 ($p < .09$), suggesting that men's sexual concordance may be somewhat stable.

Henson, Rubin, and Henson (1979) assessed genital arousal in eight women using vaginal photoplethysmography and labial thermistors across two testing sessions separated by at least seven days (a maximum number of days was not reported). The women were presented with an 11 minute erotic film that depicted heterosexual sexual behaviors.

Participants were asked to report their genital sexual arousal once before the film began, once immediately after the film ended to retrospectively assess arousal during the film, and at two minute intervals in the ten minutes that followed the film. Henson et al. reported high correlations between genital arousal (as measured by both vaginal photoplethysmography and labial thermistors) and self-reported sexual arousal in both testing sessions (Session 1: $r = .65$ and $r = .64$; Session 2: $r = .57$ and $r = .82$ for the correlation between self-reported genital arousal and actual genital arousal measured by vaginal photoplethysmography and labial thermistors, respectively).

Heiman (1977; 1980) also assessed sexual arousal in two testing sessions. Heiman's (1977) study involved presenting 39 men and 59 women with audio stimuli depicting erotic, erotic-romantic, romantic, or neutral heterosexual content while their genital arousal was measured with penile strain gauges and vaginal photoplethysmography; subjective arousal was reported after each stimulus. Participants listened to the same stimuli in both sessions, which took place two weeks apart. The erotic and erotic-romantic stimuli elicited the highest genital arousal in both sessions. Although the author did not report the sexual concordance scores for each session, she did note that sexual concordance was somewhat higher in the first testing session. Heiman's (1980) other study included 27 married and 28 unmarried women who watched an erotic heterosexual film, listened to an erotic heterosexual tape, and fantasized while their genital arousal was measured with vaginal photoplethysmography; participants reported their subjective arousal after each stimulus. Overall, genital responses were similar across sessions, in that the film elicited the most arousal in both sessions. There were some inconsistencies, however, because the unmarried women showed significantly higher genital arousal relative to the married women to the film and the tape in only the first

session. Similarly, only the unmarried women showed significant sexual concordance, and this was true only in the first session.

Although Henson et al.'s (1979) and Heiman's (1977; 1980) studies are valuable initial steps in assessing the consistency of sexual arousal patterns in women, their studies suffer from several limitations. First, Henson et al. employed a very small sample to assess the consistency of sexual concordance across testing sessions. Second, it is unclear whether Henson et al. or Heiman controlled for the effects of the menstrual cycle. Some research has indicated that women's genital arousability changes across the menstrual cycle, with higher genital responses occurring during the follicular phase (Schreiner-Engel et al., 1981; Slob et al., 1996) and the luteal phase (Schreiner-Engel et al., 1981). Other research, however, fails to find evidence of changes in genital responsiveness across the menstrual cycle (Hoon et al., 1982; Meuwissen & Over, 1992). Henson et al. simply reported that the testing sessions were separated by a minimum of seven days, but it is unclear whether most (or any) of their participants were tested in the same phase of their menstrual cycle, and if not, whether menstrual cycle phase was taken into account in the analyses. Similarly, Heiman (1977) reported that the two sessions were two weeks apart, but Heiman (1980) did not describe the amount of time separating the testing sessions. Third, Henson et al. and Heiman presented the same heterosexual sexual stimuli in both sessions; thus, women's genital category-specificity was not assessed, and it is unclear whether any changes in sexual concordance are the result of enhanced awareness, remembering the first session, or decreases in responding to the same stimulus resulting from habituation. Fourth, Henson et al. reported between-subjects correlations for sexual concordance, which may underestimate women's (and men's) degree of sexual concordance (Chivers et al. 2010). Fifth, and most germane to the

current study, Henson et al. and Heiman did not report between-session correlations to assess the stability of sexual concordance. No study has examined the stability of sex differences in genital category-specificity or sexual concordance.

In addition to Heiman's (1977; 1980) research that suggests women's arousal patterns may change over testing sessions, there are other reasons to suspect that women's sexual arousal patterns may not be stable over time, or at least not as stable as men's. Previous experience may influence sexual arousal patterns. Pearson and Pollack (1997) found that women who reported previous experience with erotic materials reported more feelings of overall sexual arousal and more genital sensations in response to a sexual film they watched in a laboratory (genital arousal was not directly assessed), compared to women who had no previous experience with erotic materials. Men report significantly more experience with erotic materials than women, in terms of both frequency and the number of years that they have used erotic materials (Buzzell, 2005; Hald, 2006), and more experience with their genitals, in that they report masturbating more frequently and begin masturbating at an earlier age relative to women (Gerressu, Mercer, Graham, Wellings, & Johnson, 2008; Laumann, Gagnon, Michael, & Michaels, 1994; Oliver & Hyde, 1993; Petersen & Hyde, 2010). Given that women have less experience with both erotic materials and their genitals, it is possible that their sexual arousal patterns may change with experience. In other words, the low genital category-specificity and sexual concordance typically observed in women in the laboratory may change with experience with the testing session.

The Current Study

The purpose of the current study was to assess the stability of sex differences in sexual arousal patterns, as well as the stability of sexual arousal patterns in general. We

expected that men and women would exhibit different patterns of genital arousal for the first testing session; men were expected to exhibit a more category-specific pattern of genital arousal and higher sexual concordance than women. We also expected men and women to both exhibit a category-specific pattern of subjective sexual arousal in the first testing session. Also, we expected that if the sex differences in genital category-specificity and sexual concordance are valid phenomena, there should be little change in sexual arousal patterns across the two testing sessions. That is, there should be high inter-session correlations for indices of genital arousal category-specificity and sexual concordance, and the size of the sex differences should remain the same.

Method

Participants

Individuals were eligible to participate if they met the following criteria: between 18 and 35 years of age, predominantly attracted to members of the opposite sex, sexually experienced (i.e., had engaged in sexual activity and used erotic materials before), fluent in English, and reported no history of mental illness, sexual dysfunction, or sexually transmitted infections. Twenty men and 25 women participated in the first session. Data from four women were excluded from data analysis because they failed to exhibit a genital response to any stimulus category that was greater than their genital response to the neutral stimulus category. Data from an additional three women were excluded because they did not attend the second testing session because of scheduling problems. Data from four men and six women (Session One only) were collected as part of a previously published study (Suschinsky & Lalumière, 2011).

The mean ages for the men ($N = 20$) and the remaining women ($N = 18$) were 24.5 years ($SD = 5.2$) and 21.6 years ($SD = 2.9$), respectively. All men and 89% of the women were Caucasian and the vast majority of men (95%) and women (94%) reported that they either completed or were currently enrolled in post-secondary education. Slightly more than half of the men (65%) and women (67%) reported that they were in a romantic relationship of some sort. The majority of men (90%) and women (94%) reported that they were heterosexual, and the remaining participants reported that they were bisexual. Half of the women reported using hormonal contraceptives. The men were significantly older than the women, $t(36) = 2.05$, $p = .048$; there were no significant sex differences for any of the other biographic information, $ps \geq .23$.

Materials and Measures

Audio stimuli. The audio narratives were identical to those reported by Suschinsky and Lalumière (2011). The stimuli were 2 minute audio narratives told from a woman's perspective by a female narrator. The narratives described an interaction between a man and a woman and followed a standard format: a few sentences to set the scene, a description of the initial contact between a man and the woman, the woman's reaction, the man's response, the woman's experience, the man's final acts, and the woman's final condition. The narratives varied based on the presence or absence of three features: *consent* (female consent and enjoyment vs. refusal and displeasure), *violence* (injury and suffering vs. none), and *sexual content* (sexual acts and nudity vs. none). These three features were factorially crossed to yield eight stimulus categories, one of which was not used (no consent, no violence, no sex). There were five slightly different narratives for each stimulus category; for each session, two narratives were randomly selected from each category for each participant.

One neutral and one consensual non-violent sex narrative were presented at the beginning of each session to acquaint the participant with the research setting; data collected during these trials were not included in analyses. For each session, the remaining 14 narratives were presented in a quasi-random order for each participant, such that no two narratives from the same stimulus category were presented consecutively.

Genital measures. All psychophysiological data were collected using the same procedure as Suschinsky and Lalumière (2011); the psychophysiological data were sampled continuously during each narrative using a Limestone Technologies Inc. (Kingston, ON) DataPac_USB and Preftest software, Version 10. Mercury-in-rubber strain gauges (D. M. Davis, New Jersey) were used to measure men's genital arousal. The signal was sampled at a rate of 10 samples/s, low-pass filtered (to 0.5 Hz), and digitized (40 Hz). The signal was transformed into mm of circumference. Baseline was captured at the beginning of each stimulus and the peak response corresponded to the highest circumference value during the stimulus presentation. The gauges were calibrated over six 5-mm steps for each participant. The gauges ranged in size from 75 mm to 100 mm; participants used the same size of gauge in both testing sessions.

Women's genital arousal was assessed with changes in vaginal pulse amplitude via a vaginal photoplethysmograph equipped with an orange-red spectrum light source (Technische Handelsonderneming Coos, The Netherlands). The photoplethysmograph signal was sampled at a rate of 10 samples/s, band-pass filtered (0.5 Hz to 10 Hz), and digitized (40 Hz). Baseline was captured at the beginning of each stimulus and the peak response corresponded to the largest peak-to-trough distance during the stimulus presentation. A piece of flexible silicone was attached to the cable 5 cm from the light detector; this placement

device was used to control the depth and the orientation of the gauge (Laan et al., 1995). Participants used the same probe in both testing sessions. Movement artifacts were detected through visual inspection of the waveforms and removed prior to data analysis for both the men's and women's data. The experimenter was blind to the stimulus content while inspecting the data.

Self-reported sexual arousal. Participants continuously rated their feelings of sexual arousal during each narrative using a button press on a keypad; the button press manipulated a vertical bar that represented the individual's subjective sexual arousal on a computer screen placed 5 feet away from the participant. Participants also used the keypad to report their sexual arousal (both overall sexual arousal and feelings of genital arousal) after each narrative; participants used a scale of 1 (*no arousal*) to 9 (*maximum arousal*).

Questionnaires. In Session One, participants answered a series of questionnaires assessing their biographic information, sexual orientation, and sexual experiences.

Procedure

Screening and Session One. Prospective participants responded to advertisements placed in a university newspaper and posters placed on a university campus. The first author responded to prospective participants either via telephone or email, at which time a description of the study and its procedures was provided. The researcher also provided the list of eligibility criteria (see above). Eligible participants booked an appointment for their first session; women's appointments were scheduled such that they did not participate while they were menstruating. Participants were asked to refrain from sexual activity of all types for 24 hours, physical exercise of all types for one hour (because exercise results in sympathetic nervous system arousal that can influence genital responses; Meston &

Gorzalka, 1996), and using substances that may influence their physiological and psychological sexual arousal on the day of testing (e.g., alcohol, tobacco, caffeine, cold medications, and recreational drugs).

Participants were assessed individually. The female experimenter explained the details of the study and obtained consent. Participants were left alone in a dimly lit room to attach the strain gauge or insert the probe. The narratives were presented via headphones; participants were instructed to rate their sexual arousal continuously during each narrative and then after each narrative. The narratives were separated by inter-stimulus intervals of 30 – 300 s to allow a return to baseline. Following the psychophysiological assessment, participants completed a questionnaire package. Session One lasted between 2 and 2.5 hours. Participants were compensated with \$50.

Session Two. On average, Session Two occurred 28 days after Session One (minimum = 27 days, maximum = 31 days); Session Two was scheduled to take place during the same time of day that Session One had occurred. Female participants were tested in the same phase of their menstrual cycle, as determined by the reverse counting method (Chen, 2005).¹ Each male participant was yoked to a female participant, to ensure a similar passage of time between testing sessions. The psychophysiological assessment in Session Two followed a procedure identical to Session One, with the exception of the questionnaire package. Session Two lasted between 1 and 1.5 hours. Participants were compensated with \$25 and debriefed about the purposes of the study. All experimental procedures were approved by the university's Human Subject Research Committee.

Data Preparation

Genital arousal and continuous subjective sexual arousal scores were calculated by subtracting the trial baseline from the peak response for each narrative. Scores for the genital arousal data were then standardized within-subjects across both sessions combined, because the response output scales differ between men and women. Subjective sexual arousal scores were not standardized. Category scores were computed separately for genital and continuous subjective sexual arousal by averaging the scores from the two narratives for each category for each session. A Kolmogorov-Smirnov test was performed on individual participant's genital arousal and continuous subjective arousal scores for each session in order to compare the distribution of responses to all non-neutral stimuli against a theoretical uniform (i.e., flat) response distribution, with higher *Z* scores indicating that the pattern reflects a less uniform distribution (i.e., a more category-specific response pattern). The resulting *Z* scores were then averaged within each sex. As per Chivers et al.'s (2010) recommendation, for each session, sexual concordance was calculated within-subjects using the genital arousal scores and post-stimulus subjective overall feelings of sexual arousal ratings collected for the eight sexual stimuli only. Coercion Indices were calculated for genital and continuous subjective sexual arousal using the sum of a participant's responses to consensual sexual activities (i.e., consenting sexual sadism and consenting sex) subtracted from the sum of that participant's responses to non-consensual sexual activities (i.e., sadistic rape and non-sadistic rape); positive scores indicate greater arousal to coercive or non-consensual sexual activities.

Results

The Stability of Genital Arousal Patterns

Figure 4.1 shows the standardized genital responses for men and women across the two testing sessions. Men were much more genitally aroused by consenting, non-violent sex,

whereas women's genital arousal was much less affected by stimulus category. A 2 (session) X 7 (stimulus category) X 2 (sex of participant) analysis of variance (ANOVA) revealed that men's and women's overall genital arousal did not change over the testing sessions, $F(1, 36) = 0.80, p = .38$. Session did not interact with stimulus category, $F(6, 216) = 0.42, p = .86$, sex, $F(1, 36) = 0.58, p = .44$, or stimulus category and sex together, $F(6, 216) = 1.07, p = .38$. The ANOVA did reveal a significant interaction between stimulus category and the participants' sex, $F(6, 216) = 7.63, p < .001$. There was also a main effect of stimulus category, $F(6, 216) = 76.27, p < .001$. The results were effectively the same when age was used as a covariate. Overall, then, the results showed a sex difference in the category-specificity of genital arousal, and that difference did not vary by session.

Figure 4.2 shows the correlation between the Z scores obtained from the Kolmogorov-Smirnov analyses for genital arousal for the two testing sessions. A Pearson r correlation revealed that, overall, participants' genital category-specificity scores were significantly correlated across the two testing sessions, $r = .35, p = .03$; the result is consistent when controlling for age. Within each sex, genital category-specificity scores were not significantly correlated across the two testing sessions ($r = .37$ and $r = -.09$ for men and women, respectively), likely because of low variability within each sex and reduced statistical power. We conducted a 2 (session) X 2 (sex of participant) ANOVA with the genital arousal Z scores as the dependent variable. There was no main effect of testing session, $F(1, 36) = 0.02, p = .90$, but there was a near significant interaction between testing session and sex, $F(1, 36) = 3.98, p = .054$. There was also a main effect of participant sex, $F(1, 36) = 18.22, p < .001$. One-way ANOVAs revealed that men's Z scores ($M = 1.49, SD = 0.44$ and $M = 1.69, SD = 0.58$ for Session One and Two, respectively) were significantly

higher than women's Z scores ($M = 1.18$, $SD = 0.47$ and $M = 1.00$, $SD = 0.32$ for Session One and Two, respectively) for both testing sessions, $ps < .05$. Although men's Z scores increased and women's decreased across testing sessions, these changes were not significant in either sex, $ps \geq .19$. When age was used as a covariate, the interaction between testing session and participant sex was significant, $F(1, 35) = 5.46$, $p = .025$; all other results remained the same. Overall, men's genital responses were more category-specific than women's, and the sex difference was even larger in Session Two (Cohen's $d = 0.68$ and 1.53 for Session One and Two, respectively).

To further investigate the degree of change in genital category-specificity across testing sessions, we computed absolute difference scores by subtracting each participant's Kolmogorov-Smirnov Z score for Session One from Session Two. If women's genital arousal patterns were less stable than men's, women should have significantly larger difference scores than men. There was no significant difference between men's ($M = 0.46$, $SD = 0.40$) and women's ($M = 0.46$, $SD = 0.40$) degree of change in genital arousal specificity, $t(36) = 0.018$, $p = .98$, $d = 0.00$.

A Pearson r correlation indicated that there was a tendency for men's and women's genital Coercion Indices to be similar across testing sessions ($r = .28$, $p = .093$). Within each sex, however, Coercion Indices were not significantly correlated across sessions ($r = .14$ and $r = -.02$, $ps \geq .55$, respectively). A 2 (session) X 2 (sex of participant) analysis of variance (ANOVA) revealed that men's and women's relative genital arousal to non-consensual and consensual sexual stimuli did not change over the testing sessions, $F(1, 36) = 0.71$, $p = .41$. Session did not interact with participant sex, $F(1, 36) = 0.14$, $p = .71$. There was a main effect of sex, $F(1, 36) = 18.16$, $p < .001$, with women having a higher Coercion Index overall

(Session One: $M = -0.78$, $SD = 1.20$; Session Two: $M = -0.42$, $SD = 1.18$) relative to men (Session One: $M = -2.07$, $SD = 1.57$; Session Two: $M = -1.93$, $SD = 1.45$). The results were similar when age was covaried. These results are consistent with the results reported above, indicating that women's genital responses are less category-specific than men's. Men's and women's relative genital responses to non-consensual versus consensual sexual stimuli were similar across sessions and men showed significantly more arousal to consensual sexual stimuli relative to non-consensual sexual stimuli in comparison to women.

The Stability of Subjective Sexual Arousal Patterns

Figure 4.3 shows the distribution of continuous subjective sexual arousal responses across the two testing sessions. Both men and women reported they were most aroused by the consenting, non-violent sexual stimuli in both sessions. A 2 (session) X 7 (stimulus category) X 2 (sex of participant) ANOVA revealed no main effect of testing session, $F(1, 36) = 1.38$, $p = .24$. Session did interact with stimulus category, $F(6, 216) = 2.98$, $p = .008$, but did not interact with the sex of participants, $F(1, 36) = 0.03$, $p = .86$, or stimulus category and sex together, $F(6, 216) = 0.68$, $p = .67$. There was also a main effect of stimulus category, $F(6, 216) = 92.66$, $p < .001$. Men and women did not differ in their overall subjective sexual arousal, $F(1, 35) = 1.19$, $p = .28$. When age was used as a covariate, all results remained the same, with one exception; the interaction between session and stimulus category was no longer significant, $F(6, 210) = 1.77$, $p = .10$. Overall, then, men and women were equally category-specific in their subjective arousal for each session.

Figure 4.4 shows the correlation between the Z scores obtained from the Kolmogorov-Smirnov analyses for continuous subjective sexual arousal across the two testing sessions. A Pearson r correlation revealed that, overall, our participants' subjective

sexual arousal patterns were significantly correlated across the two testing sessions, $r = .82$, $p < .001$; the result is consistent when controlling for age. This result was consistent when assessing the correlation within each sex separately ($r = .81$ and $r = .85$, for men and women, respectively). We also conducted a 2 (session) X 2 (sex of participant) ANOVA with the subjective arousal Z scores as the dependent variable. There was a main effect of session, $F(1, 35) = 5.76$, $p = .022$, with Session Two Z scores being higher ($M = 1.95$, $SD = 0.82$) than Session One Z scores ($M = 1.76$, $SD = 0.70$). There was no main effect of sex, $F(1, 35) = 1.32$, $p = .26$. When age was used as a covariate, there was no main effect of testing session, $F(1, 34) = 0.06$, $p = .81$. Overall, men and women showed similar category-specific patterns of subjective sexual arousal in both sessions (Cohen's $d = 0.28$ and 0.43 for the comparison between men's and women's subjective arousal patterns in Session One and Two, respectively).

To further investigate the degree of change in subjective arousal category-specificity across testing sessions, we computed absolute difference scores by subtracting each participant's Kolmogorov-Smirnov Z score for Session One from Session Two. There was no significant sex difference in degree of change in subjective sexual arousal category-specificity, $t(36) = -0.60$, $p = .54$, $d = -0.18$.

Men's and women's subjective arousal Coercion Indices were significantly correlated across testing sessions (Pearson $r = .39$, $p = .014$). Within each sex, subjective Coercion Indices were not significantly correlated across sessions in men ($r = .20$, $p = .38$), but they were in women ($r = .59$, $p = .01$). A 2 (session) X 2 (sex of participant) analysis of variance (ANOVA) revealed that men's and women's relative subjective arousal to non-consensual and consensual sexual stimuli changed over the testing sessions, $F(1, 36) = 6.48$, $p = .015$.

Men's and women's Coercion Indices were significantly lower in Session One ($M = -54.70$, $SD = 27.61$ and $M = -37.21$, $SD = 19.40$, respectively) than Session Two ($M = -39.72$, $SD = 27.90$ and $M = -27.75$, $SD = 26.82$, respectively). Session did not interact with participant sex, $F(1, 36) = 0.33$, $p = .56$. Women's Coercion Indices were significantly higher than men's Coercion Indices, $F(1, 36) = 4.60$, $p = .039$. The results were similar when age was covaried. Overall, then, men's and women's relative subjective preference for consensual sexual stimuli decreased over time, and men showed greater preference for consensual over non-consensual stimuli in comparison to women.

The Stability of Sexual Concordance

Figure 4.5 shows the Pearson r correlation between the sexual concordance scores obtained in the two testing sessions. A 2 (session) X 2 (sex of participant) ANOVA with sexual concordance score as the dependent variable revealed a near significant main effect of session, $F(1, 36) = 3.83$, $p = .058$. Session did not interact with participants' sex, $F(1, 36) = 0.91$, $p = .34$. There was a main effect of sex, $F(1, 36) = 47.86$, $p < .001$. Men exhibited significantly higher sexual concordance scores than women in Session One ($r = .57$ and $r = .37$, respectively) and Session Two ($r = .70$ and $r = .18$, respectively). There was a significant correlation between sexual concordance scores across testing sessions when looking at all participants, $r = .39$, $p = .015$. There was a near significant correlation for men ($r = .44$, $p = .06$) but not women ($r = -.20$, $p = .44$). The results remained the same when age was covaried. Overall, men showed significantly higher sexual concordance than women, and this sex difference was even larger in Session Two.

To investigate the degree of change in sexual concordance across testing sessions, we computed absolute difference scores by subtracting each participant's sexual concordance

score for Session One from Session Two. If women's sexual concordance scores are less stable than men's, they should have higher difference scores than men. An independent samples *t*-test revealed that women's sexual concordance scores ($M = .44, SD = .36$) changed to a significantly greater degree than men's sexual concordance scores ($M = .19, SD = .18$), $t(36) = 2.67, p = .011, d = 0.92$.

Discussion

The sex differences in genital category-specificity and sexual concordance were found in both testing sessions, and may have been even larger in the second session. Consistent with previous research (Chivers et al., 2004; Chivers et al., 2007; Suschinsky et al., 2009; Suschinsky & Lalumière, 2011), men's genital arousal patterns were category-specific and tended to become even more specific over the two testing sessions (Barbaree et al., 1989). Women's genital arousal patterns were much less category-specific in both testing sessions, and tended to become less category-specific in the second session. Also consistent with previous research, men's and women's subjective sexual arousal patterns were similar (Chivers et al., 2004; Chivers et al., 2007; Suschinsky et al., 2009; Suschinsky & Lalumière, 2011). In both testing sessions, men and women exhibited a category-specific pattern of subjective sexual arousal, and tended to become more category-specific in the second session. Also consistent with previous research, men had significantly higher sexual concordance scores than women (Chivers et al., 2010) in both testing sessions, with a larger difference in the second session. Although the sex difference in genital category-specificity and sexual concordance was observed in both testing sessions, the correlational analyses revealed little stability at the individual level, especially in women.

The Stability of Sexual Arousal Patterns in Men and Women

Men's genital arousal, subjective arousal, and sexual concordance patterns were relatively stable across testing sessions. Interestingly, women's subjective sexual arousal was stable across the testing sessions, but their genital arousal and sexual concordance were less stable. These results are consistent with previous research. Heiman (1977) reported that sexual concordance scores were slightly lower in the second testing session of her study, though no analyses were presented. Similarly, Heiman (1980) reported changes in sexual arousal patterns across testing sessions in her sample of married and unmarried women: The unmarried women showed significantly higher genital arousal to an erotic tape and film than married women, but this difference was only present in the first testing session. Similarly, sexual concordance was significant for the unmarried women only in the first session. These results, in combination with the results of the current study, suggest that women's sexual arousal patterns may be less stable than men's sexual arousal patterns.

Given that individual women's subjective sexual arousal patterns were relatively stable across the testing sessions, we are left to explain why their genital arousal patterns seem to vary across testing sessions. Men's genital responses are closely connected with their sexual preferences, such that men show varying degrees of genital arousal to different high and low intensity sexual stimuli that correspond with their preferred sexual partners and sexual activities. Women's genital responses are less closely connected with their sexual preferences, such that women show relatively equal degrees of genital arousal to high intensity sexual stimuli that depict both preferred and non-preferred sexual partners (Chivers et al., 2007) and sexual activities (Suschinsky & Lalumière, 2011). The seemingly on/off nature of women's genital arousal, as well as the reflex-like onset of their genital responses in the presence of sexual stimuli (Suschinsky et al., 2011), supports a functional explanation

for women's genital arousal patterns. The *preparation hypothesis* suggests that women's genital responses, as measured by changes in vaginal blood flow, should occur in the presence of any sexual stimulus, in order to induce lubrication (Levin, 2003), thus preparing women for sexual encounters (Chivers, 2005; Laan, 1994; Suschinsky & Lalumière, 2011). Women's magnitude of genital response may not need to be consistent across testing sessions (or sexual encounters, for that matter), provided that there is enough of an increase in vaginal blood flow to induce lubrication. The preparation hypothesis thus suggests that the presence of genital arousal, rather than its magnitude, should be consistent across sessions in women.

It is also possible that women's lower stability in genital arousal patterns is simply a by-product of low genital arousal category-specificity. An examination of Figure 4.2 suggests that this may be the case; women's Kolmogorov-Smirnov scores were significantly lower than men's, and it is possible that even a slight deviation from a score obtained in Session One would affect the ability to attain a significant between-session correlation. Follow-up analyses also revealed that there was no significant difference in the degree of change in genital arousal category-specificity between men and women across the two testing sessions, but that there was a significant difference in the degree of change in sexual concordance scores between men and women. Further research is clearly needed to better understand the stability, or lack thereof, of sexual arousal patterns at the individual level.

The degree of stability of sexual arousal patterns may still be related to sexual experience. Although we presented men and women with sexual stimuli at two different periods, it is possible that sexual arousal patterns are more associated with direct experience with one's genitals and the use of erotic material for sexual pleasure, rather than simple

exposure. In general, women report masturbating and using erotic materials less frequently than men (e.g., Petersen & Hyde, 2010). Thus, it is possible that women who have more experience with their own sexual responses may have more stable patterns of sexual arousal.

Methodological Considerations

The sample of participants in the current study was rather limited. The sample consisted primarily of Caucasian university students, and the results cannot be generalized to other groups at this time. There is also the known self-selection bias for sexual psychophysiological studies, in which individuals willing to participate in sexual arousal studies are typically more sexually experienced and report less sex guilt (e.g., Strassberg & Lowe, 1995). This self-selection bias may impact the stability of sexual arousal patterns if sexual experience is associated with greater stability. Future research should investigate this possibility.

Another limitation of the current study involves the devices that we used to measure genital arousal in men and women. Although vaginal photoplethysmography and penile plethysmography are valid measures of genital arousal, they do not measure homologous physiological endpoints (i.e., vaginal hemodynamics and changes in penile circumference) or structures (i.e., the vagina and penis). It is possible that sex differences in genital category-specificity and sexual concordance (and stability thereof) reflect the differences in measurement technologies. To date, genital category-specificity has not been assessed with temperature measures of genital arousal, but sexual concordance has (e.g., Henson et al., 1979; Kukkonen, Binik, Amsel, & Carrier, 2007; 2010).

A limitation associated with the stimuli may be the fact that audio stimuli tend to elicit lower levels of genital arousal relative to film stimuli (e.g., Abel, Barlow, Blanchard, &

Mavissakalian, 1975; Heiman, 1980). Four women were excluded from data analysis because they did not exhibit a genital response to any stimulus category that was larger than their response to the neutral stimulus category. Film stimuli may reduce the number of non-responder participants. Film stimuli may also reduce some ambiguity, potentially resulting in more stable patterns of sexual arousal within-subjects. The stimuli in the current study all followed the same format (described above). Film stimuli may be less ambiguous and easier for participants to interpret, thus resulting in more stable sexual arousal patterns within-subjects. Our stimuli also described relatively atypical sexual activities between male and female characters only. Future research could use interactions between different couples (e.g., two men, two women, and a man and woman) to assess the stability of sexual arousal patterns with respect to the gender of the actors depicted in the stimuli. We anticipate that the sex differences in sexual arousal patterns would be relatively stable with those stimuli.

A final limitation may involve the amount of time that passed between testing sessions. We tested participants approximately one month apart, to limit potential menstrual cycle effects on women's sexual arousability (Schreiner-Engel et al., 1980; Slob et al., 1996; but see Hoon et al., 1982; Meuwissen & Over, 1992). Most of the research that has investigated the stability of sexual arousal has looked at arousal patterns within a shorter period of time, such as one or two weeks (Barbaree et al., 1989; Heiman, 1977; Henson et al., 1979; Wormith, 1986). It is possible that the amount of time that passed between testing sessions was too long and that participants' responded to the stimuli as if they were novel, thus reducing the impact of experience on arousal patterns. There is some evidence to suggest that men's genital responses habituate or decrease over multiple testing sessions (e.g., Plaud, Gaither, Amoto, Henderson, & Devitt, 1997), but it is unlikely that we would

have found habituation in the current study because we used similar but different stimuli in each testing session. Future research could involve assessing the stability of sexual arousal patterns over shorter periods of time (e.g., days) while women are still in the same phase of their menstrual cycle, to assess the short-term effects of experience or exposure to sexual stimuli on genital arousal and sexual concordance.

Conclusions and Future Research Questions

The results of the current study suggest that the sex differences in genital arousal category-specificity and sexual concordance are stable across testing sessions, and are thus valid phenomena. More research is required to further assess the stability (or lack thereof) of women's sexual arousal patterns at the individual level. The outcome of this research will have important implications for future research. If women's sexual arousal patterns are stable across testing sessions, we can begin to investigate the development of sexual arousal patterns in men and women. We currently know very little about the development of sexual arousal patterns in either sex. For example, is genital category-nonspecificity in women something that develops over time? Do men start out nonspecific and somehow learn genital specificity? We suspect both genders begin with the female default, category-nonspecificity, and that boys, during sexual differentiation, develop category-specificity. If that is not the case, is it possible that some environmental, social, or personal cues trigger genital nonspecificity in women? It would be worthwhile to examine such cues as frequency of being the target of courtship, the sex ratio of the social environment (a male-biased sex-ratio might be more likely to lead to sexual pressures), the age of the women, or a history of sexual assault.

We can ask similar questions about sexual concordance. Men do have significantly greater experience with their genitals and erotic material relative to women (Buzzell, 2005; Hald, 2006; Laumann et al., 1994; Oliver & Hyde, 1993; Petersen & Hyde, 2010). Although age does not seem to impact sexual concordance (e.g., Chivers et al., 2010), it is possible that actual experience rather than chronological age influences sexual concordance. Alternatively, the sex difference in sexual concordance may not be the result of experience and may actually reflect a broader difference in awareness of physiological responses.

If sexual arousal patterns are not stable in women over time, this will have a significant impact on clinical applications and future research. In terms of clinical applications, it would be difficult to interpret changes in genital arousal following a therapeutic intervention or medication, especially the lack of treatment-induced changes at the group level, if sexual arousal patterns prove to be relatively unstable in women. Similarly, experimental methodology may need to be altered if women's sexual arousal patterns are not stable over time. A more accurate pattern of sexual arousal may be obtained by collecting data over multiple testing sessions. Future research is required to better understand these issues.

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Note

¹ Six women were tested in the two weeks immediately following their menstruation (i.e., pre-ovulatory and ovulatory phase). Eleven women were tested in the two weeks before their next menstruation was expected (i.e., post-ovulatory phase). Menstrual cycle phase could not be determined for one participant. Analyses were performed on women's data with menstrual cycle phase as a between-subjects factor, with no significant effect on genital arousal patterns, self-reported sexual arousal patterns, or sexual concordance.

Figures

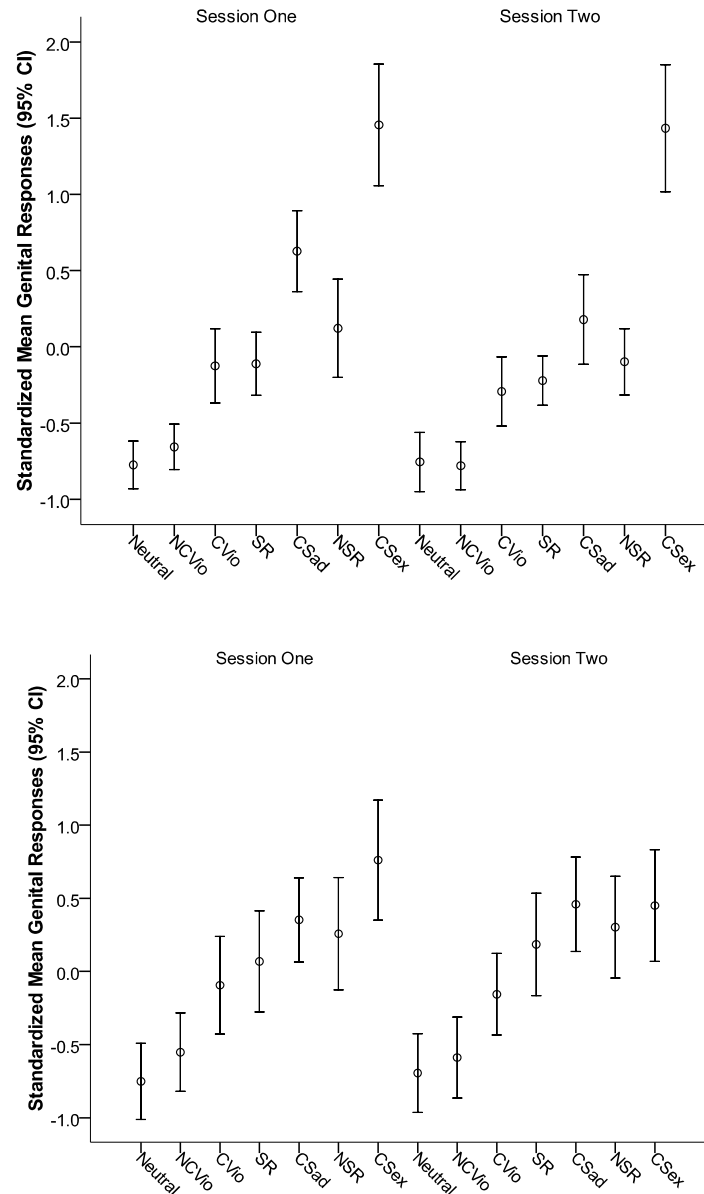


Figure 4.1.

Standardized mean peak minus baseline genital responses for men (top) and women (bottom) across testing sessions.

Note: Neutral = no sex, no violence, consent; NCVio = no sex, violence, no consent; CVio = no sex, violence, consent; SR = sex, violence, no consent (sadistic rape); CSad = sex, violence, consent (consenting sadism); NSR = sex, no violence, no consent (non-sadistic rape); CSex = sex, no violence, consent (consenting sex)

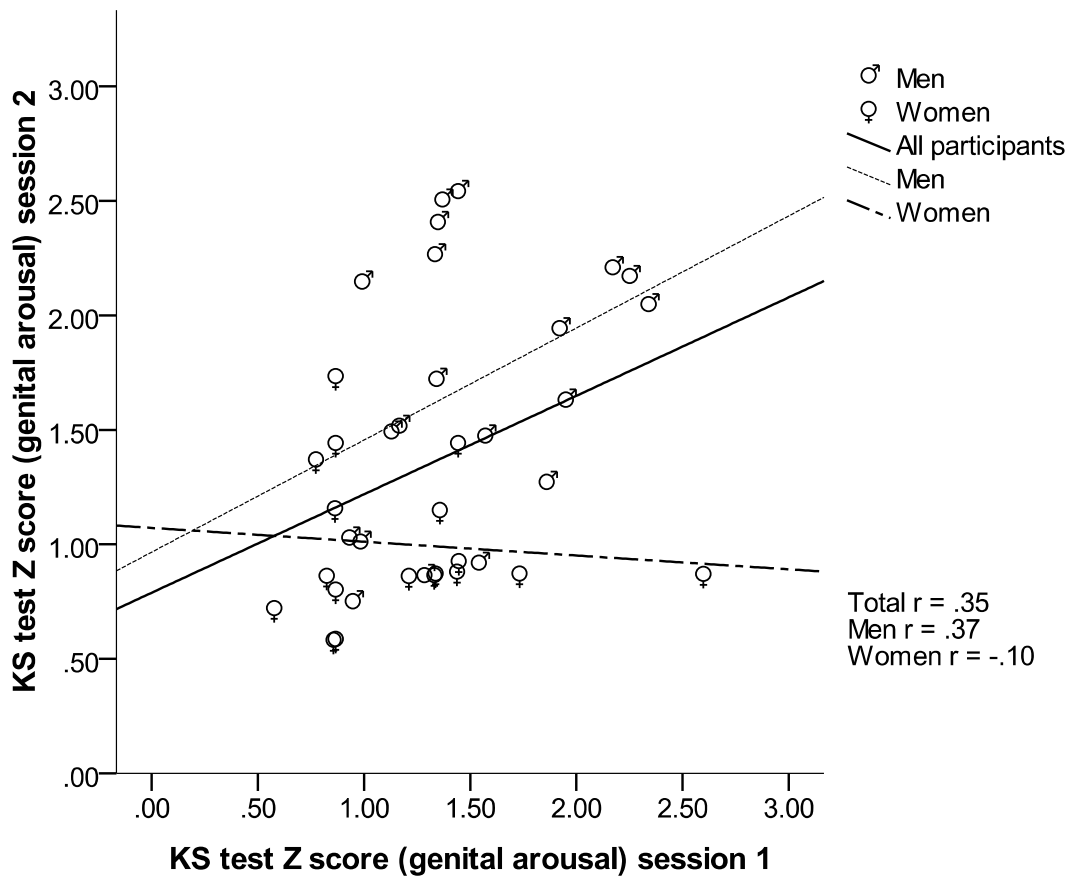


Figure 4.2.

Correlation between the genital arousal Z score from the Kolmogorov-Smirnov tests (degree of category-specificity) for Session One and Session Two.

Note: Each point represents an individual participant.

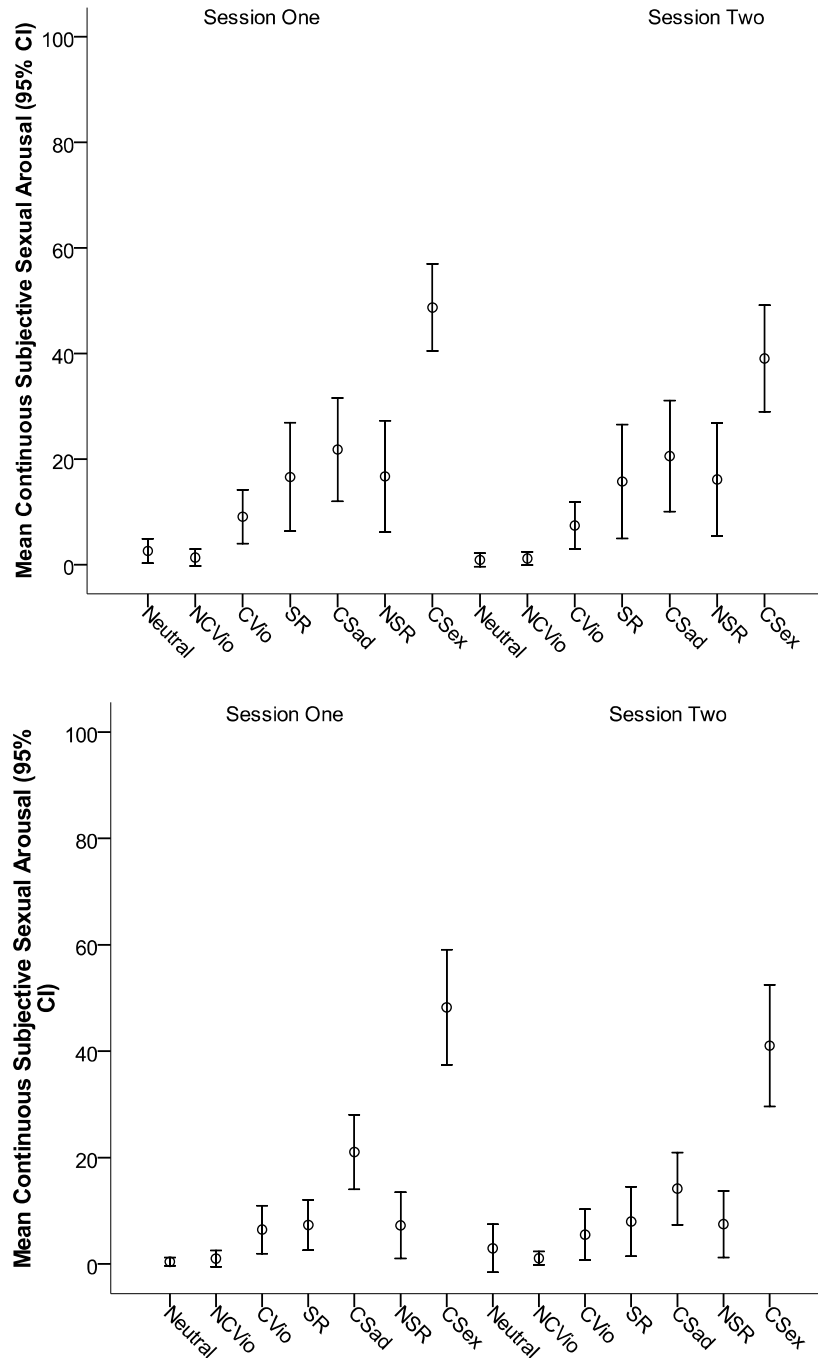


Figure 4.3.

Mean peak minus baseline continuous subjective sexual arousal responses for men (top) and women (bottom).

Note: Neutral = no sex, no violence, consent; NCVio = no sex, violence, no consent; CVio = no sex, violence, consent; SR = sex, violence, no consent (sadistic rape); CSad = sex, violence, consent (consenting sadism); NSR = sex, no violence, no consent (non-sadistic rape); CSex = sex, no violence, consent (consenting sex)

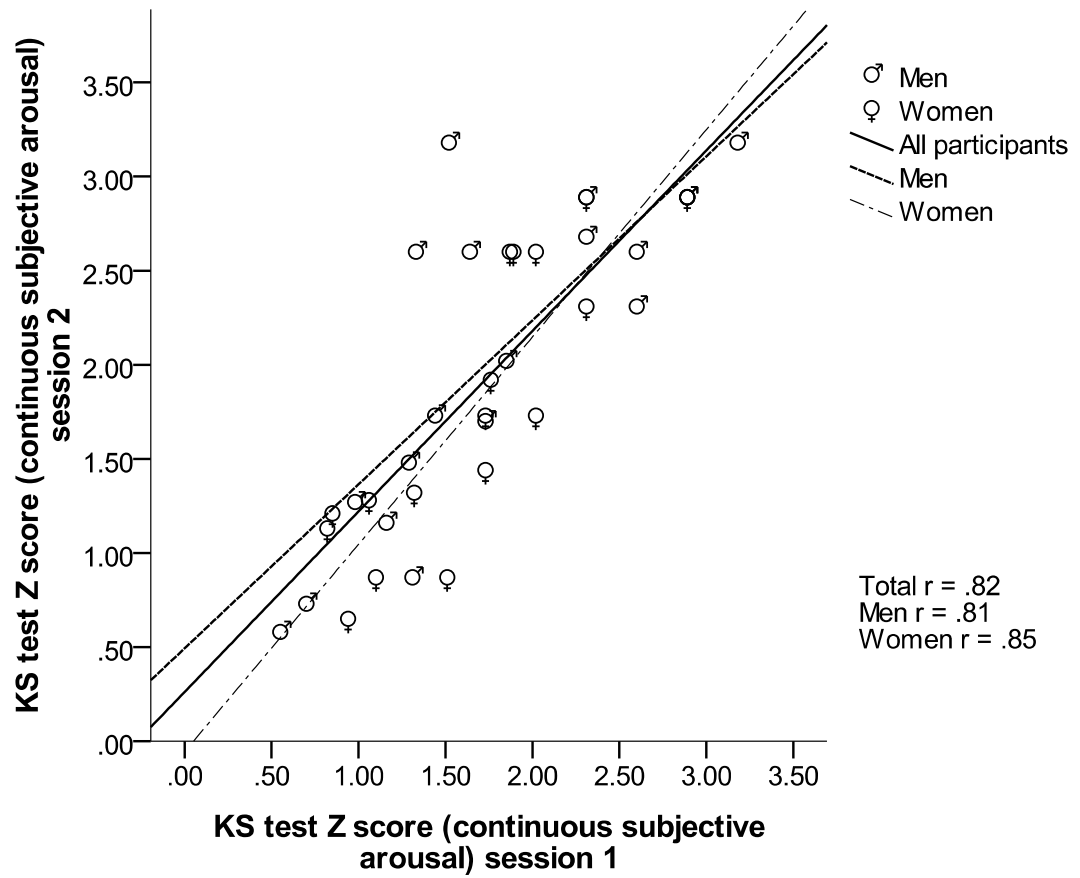


Figure 4.4.

Correlation between the continuous subjective sexual arousal Z score from the Kolmogorov-Smirnov tests (degree of category-specificity) for Session One and Session Two.

Note: Each point represents an individual participant.

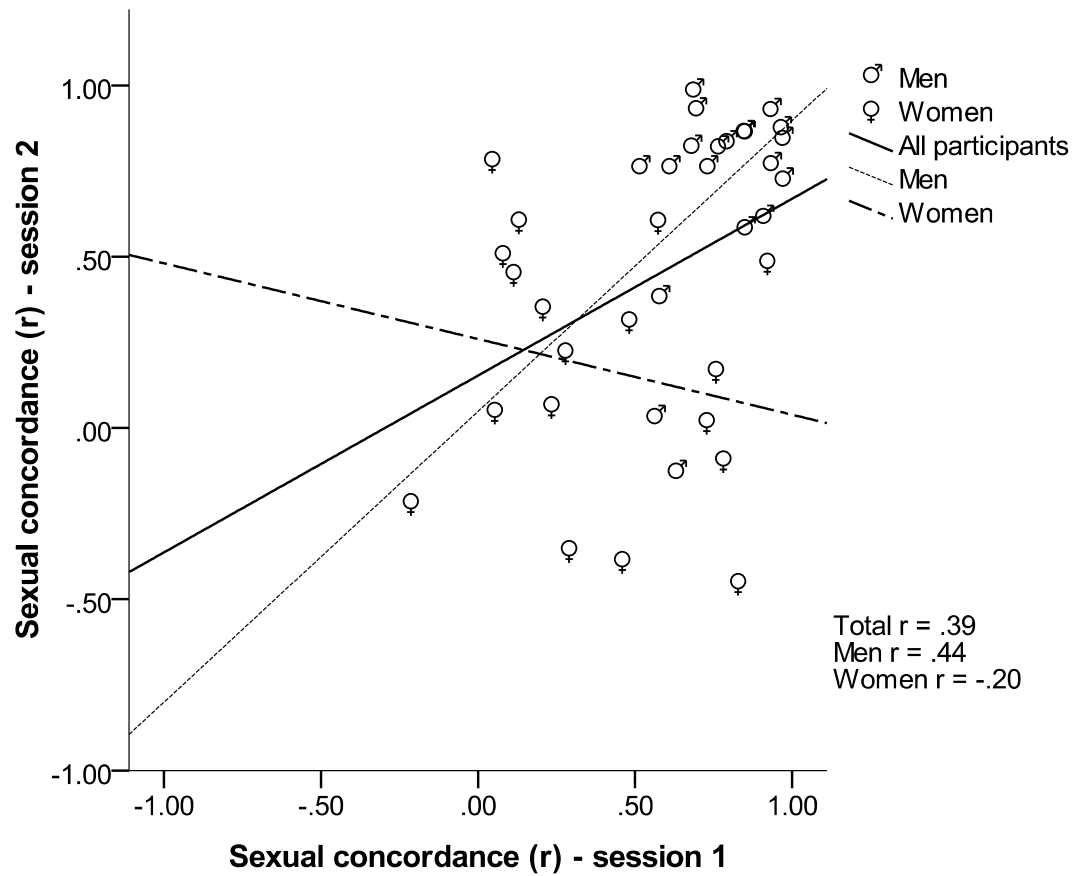


Figure 4.5.

Correlation between sexual concordance scores for Session One and Session Two.

Note: Sexual concordance is based on the correlation between genital and post-stimulus overall sexual arousal for sexual stimuli only. Each point represents an individual participant.

CHAPTER FIVE

Sexual Concordance and Awareness of Physiological States

Abstract

Sexual concordance refers to the degree to which two aspects of the human sexual response correspond with each other: physiological or genital sexual arousal and experience or self-report of sexual arousal. Researchers have consistently reported a sex difference in sexual concordance: The relationship between genital sexual arousal and feelings of sexual arousal in men is positive and large, whereas the relationship in women is positive but much smaller than that seen in men. The study of *interoception*—people’s awareness of their physiological states—reveals that men are more aware of their non-sexual states (e.g., heart rate) than women. The purpose of the current study was to investigate whether the sex difference in sexual concordance is related to a broader sex difference in interoception. Twenty men and 20 women were presented with twelve 90 second sexual and non-sexual films while their genital arousal, heart rate, and respiration rate were measured. Participants also estimated their physiological responses. Overall, men were significantly more sexually concordant than women. Men were also significantly more aware of their heart rate, but there was no significant sex difference in respiration rate awareness. Sexual concordance was not significantly correlated with either heart rate or respiration rate awareness. The results suggest that the sex difference in sexual concordance may be a unique phenomenon, separate from one’s general awareness of physiological states.

Introduction

The sexual response involves physiological, emotional, and cognitive changes (Geer & Janssen, 2000; Rosen & Beck, 1988). Because the sexual response includes a variety of response systems, researchers often evaluate and compare different aspects of the sexual response in order to better understand this complex process. *Sexual concordance* refers to the degree to which two aspects of the sexual response correspond with each other: one's physiological or genital sexual arousal, and one's experience or self-report of sexual arousal. There is a reliable sex difference in sexual concordance: The relationship between genital sexual arousal and one's experience of sexual arousal in men is positive and large, whereas the relationship in women is positive but much smaller than that seen in men. Chivers, Seto, Lalumière, Laan, and Grimbos (2010) recently conducted a meta-analysis of numerous studies ($N = 134$) examining sexual concordance and found that women (Pearson $r = .26$) were significantly less sexually concordant than men ($r = .66$). The purpose of the current study is to determine whether the sex difference in sexual concordance is part of a broader sex difference in awareness of physiological states.

The Source of Low Sexual Concordance in Women

Reports of women's low sexual concordance are not new (Heiman, 1977; Wincze, Venditti, Barlow, & Mavissakalian, 1980), but it is only recently that researchers have attempted to discover the source of the sex difference in sexual concordance. For instance, Suschinsky, Lalumière, and Chivers (2009) investigated the possibility that lower sexual concordance in women is due to sub-optimal measurement of genital arousal in women. The most commonly used measure of genital arousal in women is vaginal photoplethysmography: Vaginal photoplethysmography assesses physiological arousal by

measuring changes in vasocongestion or blood flow to the vagina (Sintchak & Geer, 1975). Although photoplethysmographic devices have been used by sex researchers since the mid-1970s, few studies have been conducted to investigate their validity (Geer, Morokoff, & Greenwood, 1974; Hoon, Wincze, & Hoon, 1976; Laan, Everaerd, & Evers, 1995). If vaginal blood flow occurs in response to both sexual and nonsexual stimuli (or to both sexual and nonsexual features of sexual stimuli), then lower sexual concordance in women would not be surprising, because women's experience of sexual arousal would be more likely to be triggered by sexual rather than nonsexual cues. Suschinsky et al.'s results indicated that increased genital responses detected by vaginal photoplethysmography occur in the presence of sexual stimuli only, similar to changes in penile circumference in men (for a review, see Zuckerman, 1971). Thus, lower sexual concordance in women is likely not because of poor validity of the device most commonly used to assess genital arousal in women.

The results from Chivers et al.'s (2010) meta-analysis suggest that the sex difference in sexual concordance is not caused by such methodological factors as stimulus characteristics (e.g., stimulus length, stimulus modality, stimulus content, and number of trials), sample characteristics (e.g., age of participants and hormonal contraceptive use in women), statistical factors (e.g., type of correlation computed), and type of vaginal photoplethysmograph component used (i.e., vaginal blood volume or vaginal pulse amplitude). Other explanations for women's lower sexual concordance have not been supported. For example, experience with one's genitals does not seem to influence sexual concordance: One would expect that older women would be more sexually concordant, given the fact that older women would have had more opportunities to explore their bodies or to experience sexual arousal, but Chivers et al. did not find a significant correlation between

average sample age and sexual concordance in women. Similarly, one would expect individuals with little experience with their genitals (i.e., recent post-operative male-to-female transsexuals) to be less sexually concordant than individuals with more experience with their genitals (i.e., natal women), but Chivers, Rieger, Latty, and Bailey (2004) obtained results contrary to this prediction.

Women tend to respond in a more socially desirable manner than men (Alexander & Fisher, 2003), so perhaps women are simply unwilling to report that they are sexually aroused to certain stimuli in the laboratory. It should be noted, however, that women who typically participate in sexual psychophysiological studies are more sexually experienced and less inhibited than other women (e.g., Morokoff, 1986) and would likely feel comfortable reporting their sexual arousal. In addition, women report some sexual arousal to sexual stimuli that evoke negative affective responses, such as sexually coercive stimuli (Laan et al., 1995; Suschinsky et al., 2009). Lastly, when women are asked to focus on their genitals and report their level of genital arousal, rather than their emotional arousal, women remain less sexually concordant than men ($r = .23$ and $r = .76$, respectively; Chivers et al., 2010).

It is important to note that not all women exhibit a low degree of sexual concordance. In fact, some women exhibit quite high sexual concordance. For example, Suschinsky and Lalumière (2011) recently reported that, on average, men ($r = .77$) were significantly more sexually concordant than women ($r = .18$) when men and women were presented with a variety of audio-taped narratives depicting different sexual interactions. Some women exhibited sexual concordance scores that were equal to that of men, and even exceeded that of some men: Men's sexual concordance scores ranged from $r = .11$ to $r = .97$ ($SD = .24$),

and women's sexual concordance scores ranged from $r = -.57$ to $r = .92$ ($SD = .41$). High sexual concordance in women is far from the norm, however. The vast majority of Suschinsky and Lalumière's male participants (93%) exhibited a sexual concordance score greater than or equal to $r = .50$, whereas only 20% of the female participants exhibited a sexual concordance score greater than or equal to $r = .50$. Similarly, low sexual concordance in men seems to be far from the norm: Only 7% of men in Suschinsky and Lalumière's study exhibited a sexual concordance score less than $r = .12$, whereas 40% of women exhibited a sexual concordance score less than $r = .12$.

Based on the findings outlined above, it is clear that there is a difference between men's and women's sexual concordance, but the source of lower sexual concordance in women still remains unknown. The research that has investigated the sex difference in sexual concordance has focused on explanations that are specific to sexual arousal. It would be worthwhile to examine the possibility that the sex difference in sexual concordance is part of a much broader phenomenon.

Interoception and Sexual Concordance

Researchers studying *interoception*, or one's awareness of physiological states, have also revealed an intriguing sex difference. In laboratory settings devoid of naturalistic cues, men are more accurate than women at detecting their heart rate (Brener & Jones, 1974; Katkin, Blascovich, & Goldband, 1981; Van der Does, Antony, Ehlers, & Barsky, 2000; Whitehead, Drescher, Heiman, & Blackwell, 1977), respiratory resistance (Harver, Katkin, & Bloch, 1993), blood glucose levels (Cox et al., 1985), blood pressure (Pennebaker & Watson, 1988), and stomach contractions (Whitehead & Drescher, 1980). In more naturalistic settings, however, women's accuracy at detecting blood pressure (Pennebaker & Watson,

1988) and blood glucose levels (Cox et al., 1985) increases, eliminating the sex difference in accuracy observed in laboratory settings.

Pennebaker and Roberts (1992) suggested that the sex difference in interoceptive abilities may be due to a fundamental sex difference in emotional processing. In laboratory settings, participants are often forced to rely on only relevant internal physiological cues because external situational cues are minimal. It is in these settings of relative closure, devoid of external cues from people or surroundings, that men are more accurate than women at detecting their physiological states or responses. When tested in naturalistic settings, complete with both internal and external cues, women's accuracy at detecting physiological states increases to match men's accuracy. Pennebaker and Roberts hypothesized that men and women differentially use internal and external cues to reach a conclusion about their physiological and emotional states. Men, according to Pennebaker and Roberts, rely more heavily on internal, physiological cues to determine their states, whereas women rely more heavily on external, contextual cues. Laan and Janssen (2007) have proposed a similar model for sexual arousal.

Given that men, on average, appear to be more accurate at detecting and reporting both sexual and non-sexual states in the laboratory, and women appear to be less accurate in detecting and reporting both sexual and non-sexual states in the laboratory, it is possible that sex differences in sexual concordance are caused by sex differences in interoceptive abilities. Based on previous research, we predicted that men would exhibit higher sexual concordance than women (Chivers et al., 2010), as well as higher heart rate and respiration rate awareness (Brener & Jones, 1974; Harver et al., 1993). If awareness of sexual arousal is part of general

interoceptive abilities, then the two forms of awareness (i.e., sexual concordance and heart rate and respiration rate awareness) should be correlated, regardless of sex.

Method

Participants

Twenty-one men and 21 women participated in the study. To be eligible for the study, individuals must have been between 18 and 45 years old, sexually experienced (i.e., had engaged in sexual activity and been exposed to erotic materials before), free from sexually transmitted infections, and fluent in English. They also had to report that they had no history of serious mental illness, substance abuse, chronic sexual arousal problems, respiratory problems (e.g., asthma) or cardiac problems (e.g., irregular heartbeat, high blood pressure), and that they were not currently using medications that may influence sexual functioning or desire, such as psychotropics or neuroleptics (Crenshaw & Goldberg, 1996). Women were required to have a regular menstrual cycle and not currently be pregnant or trying to conceive. Data from one man and one woman were excluded because the thermistor did not record their respiration rate.

The mean ages for the 20 men and 20 women with useable data were 27.5 ($SD = 9.7$ years) and 23.7 ($SD = 7.8$ years), respectively. Approximately half of the men (55%) and women (45%) reported that they were single, with most of the remaining men reporting that they were dating someone (25%) or in a common-law relationship (5%) and all of the remaining women reporting they were either dating someone (35%), married to someone (10%), or in a common-law relationship (10%). Most of the men (80%) and women (90%) were of European descent. Most of the men were attending or had received a diploma from community college (15%) or were attending university or had completed an undergraduate

degree (65%). All of the women were either attending university or had completed an undergraduate degree. Half of the women reported using hormonal contraceptives. Most men (90%) and women (75%) identified themselves as heterosexual, with the remaining identifying themselves as bisexual. There were no significant sex differences for any of the biographic variables (all $ps \geq .15$).

Materials and Measures

Audio-visual stimuli. Films elicit higher genital and self-reported sexual arousal in men and women than other stimulus modalities (Abel, Barlow, Blanchard, & Mavissakalian, 1975; Heiman, 1980). The sexual and non-sexual experimental stimuli were taken from Suschinsky et al. (2009). The sexual stimuli consisted of male-female, female-female, male-male, and sexually threatening male-female sexual interactions and the non-sexual stimuli consisted of anxiety-inducing and exhilarating films. Two 90 s exemplars for each of the six stimulus categories were presented. The stimuli were presented in a quasi-random order for each participant, such that one exemplar from each stimulus category was presented in the first set of trials and the remaining exemplar was presented in the second set of trials. The films were separated by neutral films (2 min each) to promote a return to baseline response: The neutral films depicted scenes from a women's home renovation program and a travel video. At the beginning of the experimental session, two warm-up stimuli were presented to acquaint the participant with the research setting: a 5 min still image of a beach scene presented without sound for five minutes and a 90 s film (with sound) of a beach. All stimuli were presented on a 17 in. computer screen positioned five feet away from the participant at eye level.

Genital measures. All sexual psychophysiological data were sampled continuously during each film clip using a Limestone Technologies Inc. (Kingston, ON) DataPac_USB and Preftest software, Version 10. Women's genital arousal was assessed with changes in vaginal pulse amplitude (VPA), a measure of vaginal blood flow specific to sexual arousal (Suschinsky et al., 2009) using a vaginal photoplethysmograph equipped with an orange-red spectrum light source (Technische Handelsonderneming Coos, The Netherlands). The photoplethysmograph signal was sampled at a rate of 10 samples/s, band-pass filtered (.5 Hz to 10 Hz), and digitized (40 Hz). Movement artifacts were detected through visual inspection of the waveforms and removed prior to data analysis.

Men's genital arousal was measured using mercury-in-rubber strain gauges (D. M. Davis, New Jersey). The signal was sampled at a rate of 10 samples/s, low-pass filtered (to .5 Hz), and digitized (40 Hz). The signal was transformed into mm of circumference. The gauges were calibrated over six 5-mm steps for each participant. Movement artifacts were detected through visual inspection of the response curves and removed prior to data analysis.

Other physiological measures. Heart rate and respiration rate were measured continuously at a rate of 1000 samples/s during the films using an MP36WS data acquisition unit (Biopac Systems Inc., Goleta, California). Heart rate (i.e., beats per minute) was calculated from the R-waves attained from electrocardiogram (ECG) recordings. A Lead II configuration was used, such that two electrodes were placed on a participant's stomach by the lower ribs and one electrode was placed near the participant's right collar bone. The ECG was recorded with a bandpass filter between 0.5 and 35 Hz. Respiration rate was measured using a thermistor that recorded the changes in air temperature as a participant inhaled and exhaled. The thermistor was attached to the face with surgical tape and curled up under the

nostril. Temperature was recorded in DC mode with a low pass filter at 38.5 Hz. The number of air temperature changes for each film was transformed into a rate (i.e., breaths per minute).

Self-report of physical responses and post-stimulus questions. After each film, participants answered several questions that were presented on the computer screen in front of them. Participants were asked about their sexual arousal during the previous film (both genital and overall feelings of sexual arousal), as well as their heart rate and respiration rate. Participants were also asked about their emotional responses to the previous film, including how anxious and repulsed they felt, how interested there were in the film, and how pleasant they found the film. Participants used a computer key pad to answer each question on a scale of 1 (*emotion not present at all or physical response as low or slow as possible*) to 100 (*emotion definitely present or physical response as high or fast as possible*). The questions were presented in a randomly determined order for each participant.

Questionnaires. The questionnaires included biographic questions, as well as questions about sexual history and experience.

Procedure

Screening. Prospective participants responded to email advertisements sent to psychology classes and posters placed at various locations at the local college and university campuses. During a brief telephone interview, the experimenter informed prospective participants about the physiological measurements that would be recorded, the questions that would be asked, and the experimental stimuli that would be presented during the session. The experimenter also reviewed the eligibility criteria. Women's appointments were arranged such that they did not participate while they were menstruating. Participants were

asked to refrain from sexual activity of all types for 24 hours, physical exercise of all types for one hour (because exercise results in sympathetic nervous system arousal that can influence genital responses; Meston & Gorzalka, 1996), and using alcohol, tobacco, caffeine, cold medications, and recreational drugs on the day of testing (because these substances may influence both physiological and psychological sexual arousal).

Experimental session. Participants were tested individually and were greeted by a female experimenter. The experimenter briefly reviewed the procedure and explained how to attach or insert the genital gauges. The experimenter attached the electrodes and the thermistor, and then left the room to monitor the heart rate and respiration responses in a separate room to ensure the devices were recording the responses properly. The experimenter then returned to the testing room to either fix the devices or inform the participant that he or she could attach or insert the genital gauge. The experimenter then left the participant in a dimly lit room; further communication took place via text messages sent by the experimenter to the participant on the computer monitor used for stimulus presentation and an intercom system for the participant to speak to the experimenter.

The participant first watched the warm up stimuli and then the experimental and neutral stimuli were presented. The experimental films were separated by neutral films to facilitate a return to a baseline level of arousal. Participants were asked to respond to the films as naturally as possible, and to avoid contracting their muscles, manipulating their responses (i.e., taking deep breaths), counting their pulse, touching their genitals, moving, or talking during the films. After each experimental or neutral film, participants answered eight questions that were presented on the computer screen using a key pad. The next stimulus was presented either 30 or 45 s (determined randomly for each stimulus) after the participant

answered the final post-stimulus question, regardless of whether responses had returned to baseline level or not.

Once the participant had watched all of the stimuli, he or she was instructed to remove the devices and open the door for the experimenter when he or she was ready. The participant then completed the questionnaire, and then was debriefed, thanked, and compensated with \$50. The entire procedure took approximately two and a half hours. All procedures were approved by the University's Ethics Committee.

Data Preparation

The mean for each physiological response (i.e., genital arousal, heart rate, and respiration rate) was computed for each stimulus. Pearson correlations were calculated within-subject for each combination of physiological and self-report response (i.e., genital arousal and self-reported genital arousal; heart rate and self-reported heart rate; and respiration rate and self-reported respiration rate). Although Suschinsky et al. (2009) recommended calculating sexual concordance using only data collected for sexual stimuli to avoid spuriously increasing sexual concordance, the correlations were based on the 12 pairs of data (all experimental stimuli) to retain variability in heart and respiration rates. All results reported below remain effectively the same when using correlations based on only the sexual stimuli. Four men and one woman produced at least one correlation that was considered an outlier for his or her sex, based on box and whisker plots. These outliers were replaced with the next lowest or highest correlation value ($\pm .01$) for their sex, in order to maintain their relative position, but prevent their extreme scores from distorting the results of subsequent analyses. All data reported below were normally distributed.

Results

Mean Physiological and Self-Reported Responses

Table 5.1 (top) shows the mean physiological responses for men and women. Two-tailed independent samples *t*-tests revealed that there were no significant differences between men's and women's mean heart or respiration rates. Genital responses were not compared because the output for penile strain gauges (mm of circumference) and vaginal photoplethysmography (mVolts) differ.

Table 5.1 (bottom) shows the mean self-reported physiological and emotional responses for men and women. Two-tailed independent samples *t*-tests revealed that there were no significant sex differences for any of the self-reported responses. The films were rated to be somewhat interesting and pleasant overall, and participants reported lower anxiety and repulsion during the films.

Correlations between Physiological and Self-Reported Physiological Responses

Table 5.2 shows the correlations between physiological and self-reported physiological responses for men and women. One-tailed independent samples *t*-tests were used to compare men's and women's correlations for sexual arousal, heart rate, and respiration rate. As predicted, men exhibited significantly higher sexual concordance than women, for both overall sexual arousal and self-reported genital arousal (i.e., perception of genital arousal). Men were also more aware of their heart rate, in that they exhibited significantly higher correlations between their heart rate and self-reported heart rate than women. Although men exhibited higher correlations than women, there was no significant sex difference in respiration rate awareness.

The Relationship between Sexual Concordance and Interoceptive Awareness

The relationship between sexual concordance and interoceptive awareness was assessed in two ways. First, parametric correlations (Pearson r) between the various forms of awareness were calculated based on data from both men and women combined, as well as within each sex (Figures 5.1 to 5.3). Using all participants, the two forms of sexual concordance (i.e., sexual concordance based on the correlation between genital and overall self-reported sexual arousal and the correlation between genital and self-reported genital arousal) were highly correlated with each other, $r = .94$, $p < .001$. Neither heart rate awareness ($r = .16$, $p = .32$) nor respiration rate awareness ($r = -.14$, $p = .40$) were significantly correlated with sexual concordance (based on self-reported genital arousal). Similarly, the two forms of non-sexual awareness were not significantly correlated with each other, $r = .08$, $p = .62$.

The second way that we assessed the relationship between sexual concordance and interoceptive awareness was with an ANCOVA, with sex as the independent variable, heart rate and respiration rate awareness as covariates, and sexual concordance (based on self-reported genital arousal) as the dependent variable. If heart rate awareness or respiration rate awareness is related to sexual concordance, we would expect to find a non-significant effect of sex when controlling for these two variables. The results of the ANCOVA support the correlational analyses reported above: The ANCOVA revealed a significant main effect of sex, $F(1, 36) = 4.56$, $p = .039$, $\eta^2 = .11$, even when controlling for other forms of awareness.

Discussion

The results from the current study suggest that men are more sexually concordant than women, but that sexual concordance may not be related to general interoceptive abilities. Overall, men and women exhibited similar levels of heart rate and respiration rate. They also

reported similar levels of sexual arousal (both overall and genital), heart rate, and respiration rate. Men and women also had similar emotional responses to the films. As predicted, men were significantly more sexually concordant than women were. Men were also more aware of their heart rate and there was no significant sex difference for respiration rate awareness.

Sex Differences in Various Forms of Awareness

Men were significantly more sexually concordant and more aware of their heart rate relative to women, but were not significantly more aware of their respiration rate. The sex difference in sexual concordance and heart rate awareness supports previous research, but the source of the sex difference remains to be elucidated. The sex difference in awareness does not seem to be due to differences in self-reported sexual arousal or heart rate, because men and women reported similar levels of sexual arousal and heart rate across the stimuli. Similarly, men's higher heart rate awareness does not appear to be a function of faster heart rate in general, because there was no significant difference between men's and women's average heart rate during the session.

Heart rate detection, which is a form of heart rate awareness based on reporting whether a series of tones is either synchronized or desynchronized with one's own heart rate, has been associated with greater activity in the right hemisphere of the brain (Critchley, Wiens, Rotshtein, Öhman, & Dolan, 2004; Hantas, Katkin, & Reed, 1984). Several researchers have hypothesized that men's greater heart rate awareness or detection may be the result of men's greater brain laterality or hemispheric specialization (e.g., Harver et al., 1993). Previous research has indicated that men exhibit a higher degree of hemispheric specialization than women on several verbal and non-verbal tasks (reviewed by Bryden,

1982; Kimura, 2000). We did not assess brain laterality in the current study, but it would be worthwhile to investigate this possibility further and more directly.

There may be a simpler explanation for the sex difference in sexual concordance. The physiological response that researchers measure for men (i.e., penile erection) is an external cue of men's sexual arousal, whereas the physiological response typically measured in women (i.e., vaginal blood flow) is a less obvious cue and may be less perceptible to women (Henson, Rubin, & Henson, 1979). Men's greater access to their genital responses may result in higher sexual concordance, and women may exhibit higher sexual concordance if researchers measured a more accessible genital response as well. Indeed, the limited research that has been conducted using thermographic (i.e., temperature) measures of genital arousal suggests that measures of women's external genitalia results in significantly higher sexual concordance compared to measures of vaginal blood flow (Chivers et al., 2010). Few such studies have been conducted, however, and more research comparing genital arousal measurements is required before concluding that thermographic measures yield higher sexual concordance levels in women. In any case, this explanation is unlikely to fully account for the sex difference in sexual concordance, because women show genital arousal to sexual stimuli they find very unpleasant (e.g., Suschinsky & Lalumière, 2011).

The Relationship between Various Forms of Awareness

Previous research has yielded mixed results as to whether interoceptive ability is a consistent trait within an individual. For example, Whitehead and Drescher (1980) found a significant correlation between one's ability to perceive stomach contractions and one's ability to detect heart rate in a signal detection task. Harver et al. (1993), however, did not find a significant correlation between one's ability to detect heart rate and respiratory

resistance, but noted that performance differed significantly across tasks because of their female participants' greater variability. We did not find a significant relationship between sexual concordance and either heart rate or respiration rate awareness, which suggests that sexual concordance may not be part of general interoceptive ability. We also did not find a significant correlation between heart rate and respiration rate awareness, but this may have been because we employed a methodology that differed from Whitehead and Drescher's signal detection tasks and we did not measure the same physiological responses that Whitehead and Drescher did.

The lack of a relationship between sexual concordance and general interoceptive ability may be caused by using methodologies that are different from those used by other researchers (e.g., Whitehead & Drescher, 1980), but it is possible that the difference between men's and women's sexual concordance is a unique phenomenon in need of its own explanation. Throughout evolutionary history, sex has had important consequences for men and women, but especially so for women. The minimum cost of parental investment for men is a single ejaculate. The consequences of sex are significantly higher for women because women's minimum parental investment involves not only the production of an egg, but also nine months of gestation and childbirth. Women's parental investment rarely ceases with childbirth, and may continue for months in the form of lactation or other parental care. Women's higher parental investment results in a lower potential reproductive rate relative to men (Clutton-Brock & Vincent, 1991; Trivers, 1972).

The consequences of sex are thus significantly different for men and women, and may have produced selection pressures over evolutionary history to promote sex-specific sexual response systems. Men's reproductive success likely increased with the number of partners

they could engage in sexual intercourse with (Trivers, 1972). Men's reproductive interests would thus have been best served by a psychology that is highly connected with their physiological responses, because men require both subjective sexual arousal and physiological arousal to engage in sexual intercourse: Subjective sexual arousal is required to motivate behaviour, and penile erection is required for successful penetration (Chivers et al., 2010). In contrast, women's reproductive success did not necessarily increase with the number of partners they engaged in sexual intercourse with, but rather with the quality of the partners that they chose to engage in sexual intercourse with and the timing of copulation (Symons, 1979). Similarly, women do not seem to require both subjective and physiological sexual arousal to successfully engage in sexual intercourse: The precursor to vaginal lubrication, increased vaginal blood flow (Levin, 2003), occurs even in response to stimuli that elicit little to no subjective sexual arousal in women (Suschinsky & Lalumière, 2011). Women, therefore, may have benefitted from a psychology that is less connected to their physiology to allow them to make mate choices that are not necessarily dependent on initial physiological responses.

Limitations

The measure of heart rate awareness employed in the current study was different from the measure used in previous research that has consistently yielded a significant sex difference: heart rate detection (e.g., Brener & Jones, 1974; Harver et al., 1993; Katkin et al., 1981). Studies of heart rate detection have been criticized for distracting participants from their cardiac responses because participants are required to attend to and match two different sets of stimuli (i.e., cardiac responses and a series of tones that is either synchronized or desynchronized with their actual heart beats; Ehlers & Breuer, 1992). Our participants may

have been distracted from paying full attention to their heart beats because they were watching the films and paying attention to other physiological responses, but we still found a significant sex difference in heart rate awareness, indicating that our method is likely robust to distraction. Lastly, we measured respiration rate awareness, rather than respiratory resistance awareness, in which participants are asked to report whether or not their breathing is obstructed (e.g., Harver et al., 1993). This may explain why we did not find a significant sex difference on the respiration measure.

A related limitation of the current study is the methodology we used to measure awareness of the various physiological states. Participants were asked to report their physiological states and emotional responses after each stimulus, which may reflect men's increased accuracy at physiological or emotional recall, rather than awareness per se. We used this methodology for practical reasons: Participants could not possibly concurrently rate all of their physiological and emotional responses. Participants answered the questions in a unique random order, to attempt to avoid promoting better recall for some responses over others. Unfortunately, software limitations prevented us from presenting the questions in a different order after each stimulus. It is unlikely that our results do not reflect a true sex difference in interoceptive awareness, because previous research indicates that women exhibit lower accuracy for sexual arousal and heart rate awareness when specifically focused on these states. Women still exhibit lower sexual concordance when asked to report their sexual arousal during a stimulus rather than recall their arousal after a stimulus (Suschinsky et al., 2009, Suschinsky, Chivers, & Lalumière, 2011). Similarly, men are more accurate than women when asked to tap a finger in time with one's heart beat or externally presented auditory stimuli (Ludwick-Rosenthal & Neufeld, 1985). Men are also significantly more

likely than women to be considered accurate heartbeat perceivers using a mental tracking paradigm, in which participants simply count the number of heartbeats they feel during a given time interval (Van der Does et al., 2000).

We found a relatively limited range of sexual concordance scores (for men in particular) and a broad range of heart rate and respiration rate awareness (see Figures 5.1 and 5.2). Despite the broad range of heart rate and respiration rate awareness, few men and women showed high levels of heart rate and respiration rate awareness. It is possible that the participants we tested did not exhibit a wide enough range of awareness for us to detect a significant correlation between sexual concordance and the other forms of awareness. Future research should include individuals who have been shown to have greater interoceptive abilities, such as individuals with a history of panic attacks or anxiety disorders (e.g., Van der Does et al., 2000).

Conclusions

The results from the current study are consistent with previous research indicating that women exhibit significantly lower sexual concordance than men. Several researchers, including ourselves, have tried to elucidate the source of women's lower sexual concordance to no avail. Women's lower sexual concordance may be the result of methodological issues, and measuring genital responses that may be more accessible to women via thermography may prove to be informative in assessing concordance in women. Alternatively, women's lower sexual concordance may be the result of sex-specific selection pressures having acted on women's sexual response system. Interestingly, other research on emotions has shown little convergence between different measures of emotion, including self-report, physiology, and behavior. In fact, dissociations among different measures of emotion may actually be the

norm (Mauss & Robinson, 2009). In that context, perhaps it is men's high sexual concordance that requires a special explanation.

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Tables and Figures

Table 5.1.

Mean physiological (top) and self-reported (bottom) responses for men and women based on all experimental stimuli.

	Men	Women		
Physiological response	<i>M (SD)</i>	<i>M (SD)</i>	<i>t(38)</i>	Cohen's <i>d</i>
Genital	94.3 (8.9)	4.8 (2.8)	N/A	N/A
Heart Rate	69.4 (11.2)	72.2 (13.9)	-0.72	-0.22
Respiration Rate	17.8 (1.8)	17.8 (2.7)	0.06	-0.02
Post-stimulus question	Men	Women	<i>t(38)</i>	Cohen's <i>d</i>
How sexually aroused were you?	27.2 (9.4)	29.3 (10.4)	-0.66	1.80
How sexually aroused were your genitals?	26.4 (12.0)	30.1 (12.4)	-0.98	-0.30
What was your heart rate?	43.8 (15.2)	47.4 (19.0)	-0.66	-0.21
What was your respiration rate?	43.2 (17.2)	44.4 (17.6)	-0.22	-0.06
How interested were you?	49.9 (21.2)	47.4 (20.0)	0.38	0.12
How pleasant was the film?	39.6 (9.4)	34.4 (12.8)	1.48	0.46
How anxious were you?	33.4 (16.9)	35.2 (19.0)	-0.32	-0.10
How repulsed were you?	25.5 (11.6)	27.6 (14.2)	-0.52	0.61

Notes: Genital arousal measurements are in mm of circumference for men and mVolts for women. Heart rate and respiration rate are presented as beats and breaths per minute, respectively. The post-stimulus questions were answered using a scale of 1 (*emotion definitely not present or physiological response is as low or slow as possible*) to 100 (*emotion definitely present or physiological response is as high or fast as possible*). All *ps* \geq .14.

Table 5.2.

Mean correlations (Pearson r) between physiological and self-reported physiological responses based on data from all experimental stimuli.

Responses	Men	Women	$t(38)$	Cohen's d
Sexual Arousal	0.74	0.60	1.87*	0.60
Self-reported Genital	0.74	0.56	2.32**	0.78
Heart Rate	0.26	0.11	1.80*	0.60
Respiration Rate	0.18	0.13	0.45	0.15

Notes: Sexual Arousal refers to the correlation between genital arousal and self-reported overall sexual arousal; Self-reported Genital refers to the correlation between genital arousal and self-reported genital arousal. The differences between men's and women's correlations were significant at * $p < .05$ and ** $p = .01$ (one-tail).

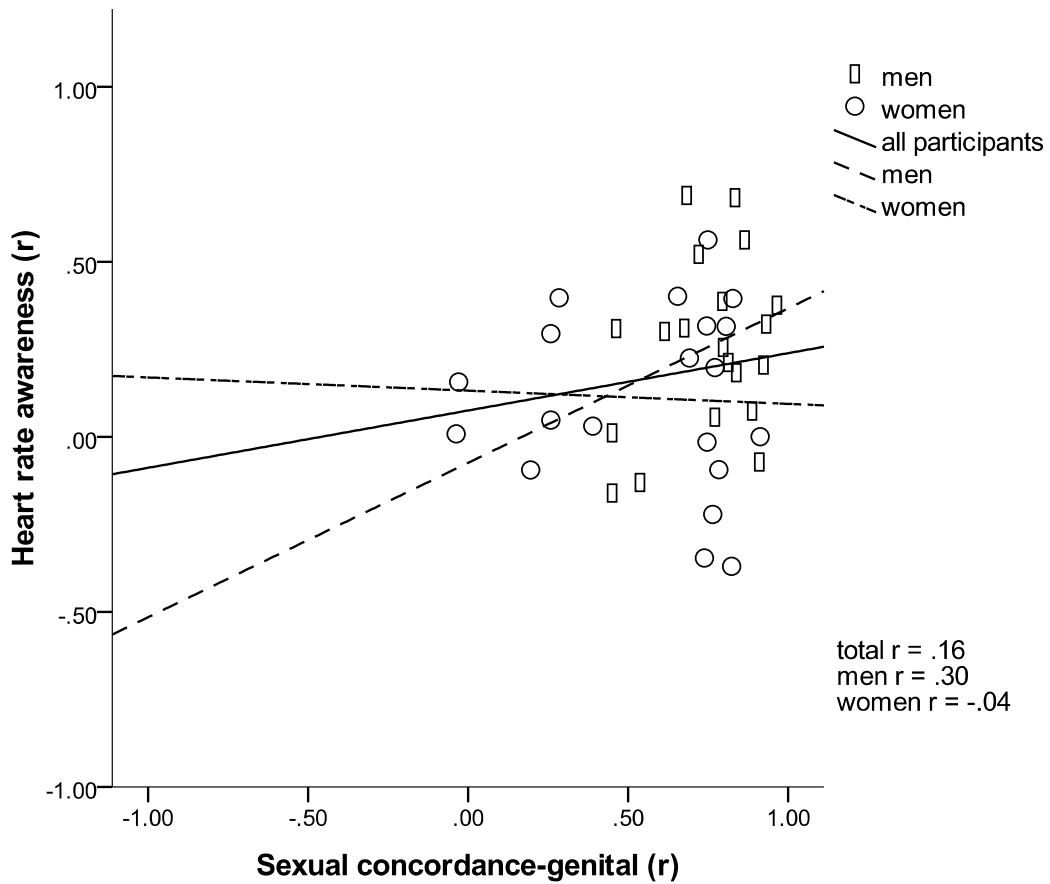


Figure 5.1.

Scatterplot of the correlations between sexual concordance (based on perception of genital arousal) and heart rate awareness (i.e., the correlation between heart rate and self-reported heart rate) in men and women.

Note: Each point represents the correlation from one participant.

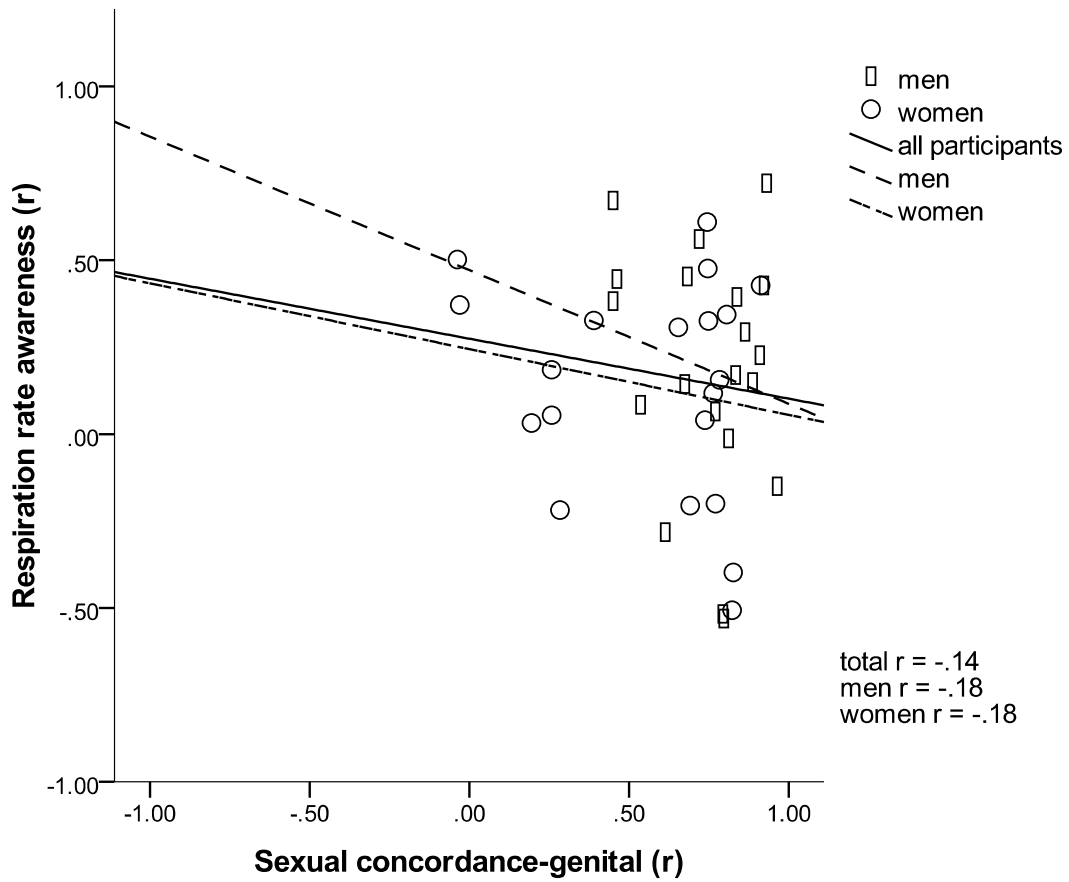


Figure 5.2.

Scatterplot of the correlations between sexual concordance (based on self-reported genital arousal) and respiration rate awareness (i.e., the correlation between respiration rate and self-reported respiration rate) in men and women.

Note: Each point represents the correlation from one participant.

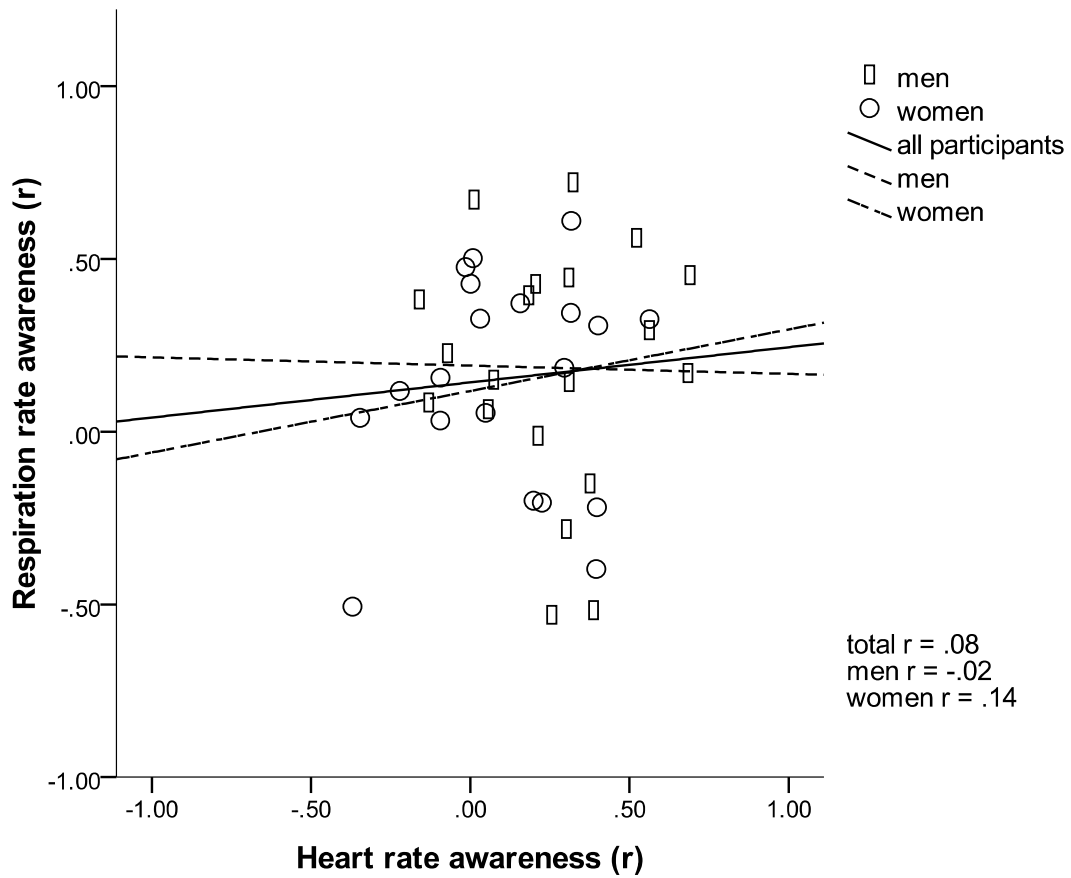


Figure 5.3.

Scatterplot of the correlations between heart rate awareness (i.e., the correlation between heart rate and self-reported heart rate) and respiration rate awareness (i.e., the correlation between respiration rate and self-reported respiration rate) in men and women.

Note: Each point represents the correlation from one participant.

CHAPTER SIX

Sexual Concordance and Awareness of Non-Sexual Physiological States in Anxious and Non-Anxious Women

Abstract

Sexual concordance refers to the association between physiological and self-reported sexual arousal. Self-reported sexual arousal may be measured by either self-reported feelings of sexual arousal or perceptions of genital arousal. There is a consistent sex difference in sexual concordance, such that women typically exhibit lower correlations than men between their physiological and self-reported feelings of sexual arousal or perceptions of genital arousal. There is also a sex difference in *interoception*—awareness of non-sexual physiological states—such that women, compared to men, tend to be less aware of and less accurate at detecting changes in their physiological states. Women with anxiety problems also tend to have better interoceptive abilities than non-anxious women. The purpose of this study was to investigate whether the sex difference in sexual concordance can be explained by a more general sex difference in interoception using a sample likely to show wide variation in interoceptive abilities. Sixteen anxious and 15 non-anxious women were presented with twelve 90 s sexual and non-sexual film clips while their genital arousal, heart rate, and respiration rate were measured. Genital arousal was measured with vaginal photoplethysmography. Heart rate was measured with an electrocardiogram and respiration rate with a thermistor. Participants estimated their physiological responses after each film. A mental tracking task was also used for heart rate. Within-subject correlations were computed for each physiological/self-reported response combination based on data collected for the 12

experimental stimuli. Overall, sexual concordance was not significantly correlated with heart rate awareness or respiration rate awareness. Anxious women did not exhibit significantly higher sexual concordance or heart rate awareness than non-anxious women; the non-anxious women actually exhibited higher respiration rate awareness. The results suggest that sexual concordance may be a distinct phenomenon from interoception and in need of its own explanation.

Introduction

The human sexual response is a complex process that involves physiological, emotional, and cognitive changes (Geer & Janssen, 2000; Rosen & Beck, 1988). These different components of the sexual response tend to be highly correlated (or concordant) in men, but less so in women. For instance, men's physiological (i.e., genital) and experience of (i.e., self-reported) sexual arousal are typically highly correlated (Pearson $r = .66$, based on correlations from 132 studies; Chivers, Seto, Lalumière, Laan, & Grimbos, 2010). Women's genital and self-reported sexual arousal are typically positively correlated, but to a significantly lesser extent than that seen in men ($r = .26$; Chivers et al., 2010). In addition to exhibiting lower sexual concordance, women also tend to exhibit lesser awareness of non-sexual physiological states (reviewed by Suschinsky & Lalumière, in press). The purpose of the current study is to examine the relationship between women's sexual concordance and awareness of other, non-sexual, physiological states.

Why is Sexual Concordance Lower in Women?

Researchers have recently attempted to explain why women's sexual concordance is lower than men's sexual concordance. The results from Chivers et al.'s (2010) meta-analysis revealed that the sex difference in sexual concordance is not caused by methodological factors. Specifically, stimulus characteristics (e.g., stimulus length, stimulus modality, stimulus content, and number of trials), sample characteristics (e.g., age of participants and hormonal contraceptive use in women), and analytical factors (e.g., type of correlation computed) did not affect the sex difference in sexual concordance levels significantly. Similarly, other factors such as experience with one's genitals (Chivers, Rieger, Latty, & Bailey, 2004; Chivers et al., 2010) and being asked to report on one's genital arousal instead

of one's personal feelings of sexual arousal (Chivers et al., 2010) did not influence the sex difference in sexual concordance.

One methodological factor that may influence sexual concordance is the device used to assess genital arousal in women. Women's genital arousal is typically assessed via changes in vaginal blood flow using vaginal photoplethysmography. Vaginal photoplethysmography is a valid measure of women's genital sexual arousal, in that it only detects increases in vaginal blood flow in response to sexual stimuli (Laan, Everaerd, & Evers, 1995; Suschinsky, Lalumière, & Chivers, 2009) and more intense sexual stimuli elicit stronger genital responses than less intense sexual stimuli (Chivers, Seto, & Blanchard, 2007; Suschinsky et al., 2009). Despite vaginal photoplethysmography's construct validity, changes in vaginal blood flow may be less perceptible to women than changes in external genitalia, such as changes in labial temperature (Henson, Rubin, & Henson, 1979), thus resulting in lower sexual concordance. The physiological response measured in men, penile erection, is an external cue that men may easily access, which may increase their sexual concordance.

The limited research that has been conducted using thermographic (i.e., temperature) measures of genital arousal does suggest that measures of women's external genitalia produce significantly higher sexual concordance compared to measures of vaginal blood flow (Chivers et al., 2010; Kukkonen, Binik, Amsel, & Carrier, 2007; Kukkonen, Binik, Amsel, & Carrier, 2010), but this research must be interpreted with caution. First, fewer studies have been conducted with thermographic measures than blood flow measures, and further research comparing the two measures with the same participants is required before concluding that thermography yields higher sexual concordance in women than vaginal

photoplethysmography. Second, the two recent thermography studies that did not obtain sex differences in sexual concordance presented the same sexual stimulus (a 15 min erotic film depicting consensual manual and oral genital stimulation, as well as penile-vaginal intercourse between adults), so it is unclear whether women's higher sexual concordance is unique to this stimulus or is more accurately assessed with thermography. Third, although the sex difference in sexual concordance was not statistically significant, 40% of the women in Kukkonen et al.'s (2010) study had a sexual concordance score less than or equal to zero, whereas all of the men had positive sexual concordance scores. Thus, it is possible that women's sexual concordance is lower than men's sexual concordance, regardless of how genital arousal is measured.

Sexual Concordance and Interoception

Most of the research on the source of women's lower sexual concordance has focused on factors that are specific to sexual arousal research. Suschinsky and Lalumière (in press) conducted a study that examined the relationship between sexual concordance and *interoception*, or one's ability to perceive or detect physiological states. Suschinsky and Lalumière hypothesized a link between sexual concordance and interoceptive ability because in laboratory settings, men are more accurate than women are at reporting several non-sexual physiological states or activities, including heart rate (Brener & Jones, 1974; Katkin, Blascovich, & Goldband, 1981; Van der Does, Antony, Ehlers, & Barsky, 2000; Whitehead, Drescher, Heiman, & Blackwell, 1977), respiratory resistance (Harver, Katkin, & Bloch, 1993), blood glucose levels (Cox et al., 1985), blood pressure (Pennebaker & Watson, 1988), and stomach contractions (Whitehead & Drescher, 1980). Similarly, there is some evidence

to suggest that different forms of interoceptive awareness are positively correlated with each other (Whitehead & Drescher, 1980; but see Harver et al., 1980).

Suschinsky and Lalumière (in press) presented men and women with a variety of short sexual and non-sexual films while their genital arousal, heart rate, and respiration rate were measured. After each film, participants were asked to report their genital arousal, heart rate, and respiration rate. Concordance scores were calculated for each response type by correlating the actual physiological response with the corresponding self-reported response. Men exhibited significantly higher correlations than women for genital arousal and heart rate, but no significant sex difference was found for respiration rate. Sexual concordance was not significantly correlated with either heart rate (Pearson $r = .16$) or respiration rate (Pearson $r = -.14$) concordance, suggesting that the sex difference in sexual concordance cannot be explained by a sex difference in general interoceptive ability.

Suschinsky and Lalumière's (in press) study did not find a significant correlation between sexual concordance and interoceptive ability, their study suffered from at least two limitations, and must be replicated and extended before conclusively determining that sexual concordance and interoceptive abilities are not related. First, the sample that Suschinsky and Lalumière tested was rather homogenous. Although their participants exhibited a relatively broad range of heart rate and respiration rate correlations, few participants showed high levels of heart rate and respiration rate awareness. The small number of individuals with high heart rate or respiration rate awareness may have prevented Suschinsky and Lalumière from detecting a significant correlation between sexual concordance and other forms of awareness.

The second limitation involves the procedure that Suschinsky and Lalumière (in press) used to assess heart rate and respiration rate awareness. They recorded participants' heart

rate and respiration rate while they watched a variety of films, and participants reported their heart rate and respiration rate after each film. Most research on heart rate perception involves no distraction, in that participants are asked to count their heart beats during a given period of time with no concurrent stimulus (Schandry, 1981; Van der Does et al., 2000). Although Suschinsky and Lalumière found a significant sex difference in heart rate awareness, it is important to include a measure of heart rate awareness that is more consistent with previous research in order to provide a better test of whether sexual concordance is associated with general interoceptivity.

The Current Study

The purpose of the current study is to further explore the relationship between sexual concordance and interoceptive ability in women. We recruited women who had a high likelihood of being accurate at perceiving their heart rate. Previous research has shown that accurate heart rate perception is more often found in individuals with panic disorder, social phobia, generalized anxiety disorder, and specific phobia (Van der Does et al., 2000). Similarly, individuals who score high on the Anxiety Sensitivity Index (Peterson & Reiss, 1992), a self-report scale that measures one's tendency to interpret the meaning of anxiety-related bodily sensations as dangerous, are also more likely to be accurate perceivers of heart rate. We also employed a *mental tracking procedure*, a heart rate perception task commonly used by other researchers (e.g., Schandry, 1981; Van der Does et al., 2000). We expected that women with a history of panic or anxiety would exhibit higher heart rate awareness than women without a history of panic or anxiety. We hypothesized that if sexual concordance is related to interoceptive ability, there should be a positive correlation between sexual

concordance and heart rate and respiration rate awareness in the combined group of anxious and non-anxious women.

Method

Participants

To be eligible for the study, women must have been between 18 and 45 years old, sexually experienced (i.e., had engaged in sexual activity and been exposed to erotic materials before), free from sexually transmitted infections, and fluent in English. The women also had to report that they had no history of substance abuse, chronic sexual arousal problems, respiratory problems (e.g., asthma), or cardiac problems (e.g., irregular heartbeat, high blood pressure). The women were required to have a regular menstrual cycle and not currently be pregnant or trying to conceive. Because we were interested in recruiting women likely to have a history of anxiety or panic (i.e., anxious women) and women who were unlikely to have such a history (i.e., non-anxious women), we employed further eligibility criteria for the psychophysiological assessment portion of the study. To be classified as *anxious*, participants must have had one or more of the following: a score of 30 or higher on the Sheehan Participant Rated Anxiety Scale (SPRAS; Sheehan, 1983), a score of 27 or higher on the Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986), or a self-reported formal diagnosis of anxiety or panic disorder from a clinician. We used these cut-off scores because Davis, Ross, and MacDonald (2002) were able to correctly identify the anxiety disorder status of 77% of their sample ($n = 70$) and 64% of their sample ($n = 58$) using the same SPRAS and ASI measures. To be classified as *non-anxious*, participants had to have an ASI and SPRAS score lower than 20 and no clinical diagnosis.

Materials and Measures

Audio-visual stimuli. The experimental films used in the current study were identical to those used by Suschinsky and Lalumière (in press). The films depicted explicit sexual interactions involving a man and a woman, two men, two women, and sexual aggression (i.e., non-consensual male-female sexual activity) and the non-sexual films included anxiety-inducing and exhilarating films. Two 90 s exemplars from each film category were presented in a quasi-random order for each participant, such that two films from the same stimulus category were never presented consecutively. The experimental stimuli were separated by neutral film clips (2 minutes each) taken from travel and home renovation videos that were meant to induce a return-to-baseline level of physiological arousal. The experimental session began with two warm-up stimuli: a still image of a beach scene (5 min) and a film clip of a beach (90 s). The stimuli were all presented on a 17 in computer screen positioned five feet away from the participant at eye level.

Genital measures. A Limestone Technologies Inc. (Kingston, ON) DataPac_USB and Prefest software, Version 10 were used to continuously sample the genital arousal data during stimulus presentation. Women's genital arousal was assessed via changes in vaginal pulse amplitude (VPA) with a vaginal photoplethysmograph equipped with an orange-red spectrum light source (Technische Handelsonderneming Coos, The Netherlands). The photoplethysmograph signal was sampled at a rate of 10 samples/s, band-pass filtered (.5 Hz to 10 Hz), and digitized (40 Hz). Movement artifacts ($M = 8.6$ artifacts, $SD = 8.8$) were detected through visual inspection of the waveforms and removed prior to data analysis.

Other physiological measures. Heart rate and respiration rate were obtained using an MP36WS data acquisition unit (Biopac Systems, Inc., Goleta, California). Responses were sampled continuously at a rate of 1000 samples/s during each film. Heart rate (i.e.,

beats per minute) was calculated from the R-waves obtained from electrocardiogram (ECG) recordings. The ECG was recorded with a bandpass filter between 0.5 and 35 Hz. The electrodes were attached in a Lead II configuration, with two electrodes placed on the stomach by the lower ribs and one electrode placed near the right collar bone. The number of heart beats that occurred during each trial of the mental tracking procedure (see below) was also calculated from the ECG data. Respiration rate was measured using a thermistor, which was attached to the face with surgical tape and curled up under the nostril to record changes in air temperature as the participant inhaled and exhaled. Temperature was recorded in DC mode with a low pass filter at 38.5 Hz. The number of air temperature changes for each film was transformed into a rate (i.e., breaths per minute).

Self-report of physiological responses and post-stimulus questions. After each film, participants answered questions that were presented on the computer screen in front of them. They were asked about their overall sexual arousal, genital sexual arousal, heart rate, and respiration rate, as well as how anxious, tense, and repulsed they felt during the film, how interested they were in the film, and how pleasant they found the film. Participants used a computer keypad to answer each question on a scale of 1 (*emotion not present at all or physical response as low or slow as possible*) to 100 (*emotion definitely present or physical response as high or fast as possible*). The questions were presented in a randomly determined order for each participant. For the mental tracking trials, participants were asked to report the number of heart beats that they felt in their body during a given trial, as well as the number of heart beats they felt that they missed.

Questionnaire. The questionnaire included biographic questions, as well as questions about sexual history and experience.

Procedure

Recruitment and screening session. Women responded to advertisements in a university newspaper and posters placed on a university campus. In an attempt to recruit women with a history of anxiety or panic, some of the posters advertised for women who considered themselves to be anxious or who had ever experienced a panic attack to participate in an arousal study. The other posters simply advertised for women to participate in an arousal study. Both types of posters mentioned that the study involved watching films, measuring arousal, answering questionnaires, compensation for one's time (although the actual amount of compensation was not specified), and private, confidential, and individual sessions.

The first author responded to the prospective participant either via telephone or email, at which time a description of the study and its procedures were provided. The researcher also provided the list of general eligibility criteria (see above). If prospective participants met the general eligibility criteria and were still interested in the study, they came to the laboratory to participate in the screening session. The screening session involved completing a brief questionnaire package, which included biographic questions, as well as the SPRAS and ASI. The screening session took approximately 20 minutes to complete, and participants received \$10 as a thank you for their time. Participants were later contacted by the researcher if they were eligible for the psychophysiological assessment.

Psychophysiological assessment session. Appointments were arranged such that no woman participated while she was menstruating. Participants were asked to refrain from sexual activity of all types for 24 hours before the session, physical exercise of all types for one hour beforehand (because exercise results in sympathetic nervous system arousal that

can influence genital responses; Meston & Gorzalka, 1996), and using substances that may influence their physiological and psychological sexual arousal on the day of testing (e.g., alcohol, tobacco, caffeine, cold medications, and recreational drugs).

Participants were tested individually and greeted by a female researcher. Upon obtaining consent, the researcher placed the heart rate electrodes and thermistor on participants. The researcher then left the dimly lit room to allow participants to insert the vaginal probe. The researcher communicated with the participant using text messages that appeared on the computer screen, and participants answered via an intercom.

The warm up stimuli were presented first to acquaint participants with the research setting. The experimental and neutral stimuli were then presented. Participants were instructed to avoid contracting their muscles, manipulating their responses (i.e., taking deep breaths), counting their pulse, touching their genitals, moving, or talking during the films. After each film, participants used a keypad to answer nine questions about their physiological and emotional responses during the previous film; the questions appeared on the same screen that presented the stimuli. The next stimulus was presented either 30 or 45 s (determined randomly for each stimulus) after the participant answered the final post-stimulus question.

The mental tracking procedure took place at two different points during the psychophysiological assessment: after participants had seen half of the experimental and neutral films and then again after the final film was presented. The mental tracking procedure required participants to count the number of heart beats they felt during three different time periods (25, 35, and 45 s), without taking their pulse (Schandry, 1981). To indicate that the mental tracking procedure was about to begin, the researcher sent participants a text message

that appeared on the computer screen; the message requested participants to count the number of heart beats they felt in their body during different time periods without taking their pulse. The time periods were indicated by the word “count” being displayed on the computer screen. Participants were not informed of the length of the time periods. After each trial, participants were asked to report the number of heart beats she felt in her body, as well as estimate the number of heart beats she may have missed (if any). The three trials in each set occurred in a random order for each participant.

After the final mental tracking trial, participants were asked to remove the devices and open the door to allow the researcher back into the room when ready. They were then given the questionnaire, and subsequently debriefed, thanked, and compensated with \$50. The session took approximately three hours. All procedures were approved by the university’s human research ethics committee.

Data Preparation

The mean response (over the duration of the stimulus) for each physiological response was computed for each stimulus. Parametric (i.e., Pearson r) and non-parametric (i.e., Kendall tau b) correlations were calculated within-subject for each combination of physiological and self-report response (i.e., genital arousal and self-reported genital arousal; heart rate and self-reported heart rate; and respiration rate and self-reported respiration rate); parametric correlations are reported here, though non-parametric correlations yielded similar results. Sexual concordance is typically assessed by the correlation between genital arousal and self-reported feelings of sexual arousal, not self-reported feelings or perceptions of genital arousal. In the current study, sexual concordance is the correlation between genital arousal and self-reported feelings of genital arousal, to be consistent with the heart rate and

respiration rate awareness tasks. Consistent with previous research (Chivers et al., 2010), the two types of sexual concordance (i.e., correlations based on overall feelings of sexual arousal and those based on feelings or perceptions of genital arousal) were highly correlated in the current study, $r = .94, p < .001$. The correlations were based on the 12 pairs of data collected during the experimental stimuli; correlations based on only the eight pairs of data collected during the sexual stimuli produced similar results to those reported below. All data were normally distributed.

Mental tracking accuracy was determined in two different ways. First, an error score was computed for each participant. The error score was the difference between the reported number of heart beats (i.e., the sum of the number of beats felt and potentially missed) and the actual number of heart beats (as measured by the ECG) divided by the actual number of heart beats, which was then multiplied by 100 to yield a percentage error score. The total error score was the sum of the absolute error score values of the six mental tracking trials, with higher error scores indicating poorer accuracy (Schandry, 1981). A total error score was used based on previous research (e.g., Schandry, 1981) and because there was no significant difference between total error scores for the first three mental tracking trials ($M = 66.4, SD = 53.6$) and the total error score for the last three mental tracking trials ($M = 54.6, SD = 37.0$), $t(60) = 0.99, p = .30$. Second, participants were assigned to one of three accuracy categories, based on the error scores for the individual trials based on procedures described by Van der Does et al. (2000). A participant was considered *accurate* if she exhibited less than 10% error score in four of six trials. A participant was considered *probably accurate* if she had: (a) less than 10% error in two of the six trials and less than 20% error in the remaining trials

or (b) less than 10% error in three of the trials and less than 20% error in at least two of the remaining trials. The remaining participants were classified as *inaccurate*.

Results

Sample Characteristics

Forty-nine women between the ages of 18 and 42 ($M = 22.5$ years, $SD = 4.7$ years) completed the questionnaire in the screening phase to determine their status for the psychophysiological phase of the study. Ten of these women ($M = 24.8$ years, $SD = 7.5$ years) were not considered for the psychophysiological phase for one of the following reasons: did not meet the general eligibility criteria ($n = 1$), did not wish to be contacted for the psychophysiological portion of the study ($n = 2$), were already participating in a different sexual arousal study investigating sexual concordance in our laboratory ($n = 1$), or had borderline scores on the ASI or SPRAS ($n = 6$). The remaining 39 women were contacted for the psychophysiological portion of the study; 6 of these women ($M = 22.0$, $SD = 2.4$ years) did not respond to the email.

The 33 women who responded and returned for the psychophysiological portion of the study ranged in age from 18 to 34 years. Two of these women were excluded from analyses because they either did not fully complete the psychophysiological session or the computer did not record their self-report responses. The final sample ($n = 31$) was composed of 16 anxious women and 15 non-anxious women. The mean age was 21.1 years ($SD = 2.1$ years) for the anxious women and 22.9 years ($SD = 4.8$ years) for the non-anxious women. More anxious women stated that they were in a dating relationship or engaged (56%) compared to the non-anxious women (46%). More anxious women reported using hormonal contraceptives (62%) than the non-anxious women (46%). More anxious women (94%) were

completing or had completed a university degree than non-anxious women (87%). Fewer of the anxious women reported that their sexual identity was heterosexual (56%) compared to the non-anxious women (80%); the remaining women reported their sexual identity as homosexual, bisexual, bi-curious, or pansexual. Chi square analyses revealed no significant group differences on any of these variables.

The anxious women exhibited significantly higher SPRAS scores ($M = 44.0$, $SD = 15.7$) relative to the non-anxious women ($M = 7.2$, $SD = 5.5$), $t(18.8) = 8.76$, $p < .001$, Cohen's $d = 3.47$. The anxious women also had significantly higher ASI scores ($M = 25.8$, $SD = 10.3$) compared to the non-anxious women ($M = 8.7$, $SD = 5.2$), $t(22.5) = 5.74$, $p < .001$, Cohen's $d = 2.20$. The SPRAS and ASI scores were significantly correlated with each other, Pearson $r = .68$, $p < .001$. The SPRAS and ASI scores were transformed into z scores and then averaged to create an Average Anxiety Score to be used in subsequent analyses. Not surprisingly, the anxious women had significantly higher Average Anxiety Scores ($M = 0.75$, $SD = 0.61$) relative to the non-anxious women ($M = -0.79$, $SD = 0.27$), $t(21.2) = 9.21$, $p < .001$, $d = 3.50$.

A chi square analysis also revealed that significantly more anxious women (31.2%) than non-anxious women (0%) reported that they had received treatment of some sort (i.e., hospitalization, medication, or psychotherapy) for anxiety or nervous disorders, $\chi^2(1, N = 31) = 5.58$, $p = .043$ (p value corrected using Fisher's Exact Test). Anxious women were also significantly more likely to have ever experienced a panic attack (68.7%) compared to non-anxious women (33.3%), $\chi^2(1, N = 31) = 3.88$, $p = .049$. More anxious women (68.7%) than non-anxious women (6.7%) reported having had a panic attack in the past year, $\chi^2(1, N = 31) = 12.57$, $p = .001$ (p value corrected using Fisher's Exact Test). More anxious women (19%)

reported that they were taking mental health-related medications than non-anxious women (6%), but this difference was not significant, $\chi^2(1, N = 31) = 1.00, p = .31$.

Mean Physiological and Self-Reported Responses

Table 6.1 shows the mean physiological responses for the anxious and non-anxious women. Independent samples *t*-tests revealed that the two groups of women exhibited similar mean genital arousal, heart rates, and respiration rates. Stimulus content had a similar impact on anxious and non-anxious women's mean genital arousal, heart rates, and respiration rates, in that 2 (anxiety status) X 6 (stimulus category) analyses of variance (ANOVAs) revealed no significant interaction between the participants' anxiety status and stimulus category for any physiological response (all $ps \geq .21$, all $\eta^2s \leq .047$).

Table 6.1 also shows the mean self-reported physiological and emotional responses for the anxious and non-anxious women. Independent samples *t*-tests revealed no group difference for any of the responses. Overall, participants rated themselves as moderately aroused, in terms of genital arousal, heart rate, and respiration rate. The participants reported that they were relatively interested in the films, even though they rated the films as being somewhat pleasant. They reported low levels of anxiety and repulsion. Stimulus content had a similar impact on anxious and non-anxious women's self-reported physiological responses and emotions, in that 2 (anxiety status) X 6 (stimulus category) ANOVAs revealed no significant interaction between the participants' anxiety status and stimulus category for seven of the post-stimulus questions ($ps \geq .10$, $\eta^2s \leq .073$). There was a significant interaction between anxiety status and stimulus category for participants' self-reported repulsion, $F(5, 145) = 3.84, p = .009, \eta^2 = .12$, and tension, $F(5, 145) = 5.52, p < .001, \eta^2 =$

.16; anxious women reported higher repulsion and tension rates for all films, except for the male-male sexual stimuli.

Mental Tracking Accuracy

Unexpectedly, the anxious women exhibited higher total error scores ($M = 139.0$, $SD = 80.9$) relative to the non-anxious women ($M = 102.0$, $SD = 74.8$). An independent samples t -test, however, revealed no significant difference in mental tracking accuracy between the two groups of women, $t(29) = 1.33$, $p = .19$, $d = 0.45$. A chi square analysis revealed no significant differences between the anxious and non-anxious women's mental tracking classification as accurate ($n = 3$ anxious women and $n = 3$ non-anxious women), probably accurate ($n = 2$ anxious women and $n = 4$ non-anxious women), and inaccurate perceivers ($n = 11$ anxious women and $n = 8$ non-anxious women), $\chi^2(2, N = 31) = 1.10$, $p = .57$. The same result was obtained when the *accurate* and *probably accurate* groups were combined and compared with the *inaccurate* women.

Correlations between Physiological and Self-Reported Responses

Table 6.2 shows the correlations between physiological and self-reported responses for the anxious and non-anxious women. Two-tailed independent samples t -tests were used to compare the women's sexual arousal, heart rate, and respiration rate correlations. On average, the anxious women exhibited a higher degree of sexual concordance relative to the non-anxious women, but this difference was not significant. Of note, the correlations obtained are higher than typical, but it should be remembered that they were calculated using all experimental stimuli, rather than with sexual stimuli only. There was no significant difference between anxious ($r = .60$) and non-anxious ($r = .36$) women's sexual concordance scores when concordance was calculated using sexual stimuli only, $t(29) = 1.60$, $p = .12$, $d =$

0.58. There was also no significant difference between the anxious and non-anxious women's heart rate awareness. There was, however, a significant difference for respiration rate awareness, with the anxious women exhibiting significantly lower respiration rate awareness than the non-anxious women.

We further examined the relationship between anxiety status and sexual concordance by calculating Pearson r correlations between the women's Average Anxiety Score and her sexual concordance score. There was no significant correlation, $r = .15, p = .41$. There was also no significant correlation between the Average Anxiety Score with heart rate awareness, $r = .06, p = .71$. Consistent with the t values, there was a significant correlation between the Average Anxiety Score and respiration rate awareness, $r = -.36, p = .043$.

The Relationship between Sexual Concordance and Interoceptive Awareness

To assess the relationship between sexual concordance and interoceptive awareness, we calculated Pearson r correlations between the various forms of awareness (Figures 6.1 to 6.3). The correlations were calculated based on data from all of the women combined, as well as separately for the anxious and non-anxious women. Sexual concordance was not significantly correlated with heart rate awareness, $r = .05, p = .77$, or mental tracking error scores, $r = .14, p = .44$. Similarly, sexual concordance was not significantly correlated with respiration rate awareness, $r = .26, p = .14$. The two forms of interoceptive awareness (i.e., heart rate and respiration rate awareness) were not significantly correlated with each other, $r = .18, p = .32$. The two forms of heart rate awareness (i.e., the correlation between actual heart rate and self-reported heart rate and the mental tracking error score) were significantly and negatively correlated with each other, $r = -.36, p = .043$, that is, in the expected

direction. Respiration rate awareness was not significantly correlated with the mental tracking error score, $r = -.26, p = .16$.

When examining the relationship between sexual concordance and interoceptive awareness within the different groups of women, there was no significant relationship between sexual concordance and heart rate awareness for either the anxious women ($r = -.12, p = .66$) or the non-anxious women ($r = .24, p = .39$). Sexual concordance and respiration rate awareness showed a near significant relationship in the anxious women ($r = .48, p = .057$), but not in the non-anxious women ($r = .14, p = .62$). Mental tracking error scores were not significantly correlated with sexual concordance in either anxious ($r = .11, p = .68$) or non-anxious women ($r = .12, p = .66$). Mental tracking error scores were also not significantly correlated with heart rate awareness for anxious ($r = -.37, p = .16$) and non-anxious women ($r = -.40, p = .14$) or respiration rate awareness for anxious ($r = -.12, p = .52$) and non-anxious women ($r = -.02, p = .88$).

Comparing Data from the Current Study with Data from Suschinsky and Lalumière (in press)

We compared heart rate awareness and respiration rate awareness in the participants from the current study and from Suschinsky and Lalumière's (in press) study. A chi square analysis revealed that significantly more participants in the current study (38.7%) exhibited a high correlation between their actual and self-reported heart rate (i.e., $r \geq .50$) relative to the participants in Suschinsky and Lalumière's original study (12.5%), $\chi^2(1, N = 71) = 6.58, p = .010$. There was no significant difference in the number of participants who exhibited high respiration rate awareness between the two studies, $\chi^2(1, N = 71) = 0.003, p = .96$.

Discussion

The results from the current study suggest that sexual concordance may not be related to general interoceptive abilities. Overall, sexual concordance was not significantly correlated with heart rate awareness, respiration rate awareness, or mental tracking error scores. Anxious women did not exhibit significantly higher sexual concordance scores than non-anxious women. Unexpectedly, the anxious women were not more aware of their heart rate or respiration rate than the non-anxious women. Similarly, there was no significant difference in mental tracking accuracy between the two groups of women.

Although the anxious women in the current study did not exhibit higher heart rate awareness, respiration rate awareness, or mental tracking accuracy, we were still able to address one of the limitations suggested by Suschinsky and Lalumière (in press). There were significantly more participants in the current study who had high heart rate awareness (i.e., $r = \geq .50$) relative to Suschinsky and Lalumière's participants (men and women combined), thus increasing the variability and increasing the likelihood of finding a significant correlation between sexual concordance and heart rate awareness. The fact that we were unable to detect a significant correlation between sexual concordance and heart rate awareness, despite having more participants with higher heart rate awareness, supports the notion that sexual concordance is not related to general interoceptive ability.

The Relationship between Various Forms of Awareness

The results from the current study are similar to those reported by Suschinsky and Lalumière (in press). Sexual concordance was not significantly correlated with any form of non-sexual awareness, including the mental tracking error score. Similarly, heart rate awareness was not significantly correlated with respiration rate awareness. Interestingly, we did find a negative correlation (as expected) between heart rate awareness and mental

tracking error scores and a near significant negative correlation between respiration rate awareness and mental tracking error scores, indicating that the different interoceptive tasks measure a similar ability with regard to heart rate despite using different methods. The heart rate and respiration rate awareness tasks may have relied more on participants' memory of their physiological state or their ability to focus on physiological states in the presence of distraction (i.e., while films were presented), whereas the mental tracking task may have better reflected a participant's ability to focus on their physiological states in the absence of obvious distraction; despite these differences in methodology, individuals who performed poorly in the awareness tasks also exhibited higher error scores on the mental tracking task (and vice versa).

It is possible that we may have found stronger correlations between sexual concordance and different forms of interoceptive awareness, or between the different forms of interoceptive awareness themselves, if we had used procedures similar to those used by Whitehead and Drescher (1980). Whitehead and Drescher used a signal detection paradigm, in which participants were asked to report whether or not a light flash coincided with their heart beat or stomach contractions. It is important to note, however, that other similar signal detection studies have failed to produce high correlations between various forms of interoceptive awareness. For example, Harver et al. (1993) found low and non-significant correlations between their participants' ability to detect heart beats and whether their breathing was being obstructed.

Should We Expect High Sexual Concordance in Women?

Sexual arousal is not the only emotion that shows low concordance or coherence between physiological and experiential response systems (reviewed by Mauss, Levenson,

McCarter, Wilhelm, & Gross, 2005). For example, Reisenzein (2000) assessed participants' self-reported and facial expressions of surprise while they completed a computer quiz. Surprise was induced when participants discovered the correct answer for a quiz item, because some of the items had unexpected or surprising results. Reisenzein found a moderate correlation between degree of self-reported surprise and facial expression of surprise ($r = .46$). Other researchers report even lower concordance or response coherence. Mauss et al. measured women's heart rate and emotional experience as the women watched amusing and sad films. Heart rate was moderately correlated with amusement rating ($r = .22$), but not at all correlated with sadness rating ($r = .00$). These and other results have led Mauss and Robinson (2009) to conclude that discordance or dissociations between different measures of emotion, rather than concordance or coherence, may actually be the norm.

Even if sexual concordance should not be expected to be particularly high, one is still left wondering why women consistently exhibit significantly lower sexual concordance than men. Suschinsky and Lalumière (in press) hypothesized that women's lower sexual concordance may function to serve women's reproductive interests. Given that women have higher minimum parental investment (i.e., an ovum, nine months of gestation, and childbirth as the minimum, but likely lactation as well as parental care) than men's minimum parental investment (i.e., a single ejaculate), women have a lower potential reproductive rate relative to men (Clutton-Brock & Vincent, 1991; Trivers, 1972). Thus, women's and men's sexual response systems may have been shaped by different selection pressures over evolutionary history. Men's reproductive output likely would have been maximized by increasing the number of partners they engaged in sexual activity with. Thus, men's sexual response system may have been selected to promote awareness of sexual arousal to motivate reproductively-

relevant behaviour. Women's reproductive potential would not have been maximized by simply increasing the number of sexual partners they had, but rather the quality of partners they engage in sexual activity with and the timing of copulation (Symons, 1979). Thus, women's sexual response system may have been selected to promote a greater disconnect between physiological and subjective experiences, to allow women to make better choices about mating opportunities. If this is true, one might therefore expect that partnered women might show higher concordance when presented with stimuli that depict cues of a committed relationship, relative to stimuli that depict cues of non-committed relationships.

Although women's lower sexual concordance may make sense when considering ancestral selection pressures, the hypothesis we propose requires a relatively complex response system, one that involves the assessment of sexual stimuli, the presence or absence of a partner or other familiar cues, and so forth. Why has an alternative and less complex response system that produces genital arousal only in appropriate contexts not evolved? There is substantial historical evidence to suggest that sexual coercion was a common feature of humans' evolutionary history (reviewed by Lalumière, Harris, Quinsey, & Rice, 2005). Sexual activity, and unwanted sexual activity in particular, can result in injuries to the reproductive tract (Anderson, McClain, & Riviello, 2006; Slaughter, Brown, Crowley, & Peck, 1997), which may have severe negative consequences, including infertility and death. Several researchers have argued that women's genital responses are automatic and occur in the presence of any sexual stimulus, as a means of preparing their bodies for sexual interactions, whether they be wanted or not (Chivers, 2005; Laan, 1994; Laan & Janssen, 2007; Suschinsky et al., 2009; Suschinsky & Lalumière, 2011; van Lunsen & Laan, 2004).

There are likely costs associated with a sexual response system that generates an automatic and non-specific genital response. The metabolic costs of automatic and non-specific genital responses are currently unknown, but they are likely relatively low in comparison to the costs associated with a failure to produce a genital response (infections, infertility, or death). Genital arousal involves increased blood flow to the genital area, but given that women only exhibit genital arousal in the presence of sexual stimuli (Laan et al., 1995; Suschinsky et al., 2009), the cost of increasing blood flow to the genital area is temporary. Thus, women's current complex sexual response system that generates low sexual concordance may serve women better than a less complex response system that produces genital arousal only in certain contexts.

Limitations

Although we assessed participants' interoceptive ability using mental tracking, a procedure that has been previously used by other researchers (e.g., Schandry, 1981; Van der Does et al., 2000), our study procedures, overall, were significantly different from those described by other researchers. For example, participants in our study were not only asked to report their heart beats during different mental tracking trials, but also to report their sexual arousal, heart rate, respiration rate, and emotional responses during other trials. Other researchers have simply asked their participants to count the number of heart beats they felt during different time periods. It is possible that the participants in the current study were not able to focus their attention solely on their heart beats during the mental tracking trials, which may have resulted in poorer accuracy. We opted to include the mental tracking trials halfway during and immediately after the psychophysiological assessment, to allow participants to get acquainted with the research setting; however, future research could

incorporate the mental tracking trials at the beginning of the session to avoid potential distraction.

Alternatively, future research could incorporate different tasks to assess interoceptive ability. The participants in the current study showed relatively high mental tracking error scores relative to error scores reported by other researchers (e.g., Van der Does et al., 2000). Antony, Brown, Craske, Barlow, Mitchell, and Meadows (1995) reported that exercise increases mental tracking accuracy in participants with and without a history of panic disorder or social phobia. Future research could incorporate methods that may increase interoceptive awareness, such as exercise, to maximize the opportunity to find correlations between sexual concordance and interoceptive awareness.

The sample employed in the current study was also somewhat limited. Although the anxious women reported a history of anxiety or panic, met the set cut-off scores, and were more likely to report receiving treatment for an anxiety or nervous disorder, they appeared to be a rather high-functioning group of women. They appeared to be high-functioning in that they were primarily university students and as likely as non-anxious women to be in dating relationships. Although more anxious women reported having ever had a panic attack and having had a panic attack in the past year, they were not significantly more likely to be taking medications for a mental illness. As such, it is possible that the cut-off scores used in the current study were not stringent enough to identify women with current anxiety or panic problems. Future research could include women with a current clinical diagnosis of panic or anxiety disorder.

Conclusions

The results of the current study are consistent with previous research that suggests that sexual concordance is not related to general interoceptive awareness. Although researchers should not necessarily expect high concordance between genital and self-reported sexual arousal (Mauss et al., 2005; Mauss & Robinson, 2009), it is still interesting that women consistently exhibit lower sexual concordance than men. Women's lower sexual concordance may be related to the device used to assess genital arousal in women, and future research should investigate the validity of measures of genital temperature in women to assess sexual concordance. Further investigation of women's lower sexual concordance may also have implications for the treatment of sexual dysfunctions. For example, women typically report higher rates of sexual desire problems than men (Laumann, Gagnon, Michael, & Michaels, 1994). Perhaps women's lower awareness of their sexual arousal negatively impacts their sexual desire. Investigating individual differences in sexual concordance and their relationship with sexual dysfunction may provide important information for developing efficacious treatment programs.

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Tables and Figures

Table 6.1.

Mean physiological (top) and self-reported (bottom) responses for anxious and non-anxious women based on all experimental stimuli.

	Anxious	Non-anxious		
Physiological response	<i>M (SD)</i>	<i>M (SD)</i>	<i>t</i> (29)	Cohen's <i>d</i>
Genital	3.9 (1.3)	3.5 (1.8)	0.70	0.26
Heart Rate	67.2 (11.1)	68.9 (8.9)	-0.45	-0.17
Respiration Rate	14.1 (2.0)	13.6 (1.9)	0.54	0.25
<hr/>				
Post-stimulus question				
How sexually aroused were you?	34.8 (12.2)	29.6 (16.5)	1.02	0.36
How sexually aroused were your genitals?	37.0 (13.5)	31.4 (17.8)	0.98	0.35
What was your heart rate?	56.4 (17.6)	53.1 (20.5)	0.49	0.17
What was your respiration rate?	52.8 (17.8)	47.3 (18.0)	0.85	0.30
How interested were you?	59.6 (19.7)	52.7 (23.4)	0.88	0.32
How pleasant was the film?	36.0 (11.4)	31.2 (18.6)	1.02	0.32
How anxious were you?	39.2 (15.6)	29.4 (22.0)	1.29	0.52
How repulsed were you?	30.0 (13.5)	21.5 (14.0)	1.48	0.62
How tense did you feel?	35.8 (18.6)	27.9 (23.4)	0.81	0.37

Notes: Genital arousal measurements are in mVolts. Heart rate and respiration rate are presented as beats and breaths per minute, respectively. The post-stimulus questions were answered using a scale of 1 (*emotion definitely not present or physiological response is as low or slow as possible*) to 100 (*emotion definitely present or physiological response is as high or fast as possible*). All $ps \geq .15$.

Table 6.2.

Mean correlations (Pearson r) between physiological and self-reported physiological responses based on data from all experimental stimuli.

Response Type	Anxious women	Non-anxious women	$t(29)$	Cohen's d
Self-reported Genital	0.69	0.63	0.69	0.08
Heart Rate	0.32	0.30	0.15	0.06
Respiration Rate	-0.01	0.26	-2.39*	-0.90

Notes: Self-reported Genital refers to the correlation between genital arousal and self-reported genital arousal.

* $p = .023$

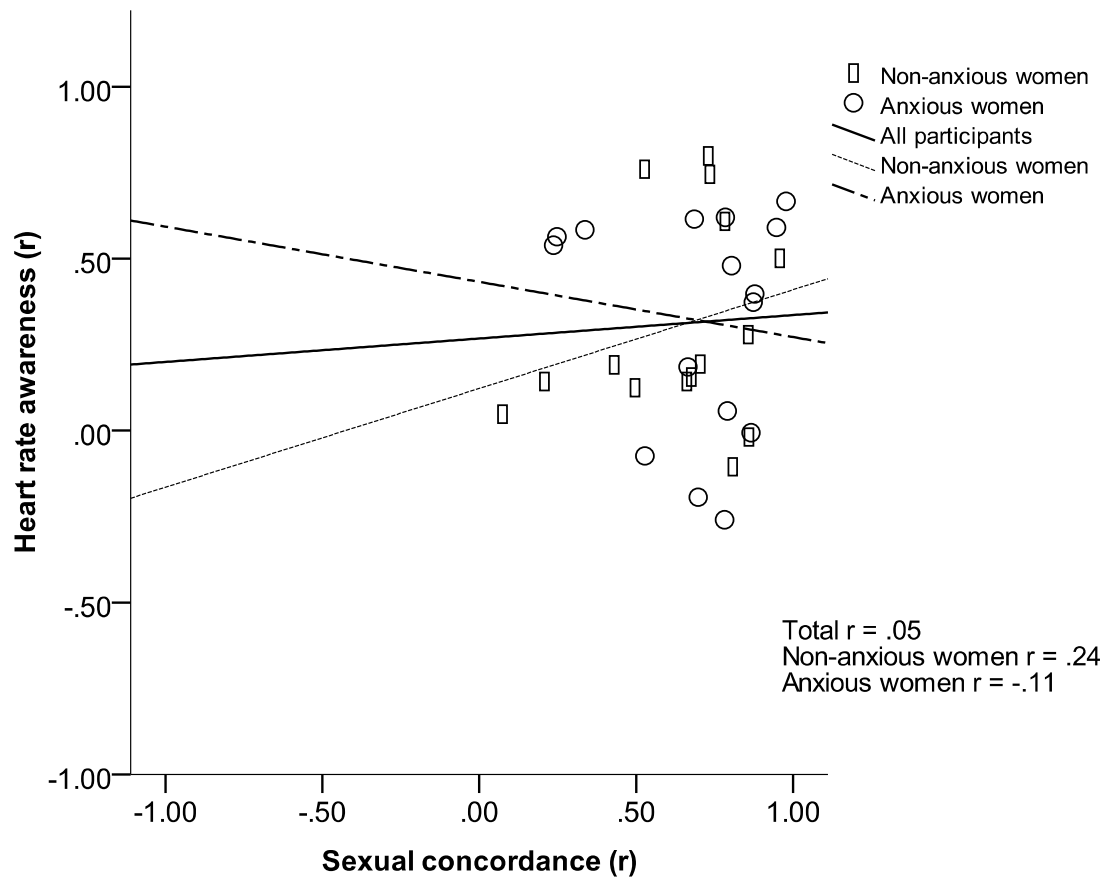


Figure 6.1.

Scatterplot of the correlations between sexual concordance and heart rate awareness in anxious and non-anxious women.

Note: Each point represents the correlation from one participant.

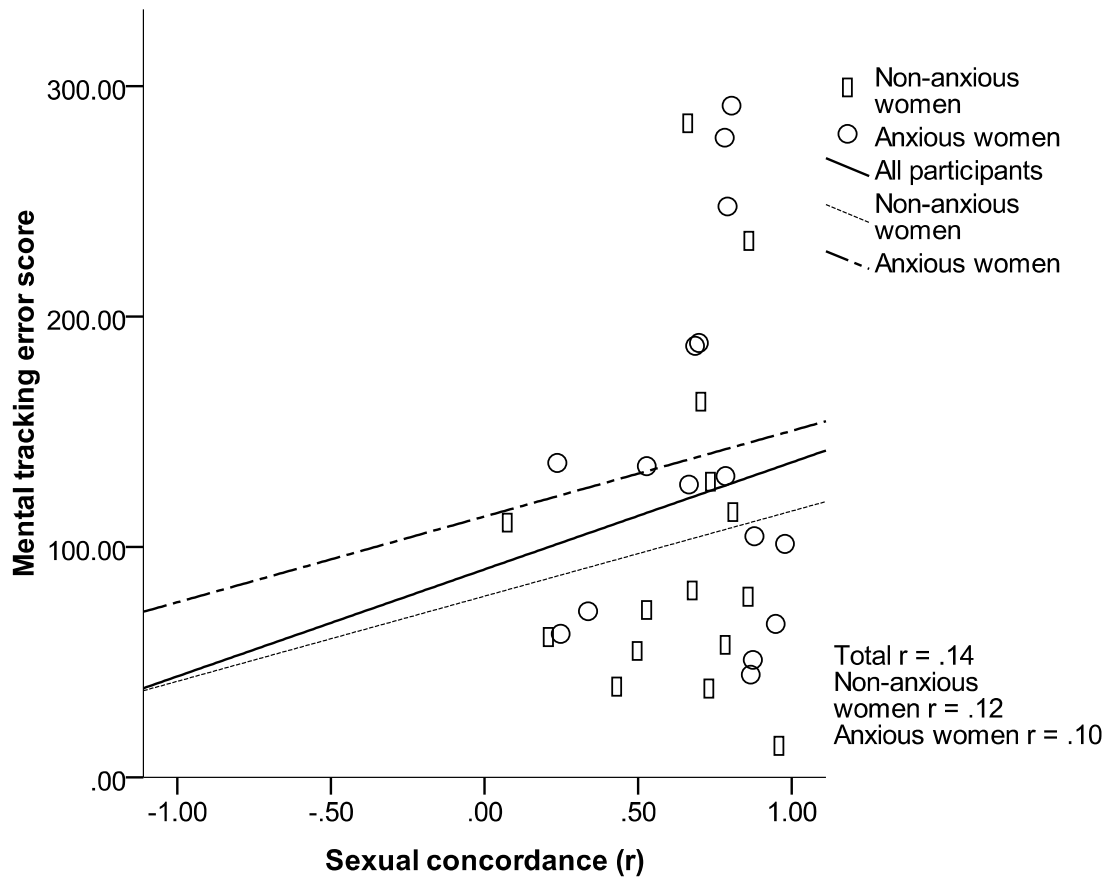


Figure 6.2.

Scatterplot of the correlations between sexual concordance and heart rate awareness measured by mental tracking task.

Note: Each point represents the correlation from one participant.

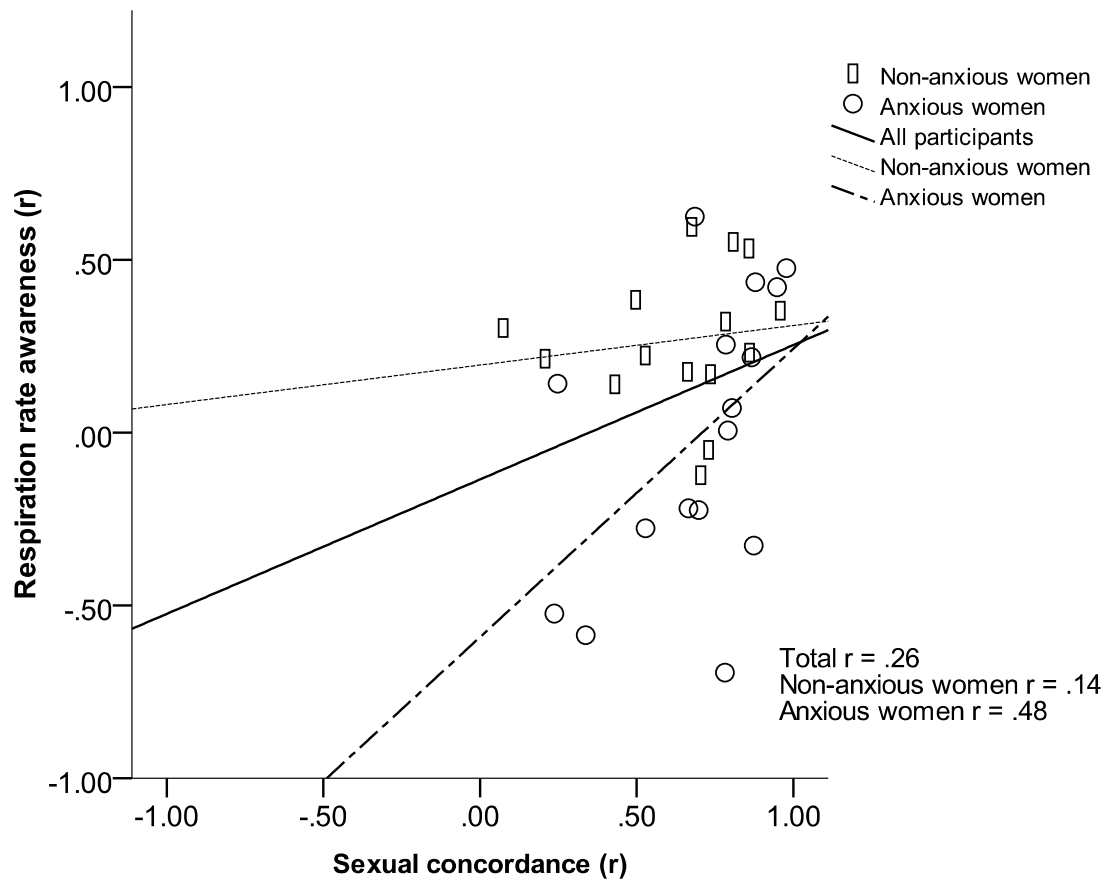


Figure 6.3.

Scatterplot of the correlations between sexual concordance and respiration rate awareness in anxious and non-anxious women.

Note: Each point represents the correlation from one participant.

CHAPTER SEVEN

Summary, Implications, and Conclusions

Summary

The research described in this dissertation investigated different explanations for the sex differences in sexual arousal patterns. Sexual arousal is a complex state that is composed of several interacting components, including physiological changes, emotional responses, and motivated behaviour (Chivers, 2005). Most research on sexual arousal patterns has focused on men's sexual arousal, but more recent research has revealed two differences between men's and women's sexual arousal patterns. Men's genital and subjective sexual arousal are *category-specific*, such that men's arousal differs across stimuli depending on the presence or absence of certain cues, including the age of the persons, sex of the persons, or activities depicted. Women's subjective arousal is category-specific, but their genital arousal is category-nonspecific with respect to the sex of the persons depicted in sexual stimuli. Men and women also differ in *sexual concordance*, or the degree to which their genital and subjective sexual arousal correspond with each other; men's genital and subjective sexual arousal are usually highly correlated, whereas women's genital and subjective sexual arousal are much less strongly correlated.

In Chapter Two I tested a functional hypothesis for women's category-nonspecific genital arousal. Women's genital arousal is commonly measured via changes in vaginal blood flow, which is the precursor to vaginal lubrication (Levin, 2003). The *preparation hypothesis* posits that women's genital responses should occur in the presence of any sexual stimulus, as a means of facilitating penetration, thereby reducing the likelihood of injuries to

the reproductive tract. Therefore, a genital response should occur for any sexual cue, not only those associated with the sex of persons depicted in a stimulus. The results described in Chapter Two support the preparation hypothesis: Women's genital responses were similar across the various sexual stimulus categories, whereas men's genital responses differed significantly across the various sexual stimulus categories. Women showed genital arousal even to stimuli depicting activities that they rated as unpleasant. These results were obtained using stimuli that were novel in two ways. First, the stimuli varied the types of sexual activities, rather than the sex of the actors depicted; this is the first study that shows that women's genital arousal is category-nonspecific in response to different partnered sexual activities of similar intensity. Second, the stimuli used were audio-taped narratives. All previous research assessing the sex difference in category-specificity has employed audio-visual stimuli. Thus, this is also the first study to report the sex difference in genital category-specificity using non-visual stimuli.

The sex difference in sexual concordance may be the result of a sex difference in information-processing. Laan and Janssen's (2007) information-processing model suggests that men's and women's genital arousal occurs shortly after a stimulus is appraised as sexual, but that their subjective sexual arousal originates from different sources. In Chapter Three I describe data from two studies that show some support for this information-processing model of sexual arousal. Consistent with the model, men were more likely than women to report being sexually aroused at their peak genital responses, a genital response was almost always present at the time of peak subjective responses in both sexes, and women's genital arousal preceded their subjective sexual arousal. Inconsistent with the model, however, were the findings that men's genital arousal did not precede their subjective sexual arousal, and

women's sexual concordance scores were less influenced by stimulus content and affective response ratings than men's. The sex difference in sexual concordance is also a robust difference: Men's sexual concordance was higher than women's sexual concordance, regardless of the method employed to calculate concordance, and in response to the vast majority of sexual stimuli.

The sex differences in genital category-specificity and sexual concordance are stable across testing sessions at the group level (Chapter Four). Overall, men showed higher genital category-specificity and higher sexual concordance than women across two testing sessions, which supports the validity of the sex differences in sexual arousal patterns. Men's genital arousal patterns and sexual concordance were correlated across testing sessions. Both men's and women's subjective sexual arousal patterns were correlated across testing sessions. Surprisingly, individual women's genital arousal patterns and sexual concordance were not correlated across the two testing sessions.

The sex difference in sexual concordance does not seem to be the result of a general sex difference in overall awareness of physiological states. Chapters Five and Six described studies that assessed whether awareness of one's sexual arousal is associated with awareness of one's nonsexual physiological responses. Sexual concordance was not significantly associated with heart rate awareness or respiration rate awareness in men or women (Chapter Five). A follow-up study of women more likely to be aware of their nonsexual physiological states revealed similar results: Sexual concordance was not significantly associated with heart rate awareness, respiration rate awareness, or heart beat perception in anxious and non-anxious women (Chapter Six).

Implications

Sex research has disproportionately focused on men's sexual arousal. In recent years, however, there has been a noticeable increase in scientific interest in women's sexual arousal. The results presented in this dissertation support this newfound interest in women's sexual arousal and the need for better understanding women's sexual arousal patterns. Overall, the results presented in this dissertation are consistent with substantial evidence suggesting that men's and women's sexual arousal patterns differ significantly. The differences between men's and women's sexual arousal patterns are valid phenomena and not simply the result of methodological peculiarities. These sex differences have several important implications for clinical practice, as well as future research.

In the past decade, there has been an increased recognition of the differences between men's and women's sexualities and how these differences apply to sexual dysfunctions. Current categories of both men's and women's sexual dysfunctions are based on linear sexual response models (Kaplan, 1977; Masters & Johnson, 1966). Basson et al. (2004) recognized that these sexual response models provided a significant basis for early research, but they also noted that these models suffered from significant limitations and inaccuracies. Because the diagnostic categories of sexual dysfunction are based on these sexual response models, the limitations and inaccuracies of the models significantly impact the clinical diagnosis of sexual dysfunctions. These limitations and inaccuracies are particularly relevant for women's sexual dysfunctions, and include the fact that some women rarely experience spontaneous sexual desire in the form of sexual fantasies or thoughts (Cain et al., 2003; Klusmann, 2002) and that sexual desire may not be the most important motivating factor in women's sexual activity (Basson, 2001; Meston & Buss, 2009). Basson (2000; 2001; 2002) has proposed a new model of sexual response in women that takes into account women's

various nonsexual motivations for sexual activity and the possibility that desire is responsive in women, such that it follows, rather than precedes, the onset of sexual activity. The results obtained in this dissertation reinforce the importance of empirically developing and testing sex-specific models of sexual response, rather than relying on models that have been developed based on our understanding of men's sexual arousal or that have become inaccurate.

Sex-specific models of sexual response will influence different facets of clinical practice, including assessment, diagnosis, and treatment. Clinical assessment of sexual preferences and sexual dysfunction will be significantly influenced by sex-specific models of sexual response. The results from the research presented in this dissertation, and elsewhere, indicate that for women, self-reported sexual arousal and genital arousal are rarely isomorphic. Given men's higher category-specific genital arousal and sexual concordance, genital arousal assessments may produce valid information about their sexual preferences. Women's category-nonspecific genital arousal and lower sexual concordance, however, precludes the use of genital assessments for inferring women's sexual preferences (see Suschinsky & Lalumière, 2009).

Similarly, women's sexual dysfunctions may be difficult to assess with either genital or subjective measures only. Given that women's genital arousal, as measured by vaginal photoplethysmography, may function to prepare a woman for a sexual encounter (Chapters Two and Four), a woman with a sexual dysfunction may still become genitally aroused to sexual stimuli (Brauer, Laan, & ter Kuile, 2006; Brotto, Klein, & Gorzalka, 2009). Similarly, the use of subjective measures alone may not produce accurate assessments of sexual arousal because subjective reports of arousal do not correlate highly with genital arousal (Chapters

Two through Six). The clinical assessment of therapy-induced changes may also prove difficult when using vaginal photoplethysmography. Given the relatively low stability in women's genital arousal and sexual concordance scores reported in this dissertation (Chapter Four), the interpretation of therapy-induced or medication-induced changes (especially the absence of changes) in genital arousal may be difficult. Future research could explore the use of alternative measures of genital arousal, such as temperature measurements (Kukkonen, Binik, Amsel, & Carrier, 2010) or clitoral blood flow measurements (Gerritsen et al., 2009), in assessing women's sexual preferences, sexual dysfunctions, and their stability.

At the diagnostic level, sex-specific models of sexual response may lead to the reduction or elimination of certain diagnoses. Low sexual desire is the most commonly reported sexual problem among women (Laumann et al., 2005). The current definition of hypoactive sexual desire disorder (HSDD) has recently been criticized (Brotto, 2010; Brotto, Bitzer, Laan, Leiblum, & Luria, 2010) for its heavy reliance on criteria that are not particularly relevant to women. In its current form, the American Psychiatric Association's (APA) *Diagnostic and Statistical Manual of Mental Disorders IV-TR* (DSM-IV-TR; APA, 2000, p. 539) defines HSDD as "persistently or recurrently deficient (or absent) sexual fantasies and desire for sexual activity" which causes "marked distress or interpersonal difficulty." Some women rarely experience spontaneous sexual thoughts (Cain et al., 2003; Klusmann, 2002), and research suggests that desire may actually be responsive (Both, Spiering, Everaerd, & Laan, 2004). The frequency of sexual fantasy may also be an inaccurate measure of women's sexual desire because women may use fantasy to focus their attention on a sexual stimulus (Cain et al., 2003), rather than to indicate desire. Women will also engage in sexual activity for reasons other than sexual desire (Meston & Buss, 2009).

Given the problems of the current HSDD definition in light of sex-specific information, Brotto rightly recommended revising the criteria to better reflect women's sexuality.

Sex-specific information is also relevant to the definition of Female Sexual Arousal Disorder (FSAD). FSAD is currently defined as the "persistent or recurrent inability to attain, or to maintain until completion of the sexual activity, an adequate lubrication-swelling response of sexual excitement," that is associated with "marked distress or interpersonal difficulty" (APA, 2000, p. 543). FSAD focuses on the genital response of lubrication because previous criteria were considered to be vague and because of the lower correlations between genital and subjective sexual arousal in women (Graham, 2010). The current definition remains problematic because of its heavy reliance on awareness of genital arousal only; the results presented in this dissertation, as well as elsewhere (Chivers, Seto, Lalumière, Laan, & Grimbos, 2010), indicate that women are not always aware of their genital responses (Chapters Five and Six). Another problem with the current definition of FSAD revolves around the fact that relatively few women visit their clinician with complaints about their genital arousal in terms of lubrication; more women present with complaints associated with the subjective aspect of sexual arousal. Given this information, different subtypes of FSAD were proposed to address deficiencies in genital arousal, subjective arousal, and both genital and subjective arousal combined (Basson et al., 2004). More recently, Graham (2010) and Brotto (2010) proposed combining HSDD and FSAD into one disorder named Sexual Interest/Arousal Disorder. The proposed criteria for the new disorder take into account both the genital and subjective aspect of sexual arousal. It is possible that fewer women will be diagnosed with a sexual dysfunction if sex-appropriate criteria are in place.

Sex-specific models of sexual response may also lead to the development of more efficacious treatments for sexual dysfunctions and other related problems. It is currently unknown whether sexual function is related to sexual concordance, though Chivers et al. (2010) noted that there is some indirect evidence to suggest that an association may exist. Although Chivers et al. did not find a significant association between sexual concordance and sexual function in either men or women, they noted that the lack of a difference in sexual concordance between sexually functional and dysfunctional individuals may have been the result of their coding rules: Some non-significant correlations were coded as 0 in the meta-analysis, and given that the majority of the studies (60%) reported higher sexual concordance for sexually functional women, there may have been a difference in sexual concordance between the two groups if actual values had been available. Similarly, there is also evidence to suggest that orgasmic capacity is associated with sexual concordance; Brody found that women with higher sexual concordance scores report more frequent orgasms during penile-vaginal intercourse, but not during other forms of sexual activity (Brody, 2007; Brody, van Lunsen, & Laan, 2003).

Given that women report more sexual desire problems than men, and that women have lower sexual concordance, it is possible that women's lower awareness of their sexual arousal negatively impacts their sexual desire. There is indirect evidence to support this hypothesis. Brotto, Basson, and Luria (2008) developed and tested a mindfulness-based psychoeducational intervention for women with sexual desire or arousal concerns. Mindfulness refers to non-judgemental attendance to one's present condition (Kabat-Zinn, 1994). Although sexual concordance was not explicitly assessed, Brotto et al. assessed women's genital and subjective sexual arousal prior to and following the intervention.

Following the intervention, there was no significant change in percentage of genital arousal elicited by the sexual stimulus, but there was a significant increase in the women's self-reported physical arousal, subjective arousal, and overall positive affect, suggesting that sexual concordance may have increased following the intervention. Brotto et al. also found that women reported a significant increase in self-reported sexual desire, self-reported genital wetness, and pleasant genital sensations after the intervention. These results suggest that sexual concordance and sexual desire may be related, in that they were both influenced by the mindfulness intervention.

Brotto, Seal, and Rellini (in press) directly tested the effects of increasing awareness of sexual arousal on women's sexual distress by giving partnered women with a history of childhood sexual abuse and current sexual dysfunctions psychoeducational treatment involving either mindfulness training meant to increase awareness of bodily sensations or cognitive behavioural training meant to challenge maladaptive thoughts. Although women in both groups reported reduced sexual distress following the treatment, only the women in the mindfulness group exhibited increased sexual concordance following the treatment. These results are promising, and future research should continue to investigate the role of sexual concordance, particularly increasing sexual concordance, in women's sexual functioning.

Sex-specific models of sexual response may also be useful in developing therapies for victims of sexual assault. Some women report that they experienced vaginal lubrication and sometimes even an orgasm during a sexual assault (Levin & van Berlo, 2004). The results presented in this dissertation, and elsewhere, suggest that women's genital arousal may function to prepare women for sexual encounters, whether these encounters are wanted or not. Women show significant genital arousal to sexual stimuli, regardless of whether those

stimuli involve consensual activities. Women's genital responses, as measured by changes in vaginal blood flow, also occur very shortly after the onset of a sexual stimulus and often without a subjective report of sexual arousal, indicating that women's physiological and subjective sexual arousal are less connected.

This information may benefit women who have been sexually assaulted, particularly those who experienced lubrication or orgasm, because these women sometimes report that they feel betrayed by their bodies (Levin & van Berlo, 2004). Shortly after Chapter Two was published online in *Psychological Science*, my co-author was contacted by a woman who reported that she had been kidnapped and raped 15 years ago. Following the rape, she suffered from post-traumatic stress disorder. She stated that an issue that kept troubling her was the fact that she became aroused and reached orgasm during the attack; since then, she has blamed herself and her body, consulted with many therapists, and tried to find an explanation for her physical responses. Given that many women experience a sexual assault at some point in their lives (Mahony, 2011) and that previous history of sexual assault, whether it be during childhood (Leonard & Follette, 2002) adolescence (Leonard & Follette, 2002), or later in life (Becker, Skinner, Abel, & Cichon, 1984), is associated with later sexual dysfunctions, among other mental health issues, it would be useful to develop and test therapeutic interventions that involve explaining women's automatic genital responses to assess whether this information could improve sexual functioning and mental health outcomes. The woman who had contacted my co-author felt great relief from the results of the study.

The results of the research presented in this dissertation support the need to better understand men's and women's sexual arousal patterns. Although the physiological

measures employed in the studies described in this dissertation measure similar processes in men and women by measuring changes in genital engorgement, they do not measure homologous structures (e.g., the clitoris and glans of the penis, or the labia and the scrotum), which is a limitation of the current research. Similarly, the genital response measured in men produces tactile feedback via the movement of penis during an erection, in addition to obvious visual feedback of arousal. Although vaginal photoplethysmography assesses vaginal engorgement, the precursor to vaginal lubrication, it may be less perceptible than the endpoint of lubrication. Alternative measures of genital arousal that measure homologous structures (e.g., clitoral photoplethysmography; Gerritsen et al., 2009), the same physiological endpoint (e.g., temperature measurements), or more tangible or obvious genital responses (e.g., lubrication in women) should be employed to better understand the sex differences in sexual arousal patterns.

At this time, it may be beneficial to begin investigating factors that may be associated with individual differences in sexual concordance, although finding correlates of sexual concordance may prove to be difficult, given the lack of stability of sexual concordance scores in women (Chapter Four). Given the evidence reported here and elsewhere (Chivers, Rieger, Latty, & Bailey, 2004; Chivers & Bailey, 2005; Chivers, Seto, & Blanchard, 2007; Suschinsky, Lalumière, & Chivers, 2009) suggesting that women's genital arousal patterns function to facilitate sexual activity, I do not anticipate many individual differences to interfere with this pattern – I expect that most, if not all women, should show considerable genital arousal to a variety of sexual stimuli, relative to nonsexual stimuli. There is some indirect evidence to support this hypothesis: Yule, Woo, and Brotto (2010) reported that there was no significant difference in amount of genital response to a sexual stimulus

between Euro-Canadian and East Asian women. Although only one heterosexual sexual stimulus was presented, the lack of a difference in genital arousal between the two groups of women stands in contrast to research that suggests that there are ethnic differences in nonsexual physiological responsivity, such as heart rate (Anderson & McNeilly, 1991). Also supporting this hypothesis is the relative lack of differences in genital arousal output between women with and without a sexual dysfunction (Brauer et al., 2006; Brotto et al., 2009).

Given the complex nature of the human sexual response, it is possible that individual factors may have little detectable influence on sexual concordance. Multivariate approaches that assess the relationship between several independent variables and a single dependent variable, such as multiple regression, may be particularly useful in elucidating predictors of sexual concordance. Possible factors that may influence women's sexual concordance, either as individual variables or in some combination, include sexual orientation and sexual experience. Sexual orientation has been indirectly linked to sexual concordance in women in two studies. Suschinsky et al. (2009) reported that women who admitted having some interest in other women tended to have higher sexual concordance than women who reported exclusive sexual interest in men, though this difference was not significant. Brotto and Yule (2011) found that asexual women were the only group of women to have significant positive correlations between their genital and self-reported sexual arousal in response to a heterosexual sexual stimulus. Both Suschinsky et al.'s and Brotto and Yule's samples were small, however, and further research could investigate the link between sexual concordance and sexual orientation, especially considering the fact that gynephilic women show category-specific genital arousal for low intensity sexual stimuli (Chivers et al., 2007).

Another factor that may influence women's sexual concordance is their sexual experience. Although experience with one's genitals during a sexual psychophysiological assessment is not imperative for high sexual concordance (Chivers et al., 2004), previous experience with one's genitals may influence sexual concordance. Men's increased masturbation experience (Oliver & Hyde, 1993; Petersen & Hyde, 2010) may be associated with their increased sexual concordance. There is some evidence to suggest that women's masturbation experience may influence one aspect of sexual concordance: Laan and Everaerd (1995) conducted a multiple regression to determine different predictors of women's subjective experience of sexual arousal, and found that the best predictor was masturbation experience. Laan and Everaerd noted that it was unclear whether these women were actually more aware of their sexual arousal or if they were simply more comfortable reporting their sexual arousal. Future research should assess sexual experience to determine its relative influence on sexual concordance.

Conclusions

Men's and women's sexual arousal patterns differ significantly. The research presented in this dissertation should contribute to a growing interest in research on women's sexual arousal patterns and provides several avenues of research to pursue. The results of the research presented here also highlight the importance of studying women's sexual arousal, as well as men's sexual arousal. Sexuality is a part of virtually everyone's life. It is imperative that the sex differences in genital category-specificity and sexual concordance be considered when developing new definitions of sexual dysfunctions, conducting clinical assessments, and developing new treatments, in order to best assist those individuals seeking to improve their sexual lives.

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