

EVALUATING GENDER-SPECIFICITY OF SEXUAL AROUSAL WITH
THERMOGRAPHY IN WOMEN AND MEN

by

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Abstract

Men's genital responses tend to be *gender-specific*, such that they show significantly greater arousal to their preferred gender compared to their nonpreferred gender, whereas the genital responses of androphilic women (i.e., sexually attracted to men) tend to be similar to stimuli depicting women or men (*gender-nonspecific*). Gender-specificity of arousal has been previously studied using short stimuli (approximately 90-second videos or audio-narratives) with genital responses assessed using vaginal photoplethysmography (VPP) in women and penile plethysmography (PPG) in men. One limitation to using these measures of genital response is that they use different scales (mV change in VPP and mm change in PPG), making it difficult to draw direct gender comparisons. In the current thesis, I examined gender-specificity of sexual arousal in women and men by measuring genital responses using thermography, which assesses similar physiological processes (i.e., temperature change associated with genital vasocongestion) in women and men. Specifically, I evaluated whether the gender-specificity of men's and women's genital temperature was similar to that observed for genital responses concurrently assessed using VPP (women) or PPG (men). I presented gynephilic men (i.e., sexually attracted to women; $n = 27$) and androphilic women ($n = 28$) with 10-minute audiovisual stimuli depicting men masturbating, women masturbating, and a nonsexual nature film. Participants reported feelings of sexual arousal before, during, and after each film, and genital responses were concurrently assessed using thermography and VPP or PPG. For all dependent variables, men exhibited gender-specific sexual arousal and women exhibited gender-nonspecific sexual arousal. These findings demonstrate that the gender difference in gender-specificity of sexual arousal persists beyond early sexual responding, including longer stimuli and relatively slow changes in genital temperature. Limitations and implications are discussed.

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Chapter 1:

Introduction

Men's sexual arousal tends to be *category-specific* in that their physiological (i.e., genital) responses to preferred and nonpreferred sexual stimuli in the laboratory typically correspond with their stated sexual attractions; women's sexual arousal tends to be *category-nonspecific* such that women exhibit genital responses to a range of preferred and nonpreferred sexual stimuli (Chivers & Bailey, 2005; Chivers, Rieger, Latty, & Bailey, 2004; Chivers, Seto, & Blanchard, 2007; Suschinsky, Lalumière, & Chivers, 2009). Category-specificity of arousal has been studied primarily using two methods of measuring genital response: vaginal photoplethysmography (VPP) in women and penile plethysmography (PPG) in men (Chivers & Bailey, 2005; Chivers et al., 2007; Suschinsky et al., 2009; Suschinsky & Lalumière, 2011a). These methods do not allow direct gender comparisons as different apparatus are used to assess genital responses in men and women (Kukkonen, Binik, Amsel, & Carrier, 2007). An alternate measure of genital response, thermography, has recently been validated and may be used with both men and women (Kukkonen et al., 2007; Kukkonen, Binik, Amsel, & Carrier, 2010). This measure has never been used to assess specificity of genital response; therefore, the current thesis will evaluate gender differences in sexual arousal to preferred and nonpreferred sexual stimulus genders, or *gender-specificity* of sexual arousal, using thermography as well as measures of VPP and PPG to assess genital responses.

Assessment of Sexual Arousal

Sexual arousal is a multidimensional state that involves a combination of emotional expression, physiological changes, and motivated behaviour (Frijda, 1986; Rosen & Beck, 1988). Sexual arousal typically occurs in response to stimuli, which may be either internal (e.g., fantasy)

or external (e.g., visual, tactile; Chivers, Seto, Lalumière, Laan, & Grimbos, 2010). An individual's experience of sexual arousal involves the integration of psychological and physiological responses and is often assumed to be an indicator of sexual interest (Basson et al., 2004; Chivers, 2005; Heiman, 1980). Physiological sexual arousal refers to a genital response, whereas subjective sexual arousal refers to a psychological or emotional state (Basson et al., 2004; Chivers, 2005; Heiman, 1980; Laan & Both, 2008). There are several validated measures of women's and men's genital responses and subjective sexual arousal (reviewed below), each assessing somewhat different aspects of sexual arousal.

Genital response. During sexual arousal, heart rate and blood pressure increase, which causes increased blood flow to the genitals resulting in vasocongestion (Levin & Riley, 2007). Genital vasocongestion causes vaginal lubrication in women and penile erections in men (Levin, 1998, 2003; Levin & Riley, 2007). A common measure of women's genital response is VPP, which records changes in vasocongestion in the vaginal epithelium using light reflectance (Geer, Morokoff, & Greenwood, 1974; Sintchak & Geer, 1975). Circumferential PPG measures changes in penile circumference during erection using a strain gauge and is commonly used to assess men's genital responses (Bancroft, Jones, & Pullan, 1966; Barlow, Becker, Leitenberg, & Agras, 1970). Genital vasocongestion is also accompanied by increases in genital skin temperature (Henson, Rubin, Henson, & Williams, 1977; Webster & Hammer, 1983). Surface thermistors positioned on the genitals measure temperature and have been validated in men and women as an index of genital vasocongestion (Henson & Rubin, 1978; Payne & Binik, 2006; Prause & Heiman, 2009; Webster & Hammer, 1983).

All of the aforementioned measures of genital response involve direct genital contact: surface thermistors must be positioned on the genitals, VPP involves vaginally inserting a small

probe, and PPG involves placing a strain gauge around the penis. It has been argued that these procedures are invasive, which may affect sexual responses (Kukkonen et al., 2007, 2010; Waxman & Pukall, 2009). More invasive measures may attract participants who are more sexually liberal than the general population (Strassberg & Lowe, 1995) and, if participants are distracted by an invasive measure, this may impede their sexual arousal (Adams, Haynes, & Brayer, 1985; Elliott & O'Donohue, 1997; Geer & Fuhr, 1976; Salemink & van Lankveld, 2006). Thermal imaging ("thermography") has recently been validated as a measure of sexual response in men and women and does not require genital contact (Kukkonen et al., 2007, 2010). Thermographic cameras use a remote sensor to detect the emission of infrared energy as surface temperature rises (Kukkonen et al., 2007). Vasocongestion results in increased blood flow to the genitals, which increases the skin temperature of the genitals and increases the infrared energy that is emitted. Thermography generates a meaningful and interpretable output measure, absolute temperature change; this same output measure is produced when thermography is used with women or with men, allowing direct gender comparisons. Thermography has never been directly compared with concurrently assessed PPG or VPP, though studies using surface thermistors to assess genital response have found that genital temperature during an erotic film was highly positively correlated with changes in penile circumferences assessed using PPG ($r_s > .76$; Webster & Hammer, 1983) and with changes in vasocongestion assessed using VPP in most women ($r_s > .60$ in six women, $r_s < .10$ in two women; Henson & Rubin, 1978).

Subjective sexual arousal. Subjective sexual arousal involves an individual's appraisals and integration of physical sensations (genital responses and general physiological responses) and psychological experiences (e.g., emotions, cognitions) in response to a sexual stimulus and is typically associated with sexual interest (Chivers & Bailey, 2005; Laan & Both, 2008). Self-

report measures are used to assess individuals' subjective experiences of sexual arousal. Participants typically report feelings of sexual arousal following stimulus presentation using discrete items with Likert-type scales or continuously with stimulus presentation using a lever, mouse, or keypad (Rellini, McCall, Randall, & Meston, 2005). Studies have found strong positive relationships between continuous and post-stimulus reporting of sexual arousal (Kukkonen et al., 2010; Rellini et al., 2005). Subjective sexual arousal is also sometimes measured prior to stimulus presentation with Likert-type scales. When pre-stimulus and post-stimulus measures are used, change scores may be computed. Change scores and continuous measures of reported sexual arousal may be less prone to response bias in women compared to pre- and post-stimulus measures (Huberman, Suschinsky, Lalumière, & Chivers, 2013). Biased self-reporting is particularly relevant in sexuality research, where questions relate to sensitive topics and social taboos (McCallum & Peterson, 2012); the use of continuous reporting and change scores in sexual psychophysiology research may therefore be important to minimize response bias.

Agreement between genital and subjective measures. Considerable research has evaluated *sexual concordance*, the agreement between physical and psychological aspects of sexual response. These components of sexual arousal tend to be significantly positively correlated, however, men's sexual concordance is typically greater than women's (Chivers et al., 2010). In a meta-analysis, women had an average Pearson correlation of .26 between genital responses and self-reported arousal, which was significantly lower than the average correlation of .66 for men (Chivers et al., 2010). This meta-analysis revealed that women's sexual concordance was significantly greater in the relatively few studies that used measures of genital temperature to assess genital responses rather than those using VPP. In light of these findings,

thermography may offer greater convergent validity for the assessment of women's sexual responses compared with VPP. It has also been argued that measures of genital temperature may be more ecologically valid than VPP for the assessment of women's sexual responses given their higher correlations with self-reported arousal and given that women's genital temperature tends to change more slowly than internal vasocongestion, assessed with VPP (Henson & Rubin, 1978; Payne & Binik, 2006). As further evidence for the ecological validity of thermography, Laan (1994) found that, in a factor analysis, women's perceptions of body temperature loaded highly onto both a sexual feelings factor and a physical feelings factor, suggesting that temperature change overlaps with both sexual arousal and general physiological arousal (Chivers et al., 2010). It is possible that changes in vulvar temperature are more perceptible to women than changes in internal vasocongestion and may be more relevant to women's experiences of sexual arousal. It would therefore be pertinent to evaluate patterns of sexual response with thermography, particularly given that research has revealed differences among men's and women's patterns of sexual arousal assessed with PPG and VPP, respectively.

Gender Differences in Sexual Arousal: Gender-specificity

Men's self-reported sexual arousal and genital responses to sexual stimuli tend to be category-specific in that men's sexual responses to stimuli in the laboratory typically correspond with their stated sexual attractions and interests (Chivers & Bailey, 2005; Chivers et al., 2004, 2007). In other words, men show greater subjective arousal and genital responses to stimuli depicting their preferred sexual stimulus compared to their nonpreferred sexual stimulus. As reviewed by Chivers (2005, 2010), category-specificity of men's sexual response has been shown to same versus opposite-gender sexual stimuli depicting adults (i.e., gender-specificity; Barr & McConaghy, 1971; Chivers et al., 2004, 2007; Chivers & Timmers, 2012; Freund,

Langevin, Cibiri, & Zajac, 1973; Rieger, Chivers, & Bailey, 2005; Sakheim, Barlow, Beck, & Abrahamson, 1985; Suschinsky, Lalumière, & Chivers, 2009), to physically mature versus immature people (i.e., age-specificity in the case of pedophilia; Blanchard, Klassen, Dickey, Kuban, & Blak, 2001; Freund & Blanchard, 1989; Seto, Lalumière, & Blanchard, 2000), and to non-fetishistic objects versus fetishistic objects (Blanchard, Racansky, & Steiner, 1986).

For women, patterns of sexual arousal have been shown to differ among those who are exclusively androphilic (i.e., sexually attracted to men) and those who are gynephilic (i.e., sexually attracted to women; Chivers et al., 2007; Peterson, Janssen, & Laan, 2010). The current thesis focused on androphilic women and, for simplicity, all future references to “women” refer to exclusively androphilic women. Women generally report increased sexual arousal to both preferred and nonpreferred sexual stimuli, but typically report greater sexual arousal to sexual stimuli depicting their preferred gender (i.e., men) compared to their nonpreferred gender (i.e., women), demonstrating gender-specific subjective sexual arousal (Chivers et al., 2004; Chivers & Timmers, 2012; Schmidt, 1975). There are, however, mixed results in the literature regarding the gender-specificity of women’s self-reported arousal such that some studies have found gender-nonspecific self-reported sexual arousal in women (i.e., not significantly greater to sexual stimuli of men compared to women; Bossio, Suschinsky, Puts, & Chivers, 2013; Chivers et al., 2007). Women tend to exhibit similar levels of genital response to sexual stimuli depicting their preferred gender or their nonpreferred gender (Chivers et al., 2004, 2007; Chivers & Timmers, 2012; Suschinsky et al., 2009); therefore, while men’s patterns of sexual arousal tend to be gender-specific, women’s genital responses tend to be gender-nonspecific.

Limitations of Past Research

Although several studies have found a gender difference in gender-specificity of sexual responses among gynephilic men and androphilic women, there have been a number of limitations to this body of literature. Most research comparing gender-specificity of genital arousal between genders has used VPP and PPG to assess genital response in women and men, respectively (e.g., Chivers et al., 2007; Chivers, 2005; Sakheim et al., 1985; Suschinsky & Lalumière, 2009). As described in detail below, the results of these studies are limited because: a) the genital measures used have not allowed direct gender comparisons, b) PPG is not reliable at detecting men's early genital responses, c) VPP is only weakly correlated with women's self-reported sexual arousal, and d) only relatively short sexual stimuli have been used.

A major limitation of past research is that direct gender comparisons cannot be made because different instruments were used to measure men's and women's genital responses, each with a different scale (mV change in VPP and mm change in PPG). It is possible that reported gender differences in sexual arousal patterns were due to technological differences or were the result of instrument artifacts (Kukkonen et al., 2007). For example, VPP and PPG may assess different phases of sexual response; contrary to PPG, VPP may primarily assess automatic sexual responses in women (Gerritsen et al., 2009), which could account for the gender difference in gender-specificity of genital response. Thermography allows for the assessment of similar physiological processes in men and women (i.e., genital temperature change) and has the advantage of assessing both men's and women's genital responses on the same scale (degrees Celsius). Direct gender comparisons can therefore be made with thermography because the same output unit is produced for men's and women's genital responses.

Previous research on gender-specificity of sexual arousal has also been limited in valid assessment of men's early genital responses with PPG. Specifically, PPG is unable to reliably detect men's early genital responses because of a phenomenon known as the "inverse" or "mirror" image effect, where penile girth decreases briefly at initial arousal while volume and length increase (Earls & Marshall, 1982; McConaghy, 1974). Based on an information-processing model of sexual responding, sexual stimuli trigger an automatic genital response (Janssen, Everaerd, Spiering, & Janssen, 2000), suggesting that men should show some level of genital response to even nonpreferred sexual stimuli. Studies have found that at low levels of genital response, however, PPG lacks sensitivity in discriminating between stimulus categories (Freund, Langevin, & Barlow, 1974; Kuban, Barbaree, & Blanchard, 1999). With respect to gender-specificity, some studies that have used PPG have found that men's genital responses were significantly greater to a nonpreferred sexual stimulus (sexual intercourse depicting only the nonpreferred gender) compared to a neutral stimulus (Chivers et al., 2007; Rieger et al., 2005) whereas others using less intense sexual stimuli (nonpreferred gender masturbating) did not (Chivers et al., 2007). Nearly all other studies on gender-specificity of sexual arousal have found that men's genital responses were at least somewhat greater to their nonpreferred sexual stimulus compared to a neutral stimulus (this pairwise comparison was not made within the study analyses, so statistical significance is unknown; Chivers & Bailey, 2005; Sakheim et al., 1985; Suschinsky et al., 2009). Thermography would not be limited in detecting men's early genital responses due to the inverse/mirror image effect, making it a more valid measure of men's early genital responses than PPG.

Thermography also offers potential improvements over VPP as a measure of women's genital responses. Studies using external measures of women's genital responses, including

vulvar temperature, have found higher sexual concordance compared to VPP (Chivers et al., 2010; Henson & Rubin, 1978; Kukkonen et al., 2010; Payne & Binik, 2006; Prause & Heiman, 2009; Waxman & Pukall, 2009). Some researchers suggest that women may be more aware of physiological changes in the vulva rather than changes in blood flow inside the vagina (Waxman & Pukall, 2009); changes in vaginal vasocongestion may not be directly perceptible to women whereas changes in vulvar temperature may be more salient cues of physical arousal (Chivers et al., 2010). As noted earlier, a factor analysis revealed that women's reported levels of body temperature loaded highly onto a sexual feelings factor (Laan, 1994), suggesting that changes in body temperature may be perceptible to women and may be related to women's subjective experiences of sexual arousal. Given that women's sexual concordance may be greater when genital responses are assessed with thermography compared with VPP (Chivers et al., 2010) and that women's self-reported sexual arousal is often gender-specific (Chivers et al., 2004; Chivers & Timmers, 2012; Schmidt, 1975), it is possible that changes in women's genital temperature, assessed with thermography, would be gender-specific.

Finally, past studies evaluating gender-specificity of sexual arousal in women and men have included relatively short stimuli, such as images of nude individuals (Freund et al., 1973), 90-second or 120-second erotic videos (Chivers et al., 2004; Chivers et al., 2007; Suschinsky et al., 2009), or 90-second erotic audio-narratives (Chivers & Timmers, 2012). To my knowledge, no study has assessed gender-specificity of sexual arousal in women or men using longer sexual stimuli. Given that sexual stimuli are processed through multiple stages involving the integration of physiological and cognitive responses (Geer, Lapour, & Jackson, 1993; Janssen et al., 2000), it would be useful to evaluate the gender difference in gender-specificity of sexual arousal using longer stimuli. Gender-nonspecific genital responses in women could reflect automatic sexual

responding; in fact, some have argued that VPP may assess an automatic, preparatory response rather than a “true” sexual response (Gerritsen et al., 2009). It is possible, for example, that automatic increases in vaginal vasocongestion occur early in the arousal process, but these wane with further elaborative processing of a nonpreferred sexual stimulus. Assessing sexual arousal using longer stimuli and a measure of relatively slower changes in women’s genital temperature would allow an examination of the gender-specificity of women’s later-stage sexual responses.

Study Overview and Hypotheses

I evaluated the gender difference in gender-specificity of sexual arousal using thermography as well as concurrent measures of VPP (in women) or PPG (in men) to assess genital responses. I presented gynephilic men and androphilic women with 10-minute erotic audio-visual stimuli (films) depicting their preferred gender, their nonpreferred gender, and a nonsexual film. Participants reported their feelings of sexual arousal in response to the films and genital responses were measured with thermography and VPP or PPG.

I predicted that men would have gender-specific genital responses (i.e., significantly greater responses to the female sexual stimulus compared to the male sexual stimulus), assessed with thermography and with PPG, as well as gender-specific self-reported arousal. I also predicted that men’s responses would be significantly greater to their nonpreferred sexual stimulus compared to the neutral stimulus when assessed with thermography but not when assessed with PPG or with self-report. I expected women to have gender-nonspecific genital responses (i.e., not significantly greater to the male sexual stimulus compared to the female sexual stimulus), assessed with thermography and with VPP, gender-specific self-reported arousal, and significantly greater genital responses and self-reported arousal to their nonpreferred sexual stimulus compared to the neutral stimulus.

Chapter 2:

Method

Participants

Participants were gynephilic men ($n = 27$; $M_{\text{age}} = 24.76$, $SD = 8.73$, range of 18 to 49) and androphilic women ($n = 28$; $M_{\text{age}} = 20.75$, $SD = 3.97$, range of 18 to 38) recruited through poster advertisements on Queen's University campus and in the Kingston community. Men were significantly older than women, $t(36.02) = 2.17$, $p = .04$, $d = 0.59$. All participants were screened for eligibility before coming into the lab and had reported being fluent in English; being exclusively sexually attracted to members of the opposite gender; having previous experience using erotic material; having no history of psychiatric illness, substance abuse, sexual dysfunction, or sexually transmitted infections; having regular menstrual cycles (25 – 32 days); not being currently pregnant; and not currently using medication that may influence sexual functioning (e.g., psychotropics, neuroleptics, antihypertensives; Meston & Frohlich, 2000). To control for potential effects of menstrual cycle phase on genital temperature and sexual arousal (Kukkonen et al., 2007; Slob, Bax, Hop, Rowland, & van der Werff ten Bosch, 1996; Slob, Ernste, & van der Werff ten Bosch, 1991), naturally-cycling female participants ($n = 7$) were tested within 12 days after menstruation began, but not during menstruation (approximately the follicular phase). Women using hormonal contraception ($n = 21$) were tested any day that they were taking their pills (i.e., not during the week of menstruation). Of note, recent evidence suggests that menstrual cycle phase does not affect the gender-specificity of women's genital responses or self-reported sexual arousal (Bossio et al., 2013).

Some participants were excluded from analyses due to problematic data. One woman and two men had unusable thermal imaging data (i.e., poor image quality or base of penile shaft was

not visible) and were excluded from thermography analyses. Two men were excluded from PPG analyses due to unusable data (technical difficulties). Six women had unusable VPP data (problematic VPA signals) and of the remaining 22 participants with usable VPP data, a subset of 15 have been processed and included in analyses in the current thesis due to time constraints¹; given the observed effect sizes, this sample size provided sufficient power for the primary analyses. All participants had usable continuous self-report data and one woman's data were excluded from analyses with pre/post-stimulus reported arousal due to missing pre-stimulus self-report data. The final sample sizes for the analyses with each dependent variable were: thermography ($n = 25$ men; $n = 27$ women), PPG ($n = 25$ men), VPP ($n = 15$ women), continuous self-reported arousal ($n = 27$ men, $n = 28$ women), pre/post-stimulus self-reported arousal ($n = 27$ men, $n = 27$ women).

Apparatus and Materials

Experimental stimuli. The stimuli consisted of audio-visual films representing four stimulus categories: baseline/temperature stabilization (Planet Earth nature video; 10-15 minutes depending on duration of temperature stabilization required; $M_{\text{duration}} = 12.38$ mins, $SD = 2.19$ mins; time to stabilization did not significantly differ by participant gender, $p = 1.00$), neutral (Planet Earth nature video; 10 minutes), male sexual (a sequence of five different two-minute films of men masturbating; 10 minutes total), and female sexual (a sequence of five different two-minute films of women masturbating; 10 minutes total). Stimuli depicting men and women masturbating were used in order to provide an optimal test of gender-specificity, as only one individual/gender is presented in each stimulus and the content is unambiguously sexual (Chivers

¹An examination of women's responses with VPP was not the primary focus of this thesis and therefore priority was not given to processing all of the VPP data.

et al., 2007). Participants watched the baseline film followed by one of the sexual films, a return-to-baseline period (described below), the neutral film, and then the second sexual film. The order of presentation of the sexual films was counterbalanced across participants. The nonsexual films were presented with music and narration. The sexual films were presented with music in the background in order to control for potential effects of sexual vocalizations on sexual arousal. Specifically, it would be difficult to control for the quantity of sexual vocalizations in the male versus female sexual stimuli. Further, there is evidence that sexual vocalizations in erotic films may impact men's and women's sexual responses differently; these may lead to increased genital and self-reported sexual responses in men (Gaither & Plaud, 1997) and may not affect women's self-reported sexual arousal (Lake Polan et al., 2003). Our sexual stimuli, therefore, included only background music in order to avoid a potential confounding variable of sexual vocalizations.

During the testing sessions, the average genital temperature during the last three minutes of the temperature stabilization film provided baseline temperature, while baseline responding with VPP and PPG was automatically calculated immediately prior to stimulus onset. Following the first sexual film, participants watched an additional neutral film to allow genital responses to decrease to approximately baseline levels. The return-to-baseline film duration ranged from 5 to 12 minutes ($M_{\text{duration}} = 7.05$ mins, $SD = 2.08$ mins), depending on the time required for the participant's genital responses to return to baseline. The duration of the return-to-baseline time period did not significantly differ by participant gender, $p = .97$.

The films and self-report questions were presented through PrefTest Professional Suite software (Limestone Technologies Inc., Odessa, ON) on a standard television monitor located at eye level, approximately 5 ft. from the participant. The sound of each film was presented through

comfortable, adjustable headphones that participants wore. When necessary, the researcher communicated with participants by sending text messages through PrefTest. The messages appeared on the television monitor and participants responded verbally using a standard intercom. The researcher could also communicate with participants verbally through the intercom if necessary.

Self-report apparatus. Participants reported their sexual arousal before and after each stimulus and continuously during each stimulus by pressing buttons on a keypad (see Self-Report Questionnaires section for details). Before and after the stimuli, participants rated their sexual arousal using a scale provided by pressing the desired number key on the keypad. To rate their arousal continuously, participants pressed a button on the keypad to manipulate a vertical bar displayed on the TV monitor that represented their level of mental sexual arousal. Participants were reminded immediately before each stimulus to adjust the bar to their current level of sexual arousal and to manipulate the bar if their sexual arousal levels changed throughout the video; the bar also acted as a visual reminder to participants to rate their sexual arousal.

Physiological sexual response.

Vaginal photoplethysmography (VPP). Women's genital responses were assessed using VPP (Sintchak & Geer, 1975) with data sampled using a Limestone Technologies Inc. DataPac_USB (Limestone Technologies Inc., Odessa, ON). Data were sampled at a rate of 10 samples per second, band-pass filtered (.5–10 Hz), and digitized (40Hz). Vaginal pulse amplitude (VPA) was used as a dependent variable, which was measured as the peak-to-trough amplitude for each vaginal pulse. VPA represents changes in vaginal blood flow with each heartbeat and has been shown to be a valid measure of sexual arousal (Laan, Everaerd, & Evers,

1995; Suschinsky et al., 2009). After each use, the vaginal photoplethysmograph was subjected to a high-level disinfection using CidexOPA (ortho-phthalaldehyde, 0.55%).

Penile plethysmography (PPG). Men's genital responses were assessed using PPG, a mercury-in-rubber strain gauge that assesses changes in penile circumference (Bancroft et al., 1966; Barlow et al., 1970). PPG has been shown to be a reliable and valid measure of men's sexual arousal (Janssen & Geer, 2000). Data were sampled using a Limestone Technologies Inc. DataPac_USB (Limestone Technologies Inc., Odessa, ON) at a rate of 10 samples per second, low-pass filtered (.5 Hz), digitized (40Hz), and transformed into millimeters of change in circumference. Before each testing session, I calibrated the gauge over six 5 mm steps (see Janssen & Geer, 2000). After each use, the penile plethysmograph was subjected to a high-level disinfection using CidexOPA (ortho-phthalaldehyde, 0.55%).

Thermography. A TS9230 Thermo Tracer (NEC Avio Co.) provided by Soltec Inc. (San Fernando, CA) continually monitored men's and women's genital temperature at a sampling rate of 60 Hz, averaged to yield one frame per second. The camera's sensitivity was 0.08°C, its operating temperature range was -40°C to 120°C, and its dimensions were 80 x 87 x 211 mm. For women, the camera was placed directly facing the chair they were seated in at approximately a distance of 2 ft., a height of 2 ft., and angled at 20 degrees. For men, the camera was placed approximately 1.8 ft. diagonally to the left of the chair at a height of approximately 2.2 ft., angled at 30 degrees. The different camera positioning for men and women was used to enable a clear image capture as the penis moves during an erection (Kukkonen et al., 2007). Regions of interest (ROIs) on the left labia majora and the shaft of the penis were used for all analyses, replicating previous research methods (Kukkonen et al., 2007); specifically, we used a region of the shaft that was near the base of the penis, maximizing our ability to capture men's early sexual

responses. A control ROI on the inner thigh was used to ensure that temperature changes across stimuli were specific to the genitals.

Self-report Questionnaires

Sexual response. Prior to each film, participants reported their levels of sexual arousal by responding to an item that appeared on the television monitor (“How sexually aroused do you feel?”) and, after each film, participants responded to two items regarding their feelings of sexual arousal (“How sexually aroused do you feel?” and “What was your highest level of sexual arousal during the video?”) Participants responded to each item by typing a number on the keypad ranging from 0 (*not sexually aroused at all*) to 9 (*most sexual arousal I’ve ever felt, sexual arousal associated with orgasm*). Throughout each film, participants responded to the question “How turned on do you feel?” on a scale of 0% (*no sexual arousal*) to 100% (*most sexual arousal ever felt, level of arousal associated with orgasm*) by manipulating a vertical bar that appeared on the screen with a keypad button. Limited data are available regarding the psychometric properties of these self-report questions. One study found good internal consistency ($\alpha = .82$) for a measure of women’s subjective sexual arousal in which women reported feelings of overall sexual arousal, strongest sexual arousal, and genital sensations using visual analog scales (Laan, 1994). Another study found that feelings of mental excitement reported following an erotic stimulus significantly predicted increases in continuously-reported sexual arousal (Rellini et al., 2005), suggesting that discrete and continuous measures of self-reported sexual arousal assess related constructs.

Sexual orientation. Participants completed the Kinsey Sexual Attraction scale (Kinsey, Pomeroy, & Martin, 1948; Kinsey, Pomeroy, Martin, & Gebhard, 1953) and reported their sexual identity. Of the 55 participants, 54 identified as heterosexual (four of whom also reported

identifying with no label and one of whom also identified as bi-curious) and one man identified with no label. Forty-nine participants reported being exclusively sexually attracted to the opposite gender (i.e., a score of 0 on the Kinsey Sexual Attraction Scale), with three women and three men reporting predominant sexual attraction to their opposite gender with occasional sexual attraction to their same gender (i.e., a score of 1 on the Kinsey Sexual Attraction Scale); note that, at screening, these individuals had reported meeting all eligibility criteria including being exclusively sexually attracted to their opposite gender. Excluding participants with Kinsey scores of 1 did not affect the patterns of results in this study; therefore, these individuals were retained in data analyses.

Background information. Participants completed a standard questionnaire battery, which included a demographic questionnaire and items related to sexual history and experiences, sexual interests, sexual functioning, and personality characteristics (see Appendix A for measures included in this thesis). A summary of participant demographic characteristics is provided in Table 1.

Table 1

Participant Demographic and Descriptive Information

	<i>n (%)</i>	<i>M (SD)</i>
Age		22.71 (6.97)
Cultural Identification		
Canadian	39 (70.9%)	
American	2 (3.6%)	
Asian	5 (9.1%)	
Hispanic	1 (1.8%)	
Eastern European	1 (1.8)	
Other	6 (10.9%)	
Relationship Status		
Single	28 (50.9%)	
Dating	24 (43.6%)	
Engaged	1 (1.8%)	
Married	2 (3.6%)	
Relationship Length in years (if applicable)		2.55 (3.06)
Highest Education Completed		
High school (or equivalent)	2 (3.6%)	
Community college (attending or completed)	3 (5.5%)	
University (attending or completed bachelor's degree)	45 (81.8%)	
Graduate or professional school (attending or completed)	5 (9.1%)	
Employment Status		
Full-time	6 (10.9%)	
Part-time	15 (27.3%)	
Full-time student	29 (52.7%)	
Retired	2 (3.6%)	
Unemployed	3 (5.5%)	

Procedure

Prospective participants were screened for eligibility via telephone or e-mail, according to their preference, and given a description of the study. Appointments were scheduled for

participants who were eligible and interested in participating. Participants were asked to refrain from sexual activity for 24 hours before testing, from physical exercise for one hour before testing (sympathetic nervous system arousal from exercise can influence genital responses; Meston & Gorzalka, 1996), and from using substances on the day of testing that may influence their sexual arousal (e.g., alcohol, tobacco, caffeine, cold medicine, recreational drugs). All participants indicated that they complied with these restrictions, with the exception of eight participants who indicated caffeine use on the day of testing ($n = 4$ women; $n = 4$ men), one man who indicated tobacco use, and one man who indicated caffeine and tobacco use. These participants were included in data analyses; excluding them did not affect the patterns of results.

At the start of the testing session, the experimenter explained the study details and obtained consent (see Appendix B). The experimenter instructed participants on how to place the vaginal or penile gauge on their own; the penile gauge was placed mid-shaft. The experimenter instructed participants on how to position themselves in the comfortable chair: the chair's leg rest was elevated and participants sat with their legs spread and their feet on the ground on either side of the leg rest. Pillows were provided to support participants' backs according to their comfort level. Women sat forward in the chair and leaned back such that hips were parallel to the ceiling, enabling optimal positioning of the thermal imaging camera and vaginal photoplethysmograph. The experimenter asked participants to position themselves in the chair while clothed, ensuring that they understood and were comfortable with the positioning; slight adjustments to pillows and seating position were made when necessary. While participants were seated and clothed, the experimenter checked the positioning of the thermography camera from the control room. The experimenter returned to the testing room and adjusted the camera if needed.

Once the camera was in approximately the proper location, the experimenter left the room and participants locked the door, undressed from the waist down, and positioned themselves in the chair. Men were instructed to place the gauge on at this point in time, whereas women were instructed to wait until they were told to go ahead and insert the gauge; this provided the experimenter with a full, unobstructed image of the vulva to ensure proper camera positioning. If the camera was not positioned properly, the experimenter instructed participants to shift how they were sitting or, if necessary, asked them to cover up (with a sheet that was provided) and re-entered the room to adjust the camera, with the participant's verbal consent. Once the camera positioning provided a clear image of the vulva or penis, the experimenter instructed women to insert the gauge and instructed participants to relax for a few minutes. Once the experimenter checked that the VPP or PPG signal was of good quality, participants were instructed to put on the headphones and told that the first trial would begin shortly.

The baseline film was presented to allow habituation to the testing environment and to allow genital temperature to stabilize to the ambient temperature (Cherner & Reissing, 2013; Kukkonen et al., 2007). Ambient temperature was set at a comfortable level ($M_{\text{temperature}} = 24.94$ degrees Celsius) using a space heater and was monitored by the experimenter throughout the testing session using a wireless temperature sensor. Across participants, the average room temperature during the testing session ranged from 24 to 26 degrees Celsius ($M = 24.94$, $SD = .50$) and throughout each testing session, the room temperature ranged from 24.47 to 25.30 degrees Celsius on average (average session $SD = .25$). The criteria for stable genital temperature was a change of less than 0.5°C over 3 minutes for men and a change of less than 0.10°C over 3 minutes for women. The stabilization criteria for women was slightly less stringent than the 0.05°C criteria used by Kukkonen et al. (2007) because the thermal imaging camera displayed

numbers only to the tenth decimal place during data acquisition. The criteria for temperature stabilization was more stringent for women than for men because temperature change is typically lower in women due to the proximity of the labia to the body compared with the penis, which can cool more quickly (Kukkonen et al., 2007). Five women's body temperature did not stabilize after the 15-minute stabilization period; these participants were not outliers for any dependent variables and excluding these women from analyses did not alter the pattern of results, therefore, they were included in the final sample.

After temperature stabilization, the remaining stimuli were presented and participants rated their feelings of sexual arousal continuously during each stimulus. Participants also rated their feelings of sexual arousal before and after each stimulus along with their highest feelings of sexual arousal after each stimulus. After the first sexual film, participants were presented with a nonsexual video of at least 5 minutes (up to 12 minutes) to allow a return-to-baseline of genital responses. All participants returned to approximately their baseline level; for thermography, this was defined as being within 5% of one's baseline genital temperature. After the last trial, participants were instructed to remove the gauge, to place it back into a plastic bag, and to get dressed. Participants then completed the self-report questionnaires and, if they indicated a moderate or greater level of arousal at the end of the psychophysiology session (i.e., reporting greater than 3 out of 9 post-stimulus feelings of sexual arousal), they were shown an additional 2-minute nonsexual film prior to leaving the lab; all participants who viewed this film reported arousal levels below 4 afterwards. The testing session took approximately 2.5 to 3 hours and participants received \$40 as compensation. At the end of the session, the experimenter debriefed participants (see Appendix C). All procedures were approved by the Queen's University Health

Sciences Research Ethics Board. Participants' self-reported experiences with the psychophysiology measures used in this study are provided in Table 2.

Table 2

Participants' Experiences of Psychophysiology Measures

	Thermal Imaging Camera		Vaginal Gauge		Penile Gauge	
	<i>n</i> (%)		<i>n</i> (%)		<i>n</i> (%)	
	Uncomfortable	Distracting	Uncomfortable	Distracting	Uncomfortable	Distracting
1	35 (64.8)	43 (79.6)	18 (66.7)	10 (37.0)	24 (88.9)	15 (55.6)
2	16 (29.6)	8 (14.8)	8 (29.6)	11 (40.7)	3 (11.1)	11 (40.7)
3	1 (1.9)	1 (1.9)	1 (3.7)	3 (11.1)	---	1 (3.7)
4	1 (1.9)	2 (3.7)	---	3 (11.1)	---	---
5	1 (1.9)	---	---	---	---	---

Note. Participants rated their level of discomfort with and distraction from each measure on a scale from 1 (*not at all uncomfortable/distracting*) to 5 (*extremely uncomfortable/distracting*). Data were missing from one female participant; proportions were computed with this individual's data removed.

Data Reduction

Prior to data analysis, I detected and deleted movement artifacts in the VPA waveforms and PPG data by visual inspection. Prior to analyzing the thermography data, camera-tracking software (MatchMover 2012, Autodesk Inc., San Rafael, CA) was used to assess and track colour contrasts in order to correct for participant movement by maintaining the positioning of regions of interest (ROIs) across the testing session. With MatchMover, I generated a list of X-Y coordinates for the center pixel of the ROIs for each frame (i.e., each second of each trial). Matlab 2014a (MathWorks Inc., Natick, MA) was then used to link these X-Y coordinates with the temperature data, creating circular ROIs with radiuses of three pixels for each frame and averaging the temperature across each ROI. To date, this is the first study that has used software to map and track thermography ROIs to enhance data quality and speed of data processing.

Next, for each experimental stimulus (neutral, male sexual, female sexual), genital and thigh temperatures were each averaged every 15 seconds, yielding 40 data points for each 10-minute trial. This binning procedure was done to smooth the temperature data, reducing error, and was appropriate given that temperature change is slow and was not expected to change meaningfully across very short time frames. There were some missing thermography data (e.g., substantial participant movement, participant's hand temporarily placed in the way of the ROI); any bins with greater than one third of data missing (i.e., greater than 5 out of 15 seconds) were not included in analyses. Any trials with more than one third of data missing were to be excluded from analyses, however this was not the case for any participants. For the genital region, there were six participants with one bin (out of 40) missing for one trial, one participant with one bin missing for two trials, five participants with two or three bins missing for one of the trials, and one participant with 11 bins missing for one trial. For the thigh region, there were four participants with one bin missing for one trial, one participant with one bin missing for two trials, and one participant with five bins missing for one trial. Given that the primary dependent variable for the current study was peak temperature (relative to baseline), missing values were not replaced.

After binning the thermography data, I computed change in peak genital and thigh temperature relative to pre-trial baseline (peak minus baseline, where baseline was computed using the 20s prior to stimulus onset) for each stimulus. For four participants (two men and two women), only 15-second pre-trial baselines were available. For two other participants (one man and one woman), more than one third of the 20-second pre-trial baseline data was missing in the genital region for one trial; in these cases, pre-trial baseline was calculated using 20-seconds of available pre-trial data including up to 30-seconds prior to stimulus onset. Similarly, at the thigh

region there were two participants (one man and one woman) with more than one third of the 20-second baseline data missing and baseline was calculated using 20-seconds of available pre-trial data in these cases. I also computed gender-specificity contrast scores for changes in genital temperature (i.e., peak-baseline genital temperature for the preferred sexual stimulus minus peak-baseline genital temperature for the nonpreferred sexual stimulus).

Further, I computed percentage change in genital temperature relative to baseline ($[\text{peak} - \text{baseline}] / \text{baseline}$) for each stimulus, in order to standardize this measure (see Heiman, 1980) as men's and women's baseline genital temperature was expected to differ. Pre-trial baseline genital temperatures did not, however, significantly differ by participant gender for any stimulus (i.e., no main effect of Participant Gender on baseline genital temperature: $F(1, 50) = .001, p = .97, \eta_p^2 < .001$); therefore, the standardized genital temperature measure was used only for comparison purposes. Gender-specificity contrast scores were computed for this standardized measure. I also computed peak room temperature relative to baseline for each stimulus, where baseline was the room temperature recorded at the start of the trial.

For each stimulus, I computed peak VPA relative to pre-trial baseline (for women) as well as peak millimeters stretch relative to pre-trial baseline (for men) and calculated gender-specificity contrast scores for each of these measures (i.e., peak-baseline response to preferred sexual stimulus minus peak-baseline response to nonpreferred sexual stimulus). These measures were analyzed separately for men and women because the outputs were on different scales and could not be z-scored due to the low number of trials. For VPA and PPG, pre-trial baseline was computed through PrefTest using approximately the 10-seconds prior to stimulus onset.

To examine changes in self-reported sexual arousal, I computed peak continuous self-reported arousal relative to pre-trial baseline for each stimulus. I also calculated the difference

between pre-stimulus reported feelings of sexual arousal and both post-stimulus reported feelings of sexual arousal and post-stimulus reported feelings of highest sexual arousal experienced during each stimulus. I computed gender-specificity contrast scores for each self-report measure. The patterns of results were consistent across self-report measures for all analyses; for simplicity, I have presented only the results for continuous self-reported arousal in this thesis.

Of note, peak responding relative to baseline was chosen as the primary dependent variable in this thesis as it is a measure of the maximum magnitude of response elicited by a stimulus. Maximum magnitude of response may be a useful way of capturing genital responses with thermography, as genital temperature changes relatively slowly making mean responding a potentially less sensitive measure. Peak responding (relative to baseline) may be particularly relevant for assessing responses to nonpreferred sexual stimuli, which may not be sustained across an entire trial, particularly in men. There are limitations to the use of peak responding, however, including it not necessarily reflecting a steady level of response; this is especially concerning for VPA. For consistency, peak-baseline was nonetheless used as the dependent variable for each measure in this thesis. I have noted throughout the results that findings were consistent with mean responding (relative to baseline), which captures more stable, sustained sexual responding, in order to address concerns with peak.

Outlier data points were defined as values falling greater than three standard deviations from the mean (Tabachnik & Fidell, 2012). There was no more than one outlier identified per dependent variable and inclusion of the outlier did not affect patterns of results; therefore, I included outlier data points in analyses to maximize power. Multivariate outliers were defined as cases with Cook's distance values greater than one (Tabachnik & Fidell, 2012). No multivariate outliers were identified for any analysis of variance (ANOVA). I assessed normality by

examining skew and kurtosis as well as frequency distribution histograms for each variable.

Though some level of skew was expected given the relatively small sample size in this study, no variables deviated substantially from normality and none were transformed. For all t -tests and ANOVAs described in this thesis, assumptions were met unless otherwise noted (i.e., assumptions of sphericity, equality of error variances, and equality of covariances, as applicable).

Chapter 3:

Results

Manipulation Check

As described in the results for each measure, I found that overall men's and women's responses to the preferred sexual stimulus were significantly greater than their responses to the neutral stimulus for each measure; therefore, the sexual stimulus elicited significant increases in genital and self-reported sexual arousal. Comparisons between responses to the preferred sexual stimulus and the neutral stimulus are provided in the sections examining each dependent variable, below.

Room Temperature Check

To evaluate whether changes in room temperature co-varied with changes in genital temperature in this study, I computed Pearson correlations between changes in room temperature and changes in genital temperature for each stimulus (i.e., peak minus baseline temperature). The correlation was not significant for any stimulus; neutral stimulus, $r(50) = -.047, p = .74$, male sexual stimulus, $r(50) = -.024, p = .86$, female sexual stimulus, $r(50) = .066, p = .64$. To further evaluate the potential role of changes in room temperature in the current study's findings, I conducted a 3 (Stimulus: Neutral, Male Sexual, Female Sexual) x 2 (Participant Gender: Man, Woman) mixed-model ANOVA with change in room temperature as the dependent variable. There was no significant main effect of Participant Gender, $F(1, 49) = 1.23, p = .27, \eta_p^2 = .02$, no significant main effect of Stimulus, $F(2, 98) = .56, p = .57, \eta_p^2 = .01$, nor was there a significant Stimulus by Participant Gender interaction, $F(2, 98) = 1.61, p = .21, \eta_p^2 = .03$.

Thigh Temperature Check

To examine whether temperature changes in a non-genital control region (thigh) varied across stimuli for men or women, I conducted a 3 (Stimulus: Neutral, Male Sexual, Female Sexual) x 2 (Participant Gender: Man, Woman) mixed-model ANOVA with change in thigh temperature (peak-baseline) as the dependent variable. Surprisingly, there was a significant Stimulus by Participant Gender interaction, $F(2, 100) = 3.31, p = .04, \eta_p^2 = .06$. Follow up Tukey's mixed-model *t*-tests revealed, however, that there were no significant differences between stimulus categories for men or for women (see Tables 3 and 4). The interaction can be explained by examining gender differences for each stimulus category. There was no significant difference between men's and women's changes in thigh temperature for the neutral stimulus, $t(50) = 0.99, p = .33, d = 0.27$, or for the male sexual stimulus, $t(50) = 0.45, p = .66, d = .11$; however, for the female sexual stimulus, men's thigh temperature increased significantly more than women's, $t(50) = 2.44, p = .02, d = 0.78$. When this analysis was repeated using mean thigh temperature, the dependent variable used in Kukkonen et al.'s (2007, 2010) thermography validation studies, there was no significant Stimulus by Participant Gender interaction, $F(2, 100) = 0.87, p = .42, \eta_p^2 = .02$, nor was there a significant main effect of Stimulus, $F(2, 100) = .78, p = .46, \eta_p^2 = .02$.

Table 3

Descriptive Statistics for Changes in Thigh Temperature by Stimulus and Participant Gender

	Neutral Stimulus <i>M (SD)</i>	Male Sexual Stimulus <i>M (SD)</i>	Female Sexual Stimulus <i>M (SD)</i>
Men	0.21 (0.24)	0.27 (0.23)	0.29 (0.19)
Women	0.26 (0.16)	0.25 (0.20)	0.16 (0.15)

Note. Change in thigh temperature refers to peak minus baseline (degrees Celsius).

Table 4

Pairwise Comparisons for Changes in Thigh Temperature by Stimulus for Men and Women

Stimulus Comparisons	Toothaker's <i>t</i> -tests	
	Men	Women
Neutral vs. Male Sexual	$t(50) = 1.15, p = .25, d = 0.27$	$t(50) = 0.26, p = .79, d = 0.08$
Neutral vs. Female Sexual	$t(50) = 1.50, p = .14, d = 0.39$	$t(50) = 1.93, p = .06, d = 0.65$
Male Sexual vs. Female Sexual	$t(50) = 0.35, p = .73, d = 0.09$	$t(50) = 1.67, p = .10, d = .51$

Note. Change in thigh temperature refers to peak minus baseline (degrees Celsius).

Effects of Stimulus and Stimulus Order on Sexual Responses

Vaginal photoplethysmography (VPP). To examine the effect of stimulus and stimulus order (i.e., order of stimulus presentation) on women's genital responses assessed with VPP, I conducted a two-way, mixed-model ANOVA. The within-subjects factor was Stimulus with three levels (Neutral, Male Sexual, Female Sexual), the between-subjects factor was Stimulus Order with two levels (Order A – male sexual stimulus, neutral stimulus, female sexual stimulus; Order B – female sexual stimulus, neutral stimulus, male sexual stimulus), and the dependent variable was change in VPA (i.e., peak minus baseline). For the male sexual stimulus, the assumption of equality of error variances was violated according to Levene's Test, $F(1, 13) = 18.95, p = .001$. There was a significant Stimulus by Stimulus Order interaction, $F(2, 26) = 3.92, p = .033, \eta_p^2 = .23$ (see Table 5, below, and Figure 1).

Table 5

Descriptive Statistics for Women's Changes in VPA by Stimulus and Stimulus Order

	Order A <i>M (SD)</i>	Order B <i>M (SD)</i>
Change in VPA (mV)		
Neutral Stimulus	11.30 (5.31)	11.50 (8.43)
Male Sexual Stimulus	34.49 (21.46)	20.02 (6.04)
Female Sexual Stimulus	27.74 (15.33)	23.32 (9.22)

Note. Change in VPA refers to peak minus baseline for each stimulus. Order A refers to the stimulus order presentation where the male sexual stimulus was presented first, whereas Order B refers to the order where the female sexual stimulus was presented first.

I followed up the Stimulus by Stimulus Order interaction by examining changes in VPA across stimuli separately for women who were presented with Order A or Order B using Toothaker's mixed-model *t*-tests (Toothaker, 1991). As shown in Figure 1 (below), women presented with Order A had significantly greater changes in VPA to the male sexual stimulus compared to the neutral stimulus, $t(13) = 3.90, p = .002, d = 1.61$, and to the female sexual stimulus compared to the neutral stimulus, $t(13) = 2.55, p = .02, d = 1.43$, and they did not have significantly greater responses to the male sexual stimulus compared to the female sexual stimulus, $t(13) = 1.36, p = .20, d = 0.47$. Women presented with Order B had greater changes in VPA to the male sexual stimulus compared to the neutral stimulus, although this difference was not statistically significant despite a large effect size, $t(13) = 1.41, p = .18, d = 1.16$. Similarly, women presented with Order B did not have significantly greater changes in VPA to the female sexual stimulus compared to the neutral stimulus, although there was a large effect size, $t(13) = 1.96, p = .07, d = 1.34$. Toothaker's mixed-model *t*-tests were used to maximize power by pooling the within- and between-subject error terms from the omnibus ANOVA; however, given that there was heterogeneity of error variances in this sample, some Toothaker's paired *t*-tests were likely underpowered. Finally, women in Order B did not exhibit significantly greater

responses to the female sexual stimulus compared to the male sexual stimulus, $t(13) = 0.55$, $p = .60$, $d = 0.42$.

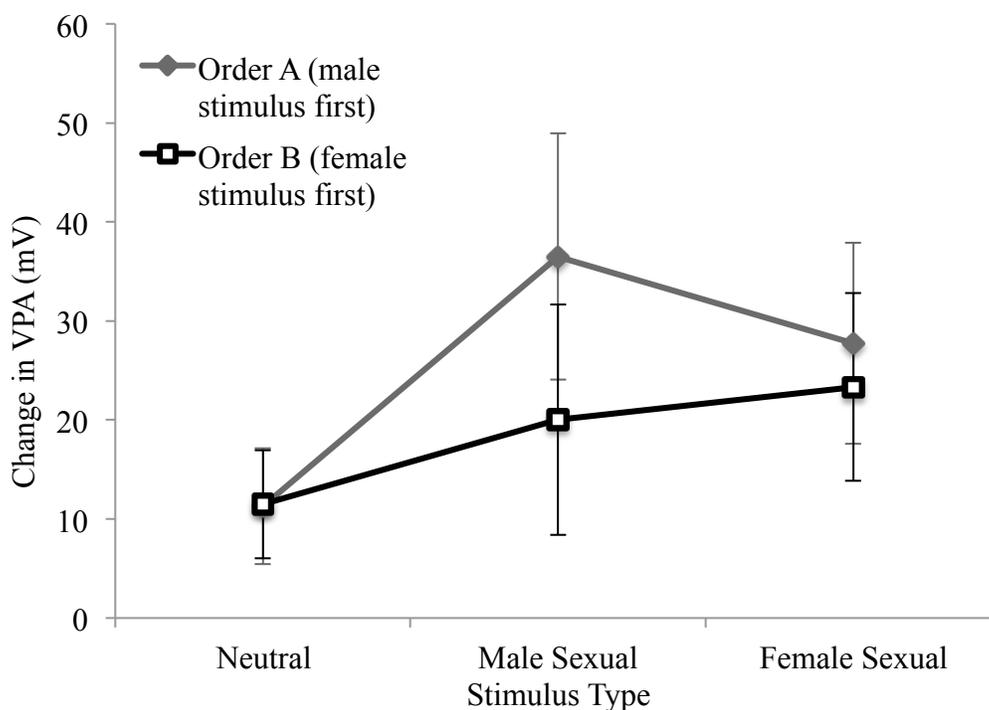


Figure 1. Change in women's VPA (peak minus baseline) in mV by stimulus type and stimulus order (Order A: male sexual stimulus, neutral, female sexual stimulus; Order B: female sexual stimulus, neutral, male sexual stimulus). Error bars represent 95% confidence intervals.

To clarify the source of the observed Stimulus Order by Stimulus interaction, I conducted Tukey's t -tests to examine the effect of Stimulus Order for each stimulus category. Changes in VPA did not significantly differ for women presented with Order A versus Order B for the neutral stimulus, $t(13) = 0.03$, $p = .97$, $d = .03$, nor did they significantly differ by stimulus order for the female sexual stimulus, $t(13) = 0.71$, $p = .49$, $d = 0.36$. For the male sexual stimulus, however, women presented with Order A had significantly greater changes in VPA than women presented with Order B, $t(13) = 2.63$, $p = .02$, $d = 1.08$. When the above analyses were repeated using women's mean VPA relative to pre-trial baseline or using peak or mean VPA (not relative to baseline), the pattern of results was identical.

Penile plethysmography (PPG). To examine the effect of stimulus and stimulus order on men's genital responses assessed with PPG, I conducted a 3 (Stimulus: Neutral, Male Sexual, Female Sexual) x 2 (Stimulus Order: Order A – male stimulus first, Order B – female stimulus first) mixed-model ANOVA with change in penile circumference as the dependent variable (i.e., peak minus baseline). There was no significant Stimulus by Stimulus Order interaction, $F(2, 46) = 1.23, p = .30, \eta_p^2 = .05$, nor was there a significant main effect of Stimulus Order, $F(1, 23) = .15, p = .71, \eta_p^2 = .006$. There was a significant main effect of Stimulus, $F(2, 46) = 47.52, p < .001, \eta_p^2 = .67$, which I followed up using Fisher's Least Significant Difference (LSD) pairwise t -tests. As shown in Figure 2 (below), men had significantly greater changes in penile circumference in response to the female sexual stimulus ($M = 22.23, SD = 10.43$) compared to the neutral stimulus ($M = 5.01, SD = 6.20$), $p < .001, d = 2.01$, or compared to the male sexual stimulus ($M = 6.34, SD = 8.02$), $p < .001, d = 1.71$. Men's changes in penile circumference did not significantly differ to the neutral versus male sexual stimuli, $p = .51, d = 0.18$. When these analyses were repeated using men's mean circumference relative to pre-trial baseline or using peak or mean circumference (not relative to baseline), the pattern of results was identical.

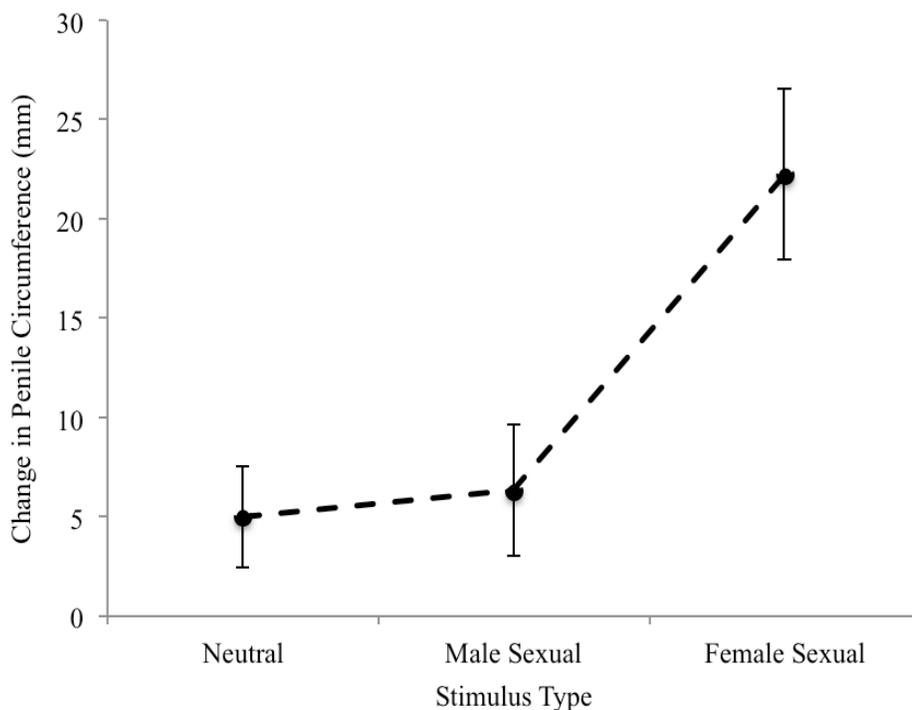


Figure 2. Change in men's penile circumference (peak minus baseline) in mm by stimulus type. Error bars represent 95% confidence intervals.

Thermography. To examine the effect of stimulus and stimulus order on men's and women's genital responses assessed with thermography, I conducted a 2 (Participant Gender: Man, Woman) x 3 (Stimulus: Neutral, Male Sexual, Female Sexual) x 2 (Stimulus Order: Order A – male stimulus first, Order B – female stimulus first) mixed-model ANOVA with change in genital temperature as the dependent variable (i.e., peak minus baseline). There was a significant three-way interaction, $F(2, 96) = 3.14, p = .048, \eta_p^2 = .06$, which I followed up separately for men and women. For men, there was no significant Stimulus by Stimulus Order interaction, $F(2, 46) = 1.39, p = .26, \eta_p^2 = .06$, nor was there a significant main effect of Stimulus Order, $F(1, 23) = .22, p = .64, \eta_p^2 = .01$. Men had a significant main effect of Stimulus, $F(2, 46) = 20.89, p < .001, \eta_p^2 = .48$ (see Figure 3). Follow up *t*-tests using Fisher's LSD revealed that men's changes in genital temperature were significantly greater for the female sexual stimulus ($M = 1.68, SD = 0.86$) compared to the neutral stimulus ($M = 0.48, SD = 0.40$), $p < .001, d = 1.81$, or the male

sexual stimulus ($M = 0.62$, $SD = 0.65$), $p < .001$, $d = 1.40$, and there was no significant difference in men's changes in genital temperature to the neutral stimulus versus the male sexual stimulus, $p = .38$, $d = 0.27$.

For women, the assumption of equality of error variances was violated for the male sexual stimulus according to Levene's Test, $F(1, 25) = 2.81$, $p = .038$. There was no significant Stimulus by Stimulus Order interaction, $F(2, 50) = 2.56$, $p = .087$, $\eta_p^2 = .093$ nor was there a significant main effect of Stimulus Order, $F(1, 25) = 1.28$, $p = .27$, $\eta_p^2 = .05$, though there was a significant main effect of Stimulus, $F(2, 50) = 17.70$, $p < .001$, $\eta_p^2 = .41$. Follow up t -tests using Fisher's LSD revealed that women's changes in genital temperature were significantly greater for the male sexual stimulus ($M = 0.68$, $SD = 0.57$) compared to the neutral stimulus ($M = 0.17$, $SD = 0.20$), $p < .001$, $d = 1.19$, as well as for the female sexual stimulus ($M = 0.91$, $SD = 0.69$) compared to the neutral stimulus, $p < .001$, $d = 1.46$. Women's changes in genital temperature were not significantly greater for the female sexual stimulus compared to the male sexual stimulus, $p = .07$, $d = .37$. Given that the omnibus ANOVA showed a significant three-way interaction and that women exhibited a marginally significant Stimulus by Stimulus Order interaction with a small-medium effect size, I followed up the interaction for women by examining changes in genital temperature across stimuli separately for women who were presented with Order A or Order B using Toothaker's mixed-model t -tests (see Table 6 and Figure 3).

Table 6

*Descriptive Statistics for Women's Changes in Genital Temperature by Stimulus and**Stimulus Order*

	Order A <i>M (SD)</i>	Order B <i>M (SD)</i>
Change in Women's Genital Temperature (degrees Celsius)		
Neutral Stimulus	0.14 (0.14)	0.20 (0.24)
Male Sexual Stimulus	0.93 (0.71)	0.44 (0.24)
Female Sexual Stimulus	0.93 (0.80)	0.89 (0.60)

Note. Change in genital temperature refers to peak minus baseline for each stimulus. Order A refers to the stimulus order presentation where the male sexual stimulus was presented first, whereas Order B refers to the order where the female sexual stimulus was presented first.

As shown in Figure 3 (below), women presented with Order A had significantly greater changes in genital temperature to the male sexual stimulus compared to the neutral stimulus, $t(25) = 3.86, p = .001, d = 1.53$, as well as to the female sexual stimulus compared to the neutral stimulus, $t(25) = 3.87, p = .001, d = 1.37$, but did not significantly differ in their responses to the male versus female sexual stimuli, $t(25) = 0.003, p = .99, d < .001$. Women presented with Order B had greater changes in genital temperature to the male sexual stimulus compared to the neutral stimulus, although this difference was not statistically significant despite a large effect size, $t(25) = 1.25, p = .22, d = 1.02$; Toothaker's paired t -tests were likely underpowered for some pairwise comparisons due to heterogeneity of error variances in this sample. For women presented with Order B, changes in genital temperature were significantly greater for the female sexual stimulus compared to both the neutral stimulus, $t(25) = 3.55, p = .002, d = 1.52$, and the male sexual stimulus, $t(25) = 2.30, p = .03, d = 0.99$.

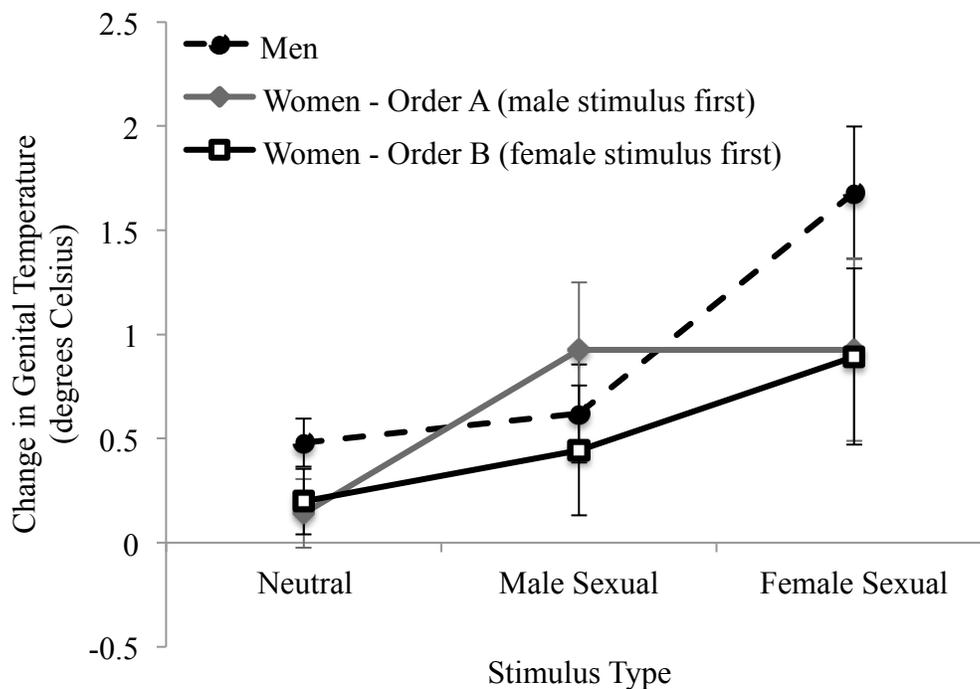


Figure 3. Change in genital temperature (peak minus baseline) in degrees Celsius by stimulus type (for men) and by stimulus type and stimulus order (for women). Error bars represent 95% confidence intervals.

To elucidate the source of women's Stimulus by Stimulus Order interaction, I conducted Toothaker's *t*-tests to examine the effect of Stimulus Order in women for each stimulus category. Women's changes in genital temperature did not significantly differ by stimulus order for the neutral stimulus, $t(25) = 0.29, p = .78, d = 0.29$, nor did they differ by stimulus order for the female sexual stimulus, $t(25) = 0.17, p = .87, d = 0.05$. For the male sexual stimulus, however, women presented with Order A had significantly greater changes in genital temperature than women presented with Order B, $t(25) = 2.41, p = .02, d = 0.92$. When the above analyses were conducted using a standardized measure of change in genital temperature (i.e., peak minus baseline divided by baseline), the pattern of results was identical. When participants' mean genital temperature (relative to baseline) was used, the pattern of results was also the same.

Continuous self-reported arousal. To examine the effect of stimulus and stimulus order on men's and women's self-reported sexual arousal, I conducted a 2 (Participant Gender: Man, Women) x 3 (Stimulus: Neutral, Male Sexual, Female Sexual) x 2 (Stimulus Order: Order A – male stimulus first, Order B – female stimulus first) mixed-model ANOVA with change in continuous self-reported sexual arousal as the dependent variable (i.e., peak minus baseline). For this analysis, the assumption of sphericity was violated (Greenhouse-Geisser Epsilon = .76) therefore Greenhouse-Geisser-adjusted F -statistics were used. Further, the assumption of equality of covariance matrices was violated as was the assumption of equality of error variances for the neutral and male sexual stimuli. Of note, the assumptions were all met for changes in discretely-reported arousal (i.e., post-stimulus reported arousal minus pre-stimulus reported arousal) and these measures had identical patterns of results. There was no significant three-way interaction (i.e., Participant Gender by Stimulus by Stimulus Order), $F(1.51, 102) = 0.18, p = .78, \eta_p^2 = .003$, nor was there a significant interaction between Stimulus Order and Stimulus, $F(1.51, 102) = 1.82, p = .18, \eta_p^2 = .03$, or between Stimulus Order and Participant Gender, $F(1, 51) = 0.47, p = .50, \eta_p^2 = .009$, and there was no significant main effect of Stimulus Order, $F(1, 51) = .027, p = .87, \eta_p^2 = .001$.

There was a significant Participant Gender by Stimulus interaction, $F(1.51, 102) = 33.66, p < .001, \eta_p^2 = .40$ (see Figure 4), which I followed up with separate Tukey's mixed-model t -tests for men and for women. For men, change in reported arousal was significantly greater for the female sexual stimulus ($M = 53.08, SD = 26.52$) compared to the neutral stimulus ($M = 0.55, SD = 1.86$), $t(51) = 10.08, p < .001, d = 2.79$, and compared to the male sexual stimulus ($M = 3.93, SD = 8.64$), $t(51) = 9.43, p < .001, d = 2.49$, but change in reported arousal was not significantly greater for the male sexual stimulus compared to the neutral stimulus, $t(51) = 0.65,$

$p = .52$, $d = 0.54$. For women, change in reported arousal was significantly greater for the male sexual stimulus ($M = 28.92$, $SD = 19.67$) compared to the neutral stimulus ($M = 0.39$, $SD = 1.69$), $t(51) = 5.57$, $p < .001$, $d = 2.04$, as well as for the female sexual stimulus ($M = 27.03$, $SD = 25.76$) compared to the neutral stimulus $t(51) = 5.20$, $p < .001$, $d = 1.46$. Women's changes in reported arousal were not significantly greater to the male sexual stimulus compared to the female sexual stimulus, $t(51) = 0.37$, $p = .71$, $d = 0.08$. When these analyses were repeated using participants' mean continuously-reported arousal relative to pre-trial baseline or using peak or mean continuously-reported arousal (not relative to baseline), the pattern of results was identical.

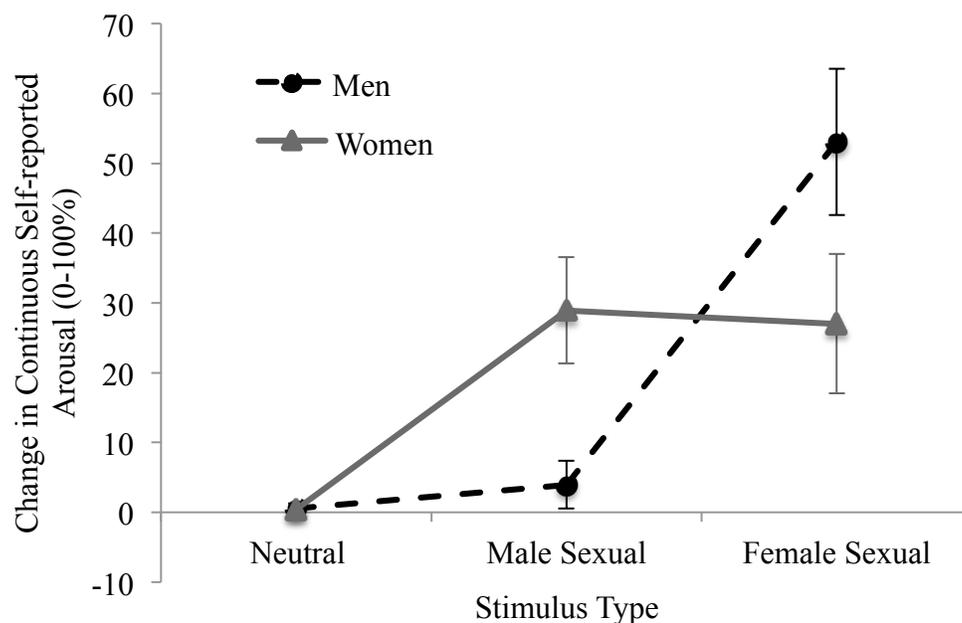


Figure 4. Change in continuous self-reported sexual arousal (peak minus baseline; 0-100% scale) by participant gender and stimulus type. Error bars represent 95% confidence intervals.

Gender-specificity of Sexual Arousal

Given the unexpected interactions observed between stimulus and stimulus order on women's genital responses, I sought to examine the influence of stimulus order on degree of gender-specificity in particular. Therefore, for each measure, I evaluated the influence of

stimulus order (and participant gender, for thermography and self-report) on gender-specificity contrast scores, i.e., response (peak – baseline) to the preferred gender minus response (peak – baseline) to the nonpreferred gender. These analyses also allowed a more specific assessment of the degree of gender-specificity of arousal in women and men.

Vaginal photoplethysmography (VPP). To examine whether the gender-specificity of women's VPA responses varied with order of stimulus presentation, I conducted an independent-samples *t*-test with Stimulus Order as the independent variable (two levels: Order A – male stimulus first, Order B – female stimulus first). The dependent variable was the gender-specificity contrast score for VPA (i.e., peak-baseline VPA for the male sexual stimulus minus peak-baseline VPA for the female sexual stimulus). VPA gender-specificity was not significantly greater for women who were presented with Stimulus Order A ($M = 8.74$; $SD = 14.60$) compared with those who were presented with Stimulus Order B ($M = -3.29$, $SD = 7.14$), $t(8.46) = 1.99$, $p = .08$, $d = 1.07$ (equal variances not assumed). Next, I conducted a one-sample *t*-test to examine whether the gender-specificity of women's VPA (across stimulus orders) significantly differed from zero. The gender-specificity of women's change in VPA ($M = 2.33$, $SD = 12.47$) did not significantly differ from zero, $t(14) = 0.72$, $p = .48$, indicating that women's VPA responses were not significantly gender-specific (see Figure 5). Of note, the standard deviations for gender-specificity of women's changes in VPA were quite large; when these analyses were repeated using a measure of change in VPA standardized to baseline levels (i.e., [peak-baseline]/baseline), the standard deviations were much smaller and the pattern of results was identical. Further, when these analyses were repeated using women's mean VPA relative to pre-trial baseline or using peak or mean VPA (not relative to baseline), the pattern of results was identical.

Penile plethysmography (PPG). To examine whether the gender-specificity of men's PPG responses varied with order of stimulus presentation, I conducted an independent-samples *t*-test with Stimulus Order as the independent variable (Order A, male stimulus first, versus Order B, female stimulus first). The dependent variable was the gender-specificity contrast score for PPG (i.e., peak-baseline millimeters circumference for the female sexual stimulus minus peak-baseline millimeters circumference for the male sexual stimulus). The gender-specificity of men's change in penile circumference was not significantly greater in men who were presented with Order B ($M = 16.81, SD = 10.18$) compared to those who were presented with Order A ($M = 14.90, SD = 10.50$), $t(23) = 0.46, p = .65, d = 0.18$. Next, I conducted a one-sample *t*-test to examine whether the gender-specificity of men's change in penile circumference (across stimulus orders) significantly differed from zero. The gender-specificity of men's change in circumference ($M = 15.90, SD = 10.16$) significantly differed from zero, $t(24) = 7.82, p < .001$, indicating that men's PPG responses were significantly gender-specific (see Figure 5). When these analyses were repeated using men's mean circumference relative to pre-trial baseline or using peak or mean circumference (not relative to baseline), the pattern of results was identical.

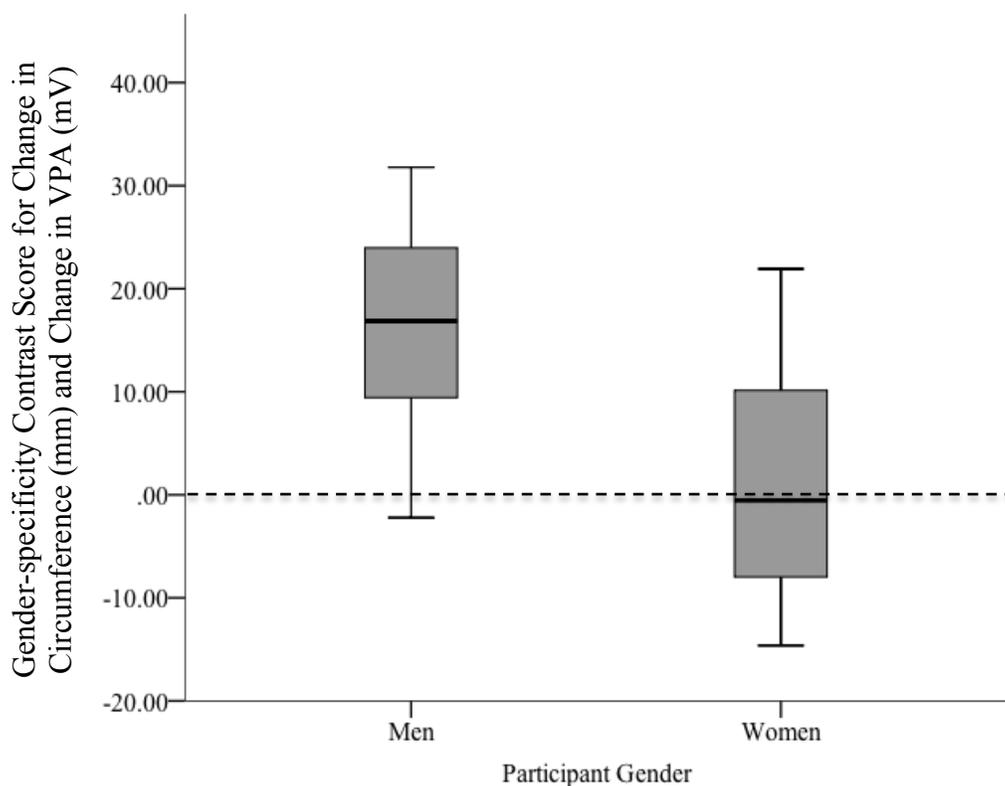


Figure 5. Boxplots reflecting the gender-specificity of men’s changes in penile circumference (mm) and women’s changes in VPA (mV). Gender-specificity refers to the difference in response (where a response was computed as peak minus baseline) to the preferred sexual stimulus (i.e., preferred gender) minus the nonpreferred sexual stimulus (i.e., nonpreferred gender). The boxplots for men and women are depicted on the same y-axis for comparison, although these variables had different scales; for both men and women, a gender-specificity contrast score of zero (indicated with the dashed line) reflects gender-nonspecificity and a higher score reflects greater gender-specificity.

Thermography. To examine whether the gender-specificity of genital temperature varied with order of stimulus presentation and/or participant gender, I conducted a 2 (Stimulus Order: Order A – male stimulus first, Order B – female stimulus first) x 2 (Participant Gender: Man, Woman) between-subjects ANOVA. The dependent variable was gender-specificity of genital temperature (i.e., peak-baseline genital temperature for the preferred sexual stimulus minus peak-baseline genital temperature for the nonpreferred sexual stimulus). There was no significant Stimulus Order by Participant Gender interaction, $F(1, 48) = 0.374, p = .54, \eta_p^2 = .008$, nor was there a significant main effect of Stimulus Order, $F(1, 48) = 1.28, p = .26, \eta_p^2 =$

.03. There was a significant main effect of Participant Gender, $F(1, 48) = 25.03, p < .001, \eta_p^2 = .34$, such that the gender-specificity of men's change in genital temperature ($M = 1.06, SD = 1.15$) was significantly greater than the gender-specificity of women's change in genital temperature ($M = -0.23, SD = 0.64$), $p < .001, d = 1.40$. Further, I conducted t -tests for men and for women to examine whether the gender-specificity of changes in genital temperature (across stimulus orders) significantly differed from zero. The gender-specificity of men's changes in genital temperature significantly differed from zero, $t(24) = 4.59, p < .001$, indicating that men's genital temperature changes were significantly gender-specific. For women, the gender-specificity of changes in genital temperature (across stimulus orders) did not significantly differ from zero, $t(26) = 1.89, p = .07$, indicating that women's genital temperature changes were not significantly gender-specific (see Figure 6). When these analyses were conducted using mean genital temperature relative to pre-trial baseline, using peak or mean genital temperature (not relative to baseline), or using a standardized measure of change in genital temperature (i.e., peak minus baseline divided by baseline), the pattern of results was identical.

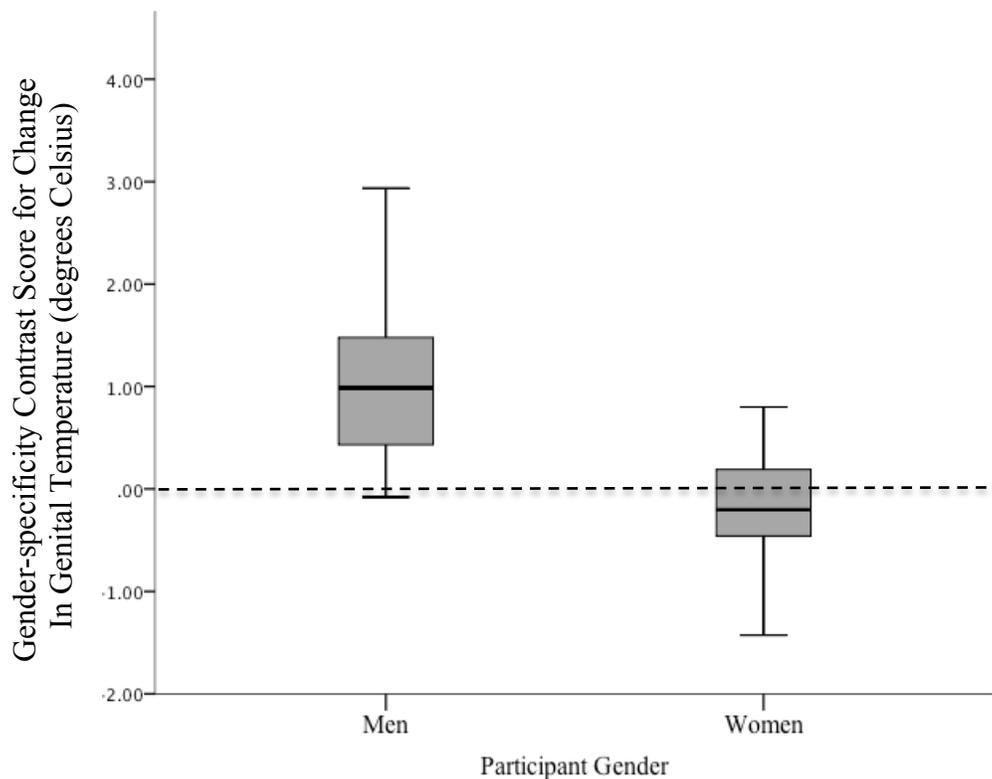


Figure 6. Boxplots reflecting the gender-specificity of men’s and women’s changes in genital temperature (degrees Celsius). Gender-specificity refers to the difference in response (where a response was computed as peak minus baseline) to the preferred sexual stimulus minus the nonpreferred sexual stimulus. For both men and women, a gender-specificity contrast score of zero (indicated with the dashed line) reflects gender-nonspecificity and a higher score reflects greater gender-specificity.

Continuous self-reported arousal. To examine whether the gender-specificity of continuous self-reported sexual arousal varied with order of stimulus presentation and/or participant gender, I conducted a 2 (Stimulus Order: Order A – male stimulus first, Order B – female stimulus first) x 2 (Participant Gender: Man, Woman) between-subjects ANOVA. The dependent variable was gender-specificity of continuous self-reported sexual arousal (i.e., peak-baseline reported arousal for the preferred sexual stimulus minus peak-baseline reported arousal for the nonpreferred sexual stimulus). There was no significant Stimulus Order by Participant Gender interaction, $F(1, 51) = 2.72, p = .11, \eta_p^2 = .051$, nor was there a significant main effect of Stimulus Order, $F(1, 51) = .009, p = .93, \eta_p^2 < .001$. There was a significant main effect of

Participant Gender, $F(1, 51) = 44.75, p < .001, \eta_p^2 = .47$, such that the gender-specificity of men's change in continuously-reported sexual arousal ($M = 49.15, SD = 28.09$) was significantly greater than the gender-specificity of women's change in continuously-reported sexual arousal ($M = 1.89, SD = 24.85$), $p < .001, d = 1.78$. Of note, the standard deviations for continuous self-reported arousal were quite large; despite this, the distributions were not substantially skewed and the pattern of results was identical for pre/post-stimulus self-reported arousal, which had smaller standard deviations.

Finally, I conducted t -tests for men and for women to examine whether the gender-specificity of changes in continuous self-reported sexual arousal (across stimulus orders) significantly differed from zero. The gender-specificity of men's changes in continuously-reported arousal significantly differed from zero, $t(26) = 9.09, p < .001$, indicating that men's self-reported arousal was significantly gender-specific. For women, the gender-specificity of changes in continuously-reported arousal did not significantly differ from zero, $t(27) = 0.40, p = .69$, indicating that women's self-reported arousal was not significantly gender-specific (see Figure 7).

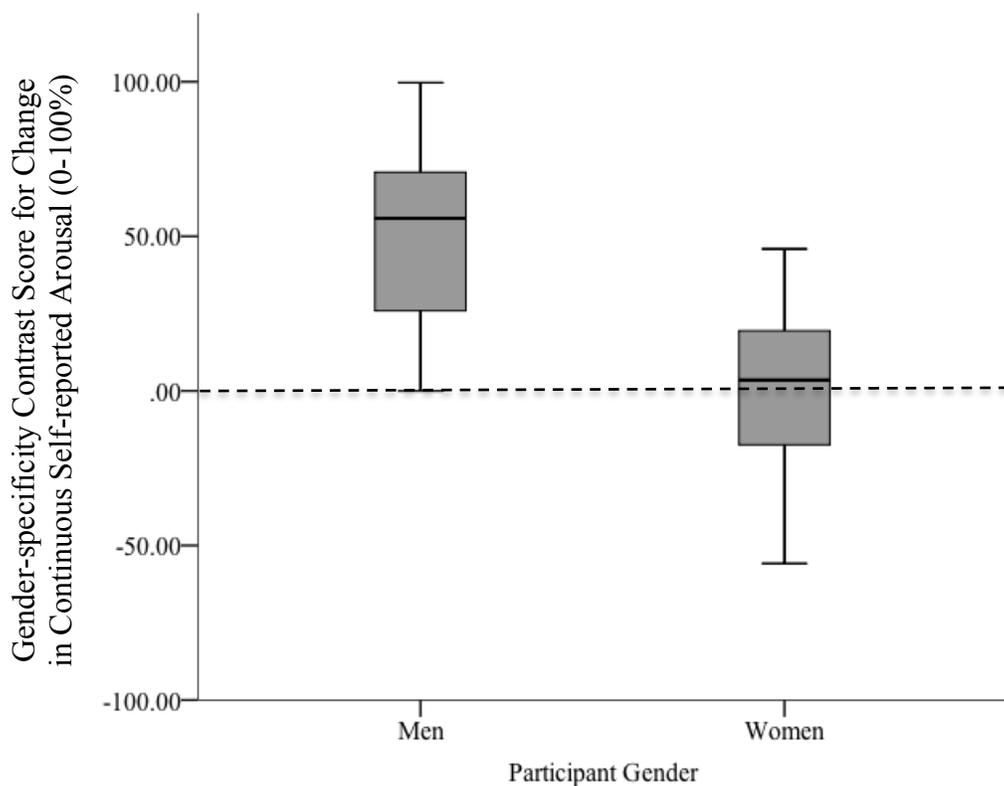


Figure 7. Boxplots reflecting the gender-specificity of men’s and women’s changes in continuous self-reported sexual arousal. Gender-specificity refers to the difference in response (where a response was computed as peak minus baseline) to the preferred sexual stimulus minus the nonpreferred sexual stimulus. For both men and women, a gender-specificity contrast score of zero (indicated with the dashed line) reflects gender-nonspecificity and a higher score reflects greater gender-specificity.

Relationship Between Psychophysiology Measures

To examine the relationship between the psychophysiology measures included in the current study, I computed Pearson or Spearman correlations between changes in genital temperature, VPA, PPG, and continuous self-reported arousal (i.e., peak minus baseline) for each stimulus (see Table 7). Note that these analyses reflect between-subject correlations of change scores within individual stimulus categories, which may account for the relatively low correlations between genital measures and self-reported arousal. For example, evaluating the agreement between genital responses and self-reported sexual arousal within-subjects across

diverse stimulus categories typically results in greater levels of sexual concordance (Chivers et al., 2010); this level of analysis was beyond the scope of the current thesis.

Table 7

Relationship Between Psychophysiology Measures

	Women		Men	
	Change in VPA (mV)	Change in Reported Arousal	Change in Circumference (mm)	Change in Reported Arousal
Change in Genital Temperature (°C)				
Neutral Stimulus	$r = .51^\dagger$	$\rho = -.12^{ns}$	$\rho = .44^*$	$\rho = .02^{ns}$
Male Sexual Stimulus	$\rho = .55^*$	$\rho = -.06^{ns}$	$\rho = .47^*$	$\rho = .32^{ns}$
Female Sexual Stimulus	$r = .70^{**}$	$r = .41^*$	$r = .18^{ns}$	$r = .10^{ns}$
Change in Reported Arousal				
Neutral Stimulus	NA		$\rho = .25^{ns}$	
Male Sexual Stimulus	$r = -.19^{ns}$		$\rho = .46^*$	
Female Sexual Stimulus	$r = -.09^{ns}$		$r = -.15^{ns}$	

Note. Change scores represent peak minus baseline for each variable. Reported arousal refers to continuous self-reported arousal (0 - 100%). Pearson correlations (r) were computed for analyses including normally-distributed variables while Spearman correlations (ρ) were computed for analyses including at least one skewed variable. One correlation could not be computed because the values of one variable were constant; specifically, for those women in the VPA analyses, changes in continuous self-reported arousal were all equal to zero for the neutral stimulus.

** $p < .01$ * $p < .05$ $^\dagger 0.05 < p < .10$ $^{ns} p > .10$

To visually demonstrate the relationship among the psychophysiological measures employed in this study, I plotted data across the preferred sexual trial of a fairly representative female participant (Figure 8) and male participant (Figure 9).

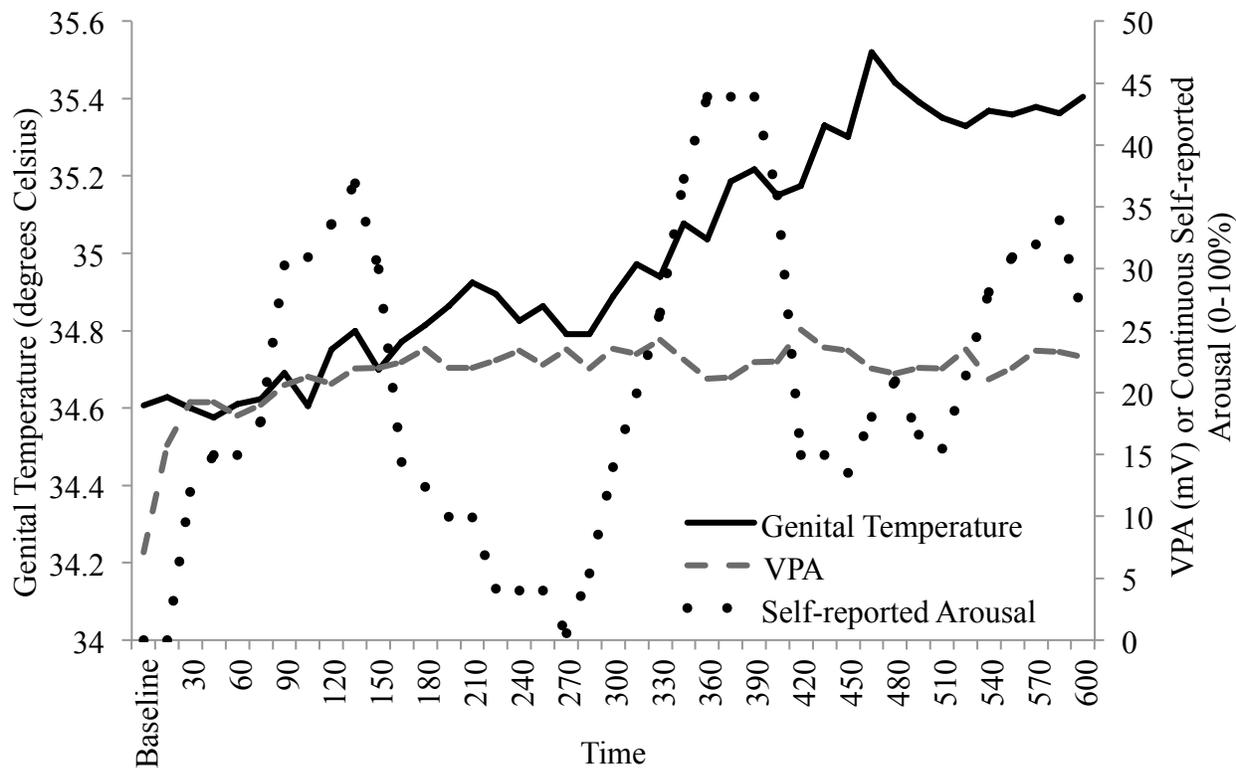


Figure 8. One woman's genital temperature (degrees Celsius; primary y-axis), VPA (mV; secondary y-axis), and continuous self-reported arousal (0-100%; secondary y-axis) across time during the preferred sexual trial (male sexual stimulus). In this figure, the participant's responses were averaged every 15 seconds, yielding 40 bins across the 600-second (10-minute) trial. Baseline refers to the pre-trial baseline period, immediately prior to stimulus onset.

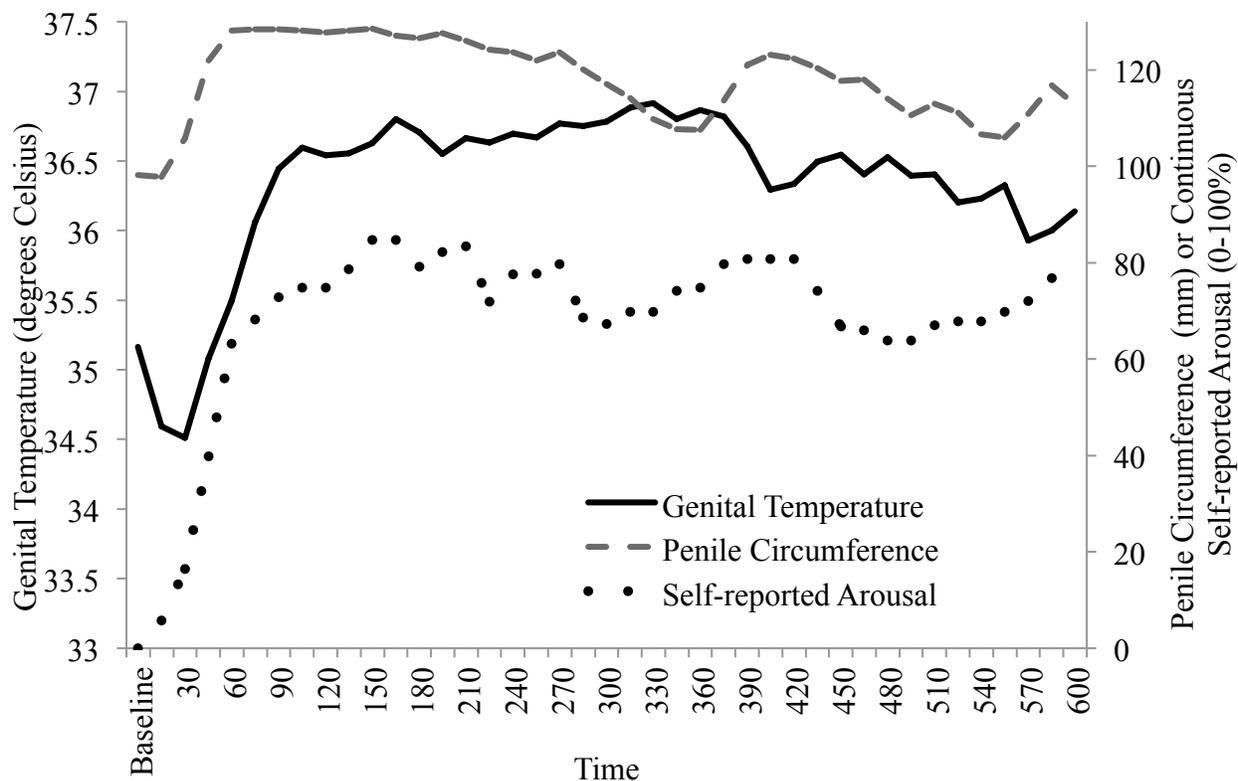


Figure 9. One man's genital temperature (degrees Celsius; primary y-axis), penile circumference (mm; secondary y-axis), and continuous self-reported arousal (0-100%; secondary y-axis) across time during the preferred sexual trial (female sexual stimulus). In this figure, the participant's responses were averaged every 15 seconds, yielding 40 bins across the 600-second (10-minute) trial. Baseline refers to the pre-trial baseline period, immediately prior to stimulus onset.

As a post-hoc ancillary analysis, I assessed whether time to peak response during the preferred sexual trial significantly differed between men and women for each genital measure. This analysis provided additional information to elucidate whether these measures may assess similar physiological processes (i.e., earlier versus later sexual responses) in men and women. As shown in Table 8, on average, men reached peak genital temperature during their preferred sexual trial significantly more quickly than women, and women reached peak responding significantly more quickly with VPP than men did with PPG. I also evaluated whether time to peak response during the preferred sexual trial significantly differed across VPP and thermography (for women) and across PPG and thermography (for men). These analyses

addressed whether the different genital measures may assess different stages of sexual responding (i.e., earlier versus later responding). Time to peak response was significantly earlier when genital responses were assessed with VPP compared with thermography ($M = 445.0$, $SD = 116.99$; subset of 15 participants with available VPP data), $t(14) = 14.04$, $p < .001$, $d = 5.04$, and with PPG compared with thermography, $t(24) = 2.97$, $p = .007$, $d = 0.70$.

Table 8

Time to Peak Response (in seconds) during Men's and Women's Preferred Sexual Stimulus for each Genital Measure

	Men's Time to Peak $M (SD)$	Women's Time to Peak $M (SD)$	Independent-samples t -test
Thermography	350.20 (169.79)	441.56 (149.78)	$t(50) = 2.06$, $p = .045$, $d = 0.57$
PPG or VPP	222.06 (196.67)	20.72 (22.24)	$t(25.02) = 5.07$, $p < .001$, $d = 1.28$

Note. This table demonstrates time to peak genital temperature (for thermography), VPA (for VPP; women only), and penile circumference (for PPG; men only), where the entire trial was 600s in length (10-minutes).

Chapter 4:

Discussion

This was the first study to evaluate gender-specificity of sexual arousal in androphilic women and gynephilic men using thermal imaging and concurrent measures of VPP (in women) and PPG (in men). Using this methodology allowed for the assessment of gender-specificity using a genital measure with the same output for both women and men (thermal imaging) and allowed a comparison of patterns of response between different sexual arousal measures. This study also allowed for the assessment of gender-specificity of later-stage sexual responses by using fairly lengthy stimuli and by assessing genital temperature, which changes relatively slowly in women (Henson & Rubin, 1978; Payne & Binik, 2006). Across all genital and self-report measures, men's sexual responses were gender-specific, such that they had significantly greater responses to sexual stimuli depicting women compared to men. Conversely, women's genital responses and self-reported arousal were gender-nonspecific, such that they did not have significantly greater responses to sexual stimuli depicting men compared to women. Further, when men and women were directly compared using thermography and self-report measures, men's degrees of gender-specificity of sexual responses were significantly greater than women's, on average, indicating that men tended to have more gender-specific sexual responses compared to women. We also found that, across measures, women's responses to their nonpreferred sexual stimulus were significantly greater than their responses to the neutral stimulus, whereas men's sexual responses did not significantly differ between these stimulus categories.

Gender-specificity of Sexual Arousal in Women and Men

Our findings revealed that patterns of gender-specificity of women's and men's genital responses were consistent across measures. Men's changes in penile circumference and changes

in genital temperature were gender-specific, consistent with a body of literature suggesting that gynephilic men respond significantly more to sexual stimuli depicting women compared to sexual stimuli depicting men (Barr & McConaghy, 1971; Chivers et al., 2004, 2007; Chivers & Timmers, 2012; Sakheim et al., 1985; Suschinsky et al., 2009). Conversely, women's changes in internal vaginal vasocongestion (assessed with VPP) and changes in genital temperature were gender-nonspecific, consistent with findings that androphilic women's genital responses are not typically significantly greater to sexual stimuli depicting men compared to sexual stimuli depicting women (e.g., Chivers et al., 2004, 2007; Chivers & Timmers, 2012; Suschinsky et al., 2009). In addition, when comparing men and women directly on the same scale (degrees Celsius), men were significantly more gender-specific in their genital responses than women. The convergence of findings across genital measures suggests that the gender difference in gender-specificity of sexual responding is robust and unlikely accounted for by limitations of each measure or by measurement artifacts. Further, the results of this thesis suggest that the gender difference in gender-specificity of genital responses extends beyond early-stage sexual responding to slower, later-stage changes in genital temperature.

Consistent with previous research (e.g., Chivers et al., 2004, 2007), I found that men's self-reported arousal was gender-specific. In terms of women's self-reported arousal, findings were contrary to the prediction that women would show gender-specific reported arousal levels (e.g., Chivers et al., 2004; Chivers & Timmers, 2012; Schmidt, 1975), but were consistent with some evidence that women report gender-nonspecific sexual arousal (Bossio et al., 2013; Chivers et al., 2007). The mixed findings in the literature regarding women's relative levels of self-reported arousal to preferred and nonpreferred sexual stimuli suggest that women's subjective arousal

may be particularly sensitive to certain stimulus features that have differed among past studies and have yet to be elucidated.

It is evident that, for both self-reported sexual arousal and genital responses, gender cues are highly relevant in affecting men's sexual responses but do not appear to be the most potent feature influencing women's sexual responses. Indeed, women's sexual responses have been shown to vary based on contextual cues such as relationship context (Chivers & Timmers, 2012) and intensity of sexual activity, more so than they typically vary based on gender cues (e.g., Chivers et al., 2007). A recent study highlighted the important role of contextual factors in women's sexual responding by presenting gynephilic men and androphilic women with images of aroused genitals only (i.e., limited contextual cues; Spape, Timmers, Yoon, Ponseti, & Chivers, accepted). Spape et al. (accepted) found that both men's and women's genital and self-reported arousal were gender-specific, indicating that gender-nonspecificity of women's sexual responses to more complex sexual stimuli likely reflects the importance of contextual cues in women's sexual responses.

Evidence that gender cues are more relevant in predicting men's sexual responses compared to women's is somewhat perplexing, given that it would seem to be evolutionarily adaptive for both men and women to respond most to sexual stimuli of their opposite gender. One proposed explanation for the gender difference in gender-specificity of genital responses is that it may be adaptive for women to exhibit an automatic genital response to the presence of both preferred and nonpreferred sexual cues, as this would lead to vaginal lubrication which would protect the body from damage to the reproductive tract in the case of sexual assault (Chivers, 2005; Laan, 1994; Laan & Janssen, 2007; Suschinsky & Lalumière, 2011b; van Lunsen & Laan, 2004). While this hypothesis provides a compelling explanation for the gender-

nonspecificity of women's early genital responses, it is likely that non-automatic processes are also involved (i.e., later-stage responses) particularly given that women's genital responses and self-reported arousal were gender-nonspecific in the current study, which used lengthy sexual stimuli and assessed relatively slow changes in women's genital temperature.

An information-processing model of sexual response may help explain findings of the gender difference in gender-specificity of sexual responses extending beyond early-stage genital responding. According to an information-processing model, erotic stimuli are processed in several stages each involving the integration of physiological and cognitive responses (Geer et al., 1993; Janssen et al., 2000). Janssen et al. (2000) suggest that a stimulus is encoded and matched with memory on a mainly automatic level. If a stimulus is matched with a sexual meaning in memory, it is appraised as sexual, it triggers a genital response, and this process directs further attention toward the stimulus. Both a genital response and the awareness of becoming sexually aroused feed back into stimulus processing, directing further attention toward the stimulus, leading to stronger or sustained genital and subjective sexual responses. Janssen et al. (2000) propose that genital responses are associated with automatic processing (implicit memory) whereas subjective sexual responses are associated with conscious appraisal (explicit memory).

Men and women may differ in how they process sexual stimuli, which may explain the gender difference in gender-specificity of arousal. Sexual stimuli of one's nonpreferred gender may trigger more negative affect in gynephilic men than in androphilic women (e.g., Israel & Strassberg, 2009; Mahaffey, Bryan, & Hutchison, 2005). Same-gender sexual relations among men may be less socially sanctioned than they are among women, which may interfere with gynephilic men's appraisal of nonpreferred sexual stimuli as sexual, thus interfering with sexual

response. Nonpreferred sexual stimuli may therefore generate greater sexual meaning in women than in men. Consistent with this hypothesis, Snowden and Gray (2013) found that, using an implicit sexual association task, gynephilic men had strong sex-related appraisals of pictures of women and no sex-related appraisals of male stimuli, whereas androphilic women had equal sex-related appraisals of male and female stimuli.

According to the information-processing model, a stimulus must be appraised as sexual to initiate a sexual response and a positive feedback loop between genital response, attention to sexual cues, and subjective sexual arousal (Janssen et al., 2000). There is considerable evidence that men and women differ in their visual attention to preferred and nonpreferred sexual stimuli. Studies of viewing time, gaze patterns, and distractibility have shown that gynephilic men tend to look longer and more often at stimuli depicting women compared to men and tend to be less distractible when viewing women, whereas androphilic women tend to divide their attention more evenly between stimuli of women and men (Israel & Strassberg, 2009; Lykins, Meana, & Strauss, 2008; Wright & Adams, 1999). A recent study also found that men's self-reported levels of attention to sexual stimuli were gender-specific, whereas women's self-reported levels of attention were gender-nonspecific (Huberman, Maracle, & Chivers, in press). Further, Huberman et al. (in press) found that the degree of gender-specificity of self-reported attention partially mediated the predictive relationship between the gender-specificity of genital responses and the gender-specificity of self-reported arousal, though this mediation was only significant in men, not in women.

The aforementioned findings regarding men's and women's relative levels of attention to and appraisals of preferred and nonpreferred sexual stimuli may help explain the results of the current study, within the context of an information-processing model of sexual response.

Specifically, the current study assessed relatively later-stage sexual responses by using longer erotic stimuli and by assessing relatively slow changes in genital temperature, and replicated findings of a gender difference in gender-specificity of genital responses and self-reported sexual arousal. Together with the information-processing model, this fits with evidence that appraisals of and attention to sexual stimuli are typically gender-specific in men and gender-nonspecific in women. Future research investigating the specific mechanisms involved in the gender difference in gender-specificity of sexual response may elucidate this phenomenon further.

The Role of Context: Order Effects

As described earlier, gender seems to be a highly potent cue for men's sexual responses, however for women, contextual factors may be more relevant at predicting sexual responses compared to gender cues (e.g., Chivers & Timmers, 2012; Spape et al., accepted). In the current study, one contextual factor that varied across participants was the order of stimulus presentation. Although we did not expect to find an effect of stimulus order on magnitude of sexual arousal or degree of gender-specificity of sexual arousal, we counterbalanced stimulus orders and assessed whether there were differences among individuals with different orders. With both VPP and thermography, women's genital responses to the male sexual stimulus were significantly greater when presented with this stimulus at the start of the psychophysiology session rather than at the end (i.e., after having seen the female sexual stimulus), whereas women's genital responses to the female sexual stimulus and to the neutral stimulus did not significantly differ by order of stimulus presentation. Women presented with both stimulus orders had gender-nonspecific genital responses, in that their responses were not significantly greater to the male compared to the female sexual stimulus; however, the degree of gender-specificity of women's genital responses (i.e., gender-specificity contrast score) was somewhat

greater (i.e., large, nonsignificant effects) when women were presented with the male sexual stimulus first rather than last for both VPP ($d = 1.07$) and thermography ($d = 0.73$; this pairwise comparison was not reported in the results because there was no significant Stimulus Order by Participant Gender interaction for thermography). In fact, for both genital measures, women presented with Order B (female stimulus first) responded more to the female sexual stimulus compared to the male sexual stimulus, with this difference being statistically significant with thermography. For self-reported arousal and for men's genital responses, there were no significant or large effects of stimulus order on degree of gender-specificity or on magnitude of genital responses.

These findings provide further support for the notion that women's genital responses may be impacted by contextual factors, whereas for men, gender cues are most relevant in predicting sexual responses. Given that this study was not designed to assess effects of stimulus order on sexual response, we do not have self-report data to elucidate the mechanism behind the order effect; furthermore, our analyses were under-powered to detect a significant difference between stimulus orders on degree of gender-specificity of women's genital responses assessed with VPP (48% power) or thermography (45% power). It would be important for a future study to examine this research question directly with an increased sample size.

Sensitivity of Thermography versus PPG

Contrary to my hypothesis, thermography was not more sensitive than PPG at detecting men's early genital responses. With both measures, men's genital responses were not significantly greater to their nonpreferred gender (male sexual stimulus) compared to the neutral stimulus. Although the information-processing model suggests that men would have some level of an automatic genital response to any sexual stimulus (Janssen et al., 2000), neither of the

measures used in the current study appeared sensitive enough to detect such a response. Despite this, men's penile circumference and genital temperature changed somewhat in response to both the male sexual stimulus (change in circumference: $M = 6.34$, $SD = 8.02$; change in genital temperature: $M = 0.62$, $SD = 0.65$) and the neutral stimulus (change in circumference: $M = 5.01$, $SD = 6.20$; change in genital temperature: $M = 0.48$, $SD = 0.40$). This suggests that men may have experienced some sexual responses during both of these stimuli, limiting our ability to detect early sexual responses during the male sexual stimulus when compared with the neutral stimulus in the current study. Given that the neutral stimulus was void of sexual content, men's low-level responses during this stimulus might be explained by their engaging in sexual fantasy, thinking about the sexual stimulus they were previously presented with, or thinking about the sexual stimulus that they might be presented with next. There is evidence that a measure of changes in penile volume (volumetric phallometry) is more sensitive at discriminating low-level genital responses in men compared to PPG, likely because penile circumference decreases briefly at the start of men's sexual response (e.g., Freund et al., 1974; Kuban et al., 1999). Given that thermography does not rely on changes in penile circumference, it would be useful to continue examining men's early changes in genital temperature. For example, a future investigation with thermography could examine men's responses to a male sexual stimulus compared to a nonsexual video presented prior to any sexual stimulus, in order to reduce a confounding variable of having recently viewed erotica. In the current study, the baseline trial was used for temperature stabilization and therefore could not be used as an experimental trial.

Associations Between Psychophysiology Measures

Throughout this thesis, I draw comparisons between patterns of sexual response observed across the various psychophysiological measures employed; therefore, I evaluated the

relationship among these measures by computing between-subject correlations. For women, changes in genital temperature were significantly positively correlated with changes in VPA for each stimulus (r_s or $r_hos > .50$). By comparison, Prause and Heiman (2009) found that, using within-subject correlations, VPA and labial temperature (assessed with surface thermistors positioned on the labia minora) were not significant correlated for a low-intensity sexual stimulus (mean $r = .9$) or a high-intensity sexual stimulus (mean $r = 0$). Likewise, Henson and Rubin (1978) found that, when evaluating within-subject correlations between changes in genital temperature at the labia minora (assessed using surface thermistors) and changes in vaginal blood volume (assessed using VPP; note that vaginal blood volume is a different output than VPA used in the current study), the correlation was not significant when pooled across subjects ($r = .05$). There was, however, a significant positive relationship in most women ($r_s > .60$ in six women, $r_s < .10$ in two women; Henson & Rubin, 1978). Overall, changes in women's genital temperature and changes in vaginal blood flow appear to be related, though the strength of this relationship may vary based on the output measure (i.e., VPA or vaginal blood volume) or the type of correlation computed and may vary across women.

For men, changes in genital temperature in this study were significantly positively correlated with changes in penile circumference for the neutral stimulus and the male sexual stimulus ($r_hos > .43$); however, there was a weak and nonsignificant correlation for the female sexual stimulus ($r = .18$). This finding was surprising considering evidence of within-subject changes in genital temperature (assessed using surface thermistors positioned on the dorsal side of the penile shaft) being significantly positively correlated with changes in penile circumference (assessed using PPG) during an erotic film ($r_s > .76$; Webster & Hammer, 1983). It is possible that this discrepancy is due to the use of between-subject correlations in the current study

analyses, rather than within-subject analyses. Another possibility is that during a preferred erotic stimulus, changes in penile circumference are not highly correlated with changes in genital temperature at the region of interest (ROI) chosen in the current study (region of the shaft near the base of the penis). This ROI was chosen as previous research validating thermography as a measure of sexual arousal in men assessed changes in genital temperature at the penile shaft (Kukkonen et al., 2007, 2010). In particular, a region of the shaft near the base of the penis was chosen to maximize our ability to capture men's early sexual responses and to be as comparable as possible with women's labia majora, which is also located very close to the body.

Observations during participant testing revealed that, during sexual arousal, the base of the penile shaft tended to increase in temperature initially followed by even more substantial increases in temperature at the glans of the penis. Future research investigating genital temperature changes along the shaft of the penis versus glans of the penis is warranted. It is possible that genital temperature changes at the base of the penile shaft reflect relatively early-stage sexual responding in men, which could explain their correlation with changes in circumference during the neutral and male sexual stimuli. Changes in temperature at the glans, on the other hand, may reflect later-stage sexual responding and might be more strongly correlated with changes in circumference during a preferred erotic stimulus compared to changes in temperature near the base of the penis. This hypothesis could be tested in future investigations with the current dataset, but was beyond the scope of the current thesis.

Finally, it was surprising that changes in self-reported arousal were generally not highly correlated with changes in genital responding. For men, changes in self-reported arousal were only significantly correlated with changes in circumference for the male sexual stimulus ($r_{ho} = .46$) and, for women, changes in self-reported arousal were only significantly correlated with

changes in genital temperature for the female sexual stimulus ($r = .41$). For all other comparisons between self-reported arousal and genital responses across stimuli there were weak, nonsignificant between-subject correlations. A meta-analysis found that for women, the average between-subject correlation between measures of self-reported sexual arousal and VPA was .27 while this correlation was .55 for thermography (Chivers et al., 2010). For men, the meta-analysis found an average between-subject correlation between measures of self-reported sexual arousal and genital responses (assessed mainly with PPG, with a few studies involving thermography) of .62 (Chivers et al., 2010). The weaker correlations observed in the current study may partially reflect that the correlations were computed using the primary dependent variable in this study - change scores (peak – baseline). Change scores involve less variability than, for example, raw peak or mean, and thus we may expect weaker correlations. Further, a more optimal test of sexual concordance would involve within-subject correlations across stimulus categories, in order to increase variability in sexual response levels. Indeed, Chivers et al. (2010) found that sexual concordance was significantly greater in both men and women using within-subject correlations rather than between-subject correlations and that, for women, sexual concordance was significantly greater when studies involved greater variation in stimulus content or modality. Computing within-subject correlations between genital responses and self-reported arousal was beyond the scope of the current thesis, in which sexual concordance was not a primary research question. Future research is warranted to more thoroughly investigate sexual concordance with thermography, VPP, and PPG.

Limitations

Although I controlled for many potential confounding variables in designing this study, there were several limitations. First, while thermal imaging produces the same output measure

for men and for women (degrees Celsius), it is important to recognize that this measure does not necessarily assess homologous processes in men and women given the different anatomies of the penis and vulva. Indeed, Kukkonen et al. (2010) found that men's initial genital temperatures were lower than women's and increased more than women's during an erotic film; men and women reached peak temperature at similar time points, however, suggesting similar overall processes of sexual responding (Kukkonen et al., 2010). In the current study, men and women did not significantly differ in their baseline genital temperatures and men reached peak genital temperature during their preferred sexual stimulus significantly earlier than women; these slight discrepancies with the findings of Kukkonen et al. (2010) may reflect the fact that the ROI on the penile shaft was somewhat closer to the man's body in the current study (near the base of the penis) as compared with the region used by Kukkonen et al. (mid-way along the shaft).

Consistent with the results of Kukkonen et al. (2010), we found that men's genital temperature increased significantly more than women's during the testing session. As noted by Kukkonen et al. (2007, 2010), the capillaries of the labia majora likely increase in temperature less substantially than the dorsal artery of the penis, which runs throughout the penile shaft.

Therefore, changes in temperature in the shaft of the penis may not necessarily be equivalent to changes in temperature at the labia majora. An improved comparison between men and women would involve assessing ROIs at the glans of the penis and the clitoris, as these regions are homologous. Assessment of temperature change at the glans may be particularly pertinent given the hypothesis purported in the previous section, suggesting that changes in temperature at the glans might reflect men's later-stage sexual responding.

Another limitation of this study relates to volunteer bias, a particular concern in all sexual psychophysiology research. Volunteers in sexual arousal studies tend to be more sexually liberal

than non-volunteers, including reporting more positive sexual attitudes, less sexual guilt, more sexual experiences, and more exposure to erotica (Strassberg & Lowe, 1995; Wolchik, Braver, & Jensen, 1985). As a result, patterns of sexual response observed in sexual psychophysiology studies may not necessarily be generalizable to the population. Further, Strassberg and Lowe (1995) found that as the “invasiveness” of sexuality studies that were described increased (e.g., from completing a survey regarding sexuality, to viewing erotica in the laboratory, to participating in a sexual psychophysiology session), fewer individuals reported being willing to participate in the study. The current study involved two concurrent measures of physiological sexual responding and may therefore have been perceived by potential participants as even more invasive than a typical sexual psychophysiology study. Measures of VPP and PPG may be perceived by participants as invasive because they involve direct contact with the genitals, while thermal imaging may be perceived as invasive as it involves a close image being captured of one’s exposed genitals. These measures have never been directly compared for volunteer biases or levels of perceived invasiveness, however, it is likely that individuals who were willing to participate in this study were fairly highly sexually liberal and comfortable with their sexuality. Given that the patterns of gender-specificity observed in women and men in this study were consistent with those observed in past studies, it is unlikely that the concurrent measures used in this study attracted a substantially different type of sample with different response patterns than typical sexual psychophysiology studies. As an additional potential limitation related to this study’s sample, I found that male participants were significantly older than female participants. Given that the overall patterns of results observed were consistent with a body of past literature, which has included men and women of various ages, it is unlikely that the age difference between men and women in this sample substantially influenced the pattern of results.

Lastly, it is possible that some participants were distracted by the sexual psychophysiology measures employed in this study. There is evidence that distraction can impede sexual response; for example, presenting men and women with a dichotic listening task or with arithmetic during a sexual stimulus typically leads to lower levels of genital responses and self-reported sexual arousal (Adams, Haynes, & Brayer, 1985; Elliott & O'Donohue, 1997; Geer & Fuhr, 1976; Saleminck & van Lankveld, 2006). Moreover, Prause, Cerny, and Janssen (2005) found that women's reported levels of discomfort with a vaginal or labial photoplethysmograph were strongly positively correlated with the degree to which they reported the instruments distracted them from the film. As summarized in Table 2 (Page 22), most participants reported that each of the physiological measures was "not at all" or "a little bit" distracting (thermography: $n = 51$, 94.4%; PPG: $n = 26$, 96.3%; VPP: $n = 21$, 77.8%) or uncomfortable (thermography: $n = 51$, 94.4%; PPG: $n = 27$, 100%; VPP: $n = 26$, 96.2%). The somewhat elevated proportion of women reporting that the vaginal gauge was "somewhat" distracting ($n = 3$; 11.1%) or "definitely" distracting ($n = 3$; 11.1%) likely reflected women feeling as though the gauge would fall out, because women's legs were spread apart in this study to allow the thermal imaging camera to capture the genital region. Participants taped to the chord of the gauge to their inner thigh to maximize its stability and their comfort and were warned in advance that it may feel as though the gauge is slipping at times. Given the low number of participants reporting being substantially distracted by the vaginal gauge, and by the physiological measures in general, it is unlikely that participants' sexual responses were substantially influenced by distraction.

Future Directions

The results of this thesis inform many important directions for future research. First, it would be pertinent to further evaluate the associations among the psychophysiological measures employed. This could involve time-series analyses to assess the time course of sexual responses assessed with thermography, plethysmography, and self-report, including the onset of sexual response as well as return-to-baseline. The use of within-subject correlations across diverse sexual stimuli and across binned time segments within stimuli would further elucidate the relationship between these different measures of sexual response. An examination of sexual concordance with VPP compared with thermography would be particularly important, given evidence that sexual concordance tends to be greater when genital responses are assessed with thermography compared with VPP (Chivers et al., 2010; Henson & Rubin, 1978; Prause & Heiman, 2009). There have been limited studies exploring this research question and a more thorough investigation is warranted given that sexual concordance in women appears to be related to sexual dysfunction. Specifically, women with greater sexual difficulties tend to have lower levels of sexual concordance (Brotto, Seal, & Rellini, 2012; Chivers et al., 2010). Further examination of women's sexual concordance assessed with VPP versus thermography could have important clinical implications, including an enhanced understanding of sexual dysfunction in women as well as increased knowledge regarding the most appropriate treatment outcome measures.

As another future research direction, it would be interesting to evaluate sexual concordance and gender-specificity of sexual arousal at different points throughout stimulus presentation. Kukkonen et al. (2007) found that while genital temperature and self-reported arousal were significantly positively correlated in men and women during the middle portion and

end portion of a 15-minute erotic stimulus, these measures were not significantly correlated in women during the first 5-minutes of the film. It would therefore be relevant to evaluate whether the degree of gender-specificity, in addition to sexual concordance, varies in men and women at different points throughout sexual stimuli; this would allow a more thorough investigation of gender-specificity of earlier versus later sexual responding.

Finally, it would be important for a future study to evaluate genital temperature changes in men and women using ROIs at the glans of the penis and at the clitoris. The use of these homologous regions would allow improved comparisons between men and women. As well, as noted earlier, the glans might provide important information regarding men's later-stage sexual responses. Creating ROIs at the glans and clitoris is limited, however, as these regions are not always accessible in a thermal image. For men, it is difficult to predict how a penis may move when it becomes erect and the glans of the penis may therefore leave the image capture region of the thermal imaging camera. For women, the accessibility of the clitoris depends on anatomy, including size of the labia minora and presence of pubic hair. For some men and women, however, these regions would be accessible and data from a subset of participants could be used to address this research question. A further limitation to assessing temperature change at the glans is that this area moves more substantially with sexual arousal than the base of the penis, making it more challenging to maintain consistent positioning of a ROI. Prior to the current study, there was no automated way to map an ROI to a thermal image, therefore, it has been necessary for researchers to manually adjust ROIs to account for participant movement (as noted by Kukkonen, 2014). With the data cleaning software employed in the current study, ROIs can be fairly simply mapped to a thermal image to allow much simpler and more automated tracking and adjustments, making it entirely feasible to assess temperature change at the glans in future

research. Therefore, an investigation of patterns of sexual response at the glans and clitoris is warranted, including examination of sexual concordance, gender-specificity, and time course of sexual responding.

Conclusions and Implications

In the current thesis, I found that, across multiple psychophysiological measures of sexual arousal, gynephilic men's sexual responses were gender-specific and androphilic women's sexual responses were gender-nonspecific. While previous research on gender-specificity of sexual arousal primarily used measures of VPP and PPG to assess genital responses, I found a consistent pattern of results using thermography, which offers the same unit of output (degrees Celsius) for men and women. Considering that measures of thermography, VPP, PPG, and self-report of arousal each carry unique advantages and limitations, the results of this thesis suggest that the gender difference in gender-specificity of sexual arousal is robust, is unlikely due to measurement artifacts, and extends to later-stage sexual responding. These findings add to a body of literature aimed at an increased understanding of men's and women's sexual response patterns, including the cues that are most relevant for sexual arousal in women and men.

More broadly, this thesis demonstrates the utility and feasibility of multi-method approaches to understanding complex human phenomena, including sexual arousal patterns. Although methodologically complex, the use of concurrent sexual arousal measures in this study was entirely feasible. Given that sexual arousal is a complex process involving the integration of various physical and emotional responses (e.g., Frijda, 1986; Rosen & Beck, 1988), concurrent measurement provides a more complete understanding of sexual arousal patterns than any one measure alone. This research, therefore, paves the way for future studies aimed at a more nuanced understanding of human sexual response.

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Appendix A:**Questionnaire****Sexuality Questionnaire***Ginger Study*

This questionnaire asks about your personal information, sexual orientation, sexual experiences, sexual attitudes, typical sexual responses to sexual stimuli, and personality characteristics as an adult (since age 18). Each section has directions, in bold type, on how to answer the questions. Please read the directions and questions carefully and either select the answer that most applies to you or enter your answer in the space provided.

If a question does not apply to you, please select or enter NA (not applicable) in the space provided. If you do not feel comfortable answering a question, please draw a slash through it and go to the next question.

When you have finished answering the questionnaire, please put it in the envelope provided. Remember, all of your answers are completely confidential and identified by a participant number only. Your name cannot be linked to your responses. Please answer as honestly as possible.

PLEASE DO NOT WRITE IN THIS AREA

Participant ID #: _____

Date Completed: _____

Initials of Experimenter: _____

Date Data Entered: _____

The following questions ask about your personal information. Please read each question carefully and either place a checkmark in the circle of the answer that best describes you, or write your answer in the space provided. Remember, all of your answers are completely confidential.

1. Participant ID: _____ (completed by experimenter)

2. Gender identification: Please select all that apply.

- Man
 Woman
 Cisgendered: felt gender matched born sex (e.g., born male, identifies as a man)
 Transgendered: felt gender differs from born sex (e.g., born male, identifies as a woman)
 Other: _____

3. Please indicate whether you currently have:

- Male-typical genitalia (penis, scrotum)
 Female-typical genitalia (vulva, clitoris)

4. Age: _____

5. Month and Year of Birth (MM/YY): _____

6. Relationship status:

- | | |
|-------------------------------------|-----------------------------------|
| <input type="checkbox"/> Single | <input type="checkbox"/> Married |
| <input type="checkbox"/> Dating | <input type="checkbox"/> Divorced |
| <input type="checkbox"/> Engaged | <input type="checkbox"/> Widowed |
| <input type="checkbox"/> Common Law | |

7. If you are currently in a relationship please state the length of that relationship (in months): _____

8. Place of birth:

- | | |
|---|--|
| <input type="checkbox"/> Canada | <input type="checkbox"/> Australia |
| <input type="checkbox"/> United States | <input type="checkbox"/> Middle East |
| <input type="checkbox"/> Western Europe | <input type="checkbox"/> Latin/South America |
| <input type="checkbox"/> Eastern Europe | <input type="checkbox"/> Caribbean |
| <input type="checkbox"/> Asia | <input type="checkbox"/> Other (please specify): |
| <input type="checkbox"/> Africa | _____ |

9. What culture do you consider yourself most associated with?

- | | |
|---|--|
| <input type="checkbox"/> Canadian | <input type="checkbox"/> Eastern European |
| <input type="checkbox"/> Québécoise | <input type="checkbox"/> Native American |
| <input type="checkbox"/> American | <input type="checkbox"/> Australian |
| <input type="checkbox"/> Asian | <input type="checkbox"/> Middle Eastern |
| <input type="checkbox"/> African | <input type="checkbox"/> Latin/South American |
| <input type="checkbox"/> Hispanic | <input type="checkbox"/> Caribbean |
| <input type="checkbox"/> Irish/Scottish/Welsh | <input type="checkbox"/> Other (please specify): |
| <input type="checkbox"/> Western European | _____ |

10. Highest level of education completed:

- Completed Grade 8
- Some high school completed (grades 9-11)
- Graduated from high school or equivalent
- Vocational, trade, or business school completed
- Community college (currently attending or completed diploma)
- University (currently attending or completed bachelor's degree)
- Graduate/professional school (e.g., MA, PhD, MBA, MD): attending or completed degree.

11. Are you currently employed at a paid job?

- Yes, full-time
- Yes, part-time
- No, full-time student
- No, full-time homemaker
- No, retired
- No, currently unemployed

12. If yes, what is your current position/title? _____**13. Please indicate your approximate yearly income (CAD or US equivalent).**

- < \$25 000
- \$25 001 - \$50 000
- \$50 001 - \$75 000
- \$75 001 - \$100 000
- \$100 001 plus

14. Did you use any of the following substances or beverages today? Please check all that apply.

- Beverage containing caffeine (e.g. coffee tea Coke Mountain Dew)
- Alcohol
- Marijuana
- Tobacco
- Other recreational drug
- I used none of these substances

15. Do you engage in regular physical activity?

- Yes
 No

16. If yes, how many times per week? _____

17. Did you engage in physical exercise today?

- Yes
 No

18. If Yes, how many hours did you exercise before coming into the laboratory today?

19. Did you take any medications today?

- Yes
 No

20. If Yes, please list:

Women Only:

21. Do you currently use hormonal contraceptives?

- Yes
 No

22. If Yes, please list the name here: _____

23. How long (in days), on average, is your monthly cycle? (From the beginning of one period to the next)? _____

24. How many days do you typically menstruate/bleed for? _____

25. Think back to your last menstrual period. For this period, what was the date of the first day you began menstruating? (e.g., June 27) If you know the day of the week but are not sure about the correct date, please look at the calendar on the table.

26. Are you currently pregnant?

- Yes
 No

The following questions ask about your romantic and sexual attractions, sexual contacts, and sexual identity in adulthood (since age 18). Please read each question carefully and read the options presented after each question. Please check the circle next to the response that best describes you. Remember, all of your answers are completely confidential.

27. Please think about the people you have typically been romantically attracted to. By "romantically" attracted we mean a deep emotional connection that is more than friendship. Would you say that your romantic attractions are toward:

- Women only
- Women mostly, but men occasionally too
- Women mostly, but men frequently (but not more than toward women)
- Women and men about equally
- Men mostly, but women frequently (but not more than toward men)
- Men mostly, but women occasionally too
- Men only
- Prefer not to respond

28. Please think about the people you have typically been sexually attracted to. By "sexually" attracted we mean you experience sexual desire or interest in someone. Would you say that your sexual attractions are toward:

- Women only
- Women mostly, but men occasionally too
- Women mostly, but men frequently (but not more than toward women)
- Women and men about equally
- Men mostly, but women frequently (but not more than toward men)
- Men mostly, but women occasionally too
- Men only
- Prefer not to respond

29. Please think about the people you typically have sexual fantasies about. By a "sexual fantasy" we mean sexual scenarios or daydreams you think about, and may use when masturbating and/or having sex with a partner. Would you say your sexual fantasies are about:

- Women only
- Women mostly, but men occasionally too
- Women mostly, but men frequently (but not more than toward women)
- Women and men about equally
- Men mostly, but women frequently (but not more than toward men)
- Men mostly, but women occasionally too
- Men only
- Prefer not to respond

30. Now, please think about having sexual contact with a man. How sexually interested or excited do you feel by the thought of having sex with a man?

- Not at all
- A little bit
- Somewhat
- Definitely
- Extremely
- Prefer not to respond

31. Keep thinking about having sexual contact with a man. How "turned off" or disgusted do you feel by the idea of having sex with a man?

- Not at all
- A little bit
- Somewhat
- Definitely
- Extremely
- Prefer not to respond

32. Now, please think about having sexual contact with a woman. How sexually interested or excited do you feel by the thought of having sex with a woman?

- Not at all
- A little bit
- Somewhat
- Definitely
- Extremely
- Prefer not to respond

33. Keep thinking about having sexual contact with a woman. How "turned off" or disgusted do you feel by the idea of having sex with a woman?

- Not at all
- A little bit
- Somewhat
- Definitely
- Extremely
- Prefer not to respond

34. Please check any of the following labels that you currently use to think about yourself.

- Heterosexual
- Lesbian or gay
- Bisexual
- Queer
- I do not use a label
- Prefer not to respond
- Other: _____

We would like to understand your experience of participating in this study. Please think about your experience today and select the answer that best describes your experience.

Did you find the vaginal gauge uncomfortable? *(Women only)*

- Not at all
- A little bit
- Somewhat
- Definitely
- Extremely

Did you find the vaginal gauge distracting? *(Women only)*

- Not at all
- A little bit
- Somewhat
- Definitely
- Extremely

Did you find the penile gauge uncomfortable? *(Men only)*

- Not at all
- A little bit
- Somewhat
- Definitely
- Extremely

Did you find the penile gauge distracting? *(Men only)*

- Not at all
- A little bit
- Somewhat
- Definitely
- Extremely

Were you uncomfortable with the thermal imaging camera?

- Not at all
- A little bit
- Somewhat
- Definitely
- Extremely

Did you find the thermal imaging camera distracting?

- Not at all
- A little bit
- Somewhat
- Definitely
- Extremely

Appendix B:
Letter of Information and Consent Form



TITLE OF PROJECT:

Evaluating Specificity of Sexual Arousal with Thermography

BACKGROUND INFORMATION:

You are being invited to participate in a research study sponsored by the Department of Psychology at Queen's University and directed by Dr. Meredith Chivers. The principle investigator for this study is Jackie Huberman, a Master's student working with Dr. Chivers. The study involves measuring your physical and mental sexual arousal responses to sexual and nonsexual films. Participating in this study also involves completing questions about your reactions to the films and a questionnaire about your sexuality.

Your participation will help scientists better understand sexual arousal patterns in men and women, which will provide an enhanced understanding of sexual function and dysfunction.

A trained research assistant will read through this form with you, describe the study procedures in detail, show you the testing room and equipment, and answer any questions you might have. This study has been reviewed for ethical compliance by the Queen's University Health Sciences Research Ethics Board.

DETAILS OF THE STUDY:

The aim of this study is to better understand the association between sexual interests and patterns of sexual responses. This study will also use a new measure of physical sexual response, thermography, which has never been used to address these research questions.

You will not be considered for this study if any of the following apply to you. You:

- 1) Are younger than 18 or older than 50;
- 2) Do not read and write English fluently;
- 3) Occasionally or frequently experience sexual attraction to your same gender (i.e., to women if you are a woman, and to men if you are a man).
- 4) Are equally or about equally sexually attracted to both women and men;
- 5) Are exclusively or predominantly sexually attracted to individuals of your same gender (i.e., gay, lesbian);
- 6) Have never seen erotic material before (i.e., pornography, erotic magazines);
- 7) Have current or past mental illness or substance abuse;

- 8) Are using medications that may influence sexual response;
- 9) Have a sexually transmitted infection;
- 10) Have difficulty becoming or staying sexually aroused;
- 11) *Women only*: are pregnant, or have been pregnant in the last six months;
- 12) *Women only*: your menstrual cycle is irregular (shorter than 25 days or longer than 32 days).

Your participation in this study involves participating in one testing session, which will take place at the Sexuality and Gender Lab, Department of Psychology, Queen's University and is expected to last between 2.5 and 3 hours. The testing session includes the following procedures:

1) Sexual Arousal Assessment: If you agree to participate in the study, the first part of the study would involve you watching sexual and nonsexual films on a TV monitor in a private room while your physical and mental sexual arousal is measured. You would rate your mental sexual arousal, or how "turned on" you feel, as well as other emotions, using a keypad. You would also briefly describe your experience of each video using pen and paper. We would measure your physical sexual arousal while you watch the films using two instruments:

- a) A thermal imager, a camera that measures infrared heat that is emitted by your body.
- b) *(Women)* a vaginal gauge, which is a small, plastic, tampon-shaped device.
(Men) a penile gauge, which is a small rubber band that goes around the middle of your penis; it measures changes in your penis during erection.

In a private room, you would undress from the waist down and sit in a comfortable chair with your legs spread apart.

(Women) You will insert the gauge into your vagina yourself. Most participants say the probe is not uncomfortable and that they can't tell they are using the gauge once they have inserted it.

(Men) You will attach the gauge yourself. Most participants say the gauge is not uncomfortable and that they can't tell they are wearing it once it is on.

The thermal imager would be positioned in front of you and would measure the temperature of your pelvic/genital region; this requires no direct physical contact. You would be presented with a 10-minute film depicting nature scenes, followed by three 10-minute films shown in a random order: a sexual video depicting men, a sexual video depicting women, and two neutral videos depicting nature scenes. When you have finished watching all the videos, you will remove the gauge and get dressed. The experimenter will guide you through this part of the study from a separate room, using messages sent over a computer monitor. You will also be able to communicate with the experimenter, if needed, through an intercom.

2) Questionnaires: The second part of this study will consist of a questionnaire asking about your personal information (age, marital status, education, household income, ethnicity, employment status, medication, substance use, mental health history, and current sexual health), sexual experiences, sexual orientation, sexual responses to sexual stimuli, sexual functioning, sexual attitudes, and personality characteristics. You will complete this

questionnaire in a private room. This part of the study will take about a 30-45 minutes. After you complete the questionnaires, you may view a short nonsexual film and would be asked to report your feelings of sexual arousal after the film.

COMPENSATION:

Upon completion of the study, you will receive \$40 as compensation for your time and study-related expenses such as travel. If the study has to be terminated for scientific reasons, or you decide to stop participation, compensation will be adjusted according to the fraction of the study completed at a rate of \$16.00 per hour.

BENEFITS OF PARTICIPATION:

The information obtained from this study will potentially improve understanding of the processes involved in women and men's sexual arousal. While you may not benefit directly from this study, results from this study will increase our understanding of the sexual psychophysiology of sexual interests.

RISKS OF PARTICIPATION:

There are no known risks from participating in this study. You may, however, feel awkward with the sexual arousal assessment procedure and with the presence of the thermal imager. You may feel awkward watching the sexual videos if you find sexually explicit materials objectionable. You may feel discomfort in answering questions about your sexual history, sexual orientation, and sexual functioning.

The genital gauges are reused and undergo thorough, high-level disinfection between uses. High-level disinfection is a common and safe way of disinfecting instruments made of plastics in hospitals. There is minimal risk from using a genital gauge after it has been disinfected.

CONFIDENTIALITY AND PARTICIPANT RIGHTS:

All information obtained during the course of this study is strictly confidential and your confidentiality will be protected at all times. Coded (ID) numbers will replace all names, and your data will be identified only by this number. There will be one password-protected file linking your name and contact information with your ID number; that password will be available only to the members of the research team working on this study. Identifying data will be stored in locked files and will only be available to the investigators and research assistants involved in this project. You will not be identified in any publication or reports of the study; data will be combined in all reports of this study.

Your participation in this study is completely voluntary. You may withdraw from this study at any time without any consequence.

SUBJECT STATEMENT AND SIGNATURE SECTION:

I, _____ (please print name), have read and understood the information/consent form for this study. I have had the purposes and procedures of this study explained to me by a trained research assistant and I understand what is required for participation in this study. I understand that my participation is voluntary and that I can withdraw my participation at this time. I have been given sufficient time to consider the above information and have had the opportunity to ask questions which have been answered to my satisfaction. I understand the potential benefits and risks associated with participating in this study and understand that my confidentiality will be protected throughout the study. I am voluntarily signing this form. I will retain a copy of this consent form for my information.

Should I have further questions, I understand that I can contact any of the following individuals:

- Jackie Huberman, Principal Investigator, (613-533-6000 ext. 79495; 7jh6@queensu.ca), M.Sc. Student.
- Dr. Meredith Chivers, (613-533-2889; Meredith.Chivers@queensu.ca), Assistant Professor in the Department of Psychology at Queen's University
- Dr. Richard Beninger (613-533-2486; psychead@post.queensu.ca), Head of the Department of Psychology at Queen's University
- Dr. Albert Clark (613-533-6081), Chair of the Queen's University Health Sciences Research Ethics Board

By signing this consent form, I am indicating that I agree to participate in this study

Participant's name	Participant's signature	Date
Person Conducting the Consent Discussion	Person Conducting the Consent Discussion's signature	Date

Please check **ONE** of the following boxes:

- I would like any identifying information destroyed once the study is completed, and I would like to remain anonymous.**
- I agree to let the researchers keep my identifying information on file in the secure lab, and to contact me for participation in future research projects.**

STATEMENT OF INVESTIGATOR:

I, or one of my colleagues, have carefully explained to the participant the nature of the above research study. I certify that, to the best of my knowledge, the participant understands clearly the nature of the study and demands, benefits, and risks involved to participate in this study.

Signature of Principal Investigator

Date

Sexuality and Gender Lab
 Director: Meredith L. Chivers, Ph.D., C.Psych.
 62 Arch Street, Kingston, ON, K7L 3N6

Limits of Confidentiality

All information disclosed during your participation in this research study is confidential and **will not** be disclosed to anyone without your written and informed consent **except** where reporting is required by law, that is –

1. Where there is suspicion that a child or children (that is, an individual who is PRESENTLY under the age of 16) has been or is being abused,
2. Where the research participant is likely to harm her- or himself unless protective measures are taken,
3. Where the research participant presents a serious danger of violence to others, and
4. If the research participant reveals that she has been sexually abused by a healthcare provider (for example, a psychologist or physician) covered by the Regulated Health Professionals Act, it is necessary by law to report the name of the perpetrator to his/her governing body.

IF YOU HAVE ANY CONCERNS ABOUT THESE MATTERS, OR ABOUT THIS FORM, PLEASE DISCUSS THESE WITH THE RESEARCH ASSISTANT.

 PLEASE SIGN THE ACKNOWLEDGEMENTS BELOW TO INDICATE THAT YOU HAVE READ THIS INFORMATION ABOUT CONFIDENTIALITY

I acknowledge the circumstances that limit confidentiality and I accept them.

 Participant's name

 Participant's signature

 Date

 Person Conducting the
 Consent Discussion

 Person Conducting the
 Consent Discussion's signature

 Date

Appendix C:

Debriefing Statement

Evaluating Specificity of Sexual Arousal with Thermography

Previous research suggests that there is a difference in the way that women and men respond to sexual stimuli. Men's sexual responses tend to match their reported sexual interests; in other words, in the laboratory men tend to show the greatest sexual response to stimuli depicting the gender that they report being sexually attracted to (their "preferred gender"). Heterosexual women, on the other hand, tend to have similar levels of physical sexual response to sexual stimuli depicting their preferred and non-preferred gender. This phenomenon has never been explored using the same measure of genital response in men and in women. This study used thermography to measure both men and women's sexual responses to preferred and non-preferred sexual stimuli. Thermography assessed change in genital temperature, and allows for better gender comparisons than previously used methodologies.

Researchers have long thought that an individual's sexual preferences are determined, in part, by their sexual arousal to different people. This may not be true for women. We expect the results of this research to provide converging evidence with a new methodology that women's sexuality is fundamentally different from men's. Along with other emerging work, this project will help researchers understand more clearly how sexual arousal relates to men and women's sexual preferences and how sexual stimuli are processed in men and women.

A reminder: All information is kept completely confidential in locked research cabinets and password-protected computer files. Only members of the research team will have access to the information. At no time will you be identified as an individual because the data will be numerically coded to ensure confidentiality and anonymity. Only the group data will be reported in the research. If you would like a summary of findings from this study, please contact Jackie Huberman by email at 7jh6@queensu.ca or Dr. Chivers at Meredith.Chivers@queensu.ca, or by telephone at (613) 533-2889.

If participating in this study leads you to feel distressed, you are encouraged to contact your family physician or mental health professional. Attached is a list of mental health resources in the Kingston and surrounding area, as well as a list of websites related to sexuality.

Thank you for participating in this study. Your time and effort is greatly appreciated.

Sexual and Mental Health Resources

Belleville General Hospital	(613) 969-5511
Brockville General Hospital	(613) 345-5645
Kingston General Hospital	(613) 548-2333
Frontenac Community Mental Health Services:	
Information.....	544-1356
24 Hour Crisis Line.....	544-4229
Leeds and Grenville Rehabilitation and Counseling Services:	
Toll Free.....	1 800 267-4406
Delta.....	(613) 928-3460
Gananoque.....	(613) 382-4016 ext. 100

Kemptville.....(613) 258-7204
 Prescott.....(613) 925-5940

KFLA Health Unit (Sexually Transmitted Infection Clinic)

Confidential diagnosis and treatment

221 Portsmouth Ave.

Phone: 613-549-1232 or 1-800-267-7875

Website: <http://www.healthunit.on.ca/programs/sexualhealth.html>

Queen's University Student Health Services

LaSalle Building, 146 Stuart St.

Phone: 613-533-2506

Website: <http://www.queensu-hcds.org>

Sexual Health Resource Centre (SHRC)

2nd Floor of the John Deutsch University Centre

Phone: 613-533-2959

Sexual Assault Crisis Centre Kingston (SACCK)

Phone: 613-544-6424

Lesbian/Gay/Bi Youth Phone Line

Phone: 1-800-268-YOUTH

Education Queer Issues Project (EQUIP)

Phone: 613-533-3154

Email: equip@ams.queensu.ca

Website: <http://clubs.myams.org/equip/>

<http://www.sexualhealth.com/>

<http://www.sexualityandu.ca/>

<http://www.plannedparenthood.org/>

<http://www.hars.ca>