Arch Sex Behav (2014) 43:941–952
DOI 10.1007/s10508-013-0233-7

ORIGINAL PAPER

Does Menstrual Cycle Phase Influence the Gender Specificity of Heterosexual Women's Genital and Subjective Sexual Arousal?

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Received: 25 September 2012 / Revised: 5 May 2013 / Accepted: 6 October 2013 / Published online: 31 December 2013

Abstract Unlike men, heterosexual women's genital arousal is gender nonspecific, such that heterosexual women show relatively similar genital arousal to sexual stimuli depicting men and women but typically report greater subjective arousal to male stimuli. Based on the ovulatory-shift hypothesis—that women show a mid-cycle shift in preferences towards more masculine features during peak fertility—we predicted that heterosexual women's genital and subjective arousal would be gender specific (more arousal towards male stimuli) during peak fertility. Twenty-two naturally-cycling heterosexual women were assessed during the follicular and luteal phases of their menstrual cycle to examine the role of menstrual cycle phase in gender specificity of genital and subjective sexual arousal. Menstrual cycle phase was confirmed with salivary hormone assays; phase at the time of first testing was counterbalanced. Women's genital and subjective sexual arousal patterns were gender nonspecific, irrespective of cycle phase. Cycle phase at first testing session did not influence genital or subjective arousal in the second testing session. Similar to previous research, women's genital and subjective sexual arousal varied with cues of sexual activity, but neither genital nor subjective sexual arousal varied by gender cues, with the exception of masturbation stimuli, where women showed higher genital arousal to the stimuli depicting male compared to female actors. These data suggest that menstrual cycle phase does not influence the gender specificity of heterosexual women's genital and subjective sexual arousal.

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Keywords Sexual arousal · Category specificity · Menstrual cycle · Ovulatory-shift hypothesis · Vaginal photoplethysmography · Sexual orientation

Introduction

Gender specific sexual arousal is a pattern of sexual response that is contingent on the gender features of a sexual stimulus (Blanchard et al., 2012; Chivers, 2005; Chivers, Rieger, Latty, & Bailey, 2004; Chivers, Seto, & Blanchard, 2007). Men's genital responses are gender specific such that heterosexual men show greatest physiological arousal to female sexual targets, whereas same-sex attracted men show their greatest physiological arousal to male sexual targets (Chivers et al., 2004, 2007; Freund, 1963; Mavissakalian, Blanchard, Abel, & Barlow, 1975; Sakheim, Barlow, Beck, & Abrahamson, 1985; Tollison, Adams, & Tollison, 1979). Unlike men or same-sex attracted women (Chivers et al., 2007), heterosexual women do not demonstrate a gender specific pattern of genital response; women's genital arousal does not differentiate between their stated preferred and nonpreferred gender (Chivers & Bailey, 2005; Chivers et al., 2004, 2007; Peterson, Janssen, & Laan, 2010; Suschinsky, Lalumière, & Chivers, 2009). Instead, women's genital sexual arousal is responsive to the intensity of the activity presented in a sexual stimulus, in that they show the highest genital and subjective arousal to stimuli depicting coupled sex, followed by solitary masturbation, and the least amount of arousal to nude exercise, irrespective of the gender of the actors (Chivers et al., 2007).

At present, it is unclear why heterosexual women's genital response patterns are gender nonspecific. A possible explanation for heterosexual women's pattern of sexual response is the inclusion of women at different phases of the menstrual cycle or women using hormonal contraceptives in sexual psychophysiology research, which may, at a group level, yield a pattern of gender nonspecific genital response. Cycle phase has not been examined as a potential mediator of gender nonspecific genital or subjective arousal in heterosexual women. If women's sexual response follows predictions derived from the ovulatory-shift hypothesis, such that a preference for masculine/male stimuli emerges during high fertility, then including women at different phases of the menstrual cycle, as well as women using hormonal contraceptives (e.g., Suschinsky et al., 2009), may obscure a gender specific pattern of genital and subjective responses.

The Ovulatory-Shift Hypothesis

Women experience a small window of fertility in their menstrual cycle; unlike most mammalian species, however, women remain sexually receptive regardless of probability of conception (POC, or the likelihood that a single act of coitus will result in pregnancy at any given phase) (Barrett & Marshall, 1969; Regan, 1996). Although her receptivity does not change with cycle phase, there is evidence to suggest that a woman's mate preferences and mating behaviors do (for a review, see Thornhill & Gangestad, 2008). According to the ovulatory-shift hypothesis, women have evolved a dynamic mating strategy whereby their preferences shift from features associated with childcare and parental contributions when POC is low (the luteal phase) to preferences for features associated with high genetic quality when POC is high (the follicular phase of the menstrual cycle) (Gangestad, Thornhill, & Garver-Apgar, 2005; Penton-Voak & Perrett, 2000). This mating strategy ostensibly maximizes the likelihood of mating with a genetically superior partner during peak fertility while simultaneously securing parental investment from a less masculine mate during periods of lower fertility.

According to parental investment theory (Trivers, 1972), the minimum cost of reproduction is much smaller for men (energy to have intercourse and produce a single ejaculate) relative to women (gestation, lactation, early childcare). Given the tremendous cost of reproduction, women are therefore more discriminating in their mate choices and seek to maximize genetic quality, thereby demonstrating preferences for androgenized phenotypes. According to the immunocompetence handicap model (Folstad & Karter, 1992), testosterone (which is associated with phenotypic masculinity in humans) acts as an immunosuppressant (Kanda, Tsuchida, & Tamaki, 1996), therefore only males of superior genetic quality can afford to display masculine features associated with higher testosterone (Rhodes, Chan, Zebrowitz, & Simmons, 2003; Thornhill & Gangestad, 1999). These features include low voice pitch (Feinberg et al., 2006; Puts, 2005) and facial masculinity (Johnston, Hagel, Franklin, Fink, & Grammer, 2001), that is, features that women find sexually attractive (Johnston et al., 2001).

Alternatively, immune system activation may suppress testosterone production (Boonekamp, Ros, & Verhulst, 2008). If a male's immune system more quickly and efficiently dealt with immune threats, then testosterone production might be suppressed less frequently, less severely, or for shorter durations, and a more masculine phenotype would emerge. To the extent that such immune efficiency was heritable, ancestral women may have produced healthier offspring by mating with phenotypically masculine men (Puts, Jones, & DeBruine, 2012).

Despite the putative high genetic rewards associated with choosing a mate displaying phenotypic markers of testosterone, high levels of testosterone are associated with considerable costs, such as marital instability (Booth & Dabbs, 1993), lower levels of attachment in relationships (Burnham et al., 2003), and lower levels of parental investment (Gangestad & Simpson, 2000; Penton-Voak & Perrett, 2001). Thus, shifting one's preference from high heritable fitness when POC is high (follicular phase) to the potential for childcare and parental contributions when POC is low (luteal phase) may represent an adaptive strategy for women (Gangestad et al., 2005). Indeed, many studies have demonstrated that women's preferences for masculine traits vary as a function of menstrual cycle phase. Preferences for facial masculinity (Frost, 1994; Johnston et al., 2001; Penton-Voak & Perrett, 2000; Penton-Voak et al., 1999), low facial asymmetry (Little, Jones, Burt, & Perrett, 2007), vocal masculinity (Feinberg et al., 2006; Puts, 2005), and skin quality (Jones, Little, Burt, & Perrett, 2004) increase during the follicular phase of the menstrual cycle. Women also prefer more masculine body shapes (Little, Jones, & Burriss, 2007) and masculinized biological movements (Provost, Troje, & Quinsey, 2008) when fertile. Another cue of masculinity–dominance–elicits higher ratings of attractiveness during the follicular phase across multiple modalities, including men's body odors (Havlicek, Roberts, & Flegr, 2005), personality characteristics (Lukaszewski & Roney, 2009), and visual behavioral displays (Gangestad, Garver-Apgar, Simpson, & Cousins, 2007; Gangestad, Simpson, Cousins, Garver-Apgar, & Christensen, 2004).

A growing body of evidence suggests that one of the proximate mechanisms mediating the ovulatory-shift hypothesis is hormone-dependent (Gangestad et al., 2005; Puts, 2006; Wallen & Rupp, 2010). For example, women's preference for vocal masculinity decreases with predicted progesterone levels and increases with predicted prolactin levels in naturally cycling women, but not in women taking hormonal contraceptives (Puts, 2006). Similarly, women using hormonal contraceptives show no mid-cycle peak in preferences for masculinity (Jones, Little, et al., 2005; Jones, Perrett, et al., 2005; Puts, 2006; Welling et al., 2007). Observed changes in sexual preferences and behaviors over the course of the menstrual cycle suggest that hormones influence some components of female sexual behaviors, such as likelihood of engaging in erotic fantasies (Dawson, Suschinsky, & Lalumière, 2012; Gangestad, Thornhill, & Garver, 2002), attending social gatherings which may yield novel sexual opportunities (Haselton & Gangestad, 2006), and experiencing orgasm, particularly with genetically compatible mates (Garver-

Apgar, Gangestad, Thornhill, Miller, & Olp, 2006; Puts, Dawood, & Welling, 2012). Changes in women's mate preferences over the menstrual cycle may represent an adaptive reproductive strategy in line with the ovulatory-shift hypothesis; however, a mid-cycle shift in preference for male stimuli has yet to be empirically examined with respect to sexual arousal in heterosexual women (Diamond, 2007).

Fertility and Sexual Psychophysiology

If hormonal shifts during the menstrual cycle influence one aspect of women's sexuality, that is, their mate preferences (Bancroft, 2005; Gangestad et al., 2005; Puts, 2006; Wallen & Rupp, 2010), then it follows that other aspects of female sexuality might be similarly affected. Although women do not need to be physically sexually aroused to reproduce, genital arousal produces lubrication that minimizes pain and discomfort (Bancroft & Graham, 2011), and reduces the likelihood of vaginal/vulvar injury (Chivers, 2005; Dawson, Sawatsky, & Lalumière, 2013; Laan, 1994; Suschinsky & Lalumière, 2011a; van Lunsen & Laan, 2004) during coitus. Arousal and orgasm may also increase the POC from a single act of intercourse with a high quality mate (Puts, Welling, Burriss, & Dawood, 2012) or genetically compatible mate (Garver-Apgar et al., 2006). Sexual arousal is another possible influential factor in mate choice: Sexual arousal to mates of high quality might motivate women to have sex with those mates again and thus be more likely to reproduce with those mates, resulting in more or better quality offspring (cf. Chivers, 2005).

A number of studies have investigated whether the menstrual cycle plays a role in patterns of female sexual response (Hoon, Bruce, & Kinchloe, 1982; Meuwissen & Over, 1992; Schreiner-Engel, Schiavi, Smith, & White, 1981; Slob, Bax, Hop, Rowland, & van der Werff ten Bosch, 1996; Slob, Ernste, & van der Werff ten Bosch, 1991). These studies investigated absolute levels of arousal response across the menstrual cycle, testing the hypothesis that, when fertile, women would show higher levels of physiological and subjective arousal to a heterosexual stimulus. Schreiner-Engel et al. found highest genital arousal during the ovulatory phase compared to follicular or luteal. Hoon et al. and Slob et al. found no significant differences between the follicular and luteal phase of the menstrual cycle, whereas Meuwissen and Over reported greatest genital arousal during the premenstrual phase (when POC is low). None of the aforementioned studies reported significant changes in subjective arousal across the menstrual cycle. Thus, results are mixed, and the role of menstrual cycle phase in genital arousal in women is not clear.

Cycle phase may affect genital but not subjective arousal although firm conclusions cannot be drawn because of inconsistencies in both methodologies and results across previous studies; the categorization of cycle phase differed across the studies, as did the assessment of menstrual cycle phase. Different psychophysiological measures were employed across the studies, including vaginal photoplethysmography (VPP) (Hoon et al., 1982; Meuwissen & Over, 1992; Schreiner-Engel et al., 1981) and labial thermography (Slob et al., 1991, 1996). The agreement of these two measures over different phases of the menstrual cycle has not been assessed and may be influenced by extraneous variables (e.g., labial temperature may be susceptible to temperature changes associated with fertility status) (Royston & Abrams, 1980).

Furthermore, all previous studies investigating the role of fertility status on the menstrual cycle have used heterosexual sex as experimental stimuli and did not vary in the couple type or the intensity of sexual stimuli. The lack of variation in stimuli is problematic inasmuch as it permits examination of changes in absolute levels of response across the menstrual cycle only, not patterns of arousal to a range of preferred and nonpreferred stimuli. Sexual stimuli depicting heterosexual sex—which contain a male and a female actor—confound gender. To date, no studies have examined fertility status and gender specificity of sexual arousal in women. Thus, the question remains whether women's sexual response patterns to male stimuli shift as a function of fertility status.

Order Effects of Testing

In their investigation of menstrual cycle effects on genital arousal measured via labial temperature, Slob et al. (1991) counterbalanced the phase in which women started testing; half of their participants began testing in the follicular phase, and half began testing in the luteal phase. Counterbalancing produced an interesting and unexpected result; women who were tested in the luteal phase first had lower levels of genital arousal in the luteal phase (first testing session) and higher levels in the follicular phase (second testing session). In contrast, women who were tested in the follicular phase first had high levels of genital arousal in the first testing session, and continued to show equally high levels of arousal when later tested in the luteal phase. In fact, women who were tested in the luteal phase in their second session showed equally high levels of arousal as women who were tested in the follicular phase during their second testing session. Slob et al. (1996) replicated these findings and concluded that initially viewing sexual stimuli in a time of high fertility renders the stimuli more sexually arousing to the observer at subsequent exposures than viewing the stimuli in a time of low fertility. No significant effect of order was observed, however, for women's subjective arousal.

Wallen and Rupp (2010) also found the order effect (e.g., Slob et al., 1991, 1996) using viewing time, an implicit measure of sexual interest in women (Brown, 1979; Conaglen & Evans, 2006; Rupp, James, et al., 2009; Rupp, Librach, et al., 2009). Viewing times were longer for stimuli presented at high fertility first and remained longer during times of low fertility compared to women who viewed the same stimuli at a time of low fertility first. As with the Slob et al. studies, subjective ratings of stimuli attractiveness obtained after each viewing did not significantly change with menstrual phase. Wallen and Rupp proposed that women's hormonal state at the time of first exposure to sexual stimuli alters the stimuli's reward value—or the positive emotional valence associated with the stimuli—which influences arousal to the same stimuli at subsequent exposures. For example, exposure to a stimulus when fertile leads to the encoding of that stimulus as sexually competent or of a higher reward value (Wallen & Rupp, 2010); thus, subsequent exposures to that stimulus will elicit increased sexual interest (as measured by viewing time) or genital arousal. Studies that have observed cycle phase order effects in genital arousal (Slob et al., 1991, 1996) and sexual interest (Wallen & Rupp, 2010) suggest that the cycle phase at time of testing is less important to arousal than cycle phase during initial exposure to sexual stimuli. Subjective arousal appears unaffected by the order of testing.

Current Study

In the present study, we wished to further clarify the phenomenon of gender nonspecific female sexual arousal by exploring the relationship between menstrual cycle phase and patterns of sexual response. Drawing from the ovulatory-shift hypothesis, we predicted that heterosexual women's genital and subjective sexual responses would be gender specific (i.e., greater sexual arousal to male stimuli) during peak fertility. Additionally, we predicted that stimuli increasing in sexual potency would elicit higher levels of genital and subjective arousal, independent of actor gender and cycle phase (Chivers et al., 2004, 2007). Last, we expected an order effect for genital responses (Slob et al., 1991, 1996; Wallen & Rupp, 2010), such that women tested in their follicular phase first would show higher levels of arousal in the second (luteal) testing session compared to women tested in the luteal phase first, and that follicular first women would show little change in sexual arousal across the two testing sessions whereas luteal first women would show greater arousal in the second testing session (follicular phase).

Method

Participants

Women responded to flyers posted on and around a university campus and were screened via a telephone interview to determine eligibility for the study. All participants were required to be between the ages of 18 and 40 years, not pregnant or nursing, and not on hormonal contraceptive or similar medications. Recruitment also required women to be experiencing regular menstrual cycles (27–33 days long) (Chiazze, Brayer, MacIsco, Parker, & Duffy, 1968). Participants had no history of sexually transmitted infections (STIs) or sexual dysfunction (including no history of pain during vaginal penetration), had experienced vaginal penetration in the past (during sexual activity, tampon insertion, or a pelvic examination), and were not taking any medications that would interfere with sexual responses (Meston & Frohlich, 2000). Only women who reported exclusively or predominantly heterosexual attractions were included (0 or 1, assessed using the Kinsey Sexual Fantasy Scale) (Kinsey, Pomeroy, Martin, & Gebhard, 1953). Study procedures were approved by the University's ethics committee.

A total of 37 women participated in the study. Data were excluded for the following reasons: Did not attend second testing session ($n = 6$); cycle phase could not be accurately confirmed by hormonal analysis ($n = 6$); problems with freezing salivary samples ($n = 1$); lacking valid data for all stimulus trials ($n = 2$). The final sample consisted of 22 women ($M = 22$ years, $SD = 4.8$, 18–36 years); 11 women were randomly assigned to start testing in the follicular phase and 11 in the luteal phase.

Measures

Salivary Assays

Menstrual cycle phase was confirmed using salivary hormone assays. Two saliva samples (approximately 1 mL each) were collected in 2 mL polypropylene vials via passive drool 30 min apart prior to the sexual psychophysiological testing, pooled together, and frozen at −80 °C after collection until assay. All samples were assayed for salivary progesterone in duplicate using a highly-sensitive enzyme immunoassay (Cat. No. 1-1502, Salimetrics LLC, State College, PA). The test used 50 µL of saliva per determination, had a lower limit of sensitivity of 5.0 pg/mL, standard curve range from 10 to 2430 pg/mL, an average intra-assay coefficient of variation of 6.2 %, and an inter-assay coefficient of variation of 7.6 %. Method accuracy determined by spike recovery averaged 99.6 % and linearity determined by serial dilution averaged 91.8 %. Progesterone assayed from saliva using these methods correlates highly with serum assays in women, median age 20 years, $r(25) = 0.87$, $p < .001$ (Nallanathan, Mendoza, Curran, & Lindau, 2007). Menstrual cycle phase was verified by progesterone levels; women were included in the analysis if progesterone levels were higher in the luteal phase ($M =$ 218.77 pg/mL, $SD = 169.07$) relative to the follicular phase ($M = 88.62$ pg/mL, $SD = 42.76$) (Regan, 1996); $t(21) = 4.20$, $p < .001$.

Genital Response

Women's genital responses were assessed using the vaginal pulse amplitude (VPA) signal from the VPP (Geer, Morokoff, & Greenwood, 1974), a reliable (Prause, Janssen, Cohen, & Finn, 2002; Wilson & Lawson, 1978) and valid (e.g., Laan, Everaerd, & Evers, 1995a; Suschinsky et al., 2009) measure of genital sexual arousal in women. The VPA signal was sampled at a rate of 10 Hz, band-pass filtered (0.5–10 Hz), and digitized (40 Hz). VPA was measured as peak-to-trough amplitude for each vaginal pulse. A placement device made of flexible silicone was positioned 5 cm from the base of the gauge, ensuring a standardized vaginal depth and orientation (Laan et al., 1995a). Movement artifacts were detected and removed by visual inspection prior to data analysis by an experimenter who was masked to stimulus category. PrefTest Professional Suite (Limestone Technologies Inc., Odessa, ON) was used to collect all psychophysiological data.

Subjective Sexual Arousal

Participants reported subjective arousal before and after the presentation of each stimulus using a hand-held keypad. Subjective sexual arousal was assessed using a pre- and post-stimulus item "How sexually aroused do you feel?" rated on a 10-point Likert-type scale, ranging from 0 (*no arousal at all*) to 9 (*most arousal ever experienced/arousal associated with orgasm*).

Experimental Stimuli

Experimental stimuli consisted of both neutral and erotic videos, presented with sound, previously used by Chivers et al. (2007) and shown to elicit both genital arousal and subjective arousal in heterosexual women. Twelve films, each approximately 90 s in length, were used, representing six stimulus categories with two exemplars per category: Female nonsexual activity (nude exercise), female masturbation, female–female intercourse (cunnilingus and vaginal penetration with a strap-on dildo), male nonsexual activity (nude exercise), male masturbation, and male–male intercourse (fellatio and anal penetration). Two neutral scenes (landscapes) and two heterosexual intercourse scenes were also presented, but these data were not included in the current analysis. The 16 experimental videos were presented in a predetermined randomized order that varied by participant, separated by 60 s intertrial intervals (ITIs) following completion of self-report items. The ITI was extended, if necessary, using distracter tasks (e.g., count backwards from 900, in multiples of seven) to facilitate return to VPA baseline.

Procedure

Participants were screened for eligibility by telephone, then randomly assigned to begin their first testing session in either the follicular phase of the menstrual cycle or the luteal phase. The second testing session (with procedures identical to the first) was scheduled to take place in the opposite phase of the menstrual cycle from which they started, approximately two weeks later ($M = 14.5$ days, $SD = 4.06$). Menstrual cycle was assessed during screening using the forwards-backwards counting technique described by Puts (2006). Women's menstrual cycles were transformed to a 28-day equivalent for consistency with the literature, which typically reports hormone levels for a 28-day cycle (Regan, 1996). The onset of the participant's next menstrual bleeding was estimated and the participant's distance from ovulation (in days) calculated. Menstrual cycle phase was reassessed at the end of the first testing session using this counting method, at which point the second session was scheduled with women in the opposite phase of the menstrual cycle. Cycle phase was confirmed using salivary assays as described above.

Before each session, women were instructed to refrain from coupled sex, masturbation, and using medications that may interfere with sexual arousal for 24 h prior to coming to the lab. Participants were also instructed to refrain from engaging in aerobic exercise for 3 h prior to their appointment (Meston & Gorzalka, 1996), and refrain from using alcohol, caffeine, and other recreational drugs on the day of testing. Participants completed questionnaires assessing demographics, sexual functioning, sexual experiences, and menstrual cycle information, followed by sexual psychophysiological testing in a private testing room.

Statistical Analyses

Genital Arousal Data

Genital arousal scores were computed by subtracting pretrial baseline arousal (mean genital response from a 5 to 10 s interval prior to the onset of each stimulus) from mean genital response during each stimulus. Change scores were standardized within subjects (i.e., *z*-scored) to control for individual variability in responses (Harris, Rice, Quinsey, Chaplin, & Earls, 1992). Genital arousal scores were averaged across two exemplars of each stimulus category.

Of the 22 women who provided useable data, all met the inclusion criteria for minimum sexual response (a minimum difference of 0.5 SD between maximum genital arousal to either male or female stimuli and arousal to the neutral stimulus) (Chivers et al., 2004). Individual trials for which there were problems with genital data acquisition were excluded from analysis (as in these instances, VPA signals were unreliable) for a total of 0.95 % of all trials removed. For these cases, mean genital response was based on the remaining trial within that exemplar category.

Subjective Arousal Data

Change scores between pre- and post-stimulus ratings were calculated such that a positive score indicated an increase in arousal following stimulus presentation, a negative score indicated a decrease in arousal, and a score of zero indicated no change in arousal. Change scores were used because these are less influenced by impression management biases than discrete measures of subjective arousal (Huberman, Suschinsky, Lalumière, & Chivers, 2013). Subjective arousal scores were also averaged across two exemplars of each stimulus category.

Data Analysis

We examined the gender specificity of women's genital and subjective response at two phases of the menstrual cycle. Genital and subjective arousal data were subjected to separate 2 (Order: follicular first, luteal first) × 2 (Cycle Phase: follicular, luteal) × 2 (Actor Gender: male, female) × 3 (Sexual Activity: exercise, masturbation, couple sex) mixed repeated-measures analysis of variance (ANOVA), where order was a between-subject factor and cycle phase, gender, and sexual activity were within-subject factors. Statistical analyses were completed using IBM SPSS Statistics software v19.

Results

Genital Sexual Responses

Figure 1 shows the mean standardized genital responses and SEM for all women as a function of Cycle Phase, Actor Gender, and Activity Type. The omnibus test revealed no significant main effect of Cycle Phase, $F(1, 20) = 2.42$, $\eta_p^2 = 0.11$; thus, cycle phase at the time of testing did not influence women's genital responses overall. No significant main effect of Gender indicated that women's genital responses were gender nonspecific, $F(1, 20) < 1$, $\eta_p^2 < 0.01$.

Contrary to the ovulatory-shift hypothesis, the Cycle by Gender interaction was not significant, $F(1, 20) < 1$, $\eta_p^2 = 0.04$, which indicated that women's genital responses did not differentiate between male and female stimuli as a function of cycle phase.

A significant main effect of Sexual Activity, $F(2, 40) = 56.10$, $p < .001$, $\eta_p^2 = 0.74$, was followed up using paired sample *t*-tests. Consistent with previous research, stimuli depicting couples having sex elicited significantly higher levels of genital arousal than masturbation stimuli, $t(21) = 7.30$, $p < .001$, $d = 2.07$. Both couple sex, $t(21) = 8.77$, $p < .001$, $d = 3.35$, and masturbation stimuli, $t(21) = 4.92$, $p < .001$, $d = 1.68$, elicited significantly higher levels of genital arousal than exercise stimuli.

No main effect of Order was found, $F(1, 20) < 1$, $\eta_p^2 = 0.04$, indicating that the cycle phase during the first testing session did not influence women's genital responses at the subsequent session.

Unexpectedly, a significant interaction between Gender and Sexual Activity was found, $F(2, 40) = 6.45$, $p = .004$, $\eta_p^2 = 0.24$. Paired *t*-tests revealed that women's genital responses, when collapsed across Cycle Phase and Order of testing, did not differentiate between exercise stimuli, $t(21) = 1.21$, $d = 0.34$, or couple sex stimuli, $t(21) = 1.28$, $d = 0.44$, based on gender. However, women showed significantly higher levels of genital responding to stimuli depicting men masturbating compared to women masturbating, $t(21) = 2.22$, $p = .037$, $d = 0.74$ (means and SEM are presented in Fig. 1).

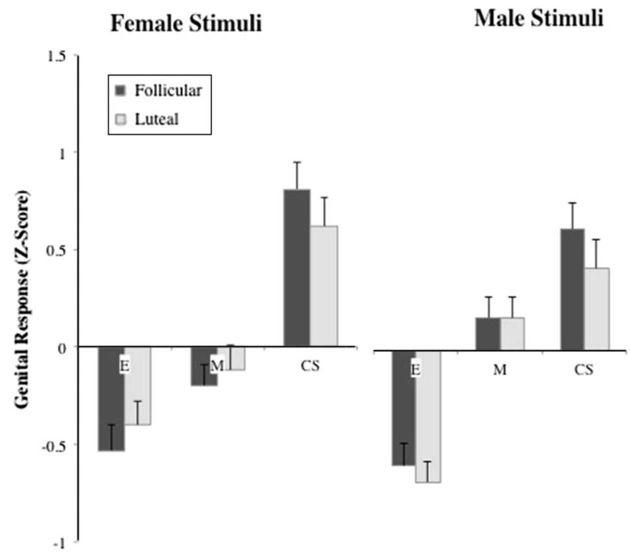

Fig. 1 Mean standardized genital arousal for experimental stimuli collapsed across order of testing. *E* exercise stimuli; *M* masturbation stimuli; *CS* couple sex stimuli. *Error bars* indicate SEM

Subjective Sexual Arousal

Self-reported arousal change scores were submitted to the same mixed repeated-measures ANOVA as the genital data to evaluate the effect of cycle phase on women's subjective sexual arousal. One participant was removed from this analysis due to errors with data collection, resulting in a final sample of 21 women for the following analyses. Figure 2 shows the mean subjective sexual arousal responses and SEM for all women.

The main effects of Cycle Phase, $F(1, 19) < 1$, $\eta_p^2 = 0.11$, and Gender, $F(1, 19) = 1.86$, $\eta_p^2 = 0.01$, were not statistically significant. No interaction between Cycle Phase and Gender was found, $F(1, 19) < 1$, $\eta_p^2 < 0.01$. A significant main effect of Sexual Activity was found, $F(2, 38) < 1$, $\eta_p^2 = 0.27$. Follow-up paired sample *t* tests revealed that, compared to the exercise stimuli, women reported significantly larger increases in subjective arousal to couple sex, $t(20) = 2.97$, $p = .008$, $d = 1.05$, and masturbation stimuli, $t(20) = 3.30$, $p = .004$, $d = 0.99$. Changes in subjective responses to couple sex and masturbation stimuli were not significantly different, $t(20) < 1$, $d = 0.17$. No significant main effect of Order on subjective arousal was found, $F(1, 19) = 2.85$, $p = .108$, $\eta_p^2 = 0.13$. Similar to genital arousal, the cycle phase at time of first testing did not influence women's subjective sexual arousal.

Stability of Nonspecific Genital and Subjective Sexual Arousal Across Cycle Phase

The analyses described above found no effect of Cycle Phase or Order of testing on gender specificity of sexual arousal at the group level. To assess whether individual women's pattern of

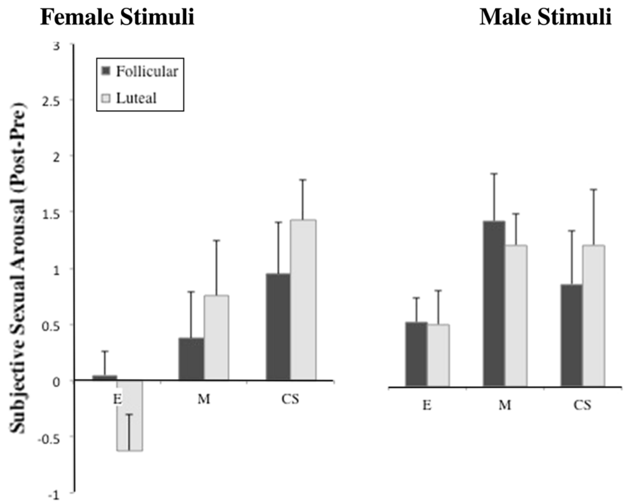

Fig. 2 Mean self-report change scores (post–pre) scores for experimental stimuli collapsed across order of testing. *E* exercise stimuli; *M* masturbation stimuli; *CS* couple sex stimuli. *Error bars* indicate SEM

sexual arousal changed as a function of testing session, we performed additional analyses. Separate *gender specificity indices* were calculated for genital and subjective sexual arousal for each participant by subtracting the average response (genital or subjective) to all of the female stimuli combined (i.e., exercise, masturbation, and partnered sex) from the average response to all of the male stimuli combined. Positive scores indicate greater responses to male stimuli and negative responses indicate greater responses to female stimuli.

Separate paired samples *t*-tests were performed on the genital and subjective gender specificity indices. Women showed gender nonspecific genital responses to male and female stimuli during Session 1 ($M = -0.04$, $SD = 0.56$) and Session 2 ($M = -0.05$, $SD = 0.58$), $t(21) < 1$. Although women reported more subjective arousal to the male stimuli than the female stimuli in Session 1 ($M = 0.52$, $SD = 1.82$) and Session 2 ($M = 0.50$, $SD = 1.72$), there was no significant change across the two testing sessions, $t(20) < 1$. When we recalculated specificity indices based only on sexual stimuli (i.e., masturbation and partnered sexual activity), the results were identical. Overall, women's pattern of genital and subjective sexual arousal did not change across testing sessions; women, on average, showed gender nonspecific genital response and gender specific subjective arousal in both testing sessions.

Discussion

The aim of this study was to investigate the effect of menstrual cycle phase on gender specificity of heterosexual women's genital and subjective sexual arousal. Our findings suggest that heterosexual women's pattern of genital and subjective arousal does not become more gender specific when the POC is highest; heterosexual women's sexual arousal does not appear to be influenced by the same hormone-mediated mechanisms as mate preference. The intensity of sexual activity was a stronger predictor of genital and subjective arousal than the gender of the actors independent of cycle phase although, unexpectedly, women showed higher genital arousal to masturbation stimuli depicting men compared to women across testing sessions. No order effects were found; cycle phase at time of first testing did not influence genital or subjective arousal at a later testing session. Finally, women showed gender nonspecific genital arousal and gender specific subjective sexual arousal during both testing sessions when gender specificity indices were calculated.

Genital Sexual Responses

Gender specificity of women's genital arousal did not change as a function of menstrual cycle phase; women's genital arousal was not greater for male stimuli when POC was highest. It is possible that a different means of assessing cycle phase or a larger sample would have revealed an effect of POC, as might be predicted from the ovulatory-shift hypothesis. However, our use of self-report in combination with hormonal data should have increased the precision of our POC estimates relative to other studies of menstrual cycle effects, which have tended to use self-report only. Moreover, some studies (e.g., Penton-Voak et al., 1999) have found cycle phase effects on women's mate preferences using samples approximately equal in size to ours and, importantly, our within-subjects design increased our statistical power to detect such effects.

Using the same audiovisual stimuli as Chivers et al. (2007), we obtained a similar gender nonspecific pattern of genital response using a different sample of heterosexual women. Furthermore, the same pattern of gender nonspecificity was observed within participants at two time points and at two different phases of the menstrual cycle, suggesting that their gender nonspecific response is robust to hormonal status at the time of testing, and to novelty effects. This study lends further support for the growing body of literature demonstrating the reliability of gender nonspecific genital response among heterosexual women (Chivers et al., 2004, 2007; Chivers & Bailey, 2005; Peterson et al., 2010; Suschinsky et al., 2009).

The gender nonspecific pattern of genital arousal observed irrespective of cycle phase suggests that mate preferences and sexual arousal (both genital and subjective) are governed by distinct systems. Women display a preference for masculine features during peak fertility, but their genital and subjective arousal responses do not mirror this shift. It is possible that changes in mate preference benefit women by increasing the likelihood of choosing a sexual partner of high genetic quality when her POC is high, which will in turn increase her reproductive fitness by securing strong genetic contributions for her offspring. Gender nonspecific sexual arousal may serve a separate function to ensure that genital vasocongestion and vaginal lubrication reduce the risk of vaginal/vulvar injury from penetrative sex, regardless of sexual partner identity and cycle phase (Dawson et al., 2013; Levin, 2003; Suschinsky & Lalumière, 2011a).

Research documenting the responsivity of women's genital arousal to the intensity of sexual cues is extensive (Both, Boxtel, Stekelenburg, Everaerd, & Laan, 2005; Chivers, 2005; Chivers et al., 2004, 2007; Laan, Everaerd, van der Velde, & Geer, 1995b). Consistent with this literature, women experienced highest genital arousal to stimuli depicting couples engaging in sex, followed by masturbation and exercise; the large effect size ($\eta_p^2 = 0.74$) supports the robust nature of this phenomenon. It is possible that changes in women's genital responses across the menstrual cycle are overwhelmed by an effect of sexual activity, however, this is an unlikely explanation for the lack of mid-cycle shift observed in the present sample's pattern of genital responses. The low-intensity videos of men and women exercising should have induced sufficiently low sexual response as to allow for a shift in genital responses over the menstrual cycle to be observed.

Although gender cues appear to be less important to heterosexual women's genital arousal than sexual activity cues, women in the present study did show some differentiation towards the gender of actors in lower-intensity sexual stimuli. Women showed significantly higher genital response to male masturbation versus female masturbation stimuli. This finding is inconsistent with previous research demonstrating that heterosexual women showed greater genital arousal to stimuli containing female targets (e.g., heterosexual or lesbian couples engaged in sex) versus only male targets (Chivers et al., 2004, 2007). The overall gender nonspecific pattern of response supports the preparation hypothesis (Suschinsky & Lalumière, 2011a), which posits that genital arousal to cues of sexual activity—consensual or non-consensual—acts as a protective mechanism against damage or pain from penetration via automatic increases of blood flow to vaginal tissue producing vaginal lubrication (Bancroft & Graham, 2011; Dawson et al., 2013; Levin, 2003). When exposed to stimuli that contain cues of possible penetration (e.g., two women using a dildo, men having anal sex, a man and woman having penile-vaginal intercourse, and a masturbating man), women experience genital arousal and thus, presumably, lubrication (Dawson et al., 2013). When cues of penetration are absent (e.g., nude men and women exercising, a woman masturbating), there is significantly less arousal.

Stability of Gender Nonspecific Genital Arousal

Interestingly, our results suggested that women's genital response patterns may be more stable than initially supposed. Women in the current study showed gender nonspecific genital responses across two testing sessions. This is counter to Heiman (1980), who found that unmarried women showed significantly higher genital arousal to an erotic film and audiotape relative to married women, but only in the first of two testing sessions, and to Suschinsky and Lalumière (2011b) who reported that women's genital responses to audiotaped narratives of sexual and nonsexual activities were less category specific than men's in two testing sessions.

The stability of women's genital responses in the current study, and the lower stability documented by Suschinsky and Lalumière (2011b), may be a function of the stimuli used in each study. Suschinsky and Lalumière noted that their audiotaped stimuli may not have been optimal for assessing the stability of genital response patterns in women because audio stimuli tend to elicit smaller genital responses in women (e.g., Heiman, 1980), and because the stimuli all followed a similar format (e.g., a description of the setting, followed by the initial interaction between the woman and man, and so forth). Audiovisual stimuli, such as those employed in the current study, provide both audio and visual cues and therefore may be more sexually intense, capture greater attention, and produce less variation in responding, which may result in more stable genital response patterns over testing sessions. Most remarkably, our data suggest that gender nonspecific genital responses are likely not due to the potential novelty of the same-gender stimuli; if this were the case, we would expect that women would show gender specific responses in their second testing session, when stimuli are no longer novel.

Subjective Sexual Responses

Consistent with genital arousal, women did not experience greater gender specificity of subjective arousal during the follicular phase of the menstrual cycle; therefore, patterns of subjective arousal may not be influenced by cycle phase. Women's subjective arousal mirrored their genital arousal with respect to cues of sexual explicitness, and replicated previous research (e.g., Chivers et al., 2007). Women reported lowest arousal to exercise stimuli, compared to masturbation and couple sex stimuli (which did not differ from one another). Low sexual concordance (i.e., the agreement between women's subjective and genital arousal) has been consistently documented throughout the sexual psychophysiology research corpus (for a quantitative review, see Chivers, Seto, Lalumière, Laan, & Grimbos, 2010), so it is not surprising that the pattern of response for genital arousal is different from that observed for subjective responses.

Order Effects of Testing

Based on findings by Slob et al. (1991, 1996) and Wallen and Rupp (2010), we predicted that the cycle phase during the first testing session would affect genital but not subjective arousal in the following testing session. No order effects were observed, however. Cycle phase at the time of first exposure to sexual stimuli was not associated with patterns of genital sexual arousal in the second testing session. A lack of order effect obtained in the present study is consistent with past studies exploring cycle phase and genital arousal in heterosexual women. These studies either started all women in the same phase of the menstrual cycle (Morrell, Dixon, Carter, & Davidson, 1984) or did not report an order effect (Hoon et al., 1982; Schreiner-Engel et al., 1981).

Slob et al. (1991, 1996) obtained an order effect of sexual arousal using labial temperature, not VPP, which was used in the present study. It is possible that vaginal vasocongestion, as measured by VPP, is less sensitive than labial temperature to a cycle phase-mediated learning effect. Naturally-cycling women, compared to women using oral contraceptives in the studies by Slob et al., had lower labial temperatures in the follicular phase and experienced smaller changes in temperature during erotic videos. Additionally, basal body temperature changes as a function of hormonal status (women's temperatures increase by at least four tenths of a degree at the time of ovulation) (see Royston & Abrams, 1980). Changes observed in labial and basal body temperature mediated by cycle phase suggest that labial temperature may, in fact, be more responsive to changes across the menstrual cycle than VPP. Whether the labial thermistor's sensitivity to cycle phase is suggestive of differences in sexual arousability or simply temperature changes is unclear. VPA and labial thermography are positively correlated (Henson, Rubin, & Henson, 1979; Payne & Binik, 2006), therefore it is unclear why we failed to detect an order effect for genital response (Slob et al., 1991, 1996; Wallen & Rupp, 2010). Replication of the present study using a different psychophysiology methodology, such as thermography, a reliable measure of genital arousal which assesses changes in skin temperature (Kukkonen, Binik, Amsel, & Carrier, 2007), may prove more sensitive to an order effect in genital response than VPP.

Subjective arousal was not influenced by order of the cycle phase at time of first testing, which is interesting given that Wallen and Rupp (2010) observed an effect on sexual interest using a viewing time paradigm. One possible explanation for the lack of effect of order in the current study is that sexual interest is not the same construct as sexual arousal for women (self-reported or genital). Furthermore, the stimuli used by Wallen and Rupp were still images, which are less potent than audiovisual stimuli used in the present study (Chivers et al., 2007; Heiman, 1980; Julien & Over, 1988). The high intensity of the audiovisual stimuli may have overwhelmed the possible influence of cycle phase on subjective arousal at first exposure, although the low intensity stimuli used within this study—males and females exercising—also failed to produce the same results as Wallen and Rupp, which makes this explanation less likely. The influence of hormonal status on the meaning attributed to sexual stimuli requires further investigation and attention should be drawn to discerning whether this phenomenon is unique to sexual interest and not sexual arousal.

One additional explanation for the lack of an observed order effect in the present study may be attributable to differences in the stimuli used in the present study compared to past research (i.e., the inclusion of same-sex stimuli). It is possible that the heterosexual women in the present sample had little exposure to same-sex sexual stimuli, although we did not assess previous exposure to same-sex stimuli in the present sample. As a result, women who were first exposed to the same-sex sexual stimuli during the follicular phase of the menstrual cycle would encode the "new" stimuli as sexually relevant, while women exposed to the same stimuli during the luteal phase would encode them as non-sexual. If this were the case, one would expect women who were tested in the luteal phase first to show more gender specific patterns of response overall; this, however, was not observed in the present sample of women. Nonetheless, future research should control for women's past exposure to same-sex sexual stimuli in order to directly explore the role that learning via past exposure plays in the order effect of sexual arousal observed in heterosexual women.

Conclusions

Results from the current study suggest that including women at different points in the menstrual cycle, or women using hormonal contraceptives, is not a likely explanation for heterosexual women's gender nonspecific patterns of genital response. Our results provide preliminary evidence that patterns of sexual arousal and mate preferences may not be overlapping phenomena, as the latter (but not the former) demonstrates a mid-cycle shift towards preferring masculinity, as predicted by the ovulatory-shift hypothesis. Unlike genital responses measured using labial temperature (Slob et al., 1991, 1996) and viewing time (Wallen & Rupp, 2010), however, genital arousal and subjective arousal were not influenced by the participants' cycle phase at first testing session. Furthermore, this study was the first to demonstrate gender nonspecific genital responses over two time points and two phases of the menstrual cycle, providing additional evidence for the robustness of this pattern of sexual response among heterosexual women.

Acknowledgments Many thanks to the study participants and to Sari van Anders for her guidance on assessment of cycle phase. This research was supported by grants from the Natural Sciences and Engineering Research Council of Canada (Grant No. 386198-10) and the Queen's Senate Advisory Research Council, awarded to Meredith L. Chivers.

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