# Oral Contraceptive Use and Female Genital Arousal: Methodological Considerations

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*This study explored effects of oral contraceptive pill (OCP) use on physiological sexual arousal as measured by a vaginal photoplethysmograph. Sixteen women aged 18-29 viewed audiovisual neutral and erotic stimuli before and an average of 6 weeks following the onset of OCP use. Although subjective measures of sexual arousal, including perceptions of genital arousal, significantly increased in response to erotic stimuli both before and after OCP onset, physiological sexual arousal only increased before OCP use. A comparison of individual responses before and after OCP onset reveals a much higher degree of intrasubject variability after OCP onset. We discuss these findings as they relate to OCP use as a confounding methodological variable to consider in future investigations employing vaginal photoplethysmography.*

The use of the vaginal photoplethysmograph (VPP) over the past three decades has enriched our understanding of the factors that influence and are implicated in female sexual arousal. Its development allowed for many of the observations made by Masters and Johnson (1966) with respect to physiological sexual excitement to be quantified objectively. The VPP consists of a clear, acrylic, tampon-shaped probe that is inserted vaginally. A light-emitting diode projects a beam of infrared light that illuminates the capillary beds of the engorging vaginal tissue. Embedded in the probe is a photosensitive light detector, which detects the amount of backscattered light reflected from the vaginal wall (Sintchak & Geer, 1975). The relative degree of back-scattered light detection from the engorged to the unengorged state is interpreted as an indirect measure of vasocongestion within the area (Laan & Everaerd, 1998).

Because of the absence of an absolute metric in the VPP, within-subjects protocols are necessary wherein the subject is exposed to neutral and subsequently erotic stimuli, and responses to the two conditions are compared. Two signals are derived from the VPP: one that reflects a general pooling of blood in the vaginal tissue (vaginal blood volume) and one that reflects moment-to-moment changes in blood flow that occur with each heart beat, with larger amplitudes reflecting higher levels of vasocongestion (vaginal pulse amplitude; VPA). Because of its sensitivity and specificity, VPA is the preferred measure when using the VPP (Laan, Everaerd, & Evers, 1995).

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Since the introduction of the VPP in 1975, a number of other psychophysiological instruments have been developed in attempts to quantify the female genital arousal response more accurately, and thus shed light on the mechanisms involved in female sexual arousal. Such instruments have included the labial thermistor (Cohen & Shapiro, 1970; Shapiro, Cohen, DiBianco, & Rosen, 1968), the heated electrode (Wagner & Levin, 1978), and magnetic resonance imaging (Maravilla et al., 2003). However, the VPP remains a popular instrument for the study of female psychophysiology because of practical advantages such as its ability to be inserted by the research subject, its ease of disinfection and handling, its relative durability with repeated use, the low cost of its laboratory hardware, and the fact that it is relatively unobtrusive once inserted.

The VPP has been employed in a wide array of research designs and in response to varied research questions pertaining to genital arousal. For example, it has been used to study gender differences (e.g., Heiman, 1977), effects of menopause (e.g., Brotto & Gorzalka, 2002; Laan & van Lunsen, 1997), female sexual dysfunction (e.g., Heiman, 1976; Meston & Gorzalka, 1996; Palace & Gorzalka, 1990; Wouda et al., 1998), sexual orientation (e.g., Chivers, Rieger, Latty, & Bailey, 2004), and in pharmacotherapy outcome trials (e.g., Laan, van Lunsen, & Everaerd, 2001; Meston & Heiman, 1998, 2002; Meston & Worcel, 2002; Rubio-Aurioles et al., 2002; Sipski, Rosen, Alexander, & Hamer, 2000a). Despite the widespread adoption of this methodology across international research sites, the current lack of established guidelines for using the VPP has led to methodological variation across studies, resulting in difficulties with cross-study comparisons and gaps in our understanding of the factors influencing female genital arousal.

The extent to which cross-study variability in design and analysis is responsible for discrepancies in the literature has received minimal attention, despite the potential for having significant consequences. For example, Palace and Gorzalka (1992) found dramatic differences in the strength of the vaginal blood volume response depending on the type of erotic stimulus employed, and whether it was drawn from educational or commercial sources. The method of data analysis has also been found to influence results, with within-subjects analyses being more likely than between-subjects analyses to reveal positive correlations of psychophysiological with subjective sexual arousal (Merritt, Graham, & Janssen, 2001). Hormonal status of research participants is a critical methodological factor to consider when interpreting results, in light of the finding that menstrual cycle stage can significantly influence vaginal responding (Graham, Janssen, & Sanders, 2000; Slob, Bax, Hop, Rowland, & van der Werff ten Bosch, 1996; Wincze, Hoon, & Hoon, 1976). However, hormonal status is rarely controlled for in VPP studies of premenopausal women.

Similarly, use of the oral contraceptive pill (OCP) is a methodological factor that is not consistently controlled for in female sexual arousal research using the VPP. We arbitrarily chose to review articles published between 2000 and 2003 in hopes of examining this independent variable and identified 15 studies that employed the VPP in premenopausal women during this time. There was tremendous cross-study variability in terms of whether or not the OCP status of premenopausal participants was controlled for or even mentioned. Two studies excluded women using OCPs (Graham, et al., 2000; Meston & Heiman, 2002), two reported including women both using and not using OCPs (Polan et al., 2003; Tuiten et al., 2000), and 11 reports failed to mention the OCP status of the participants (Berman et al., 2001; Both, Everaerd, & Laan, 2003; Brotto & Gorzalka, 2002; Islam et al., 2001; Laan et al., 2002; Pras et al., 2003; Salerian et al., 2000; Sipski, Alexander, & Rosen, 2001; Sipski et al., 2000a, 2000b; Tuiten et al., 2002).

It seems reasonable to predict that OCP status would have an impact on female genital responding and might be a confounding variable. Animal literature indicates that vaginal lubrication (Min et al., 2003), genital blood flow (Park et al., 2001), vaginal muscle contractility (Kim et al., 2004), and genital sensation (Komisaruk, Adler, & Hutchinson, 1972) are estrogen-regulated. The typical animal paradigm investigates the restorative effects of estrogen administration after hormonal deprivation via ovariectomy, whereas OCPs expose women with functioning ovaries to supraphysiological quantities of estrogens and progestins. Notwithstanding this limitation, animal studies suggest that estrogen may mediate many aspects of female physiological sexual arousal.

In theory, the progestational component of OCPs may also play a role in genital responding. In an older study, Barraclough and Cross (1963) observed that intravenous progesterone administration depressed the response of hypothalamic neurons to cervical probing in gonadally-intact female rats. Estrogen has also been shown to alter the response of rat hypothalamic neurons to vaginal stimulation (Law & Sackett, 1965/1966). These early findings may provide clues to a putative central mechanism of action through which OCPs could influence perception of genital arousal.

Human studies showing a relationship between hormone levels and sexual functioning also imply that OCPs may have an influence. For example, female sexual responsiveness has been linked to circulating androgens (Davis & Burger, 1997; Sarrel & Whitehead, 1985; van Lunsen & Laan, 1997; Zussman, Zussman, Sunley, & Bjornson, 1981), as post-menopausal women with reduced androgen stores have diminished sexual response, as well as desire, relative to premenopausal women (Malacara et al., 2002; Padero, Bhasin, & Friedman, 2002; Sarrel, 2000; Sarrel, Dobay, & Wiita, 1998). Moreover, these effects are reversed with hormone replacement therapy (Sarrel et al.). A hormone-sexual response relationship has also been demonstrated in premenopausal women, as diminished sexual response has been found in women who have had salpingo-oophorectomy (Judd, 1976; Nathorst-Bass & von Schoultz, 1992; Sarrel & Whitehead; Zussman et al.) and in women who have naturally low androgen levels (Guay & Davis, 2002).

From an evolutionary perspective, there is reason to speculate that OCP use may influence sexual response based on the suggestion that women's mate preferences shift according to likelihood of conception. There is a growing literature on the discrimination between potential mates based on mate attractiveness. For instance, it has been suggested that higher degrees of facial and body symmetry are signs of attractiveness and mate quality (for a review, see Thornhill & Gangestad, 1999a). Such findings have been interpreted based on an evolutionary perspective which suggests that symmetry reflects information about an individual's health (Thornhill & Gangestad). Females have been shown to prefer the scent of symmetrical male bodies only during the high-fertility phase of the menstrual cycle (Gangestad & Thornhill, 1998; Thornhill & Gangestad, 1999b), a shift that does not hold in women taking OCPs (Gangestad & Thornhill; Thornhill & Gangestad, 1999b). Likelihood of conception has also been linked to preference for masculine male faces (Penton-Voak & Perrett, 2000; Penton-Voak et al., 1999). Such preferences may be an adaptation for obtaining genetic benefits for offspring (Koehler, Rhodes, & Simmons, 2002).

Despite nearly three decades of research using the VPP, we could find no published literature examining physiological measures of genital arousal before and after the onset of OCP use. In a study assessing response specificity of female sexual arousal, Laan, Everaerd, and Evers (1995) included a separate set of analyses in which they compared OCP users to non-users on VPA. Although they

failed to find group differences, this study does not answer the question of whether OCP use affects genital arousal, given that the participants in the OCP group entered the study already using OCPs. It has been shown that OCP users may differ from non-users on a variety of variables, including the likelihood of having a steady sexual partner (Bancroft, Sherwin, Alexander, Davidson, & Walker, 1991; McCoy & Matyas, 1996), level of partner-related sexual activity (Bancroft & Sartorius, 1990; Cvetkovich & Grote, 1981), attitude towards sexuality (Bancroft et al., 1991), partners' and friends' attitudes toward OCP use (Werner & Middlestadt, 1979), age of first sexual experience (Cvetkovich & Grote; McCoy & Matyas), frequency of sexual intercourse (Alexander, Sherwin, Bancroft, & Davidson, 1990; Cvetkovich & Grote; McCoy & Matyas), perceptions of risk of sexual intercourse (Cvetkovich & Grote), and perceived consequences of OCP use (Werner & Middlestadt). The design employed in the study by Laan et al. (1995) does not account for these potentially confounding variables. Moreover, since the authors did not report means or measures of variance, any inter-subject differences are unknown.

Given that established guidelines for using the VPP do not exist, the potential effect of OCP use as a methodological variable to consider is an important area to explore. This study examined the effect of OCP use on genital arousal (using the VPP) and subjective arousal (using self-report). Responses were compared before and six weeks after the onset of OCP use in premenopausal women. Considering that the visual system might be sensitive to hormonal changes (Graham et al., 2000; Koehler et al., 2002), we chose exposure to audiovisual erotic stimuli as a means of enhancing sexual arousal. Given the exploratory nature of this study, we did not have a priori hypotheses about the findings. Rather, we aimed to establish some basic information that might inform future research with respect to this methodological variable.

## Method

### *Participants*

Twenty-two premenopausal women, free of sexual complaints, were enrolled in this study which consisted of two sessions. Six of the 22 women were excluded from the study after their first session for the following reasons: did not start an OCP ($n = 3$); stopped OCP use due to medical reasons ($n = 1$); and did not return telephone calls to schedule the second session ($n = 2$). Therefore, we present data from 16 participants. We recruited women via advertisements posted campus-wide at the University of British Columbia and in local newspapers. All women were planning to take a self-selected OCP in the near future and were involved in a heterosexual relationship. Exclusion criteria were assessed during an initial telephone screen and included (a) age less than 18 years and older than 30 years, (b) non-heterosexuality, (c) use of medications known to affect sexual functioning (e.g., antihypertensives, antidepressants), (d) diabetes, (e) hypertension, (f) endorsement of sexual difficulties, (g) unstable psychopathology (determined by the Brief Symptom Inventory of the Derogatis Sexual Functioning Inventory), and (h) lack of prior sexual experience. Two women were excluded from participation based on these criteria, one who was using antidepressant medication and one who had untreated Major Depression. Prospective participants were told during the telephone screen that the purpose of the study was to examine the effects of the oral contraceptive pill on sexual function.

### *Measures*

*Derogatis Sexual Functioning Inventory* (DSFI; Derogatis & Melisaratos, 1979). The DSFI is a self-report questionnaire made up of 10 subscales. The Brief Symptom Inventory, Experiences, Attitude, and Satisfaction subscales of the DSFI were included in the current study.

The Brief Symptom Inventory (BSI) subscale of the DSFI is a self-report questionnaire that measures psychological symptoms in terms of 9 major symptom dimensions and 3 global indices of distress. Respondents rate the level of distress or bother that they have experienced from each of 53 items over the past two weeks. The items are rated on a 5-point Likert scale, ranging from 0 (*not at all*) to 4 (*extremely*). The Experiences subscale consists of a list of 24 distinct sexual behaviors (e.g., mutual oral stimulation of genitals, deep kissing), in which subjects indicate if they have engaged over the past 60 days. The Attitude subscale consists of 15 statements reflecting a liberal attitude (e.g., wife-swapping is acceptable if all four partners agree) and 15 statements reflecting a conservative attitude (e.g., sex is morally right only when it is intended to produce children). Respondents are instructed to rate the degree to which each statement is reflective of their beliefs on a 5-point Likert scale. The Satisfaction subscale requires individuals to answer either "True" or "False" to 10 questions regarding their satisfaction with their sexual relationship (e.g., usually, after sex I feel relaxed and fulfilled).

The DSFI has been shown to have good psychometric characteristics (Derogatis & Melisaratos, 1979). Its overall inter-rater reliability is high, at .91, and the test-retest reliabilities of the individual subscales range from .80 to .90. It has been shown to have good predictive validity and is capable of discriminating between groups at levels significantly above chance.

*Sexual Inventory.* The Sexual Inventory is an unpublished survey developed by our research group that assesses anticipated sexual arousal in response to viewing an erotic visual stimulus (e.g., "Given the appropriate situation, what it the highest level of sexual arousal that you think you could experience?"; "What is the highest level of sexual arousal that you think you could experience viewing an erotic film alone?").

*Side Effects Survey (SES).* The SES is a clinician-derived retrospective self-report survey written by our

research group. Women are instructed to indicate which of 13 physical and emotional side effects they have experienced since onset of OCP use and to report the duration of the side effects in days. Respondents are also asked to indicate the degree of change, if any, in sexual side effects attributable to OCP use, including sexual desire, vaginal lubrication, pain during intercourse, and mental sexual excitement with a partner.

*Film Scale* (Heiman & Rowland, 1983). The Film Scale is a 34-item self-report questionnaire assessing autonomic arousal, perceptions of genital sexual arousal, mental sexual arousal, anxiety, positive affect, and negative affect. Participants complete items on the 7-point Likert scale, ranging from 1 (*not at all*) to 7 (*intensely*) both before and immediately after erotic film presentation.

*Vaginal Pulse Amplitude (VPA).* The VPA signal of the VPP was used to assess genital arousal. VPA was monitored throughout exposure to each film segment and recorded on a HP Vectra Celeron personal computer using the software program AcqKnowledge III, Version 3.5 (BIOPAC Systems, Inc., Santa Barbara, CA) and a Model MP 100WSW data acquisition unit (BIOPAC Systems, Inc.) for analog/digital conversion. A sampling rate of 200 samples per second was used for VPA throughout the 180 seconds of neutral exposure and 180 seconds of erotic film exposure. The signal was band-pass filtered (0.5-30 Hz). Data were analyzed in 30-second segments and then averaged over the neutral and erotic segments separately, resulting in one data point for neutral and one data point for erotic segments per subject per session. In accordance with other studies of this nature, we used visual inspection of the data to detect artifacts caused by movement or contraction of the pelvic muscles. This method is considered a reliable method of artifact detection, given the intensity of the increase in amplitude resulting from movement or contractions (Laan, Everaerd, & Evers, 1995). We replaced each 30-second epoch containing an artifact with the average VPA of the intervals immediately preceding and following.

### *Procedure*

A repeated-measures design allowed each subject to serve as her own control. Session one was scheduled approximately one week before the onset of OCP use and consisted of a female researcher orienting the woman to the laboratory equipment, obtaining written consent, and providing the battery of questionnaires to be completed in a private room. Following completion of the questionnaires, each woman was seated comfortably in a reclining chair and asked to insert the probe with the aid of diagrammed instructions after the female researcher had left the room. A TV monitor was placed on a table so that participants could comfortably recline on a couch with full view of the screen. We provided each woman with a light blanket and instructed her to lie quietly for a 5-minute adaptation period before the onset of the video.

Each film sequence included a 1-minute display of the word "relax," followed by a 3-minute neutral stimulus depicting a documentary of a geographical location (either glaciers or Stonehenge). Immediately following, we presented a 3-minute erotic stimulus of the "female-friendly" variety consisting of a nude heterosexual couple engaging in foreplay, mutual manual-genital and oral-genital stimulation, and intercourse. Content order was matched across both films. We chose these film segments based on pilot work in our laboratory in which they were shown to elicit positive sexual feelings and affect, and not to offend or induce feelings of disgust or guilt. Immediately prior to and following the films, participants completed the Film Scale.

We scheduled a second session approximately six weeks ($M$ = 44 days) after the onset of OCP use. It consisted of women completing the SES and then repeating a psychophysiological assessment. Psychophysiological testing was identical in sessions one and two, apart from different film stimuli, presented in a counterbalanced fashion across sessions to control for possible order effects. At the conclusion of session two, we debriefed each woman to any questions that she might have had during the course of the investigation and provided $10 for her participation.

## Results

### *Demographic Information*

The mean age of the women in the sample was 21.6 years ($SD$ = 3.2) with a mean education level of 14.3 years ($SD$ = 1.6). The majority of women were Caucasian (81%). All participants were unmarried, and all were involved in a heterosexual relationship with an average of 13.5 months ($SD$ = 18.7) in duration. They used a variety of OCP types (5 on Tricyclen, 4 on Alesse, 3 on Triphasyl, 2 on Marvelon, 1 on Micronor, and 1 on Synphasic). Given the small number of women in each OCP group, analyses by OCP type were not possible. When asked reasons for wishing to begin OCP use, 50% of the women reported it was exclusively to avoid pregnancy, and 50% reported it was for one or more other reasons in addition to a method of contraception, including to regulate menstrual period ($n$ = 4), to reduce menstrual pain ($n$ = 4), to reduce premenstrual symptoms ($n$ = 3), and to control acne ($n$ = 4). Other demographic data are presented in Table 1. According to the DSFI, women appeared to be in the upper range of sexual experience (21.7 out of a possible 24.0) and had liberal attitudes towards sexuality (22.8 out of a possible 26.0). Their level of relationship satisfaction was at the mean level for this variable according to the scale's standardization data. Women reported an above average likelihood of becoming sexually aroused in response to erotic films (4.4 out of a possible 7.0).

### *Effects of Erotic Stimuli on Sexual Arousal Before OCP Use*

As presented in Table 2, data showed that the erotic film significantly increased VPA at pre-OCP, $t(15) = -2.84$, $p = .012$. Specifically, 14 of the 16 women (87.5%) had higher VPA levels in the erotic compared to the neutral stimulus condition. Using the quotient *(erotic mean VPA - neu-*

**Table 1. Demographic Information on Women ($n$ = 16) Prior to Beginning Oral Contraceptive Pill Use**

| Measure | | Mean (± SD) | Range |
|---|---|---|---|
| Age | | 21.8 (3.2) | 18-29 |
| Ethnicity | | | |
| Caucasian | | 14 | – |
| East Asian | | 1 | – |
| Hispanic | | 1 | – |
| Education (years) | | 14.3 (1.5) | 12-16 |
| Relationship duration (months) | | 13.5 (18.7) | 2.5–66.0 |
| Alcohol (drinks per week) | | 1.4 (1.5) | 0-5 |
| Do you smoke? | Yes | 2 | – |
| | No | 14 | – |
| DSFI – BSI[a] | | 0.59 (0.35) | 0.09-1.32 |
| DSFI – Information | | 22.8 (1.5) | 20-25 |
| DSFI – Experience | | 21.8 (2.4) | 17-24 |
| DSFI – Satisfaction | | 8.3 (1.4) | 5.0-10.0 |

[a]Brief symptom inventory scores are within one standard deviation of the mean. Maximum possible DSFI scores are as follows: Information subscale = 26, Experience subscale = 24, and Satisfaction subscale = 10.
*Note.* Data represent means (± SD) and range of scores.

*tral mean VPA) divided by neutral mean VPA* as a measure of percent change, we found that 8 women responded to the erotic film with a VPA increase in the 1-25% range, 3 women had a VPA change in the 26-50% range, one woman responded in the 50-100% range, and 2 women responded in the range above 100%. Of the 2 women who did not respond to the erotic film, one experienced no change in VPA, and the other had a 10% decrease with exposure to the erotic film (see Table 3).

Women's self-reported mental sexual arousal to the erotic film significantly increased, $t(15) = -2.57$, $p = .021$, as did perception of genital arousal, $t(15) = -5.17$, $p = .001$. On measures of affect, positive affect showed an increasing trend with the erotic film, $t(14) = -2.01$, $p = .06$, negative affect was unaffected, $t(14) = -1.50$, $p > .05$, and anxiety was significantly reduced, $t(15) = 2.08$, $p = .05$. Perception of autonomic arousal increased significantly with the erotic film, $t(15) = -4.50$, $p = .001$, at pre-OCP.

**Table 2. Effects of Neutral and Erotic Stimuli Before and After Oral Contraceptive Onset**

| Measure | Pre-OCP | Post -OCP |
|---|---|---|
| VPA(millivolts) | | |
| Neutral | 4.72 (3.3) | 5.4 (2.8) |
| Erotic | 6.00 (3.6)* | 7.8 (7.4) |
| Mental sexual arousal | | |
| Neutral | 7.8 (2.7) | 8.1 (2.3) |
| Erotic | 9.9 (3.1)* | 10.9 (2.0)*** |
| Perception of genital arousal | | |
| Neutral | 10.8 (5.8) | 12.2 (5.6) |
| Erotic | 19.5 (7.9)*** | 18.9 (6.9)*** |
| Positive affect | | |
| Neutral | 13.9 (5.0) | 13.8 (4.2) |
| Erotic | 17.6 (7.1) | 18.9 (7.2)** |
| Negative affect | | |
| Neutral | 12.6 (1.9) | 12.4 (4.4) |
| Erotic | 14.0 (3.7) | 12.9 (4.8) |
| Perception of autonomic arousal | | |
| Neutral | 12.5 (4.7) | 12.0 (6.3) |
| Erotic | 17.3 (5.6)*** | 16.7 (6.4)*** |
| Anxiety | | |
| Neutral | 2.1 (1.5) | 1.4 (0.6) |
| Erotic | 1.5 (0.7)* | 1.4 (0.8) |

***$p < .001$ **$p < .01$ *$p < .05$

### *Effects of Erotic Stimuli on Sexual Arousal After OCP Use*

At post-OCP, the erotic film did not significantly increase VPA, $t(15) = -1.35$, $p > .05$ (see Table 2). The data revealed that the variability in genital responses post-OCP onset caused this lack of significance. A comparison of the variances of genital responses from pre-OCP onset to post-OCP onset using an $F$-ratio revealed a significant difference, such that the variability in responses post-OCP ($s^2$ = 2.103) was greater than that pre-OCP ($s^2$ = .292), $F$ (15,15) = 7.202, $p < .001$. Accordingly, individual percent change scores from the neutral to erotic stimulus conditions at post-OCP revealed that 12 of the 16 women responded with higher VPA levels. Of these women, 9 responded in the 1-25% range, one in the 50-100% change range, and 2 women responded in the greater than 100% range (with one of these having a 573% increase). The remaining 4 women all experienced a decrease in VPA percent change that ranged from 13-36% (see Table 3).

Women's mental sexual arousal post-OCP onset was significantly increased with the erotic film, $t(15) = -5.06$, $p < .001$, as were perception of genital arousal, $t(15) = -4.95$, $p < .001$, and perception of autonomic arousal, $t(15) = -4.93$, $p < .001$. Positive affect significantly increased, $t(15) = -3.87$, $p = .002$, and negative affect was unaffected, $t(15) = -0.68$, $p > .05$, with exposure to the erotic film. Anxiety did not change in response to the erotic film at post-OCP onset, $t(15) = 0.00$, $p > .05$; however, the difference in anxiety

**Table 3. Individual Vaginal Pulse Amplitude (VPA) Percent Change Responses Before and After Oral Contraceptive Onset ($n$ = 16)**

| Woman | Pre-OCP | Post-OCP |
|---|---|---|
| 1 | 1% | 2% |
| 2 | 83% | -19% |
| 3 | 49% | 87% |
| 4 | 204% | 573% |
| 5 | 0% | -13% |
| 6 | 22% | -36% |
| 7 | 33% | -23% |
| 8 | 102% | 112% |
| 9 | 13% | 2% |
| 10 | 2% | 9% |
| 11 | 16% | 35% |
| 12 | 18% | 21% |
| 13 | 46% | 33% |
| 14 | 9% | 39% |
| 15 | -10% | 13% |
| 16 | 10% | 48% |

*Note.* Percent change responses were calculated using the following formula: *(mean erotic VPA - mean neutral VPA) divided by mean neutral VPA.*

change scores from neutral to erotic stimulation across the two time periods was not significant, $t(15) = -1.619$, $p > .05$.

### *Genital and Self-Report Sexual Arousal Correlations*

We conducted correlations between genital and self-report measures by computing Pearson product moment correlation coefficients of the percent change scores in VPA and self-reported arousal (mental and perception of genital arousal). We computed analyses separately before and after OCP use. The correlation between VPA and mental sexual arousal before OCP use was statistically significant, $r = 0.498$, $p = .05$. However, the correlation of VPA with perception of genital arousal, $r = 0.111$, $p > .05$, was not statistically significant.

Following OCP onset, the correlation between VPA and mental sexual arousal remained statistically significant, $r = 0.825$, $p < .001$. In addition, the correlation between VPA and perception of genital arousal was now significant, $r = 0.568$, $p = .02$. In order to compare pre- and post-OCP correlations statistically, we derived a Fisher $z$ transformation value for each correlation coefficient and subsequently computed a standardized $z$-score based on the Fisher $z$ transformation scores. These analyses revealed that neither the increase in correlation of VPA with perception of genital arousal ($z = 1.369$, $p = .1706$) nor the increase in correlation of VPA with mental sexual arousal ($z = 1.629$, $p = .1032$) was significant.

### *Side Effects of OCP Use*

According to the SES, subjects retrospectively reported experiencing a mean of 2.6 ($SD = 1.8$) out of a possible 13 physical and emotional side effects over the previous six weeks that they attributed to the OCP. The most common side effects were weight gain ($n = 8$) and breast tenderness ($n = 6$). Other side effects reported included nausea ($n = 5$), headache ($n = 5$), irritability ($n = 4$), fatigue ($n = 4$), emotional lability ($n = 2$), acne ($n = 2$), and leg pain ($n = 1$). Reports of sexual side effects on the SES varied markedly. Five women reported experiencing decreased sexual desire, 5 reported increased sexual desire, and 6 reported no change in their sexual desire. Three participants reported decreased lubrication, 2 reported increased lubrication, and 11 reported no change in lubrication. Two women reported an increase in pain during sexual intercourse, 13 subjects reported no change, and one woman did not respond. Three participants reported a decrease in mental sexual excitement when with a partner, 4 reported an increase in mental sexual excitement, 8 reported no change in mental sexual excitement, and one did not respond.

## Discussion

This study examined the effects of oral contraceptive use on genital arousal response as measured by the VPP. Overall, the significant increase in VPA that was found at time 1 was absent at time 2 after OCP onset; however, closer examination of individual responses suggests that the significantly higher variability of responses after OCP onset masked an effect. Prior to OCP use, there was an overall significant increase in VPA with the erotic film, and consistent with female sexual psychophysiological studies in general, only 2 women failed to show a VPA increase with the erotic film. However, after OCP onset, 4 women responded with a decrease in VPA to the erotic film, despite an overall significant increase in subjective sexual arousal with the erotic film. Furthermore, exploring the degree of percentage increase in VPA following and prior to OCP onset highlights significant variability of responses. Whereas the range of percentage increase was from 1 to 204% prior to OCP use, the range doubled following OCP onset from 2 to 573%. We believe that this marked variability of VPA responses, including the fact that there were 4 non-responders, accounts for the failure to detect a significant effect of the erotic stimulus on physiological arousal.

Data from this study suggest that subjective sexual arousal does not change pre- to post-OCP onset. Both before and after OCP onset, women responded with increased mental sexual arousal, increased perception of autonomic arousal, and increased perception of genital arousal in response to erotic stimulation. Our findings are corroborated by previous research suggesting that a large portion of OCP users do not experience changes in subjective aspects of sexuality with OCP use (e.g., Graham, Ramos, Bancroft, Maglaya, & Farley, 1995; Sanders, Graham, Bass, & Bancroft, 2001). However, it is worth mentioning that despite a significant increase in self-reported arousal in response to erotic stimuli post-OCP onset, 5 women reported a decrease in sexual interest on the SES, and reports of other sexual concerns (e.g., decreased arousability and pain during penetrative sex) were also found in a minority of women. Others have also found support for this observation. For example, Graham et al. found adverse effects of an estrogen/progestin OCP compared to a progestin-only OCP, but only in women from Scotland, not in women recruited from the Philippines. Others have also found reduced sexual interest following OCP use, as compared to a placebo (Graham & Sherwin, 1992; Leeton, McMaster, & Worsley, 1978). It is possible that these effects are due to the particular hormonal composition of the OCPs, given that sexual arousal and interest are found to be lower in women using monophasic OCPs versus women using triphasic OCPs (McCoy & Matyas, 1996). These results suggest the importance of considering both self-reported responses in a controlled laboratory setting as well as self-reported responses in the real-life setting and highlight the fact that women may respond differently to an OCP depending on a number of factors.

If we had employed a different method for assessing sexual response, this might also have revealed different effects. For instance, in both the Graham et al. (1995) and the Graham and Sherwin (1992) placebo-controlled studies of OCP use, daily diary ratings were used. In the Leeton et al. (1978) study, participants completed self-report ques-

tionnaires during in-laboratory interviews, and not specifically in response to audiovisual stimuli. We argue that the current methodology involving measurement of self-reported sexual arousal immediately before and after exposure to an erotic film might be more relevant, given that the stimulus employed is more powerful in elucidating an arousal response than other methods that assess sexual response in the absence of an activating stimulus.

Despite no changes in subjective sexual arousal, there appeared to be a change in anxiety response across the two sessions, with a less marked decrease in anxiety at post-OCP compared to session 1. We can rule out an effect of OCP use on this variable after closer inspection of Table 2, which reveals a lower anxiety response during the neutral film at post- compared to pre-OCP use, but no overall difference in anxiety scores during the erotic film across the two sessions. One explanation for the lower baseline score is the women's increased familiarity with the laboratory and with the procedures. This is supported by information provided to the researchers by participants during the debriefing segment. There is also physiological support for increased comfort across sessions, as baseline heart rate is found to decrease over multiple physiological assessments (Laan, Everaerd, & Evers, 1995). We do not believe that this change in anxiety mediates the observed changes in VPA response, given that subjective anxiety and VPA are not found to be correlated (Laan, Everaerd, & Evers).

There were significant correlations between mental and physiological sexual arousal in response to the erotic stimuli both before and after OCP onset, and although not statistically significant, there was a trend toward significance for these correlations to be higher after ($r = 0.825$) than before ($r = 0.498$) OCP onset. Previous studies reporting subjective-genital correlations have revealed conflicting results. For instance, there have been reports of no significant correlation (e.g., Both, Spiering, Everaerd, & Laan, 2004; Geer, Morokoff, & Greenwood, 1974) and low, but significant correlations between the two measures (e.g., Heiman, 1977; Laan, Everaerd, & Evers, 1995; Wincze et al., 1976). There has been speculation as to why this relatively low degree of concordance in women has been found, including the way in which subjective sexual arousal has been measured (e.g., Wincze et al.) and the use of male-produced erotica in studies (e.g., Laan, Everaerd, van Bellen, & Hanewald, 1994).

Regarding the inconsistencies in findings, it has been speculated that some women may have difficulties detecting subtle changes in genital arousal (Heiman, 1976). Heiman suggested that the correlation between subjective and genital arousal may be lower when levels of arousal are lower, at which time women are less able to detect changes in vaginal blood flow. However, in a study testing whether higher arousal resulted in higher correlations, Laan, Everaerd, van der Velde, and Geer (1995) found that the correlation between the two measures of arousal was independent of the strength of genital arousal.

There are a variety of other factors that may be implicated in the degree to which subjective and genital arousal correspond. For instance, it has been suggested that subjective arousal in women is partially influenced by interpretation of external stimuli (Meston, 2000) and by meaning attributed to the sexual situation (Laan & Everaerd, 1995). Moreover, correlations have been found in women with greater orgasmic consistency during penile-vaginal intercourse (Brody, Laan, & van Lunsen, 2003) and in women with higher lifetime intercourse frequency (Adams, Haynes, & Brayer, 1985), supporting the suggestion of intra-individual differences. The latter study consisted of a sample of women similar in age to those in the current study. The correlations found in the current study may be accounted for by the relatively young, healthy sample of women who were in sexually active relationships and who had experienced a wide variety of sexual activities. Future research should aim at identifying possible moderators of subjective-genital correlation, including age, health, and sexual experiences.

An unanticipated finding in the present study was the significant correlation between VPA and perception of genital arousal which emerged following OCP onset. Although this change from pre- to post-OCP onset was not statistically significant, this trend may have reached significance with a larger sample size. It seems unlikely that OCPs directly enhance perception of genital arousal. Rather, it is possible that OCPs reduce the variability in perception of genital arousal, a trend also observed with mental sexual arousal (see *SD*s in Table 2). Given that this occurred with a variety of OCPs, it seems reasonable to predict even lower subjective variability if all women were on a single OCP.

An evolutionary perspective might be taken to explain the current findings. As noted earlier, potential to conceive and OCP use significantly affect mate preference (Gangestad & Thornhill, 1998; Thornhill & Gangestad, 1999b). After 6 weeks of OCP use, the significant physiological response to erotic stimuli apparent before OCP use disappeared. Considering that OCPs reduce potential to conceive, it may be the case that when there are no clear genetic gains for women, genital arousal is not activated to the extent that is it when genetic benefits are available for gain. Although this is supported by other literature on mate choice, scent, and symmetry, this point is merely speculation and deserves additional study.

Although it is possible that the current findings are due to an effect of having subjects repeatedly measured in the laboratory, we ruled out this conclusion based on a number of studies suggesting otherwise. Other research that has assessed women across two time points has not revealed an effect of repeated measures on genital arousal, whether the focus of the study was to explore age and menopausal effects (e.g., Brotto & Gorzalka, 2002), to explore the effects of sympathetic nervous system activity (Meston & Gorzalka, 1996), or to explore the effects of fragrance (Graham et al., 2000). To examine this further, we selected an age-matched sample of women from the Brotto and Gorzalka study in an effort to explore and compare the

range of individual VPA responses to the current sample. We found the responses of the 16 OCP users from the current study to be unique, as the rates of non-responses were quite low and the variability of VPA responses much less in the comparison sample compared to the current sample.

A number of limitations in this study must be considered. For example, although our sample size ($n$ = 16) is typical of female sexual psychophysiological research, the number of different OCP types used results in a small number of women using any particular OCP. Given the large variety of options women find when selecting an OCP, this heterogeneity may be typical of research participants in sexual response research, and therefore is worthy of mention. Although we assessed OCP type in the study, neither the overall sample size nor sample sizes of different OCP-type groups was large enough to separate subjects based on this variable for purposes of statistical analyses.

In a study on symptom change across the menstrual cycle, Ross and colleagues found differences among OCP users depending on type of OCP employed, such that monophasic OCP users reported higher levels of fluid retention and more somatic symptoms than triphasic OCP users (Ross, Coleman, & Stojanovska, 2003). Furthermore, in a study on premenstrual symptoms and OCP use, Walker and Bancroft (1990) found that monophasic OCP users showed less premenstrual breast tenderness than triphasic OCP users and a non-OCP control group. Although the authors did not detect differences among the groups on other variables, including sexual interest, they noted that for most subjects, the cyclical changes in symptoms across the menstrual cycle were relatively mild. These studies suggest differences in symptoms associated with different OCPs and suggest, perhaps, that the high degree of variability in VPA response in this study may be attributable to different OCP types. Future research should explore the effects of specific OCP type, based on estrogen-progestin concentrations, in order to make inferences about precise hormone combinations on genital arousal.

One other factor limiting the generalizability of the findings is the time period chosen of six weeks of OCP use. Using either a shorter or longer period before repeat physiological testing may have produced different findings. Our understanding of the effects of OCP use on physiological arousal might benefit from manipulating this variable and examining the resulting VPA responses.

The mechanisms by which OCP use led to high variability in VPA responses is unknown and were not a focus in this study. However, given the role of hormones in female sexual response, it is likely that differences in hormonal combinations are at least partially responsible for the findings. It is also possible that differences in hormone levels prior to OCP use might account for some of the findings. Although we did not measure hormone levels in this study due to problems in available assays being inaccurate for hormones in the female range (especially androgens), it is possible that an interaction between baseline hormone levels and hormonal influences of the OCP could have produced the observed variability in VPA. Future studies that employ more accurate assays of female hormones (e.g., Labrie, Luu-The, Labrie, & Simard, 2001) and track women prior to and following OCP use are fundamental for understanding the precise hormonal mechanisms by which OCPs influence sexual response.

The findings in this study suggest that women using OCPs respond with greater variability on measures of physiological arousal than women not using OCPs. In our opinion, these findings strongly support the inclusion of OCP status as a methodological factor to consider in research employing the VPP. The extent to which failure to control for this variable has led to conflicting findings in past literature is unknown. Future research should include mention of OCP status in methodology descriptions in order to facilitate cross-study comparisons.

Overall, these data suggest that OCP status as a methodological variable is an important consideration when using the vaginal photoplethysmograph to explore female sexual arousal. By reducing, or at least accounting for, such methodological variance, we can ensure that a common dialogue between investigators at different research sites takes place, and in so doing, the study of women's sexuality is advanced.

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