

Assessment of Female Sexual Arousal in Forensic Populations

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Abstract Sexual offenses cause significant harm to victims, their families, and society as a whole and thus are an important social concern. While it is commonly assumed that sexual offenses are committed solely by males, research has shown that approximately 5 % of sex crimes in the USA and Canada are committed by females. Penile plethysmography (PPG) is a method to measure male genital arousal, which is commonly used in the assessment and treatment of male sex offenders and men with paraphilic sexual interests. Similarly, vaginal photoplethysmography (VPP) is a test to measure female gen-

ital arousal and is commonly used to assess female sexual dysfunctions. Although VPP is currently the most validated method to measure genital arousal in women, its use with female sex offenders or females with paraphilic sexual interests has been almost nonexistent. One explanation for this is that some research has suggested that female genital arousal may not be category-specific, meaning that women will respond to any sexual cues, not just those involving their preferred sexual interests. However, not all research supports this finding. Due to the potential benefits of using VPP in the assessment and treatment of female sex offenders or females with paraphilic sexual interests, it is important that further research be done before dismissing the use of VPP in forensic populations. The purpose of this article is to review the current research on VPP and its applicability to female sex offenders and females with paraphilic sexual interests.

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Introduction

Vaginal photoplethysmography (VPP) is, to date, the most frequently used measure of genital (physiological) sexual arousal in women [1–4] and the most validated instrument used to assess women's genital responses [1]. VPP measures physiologic changes in genital blood flow associated with subjective sexual arousal in women. During the VPP test, the woman being tested is presented with a variety of sexual and neutral (nonsexual) stimuli in the form of slides, audiotapes, and videos, during which photoelectric measurements are made of changes in the volume of blood flow in the vaginal walls.

The accuracy of VPP has been tested, and results have provided significant evidence to support both its validity and reliability as a physiological measure of women's genital sexual arousal, mostly involving women with potential sexual dysfunctions [5]. For example, Meston et al. conducted a study to determine if VPP was sensitive enough to distinguish between women with sexual arousal disorder or orgasm dysfunctions and those without [4]. The study found that women with sexual arousal disorder showed less concordance between their subjective and physiological sexual arousal compared to women with orgasm disorder or those who were sexually healthy, supporting the idea that VPP can be used to discriminate between these groups. A study by Rellini and Meston used VPP, along with self-administered questionnaires, to see if there were any treatment-related changes in a group of women with female sexual arousal disorder (FSAD) [6]. They found that VPP accurately predicted 80 % of women still suffering from FSAD and 67 % no longer suffering FSAD after receiving treatment. These findings support the notion that VPP is able to detect treatment-induced changes. Another study used VPP testing, in combination with participant's self-reported mood and sexual arousal, to determine how positive, negative, and ambivalent affect influence subjective sexual arousal and genital responses [7]. The study indicated that both positive and ambivalent affect had a relatively strong positive correlation with subjective sexual arousal, whereas negative affect was positively correlated with genital responses towards some of the films used in this study, but was typically not related to subjective sexual arousal. VPP has also been used to study the effects of past sexual assault and alcohol consumption and intoxication on women's sexual arousal [8] and as a comparison measure when evaluating the efficacy of new instruments used to assess women's genital responses, such as the labial photoplethysmography [1] and labial thermography [9].

Despite the growing evidence that VPP is a valid and reliable measure of women's genital sexual arousal, it has rarely been used with female sexual offenders or females with paraphilic sexual interests. In contrast, penile plethysmography (PPG; also known as phallometric testing) is a physiological measure of male genital arousal that is commonly used in the assessment and treatment of male sex offenders. One historical explanation for the lack of VPP testing in female forensic populations is the misconception that women do not commit sexual offenses, or that if they do commit these types of crimes, it is for nonsexual reasons or because they are complying with the actions of a male partner. Some research has also indicated that female's sexual response patterns may be different than those of males, with women showing significantly less concordance between their subjective and genital sexual arousal responses as compared to men [10]. Although this finding indicates the need for further research on VPP testing before it becomes standard practice in female forensic

populations, it should not be considered sufficient to discount the many potential benefits of using VPP to assess female sex offenders or females with paraphilic interests.

VPP Technical Information

The VPP gauge is a cylindrical probe made of acrylic plastic that is approximately the size and shape of a menstrual tampon. This probe is easily inserted into the vagina by the subject. Within the probe is a photoelectric transducer. Changes in blood volume within the vagina produce changes in the amount of light reflected back and detected by the transducer [9, 11]. VPP measures two components of vaginal physiologic changes associated with sexual arousal: vaginal blood volume (VBV) and vaginal pulse amplitude (VPA). VBV allows for the detection of slow changes in blood pooling, while VPA detects changes in vasocongestion, or pressure changes within the vessels, that accompany each heart beat [2, 10]. These are both hemodynamic measures that women may be unable to detect. It has been suggested that changes in VPA are specific to sexual stimuli whereas VBV has been found to increase in response to both sexual and anxiety-producing stimuli [12]. However, Suschinsky et al. argue that VPP is exclusively a measure of sexual arousal, based on their finding that women's genital sexual arousal was highest in response to sexual stimuli and absent during the presentation of nonsexual stimuli [3]. In addition, an experiment performed by Beggs, Calhoun, and Wolchik found that, although stimuli involving sexual pleasure or sexual anxiety both produced greater arousal than baseline levels, sexual pleasure stimuli produced significantly greater sexual arousal than did sexual anxiety stimuli [13]. A linear increase in sexual arousal, but not sexual anxiety, was found over time, suggesting that the results from each type of stimuli differed significantly in both magnitude and pattern [13]. It has been hypothesized that VBV may be a stronger correlate of subjective sexual arousal than VPA due to its reactivity to negative affect [14]. However, one study found that VPA demonstrated steady increases as an erotic film progressed, whereas VBV did not generate a similar pattern [12].

VPP in Forensic Populations

Sex offenses are a significant social problem. Based on the official crime statistics in the USA, there were 16,916 arrests for forcible rape and 60,804 arrests for sex offenses other than forcible rape and prostitution during 2008 [15]. According to the National Victimization Data Report, there were 191,670 rapes and sexual assaults in the USA during a single year [15]. Although the majority of these sexual offenses are committed by males, it has been estimated that approximately 5 % of all

known sex offenders are female [16]. Research has indicated that in the USA, approximately 25 % of male victims and 13 % of female victims were sexually assaulted by women [17]. In 2005, it was estimated that 1500 female sex offenders were imprisoned across the USA [18], representing 2 % of all adult females incarcerated at that time [19]. As of 2006, approximately 7 % of all adult sex offenders arrested in the USA were female, with 1 % of female sex offenders arrested for rape and 6 % for other sex offenses [20]. These figures are even higher for adolescents, with 3 % of rapes, 5 % of other violent sexual offenses, and 19 % of nonviolent sexual offenses being committed by adolescent females [19]. It has also been found that females are involved in up to 40 % of multi-perpetrator sexual offenses [21]. These figures are similar in Canada, where females were found to comprise 3 % of the total population of sex offenders, committing approximately 800 sexual assaults in 1 year [22]. This is in line with the finding that 1 to 2 % of all sexual offenses reported to Canadian police between 2000–2010 involved female offenders [16]. These statistics reveal that incidents of child sexual abuse by women are likely much higher than has previously been assumed.

Regardless of the offender's gender, the actual number of sex offenses committed is difficult to determine due to the fact that these incidents often go unreported. Plummer [23] asserts that female sexual offending against children remains largely hidden due to the social expectation of the typical female role, "which simultaneously expect[s] a degree of bodily contact between women and children and [denies] the existence of sexuality in women" (as cited in [24], p. 65). Society's denial of women's ability to commit acts that are deemed morally reprehensible contributes greatly to the skewed perception of female sex offenders. It has been argued that boys who were sexually molested by adult women may not always consider the incident to have been abusive, possibly because societal and/or peer pressure may cause them to feel as if they should be proud that they were sexually involved with an older woman [25]. It is also possible that boys who are assaulted by adult women may consider the abuse to be a type of sexual initiation [26]. In other cases, young males may not report sexual abuse out of shame or due to concerns that they will not be taken seriously.

Although it has been well-established as a measure of genital sexual arousal in non-paraphilic women, and has been proposed as a test that may help to confirm sexual preferences in female offenders, VPP has yet to be validated for use in forensic populations. In fact, a literature review revealed only one study that used VPP to assess the arousal patterns of a single female sexual offender. This was a case study of a 20-year-old woman with pedophilia who was charged with sexual assault for engaging in sexual relations with two of her sisters (aged four and five) while she was babysitting them. The study indicated that "since the physiologic mechanisms of arousal are homologous for both sexes," VPP could play an

important role in future assessments of female sexual offenders, including supplying baseline data on arousal in order to evaluate the success of various treatments [27]. However, since that recommendation, no further research has investigated this potentially useful measure within forensic clinical populations. In contrast, PPG, which is currently viewed as the most valid and reliable laboratory method to measure objective sexual arousal in males [28], has been validated for use in forensic populations. PPG is an important and commonly used tool for objective assessments of arousal patterns in male sexual offenders and in the development and appraisal of treatment plans for men who have sexually offended or who have paraphilic sexual interests [28].

Category Specificity

One of the current issues regarding use of VPP in forensic populations is research on VPP in non-forensic populations, which has found that female sexual arousal patterns as measured via VPP seem different from male sexual arousal patterns as measured via PPG. Male sexual arousal patterns have been found to be category-specific, meaning that men will only become genitally aroused by the sexual cues that they report being sexually interested in (i.e., a heterosexual man will typically only respond to stimuli involving sexual activity with women), and will not show genital arousal in response to stimuli depicting sexual cues in which they have no self-reported sexual interest [10]. For example, a heterosexual man would not be expected respond to a video of two males engaging in intercourse even though he recognizes the video as depicting sexual behavior. Women, on the other hand, have been found not to demonstrate category specificity in their genital arousal responses [29]. For example, women's VPP response profiles show evidence of physiologic changes associated with subjective sexual arousal. However, they also demonstrate similar changes in VPP response profiles in response to all types of sexual stimuli, including stimuli that contains images or descriptions that do not match their stated preferred sexual cues [3].

As evidence to this, heterosexual and homosexual women have been shown to produce identical patterns of VPP responses to erotica-displaying men. Consequently, the sexual orientation of women has often been viewed as indistinguishable based on women's genital arousal responses to heterosexual and lesbian stimuli [30]. In addition, other studies have found that women show genital arousal in response to coercive or threatening sexual stimuli, such as violent rape scenes, and will even demonstrate genital responses to images of bonobo apes engaged in sexual intercourse [29]. One explanation for women's seemingly indiscriminate sexual responses is related to possible gender differences in terms of the observational stance taken by men and women when exposed to sexual stimuli. It has been hypothesized that men experience

sexual stimuli objectively, or from the camera's stance, whereas women project themselves into the scene the camera is observing [31], and thus identify with the female actors [14]. Another explanation is based on the hypothesis that women's sexual arousal is more closely related to a person's physical features, the type of sexual activity taking place, or the relationship context, as opposed to the gender depicted in the stimulus [32•].

Although most current literature on the topic has found women's genital responses to be unassociated with specific stimuli, some recent studies have provided evidence that it is possible for women's genital sexual arousal to be category-specific. A study by Chivers, Rieger, Latty, and Bailey ($n=43$ females) found that although 37 % of women did not show a stronger genital response when presented with their preferred stimuli, 63 % of women *did* respond in a category-specific manner, as their highest levels of genital arousal were in response to the category of people (men or women) that matched their self-identified sexual orientation [33]. A similar study on category specificity ($N=52$), which compared the responses of heterosexual and homosexual women to heterosexual and homosexual stimuli, found that 40 to 46 % of participants had genital responses that were category-specific, meaning that the women showed the highest level of arousal in response to the stimuli depicting their preferred gender [30].

Differences in category specificity have also been reported in relation to self-reported sexual orientation. Peterson et al. found that heterosexual women demonstrated greater category specificity than homosexual women [30]. This outcome is not consistent with findings from studies by Chivers et al. ($n=47$ females) and Rullo, Strassberg, and Israel ($n=47$ females), which indicated that homosexual women show higher levels of category specificity than heterosexual women [14, 34]. These findings are in line with a more recent study by Dawson and Chivers ($n=51$ females), which indicated that for homosexual women, similar to homosexual and heterosexual men, sexual arousal is related to gender-specific stimuli; however, sexual arousal in heterosexual women was associated with the sexual activity being portrayed [32•]. These contradictory results may be related to the intensity of the stimuli, which has been found to be correlated with sexual arousal [32•], as Peterson et al. [30] used stimuli depicting sexual intercourse, whereas Chivers et al. [14] used stimuli showing nude models exercising and masturbating.

One explanation to account for this sexual orientation discrepancy is based on the theory that homosexual women are exposed to heightened levels of androgens during the prenatal period. It is hypothesized that this could result in an "over masculinized" brain, causing lesbians to show stronger patterns of category-specificity, which more closely resemble men [14, 34]. Although research on this topic is relatively sparse, these studies demonstrate that women's genital arousal may actually show some degree of category specificity and

that there may be more factors involved in understanding women's genital arousal patterns than have previously been explored.

Preparation Hypothesis

Another issue with using VPP in forensic clinical populations, which may be related to the lack of category specificity, is past research that has found low rates of concordance between women's subjective and physiologic (genital) arousal [35]. Physiologic sexual arousal refers to unconscious and uncontrollable genital responses to sexual stimuli and is typically measured with VPP in women and PPG in men. In contrast, subjective arousal refers to sexual arousal that is consciously experienced and based on an individual's preferred sexual partners, themes, and/or cues. It is typically measured using self-report ratings of arousal. Discordance between physiologic and subjective measures of arousal has been found to exist regardless of the self-reporting method being used [36•].

One explanation for these low concordance rates is the "preparation hypothesis," which is thought to be an evolutionary response designed to prepare a woman's body for vaginal intercourse in order to protect against injuries. Since penetrative sex, especially nonconsensual penetration, can cause tearing and bruising in the genital tract, the preparation hypothesis predicts that women's genitals will respond to sexual cues with increases in vaginal blood flow, leading to vaginal lubrication. This would theoretically protect the genital tract from injury [29, 37, 38•]. Based on the preparation hypothesis, women's genital responses are not category-specific because females have evolved to become lubricated by anything that may be associated with possible vaginal penetration, as opposed to only having genital responses towards cues that are found to be subjectively arousing.

In order to test the preparation hypothesis, Pulverman et al. used a new method of analysis developed by Dr. Cindy Meston, which calculated participant's maximum level of arousal, the time it took to reach maximum arousal, and the amount of time spent at maximum arousal [39]. Maximum arousal was measured as the top 10 % of the participant's change from baseline to the highest point of arousal. Once this threshold was determined for each stimulus, then the length of time spent in the maximum arousal state was calculated. This study, conducted in Dr. Meston's Sexual Psychophysiology Laboratory at the University of Texas at Austin, used VPP to measure the sexual arousal of ten women as they were exposed to images of a heterosexual couple engaged in sexual activity. In the "threatening" sexual stimulus, the lack of consent was indicated by displays of negative affect, whereas the "non-threatening" stimulus implied consent through displays of positive affect. It was hypothesized that women would spend more time at maximum arousal in response to the non-threatening stimulus compared to the threatening stimulus.

The theory behind this hypothesis is that, although all women show reflexive genital responses to all sexual cues, once women become consciously aware of the stimulus, genital responses will only be maintained if women are subjectively aroused by the content of the stimulus. The study found that “arousal responses came on with similar speed and were of similar magnitude to both threatening and non-threatening sexual stimuli, but more time was spent at the highest levels of arousal in response to the non-threatening stimuli” [39].

Affect and Sexual Arousal

Another explanation of nonspecific genital responses in women involves the relationship between affect (positive and/or negative) and sexual arousal. The hypothesis is that the general autonomic arousal that is activated in response to any emotional reaction may indirectly facilitate physiologic arousal and explain why women appear genitally aroused in response to stimuli that they find subjectively un-arousing, or even disturbing and upsetting [30]. A number of studies have been conducted to explore the complex relationships between affect and sexual arousal in women; however, the results have been inconsistent.

While Heiman [40] found that positive affect was related to increases in women’s subjective and genital arousal, a later study found that positive affect was only related to higher levels of subjective, but not genital, arousal [41]. A study by Peterson et al. [30] found positive affect to be strongly correlated with subjective sexual responses, whereas negative affect was found to be both a predictor of subjective arousal and, even more significantly, genital arousal. Interestingly, in the aforementioned case study involving a female sexual offender with multiple paraphilias, the subject reported feelings of anger directed towards the individuals in the stimuli and noted that these feelings of anger increased her subjective arousal rather than diminished it [27]. Heiman found that while specific negative emotions (e.g., guilt and anxiety) were not significantly related to genital arousal, the feeling of disgust was positively correlated with genital responses [40]. Meston also explored the relationship between anxiety and sexual arousal

and found that women who viewed a nonsexual anxiety-stimulating film or engaged in exercise before being exposed to an erotic film demonstrated higher levels of sexual arousal during the sexual stimulus, as compared to participants who did not engage in anxiety-producing activities [12]. A meta-analysis by Laan and Everaerd explored factors impacting women’s sexual arousal and found that negative affect was one of the strongest predictors of increased genital (objective) arousal but was not related to self-reported (subjective) sexual arousal [42]. This is consistent with findings by Laan, Everaerd, Van Aanhoud, and Rebel which provided evidence to indicate that women’s genital arousal was not inhibited by negative affect [43]. A recent study by Vilarinho et al. found that neither positive nor negative affect had a significant impact on women’s genital response [44]. Based on a review of the current literature available on this topic, it has been hypothesized that lowered sexual responses may be related to the absence of positive affect, rather than the presence of negative affect [7].

Conclusion

The science and practice of assessing female sex offenders is in its infancy. Women have only recently been recognized by society as potential or actual sex offenders. They are often mistakenly considered to be the passive partners of co-accused male sex offenders. Even when convicted, they may be assessed as having nonsexual motivations for committing sex offenses. In contrast, male sex offenders are typically understood as people who have committed these types of crimes due to criminal sexual interests. It is now known that both men and women commit sexual offenses, and although not all of these crimes are sexually motivated, sexual desire or gratification is the motivation for many sex crimes committed by both men and women. The assessment of sexual interests in men was advanced in the 1950s when Kurt Freud began measuring change in penile volume in response to homosexual and heterosexual stimuli. His intent at that time was to detect men who were claiming to be homosexual in an attempt to

Table 1 Penile plethysmograph testing (PPG) vs. vaginal photoplethysmography (VPP) testing

	PPG	VPP
Population assessed	Men	Women
Measurement	Change in penile volume Change in penile circumference	Change in vaginal blood volume Change in vaginal pulse amplitude
Established reliability	Laboratory specific	Laboratory specific
Established validity	Yes	On-going
Assessment of sexual dysfunction	Currently rare; more common in the past	Occasional
Forensic assessments	Routine for assessment and treatment	Almost none to date

avoid being drafted into the Czechoslovakian army. Since then, PPG has been refined and its use in the assessment of male sex offenders has become extensive [28]. It is of interest that the use of phallometric testing has changed from detecting heterosexual men attempting to pass as homosexual (to avoid induction into the army) to assessing men with paraphilic disorders in order to design treatment programs, and most recently is being used to measure the efficacy of treatment for paraphilic interests [45]. Clearly, the assessment of sexual arousal in women has lagged significantly behind the assessment of sexual arousal in men.

On a superficial basis, VPP testing resembles PPG. Both procedures attempt to measure the results of changes in genital blood flow associated with exposure to sexually provocative visual and/or auditory stimuli. However, PPG measures circumferential or volumetric changes in the size of the penis, whereas VPP measures changes in the reflectance of the lining of the vagina caused by changes in blood flow and vaginal pulse amplitude. It is assumed that the change in penis size, which is largely due to increased blood flow, is equivalent to the increase in vaginal blood flow associated with self-reported sexual arousal. However, change in penis size is primarily due to congestion of corpora cavernosa, which are not present in women. The physiology of sexual arousal of men and women, while homologous, is not strictly homogeneous. The features of PPG and VPP testing are summarized in Table 1.

To date, studies have found that female genital arousal patterns are typically not category-specific. Researchers have suggested that women may be more impacted by their sexual orientation and affect during VPP testing. In our opinion, while accepting that men and women are obviously physiologically different, the current data are insufficient to rule out VPP as a potentially useful tool in the assessment of female sex offenders and females with paraphilic interests. However, there are several important things that need to happen in order for this to come to fruition.

First, it is important that VPP not be viewed as a “vaginal lie detector.” PPG’s legitimacy was held back by the misconception that “the penis does not lie.” PPG is based on a procedure in which a man’s responses to one set of test stimuli are compared to a second set of test stimuli. In this way, the person is his own control. However, it is a mistake to use PPG testing as a substitute for the judicial determination of guilt or innocence.

Second, it is important that standardized test stimuli be developed both within labs and between testing centers. To a certain extent, this has happened with PPG, as some standard stimulus sets have already been developed and new, more specialized, stimulus sets are on the horizon. Unfortunately, the establishment of universal testing batteries has yet to be implemented for PPG. The establishment of similar test batteries for use among female sex offenders or those with

paraphilic interests will ideally benefit from the work that has already been done on PPG test stimuli.

Third, work is needed to establish experience in translating VPP laboratory findings into information that is useful in designing treatment for female sex offenders and in tracking their response to treatment. Using PPG for the purpose of evaluating treatment effectiveness is still in the beginning stages [45], but it will be useful for researchers who are using PPG to assess the efficacy of treatment for male sex offenders to collaborate with researchers using VPP to assess sexual arousal in women.

VPP is one of several new measures of sexual arousal. Similar to PPG, it is certain to be viewed with skepticism and misunderstanding. However, like PPG in men, it also shows promise to become an invaluable addition to the assessment of sexual response profiles in women of all sexual orientations and types of sexual interests.

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Compliance with Ethics Guidelines

Conflict of Interest Natasha M. Knack, Lisa Murphy, Rebekah Ranger, Cindy Meston, and J. Paul Fedoroff declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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Positive and negative affect, distracting thoughts and sexual arousing thoughts did not significantly impact women's genital responses, however thoughts of sexual arousal were found to be the greatest predictor of subjective sexual arousal.