

## **Sexual Arousal in Women: The Development of a Measurement Device for Vaginal Blood Volume<sup>1</sup>**

**James H. Geer, Ph.D.,<sup>2</sup> Patricia Morokoff,<sup>2</sup> and Pamela Greenwood<sup>2</sup>**

*Undergraduate women were shown erotic and nonerotic films. A vaginal photoplethysmograph was developed and used to measure pressure pulse and vaginal blood volume during film presentations. All subjects yielded a visible increase in pressure pulse amplitude during the presentation of the erotic films. Statistical analyses of the pressure pulse data strongly confirmed ( $p < 0.001$ ) the visual impressions. In addition, total blood volume in the vaginal wall also increased ( $p < 0.005$ ) during the presentation of the erotic film. Subjective ratings of sexual arousal did not correlate with physiological measures. The results indicate that a simple and reliable device for measuring vaginal pressure pulse and blood volume is available. Measures obtained from the device appear to be useful for detecting sexual arousal in women.*

### **INTRODUCTION**

Research on sexual arousal in women has, in the past, been hindered by both the lack of a reliable method of measuring responses in female genital structures and ethical considerations of privacy and confidentiality. This paper reports the development of a simple, reliable, inexpensive, and experimentally valid instrument for obtaining direct measurement of vaginal blood volume and pressure pulse. The development of such a device hopefully will aid in furthering our understanding of female sexuality.

Masters and Johnson (1966) have reported that one of the principal physiological responses during sexual arousal is genital vasocongestion. A promising method of measuring vaginal blood flow was reported by Cohen and Shapiro (1970). Their device consisted of two thermistors mounted on a diaphragm ring

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<sup>2</sup> Psychology Department, State University of New York at Stony Brook, Stony Brook, New York.

and was partially validated on a subject who reported she could produce high levels of arousal through sexual fantasy. The disadvantage of the Cohen and Shapiro method is that it requires individual fitting for each subject and detailed instructions for proper placement. Zuckerman (1971) has reviewed the relatively unsuccessful work on such physiological measures of sexual arousal in women as vaginal pH and temperature (Shapiro *et al.*, 1968). Zuckerman (1971) also noted the use of a photoplethysmograph (Fisher and Osofsky, 1968) for studying vaginal response. We are unaware of any other publication reporting further work with such a device.<sup>3</sup> The present paper reports the development of photoplethysmography for detecting changes in vaginal pressure pulse and blood volume.

## METHOD

The device used in the present research was a vaginal photoplethysmograph. In photoplethysmography, blood in tissues is detected by placing a light source so that either direct or reflected light will be affected by changes in blood volume. To detect those events, a plexiglas cylinder 4.5 mm long and 1.2 mm in diameter was hollowed out for placement of a small lamp, photocell, and connecting wires. The lamp was placed near the end of the cylinder and the photocell was mounted in a hole placed midway on the side. The attached shielded cable was encased in soft vinyl tubing that extended 8 inches from the end of the probe. The wire leads were attached to a plug that could be inserted by the subject into a phone jack leading to a polygraph.

Two-channel recording was done on a Beckman model R411 polygraph. One channel recorded the pressure pulse at a relatively high amplitude, using a 1-sec time constant to reduce baseline drift. The second channel produced unmodified data on slow changes (dc) in reflected light. Slow changes index the pooling of blood in vaginal tissues. Novelty *et al.* (1973) present a discussion of photoplethysmographic procedures to which the reader is referred for more detailed information.

The purpose of the present investigation was the validation of the device as a measure of sexual arousal. This was effected by recording during the presentation of erotic and nonerotic stimuli (films). Subjects in the present research were 20 undergraduate females at the State University of New York at Stony Brook. Subjects volunteered for a study entitled "Measurement of Female Arousal." On arrival for the first session, each subject was met in the experimental rooms by the two female authors and informed in detail of the exact nature of the study.

<sup>3</sup> A personal communication from Jerry W. Koppeman, California State University, San Diego, suggests that he is working on a similar device. No further information is available at this time.

Subjects were shown the photoplethysmograph and instructed in its use. In addition, the content of both films was described and complete confidentiality was assured. The purpose of this interview was to inform the subjects about all aspects of the experiment so that they could decide whether they wished to participate. Subjects were told that they would be contacted in 2 or 3 days to inform us of their decision and arrange for an appointment, if appropriate. On contact, all but two of the 20 subjects interviewed agreed to return for the experiment proper.

On return for the second session, the subject was taken by one of the female authors into the experimental chamber, a hospital room with an adjacent bathroom. She was shown the bathroom where the device was resting in a 750:1 solution of Zephiran Chloride and was told that, after the experimenter left the room, she should rinse the probe and insert it about an inch into the vagina. It was specified that the probe should not be placed as deeply as a tampon. She was shown the armchair and the phone jack where the plug from the device was to be inserted and told to call over the intercom when ready. At that point, the experimenter left the room, and the subject's privacy was maintained throughout the duration of the session.

A 3-min rest period preceded two films, which were shown by two 8-mm remotely operated projectors located on a table beside the subject. The erotic film lasted 8 min and was in color. The actors were a young man and woman involved in a sexual encounter which included undressing, foreplay, oral-genital sex, and coitus. The nonerotic film was an 8-min black and white film entitled "The Crusades" which depicted scenes of battles and court life during the time of the Crusades. The film was selected because of its nonsexual and generally boring content. After both films had been presented and a 3-min period had elapsed, the subject removed the vaginal probe, rinsed it in the sink in the bathroom, and then summoned the experimenter, who provided a questionnaire on the subject's subjective response to the films. The subject was also informed that she would receive a second questionnaire by mail (in order to assure privacy) for determination of her sexual history.

## RESULTS

Two principal measures of vaginal blood volume were obtained from 14 subjects and analyzed. Data from four subjects were unavailable due to recording and procedural problems. The primary measure, pressure pulse, reflects the distensibility of the vascular bed in response to changes in blood pressure resulting from the heart forcing blood into the arterial system. Figure 1 is a sample of the pressure pulse waves and blood volume measures obtained from a reactive subject.

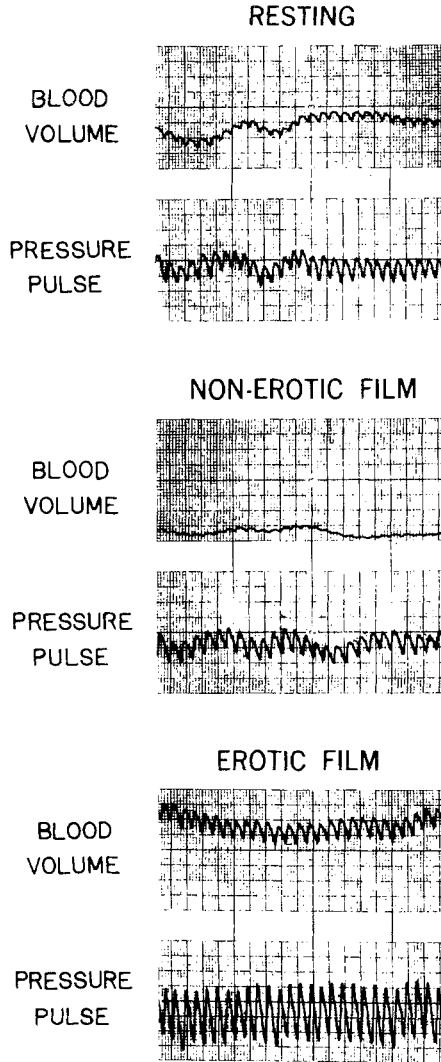


Fig. 1. Illustrative polygraph tracings from one subject. Each tracing has two components; the upper is the dc measure of blood volume and the lower is the pressure pulse. The uppermost tracings were made during the rest period, the center tracings during the nonerotic film, and the lower tracings during the erotic film. Polygraph settings were fixed throughout the session.

Visual inspection revealed that the pressure pulse amplitude increased dramatically during the erotic film and that the dc component, as measured by height of the upper traces, was elevated. Pressure pulse data for *all 14 subjects showed a visually detectable increase in amplitude during presentation of the erotic film.*

For analysis of the pressure pulse data, a mean pressure pulse amplitude, in millimeters, was computed for three 12-sec intervals during each of the rest periods and five 12-sec intervals during each of the films. *t*-Tests were applied to these data, indicating that pressure pulse amplitude was significantly greater during both films than baseline and significantly greater during the erotic than the nonerotic film ( $p < 0.001$ ).

A second measure taken was of the blood volume in vaginal tissues, obtained by measuring the dc output of the photocell. These volume change data were similarly analyzed, with parallel results ( $p < 0.005$ ). Thus there is statistical confirmation from both pressure pulse and volume change data that responding was greater during the erotic than the neutral film.

Order of film presentation and changes across time were assessed by analyses of variance for both measures. Analysis of the pressure pulse data revealed a significant effect of film content ( $p < 0.025$ ) and of film content  $\times$  intervals interaction ( $p < 0.01$ ). Inspection of the data indicated that as the erotic film progressed, pressure pulse amplitude increased, whereas during the nonerotic film it remained lower and relatively stable. There was no significant variance in the data produced by the blood volume measure. Pressure pulse appears to be the more sensitive of the two measures.

A third measure, heart rate, was computed from the pressure pulse records. A *t*-test comparing the heart rate before and during films revealed no significant differences, although small increases in heart rate during the erotic film were observed.

In order to better evaluate measurements of vaginal blood flow change as a correlate of subjective sexual arousal, self-report data were obtained. During the erotic film, subjects were instructed to indicate their level of sexual arousal by pressing the intercom button according to the following code: 1 press for low arousal, 2 for moderate, and 3 for high. No significant correlation was obtained between subjects' average score for both slow- and fast-change data during the erotic film and the number of presses made. Subjects were also given a questionnaire following the experiment in which they were asked to indicate, among other things, how sexually arousing they found the erotic film by choosing a number on a 5-point scale ranging from "not aroused" to "highly aroused." Again no significant correlation was found between this number for each subject and her pressure pulse or blood volume change data during the erotic film. The crudeness of these self-report measures may have contributed to the lack of a significant correlation with vaginal blood responses. However, since the stimulus

used almost certainly elicited only low to moderate levels of sexual arousal, the lack of correlation with subjective report is perhaps not surprising.

## DISCUSSION

These results indicate that two measures of vaginal blood volume are reliably obtainable and are able to detect what is assumed to be sexual arousal. While pressure pulse appears to be the more sensitive measure, total volume of blood in the tissues also seems to be a valid measure. We feel that these data are particularly encouraging since results were statistically reliable, although the size of the sample was small. Furthermore, in many subjects the phenomena are readily observable by visual inspection of the data, a result often not the case in human psychophysiological research. In spite of some difficulties, the robustness of the phenomena and results of additional pilot data from our laboratory make us confident that we have developed a reliable and valid measure of sexual arousal in women.

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