VAGINAL PULSE AMPLITUDE IN LOW- AND HIGH-AROUSABILITY FEMALES DURING EROTIC STIMULI CONDITIONS AND SLEEP

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Vaginal photoplethysmography was utilized in combination with standardized sleep-recording procedures to investigate changes in vaginal pulse amplitude (VPA) during both waking and sleeping conditions in low- and high-arousability females (n = 10 per group), as classified by the Sexual Arousalability Inventory. Based upon previous research, it was predicted that both groups would exhibit similar mean levels of VPA during waking exposure to erotic stimuli and during various stages of sleep. Despite hypothesized physiological similarities between groups, the low-arousability group was expected to subjectively report less arousal during the waking erotic conditions.

Subjects underwent a physical examination and came to the sleep laboratory for two consecutive nights between days 4 and 10 of their menstrual cycles. In addition to standard electroencephalographic (EEG) measures, electromyographic (EMG) recordings from subjects' legs were employed to discriminate artifactual VPA changes. On the first night, VPA, EEG, and EMG was recorded during baseline, erotic film,
second baseline, and erotic fantasy periods. Subjects were then allowed to fall asleep. On the second night, no waking stimuli were presented; however all the aforementioned physiological measures were obtained during sleep.

As predicted, no differences were found between groups during either waking or sleeping conditions. Contrary to expectation, groups also did not differ on subjective rating of the erotic stimuli. Post-hoc analyses with group factor collapsed indicated significant VPA differences between baseline and erotic stimuli conditions. Similarly, VPA significantly differed between stages of sleep, with highest levels observed during stage REM.

These findings suggest that self-reported low-arousability is not based upon lack of physiological response and that retrospective report measures of arousability differ from physiological and immediate self-report measures in important ways (e.g., the nature of the erotic stimuli utilized and demand characteristics associated with the laboratory setting). Suggestions for further research were offered and the possible diagnostic role of nocturnal measures of genital response was discussed.
TABLE OF CONTENTS

LIST OF TABLES ........................................... iv

VAGINAL PULSE AMPLITUDE IN LOW- AND HIGH-AROUSABILITY FEMALES DURING EROTIC STIMULI CONDITIONS AND SLEEP

Introduction ........................................... 1

Normal Sexual Response in the Female
Sexual Dysfunction in the Female
Physiological Measures of Sexual Arousal
Vaginal Photoplethysmography
Vaginal Response in Various Sample Populations
Nocturnal Vaginal Response Measures
Research Design and Hypotheses

Method ............................................... 33

Subjects
Instruments
Procedure

Results ............................................... 40

Quantification of Data
Data Analysis

Discussion ........................................... 47

"Low" Versus "High" Arousability
Factors Influencing Self-Report of Sexual Arousal
Independence of Arousability Measures
Summary of Arousability Findings
Recommendations for Future Arousability Research
Value of Nocturnal Assessment Procedures
Differential Diagnosis of Sexual Dysfunctions
Conclusion

Appendix ............................................ 61

References ....................................... 84
LIST OF TABLES

Table                      Page

1. Age x Integrated Vaginal Pulse Amplitude Correlations for Waking and Sleeping Conditions .......................... 68

2. Integrated Vaginal Pulse Amplitude Correlations Between Initial Baseline and Other Experimental Conditions ................................ 69

3. Integrated Vaginal Pulse Amplitude Adjusted Cell Means for Waking Conditions ............................................ 70

4. Analysis of Covariance Summary Table for Waking Conditions ................................................................. 71

5. Measures of Central Tendency for Integrated Vaginal Pulse Amplitude During Waking Conditions ................................. 72

6. Integrated Vaginal Pulse Amplitude Adjusted Cell Means for Sleeping Conditions ............................................. 73

7. Analysis of Covariance Summary Table for Sleeping Conditions ................................................................. 74

8. Measures of Central Tendency for Integrated Vaginal Pulse Amplitude During Sleeping Conditions (by Group) .............. 75

9. Analysis of Variance Summary Table for Sleeping Conditions ................................................................. 76

10. Measures of Central Tendency for Integrated Vaginal Pulse Amplitude During Sleeping Conditions ....................... 77

11. Integrated Vaginal Pulse Amplitude Adjusted Cell Means for Film and Fantasy Rating Scales .......................... 78

12. Analysis of Covariance Summary Table for Film and Fantasy Rating Scales .................................................... 79
Tables--Continued

13. Correlations Between Sexual Arousability Inventory and Laboratory Arousal Ratings .... 80
14. Sexual Arousability Inventory Subscore Correlations ....... 81
15. Sexual Arousability Subscore Correlations with Laboratory Arousal Ratings .... 82
16. Correlations among Sexual Arousability Inventory Measures, Laboratory Arousal Ratings and Vaginal Pulse Amplitude Change Scores .... 83
VAGINAL PULSE AMPLITUDE IN LOW- AND HIGH-AROUSABILITY FEMALES DURING EROTIC STIMULI CONDITIONS AND SLEEP

The physiological nature of human female sexual response has recently become the subject of increased investigative attention, indicating a new willingness to explore a controversial and "taboo" area that even gynecologists have avoided (Kresch & Kresch, 1976). Because physiological research in this area has often been predicated upon general knowledge regarding sexual functioning, a brief synopsis of relevant literature will be presented before reviewing recent physiological findings.

**Normal Sexual Response in the Female.**

In one of the first publications on the topic of female sexuality, Kinsey and his associates (Kinsey, Pomeroy, Martin, & Gebhard, 1953) presented qualitative descriptions of physiological changes associated with sexual response in the female, including pulse rate, heart rate, blood flow, and muscle tension increase. Thirteen years later, Masters and Johnson (1966) further defined female sexual response, objectively measuring various aspects of sexual response within an quantitative framework of mean values and ranges.

Masters and Johnson promulgated a heuristic, if somewhat arbitrary, division of the human sexual response into a cycle consisting of four phases: (a) the excitement phase,
developing from any source of somatogenic or psychogenic stimulation, (b) the plateau phase, in which sexual "tensions" become increasingly greater up to an extreme level, (c) the orgasmic phase, limited to a few seconds during which vaso-congestion and myotonia are quickly reduced, and (d) the resolution phase, a period of involuntary tension loss that returns the individual through the first two stages to an unstimulated condition.

Later studies have added knowledge about many variables which may influence normal sexual response in the female. For example, in a study by Luschen and Pierce (1972), menstrual cycle was found to influence affective mood state and sexual arousability. Obtaining responses from 48 women on both an adjective check list and on arousal rating scales administered during a series of slides, the investigators found that subjects were more affiliative and more responsive to sexually arousing stimuli during ovulation than during premenstruation. Although the findings indicated no differences on these measures between birth-control-pill users and nonusers, the authors suggested that differences in affiliation and arousability may have been related to changes in hormonal levels during the menstrual cycle.

Hormonal interactions with sexual responsivity were also the subject of an article by McCauley and Ehrhardt (1976). Reviewing the recent literature regarding sexual functioning in the contexts of menstruation, oral contraception,
pregnancy, and menopause, McCauley and Ehrhardt discovered many inconsistencies in published findings, but nevertheless concluded that hormonal variations played an important role in the expression of female sexual behavior.

**Sexual Dysfunction in the Female.**

As knowledge regarding normal sexual response in the female developed, similar progress was made in terms of classification of different types of sexual dysfunction, often utilizing paradigms formulated for male populations. For example, "excitement phase" dysfunctions in the female have been related to erectile dysfunctions in the male (Kaplan, 1974; Levine & Rosenthal, 1977), and orgasmic dysfunctions have been described in terms of premature or retarded orgasm, or inability to attain orgasm. Distinctions between "primary" and "secondary" orgasmic dysfunctions in women have followed a scheme similar to that given for classifying male impotence. Women who have never attained orgasm are classified as having "primary" anorgasmia, while those who have experienced orgasm in the past, but not currently, are diagnosed as having "secondary" orgasmic dysfunction. Dyspareunia (painful intercourse) and vaginismus have been noted as additional forms of sexual dysfunction in females. Vaginismus, which designates involuntary contraction of the vaginal musculature when penetration is imminent, seems to be a type of sexual dysfunction unique to the female. However, if vaginimus is simply a behavioral expression of intense
anxiety (Levine & Rosenthal, 1977), one might expect males to exhibit similar anxiety in different ways than females (e.g., failure to achieve erection), due to differences in physical anatomy between the sexes.

Etiologies for sexual dysfunctions have been theoretically categorized into three groups: constitutional, organic, and psychogenic (Cooper, 1972). Characteristics associated with a theoretical "low end" of an assumed normal curve of sexual drive responsiveness are described as being "constitutional" in nature. Constitutional factors are suspected with evidence of very infrequent types of sexual expression in the absence of organic pathology. One might assume that psychogenic factors would also have to be ruled out, making a diagnosis of "constitutional sexual dysfunction" difficult in clinical practice.

Organic sexual dysfunctions are thought to develop typically after prior competency and can be associated with lesions, anatomical deformities, endocrine disorders, infectious diseases, neuropathy, vascular disease, or drug effects. In males, for example, one organic condition associated with a high incidence of impotence is diabetes. Both autonomic neuropathy and/or vascular insufficiency concomitant with diabetes are suspected to affect sexual functioning (Abelson, 1975; Ellenberg, 1977; Karacan, Salis, Ware, Dervent, Williams, Scott, Attia, & Beutler, 1978). These same organic pathologies could be expected to create
problems in diabetic women, yet the evidence for this is scant and sometimes conflicting (Abramov, 1976; Brooks, 1977; Ellenberg, 1977; Kolodny, 1971; Renshaw, 1979). Organic conditions are usually observed to be constant, irrespective of the nature of any sexual stimulation (Cooper, 1972); however, this pathognomic sign has lately been questioned by findings of transient organic dysfunctions (Karacan et al., 1978).

In contrast with organic dysfunctions, psychogenic dysfunctions are held to be generally selective and transient. Major psychological states associated with sexual dysfunction include anxiety, fear, hostility, resentment, disgust, depression, and habituation. Selection of atypical sexual objects or aberrant cognitive belief systems may also be designated as psychogenic determinants of sexual dysfunction. Traditionally, "psychogenic" etiologies have been invoked to explain most cases of sexual dysfunction, despite awareness of our present limitations in diagnostic skills (Karacan et al., 1978). It should be remembered that constitutional, organic, and psychogenic classifications are theoretical concepts which may overlap considerably in clinical practice. Physiological Measures of Sexual Arousal.

Zuckerman (1971) has noted that while the forgoing literature is informative, most of it is based upon subjective report. Many questions as to the physiological nature of sexual response remain unanswered. Measures of physiological
responses offer unique advantages of objectivity, the
detection of otherwise unobservable phenomena, and the possi-
bility of continuous sampling. Several practical problems in
attempting to measure and interpret physiological changes
have had to be examined, however. Beyond problems of indi-
vidual variations in response (e.g., law of initial values,
individual differences in latency of response, and time to
return to baseline), the first major question addressed was
that of response specificity, or response validity.

One characteristic of a large number of different
physiological measures was that they reflected gross changes
in the state of the individual and were susceptible to
influence by many variables extraneous to those of scientific
interest in a particular study. Thus, while such measures as
heart rate, pulse rate, respiration rate, and galvanic skin
response showed somewhat consistent changes during the pre-
sentation of erotic stimuli to subjects, these same measures
also appeared sensitive to many other stimulus conditions,
including anger, fear, pain, and epilepsy (Zuckerman, 1971).
Later confirmation of the nonspecificity of heart rate, skin
conductance, blood pressure, and forehead temperature was
presented in the studies of Fox and Fox (1971), Hoon, Wincze,
and Hoon (1976), Heiman (1977), and Kabash, Brender, and

In recent years, physiological measures specific to
sexual arousal have been found. Invariably, these measures
have recorded physiological changes in genital areas. For those interested in developmental history, Zuckerman (1971) has provided a comprehensive review of early studies attempting to specifically validate physiological measures of sexual arousal.

In regard to the physiological measurement of sexual arousal in females, an early attempt to use mechanical plethysmographs to record clitoral tumescence in a small group of women with congenitally large clitori (Karacan, Rosenbloom, & Williams, 1970), showed that enlargement did occur upon sexual arousal. Due to the technical difficulties involved in designing plethysmographs for normal females, replication of this study was never attempted. Although early efforts by Fisher and Osofsky (1968) and Jovanovic (1971) to measure genital temperature in females were unsuccessful, a simple device for measuring labial temperature was later designed by Henson and his associates (Henson & Rubin, 1978; Henson, Rubin, & Henson, 1978; Henson, Rubin, Henson, & Williams, 1977). The instrument was constructed by mounting a thermistor on an adjustable metal clip which was attached to the subject's labia minora, with another thermistor used to monitor ambient temperature. Specific and consistent changes in genital temperature were observed during erotic film exposure. Genital temperature appeared fairly reliable over time and was highly correlated with other measures of vaginal blood flow.
A different approach for measuring genital temperature was devised by Shapiro, Cohen, DiBianco, and Rosen (1968). This device consisted of a vaginal diaphragm implanted with two thermistors, one of which was used to monitor vaginal wall temperature while the other was maintained at a slightly higher temperature. Current supplied to stabilize the latter thermistor was the quantitative measure of interest as it was assumed that heat loss in this thermistor resulted from increased vaginal blood supply. The device was employed to measure vaginal blood flow (VBF) during rapid-eye-movement (REM) sleep (Cohen & Shapiro, 1970; 1971), during masturbation (Cohen, Rosen, & Goldstein, 1976), and combinations of the above (Fisher, Cohen, Schiavi, Davis, Furman, Ward, Edwards, Cunningham, & Plachta, 1980). Only minimal data were offered by these authors as all of the above studies were published in abstract form only. Geer (1975) suggested that this device has not found general acceptance among researchers due to the need for individual fittings of the diaphragm and the complexity of the placement instructions.

**Vaginal Photoplethysmography.**

Modern technological developments have resulted in the development of a light-reflectance photoplethysmograph which can be inserted intravaginally. This form of photoplethysmography is based upon changes in opacity of the vaginal wall caused by blood pulsing through the capillaries of the tissue. A light, emitted from a source in the photoplethysmograph,
falls upon the vaginal wall and is reflected back to a photoelectric sensor. Variations in the amount of reflected light are almost entirely dependent upon the amount of blood in the tissue. Since this amount changes with each pulse wave, the output of the phototransistor can be amplified and used as a measure of vaginal pulse amplitude (VPA). Both frequency and amplitude of recorded pusatile waves can be quantified.

The first instrument of this nature was devised by Palti and Bercovici (1967), two gynecologists interested in vaginal capillary engorgement during the menstrual cycle. Fitting a photoelectric cell assembly into a vaginal speculum, Palti and Bercovici observed two peaks in VPA during subjects' cycles: one occurring temporally near ovulation and the other around the twenty-first day. The vaginal pulse amplitude of women with irregular (oligomenorrheic) or absent (amenorrheic) menstrual cycles was generally much smaller, as was the pulse amplitude of menopausal women.

Improving upon the original design, Geer, Morokoff, and Greenwood (1974) used an incandescent light source and a photocell in a plexiglass cylinder and initially validated this form of photoplethysmography as a specific measure of sexual arousal in women. Geer created a new name for the VPA measure, i.e., "vaginal pressure pulse," as he believed that changes in photoelectric potentials reflected distensibility of the vascular bed in response to changes in blood pressure
caused by the heart forcing blood into the arterial system. Since it has not been empirically demonstrated that vaginal blood pressure, as measured by light-reflectance photoplethysmography, is indeed similar to conventionally recorded blood pressure, the term "VPA" will be retained in the present paper.

Geer et al. (1974) also pioneered the use of a second vaginal measure, termed vaginal blood volume (VBV), derived from the same electrical signal as VPA, but amplified at low D.C. levels. This slowly changing measure was thought to index the total pooling of blood in sampled vaginal tissue. Although neither VPA or VBV significantly correlated with subjective report of sexual arousal in the study of Geer et al., VPA changed according to the erotic content of presented films, while vaginal blood volume appeared less sensitive to film content. Vaginal photoplethysmography was discussed by Geer in subsequent papers (Geer, 1975; Sintchak & Geer, 1975) and further validated in a study in which female subjects were measured during masturbation to orgasm (Geer & Quartararo, 1976). Although the variability of the data combined with small sample size precluded adequate statistical analysis, visual inspection of the data revealed that both VPA and VBV increased during masturbation and postorgasm periods over prestimulation baselines.

Hoon, Winzce, and Hoon (1976) modified the vaginal photoplethysmograph by the substitution of a light-emitting diode
(LED) for the light source and a phototransistor for light detection in order to improve the linear response of the device and reduce instrument-produced artifacts. Using only the vaginal blood volume measure from their improved probe, these investigators presented subjects with erotic, dysphoric, and neutral films in counterbalanced order, finding that VBV was statistically more sensitive to erotic stimuli than forehead temperature, systolic or diastolic blood pressure, and skin conductance levels. The measure was exclusively responsive to erotic stimulation, again confirming its specific validity as a measure of sexual arousal. In a subsequent study (Wincze, Hoon, & Hoon, 1977), VBV proved to be significantly correlated with breast and groin temperature, as well as subjective indication of sexual arousal. The singular use of VBV by these investigators was theoretically justified in their studies by reference to papers by Weinman (1967) and Cook (1974), implying that blood volume changes produced by the heart represent only a small fraction of total blood volume in a capillary bed (thus indicating that VBV, which represents the amount of blood remaining in vaginal tissue over comparably longer time periods than VPA, might be a better indicator of arousal).

In contrast to the above conclusions regarding the relative superiority of VBV over VPA, Geer and colleagues (Geer et al., 1974; Geer & Quartararo, 1976; Sintchak & Geer, 1975) have found VPA to be the better measure, exhibiting
greater sensitivity to change in arousal. Heiman (1976) supported this claim, finding that VPA changes more closely coincided with self-report of sexual arousal in sexually functional college women. Later data (Heiman 1977), again supported the superiority of VPA over VBV and additionally provided information about the reliability of these measures over time. Assigning 77 women to differing romantic-erotic conditions (audio tapes), Heiman obtained measures of VPA, VBV, finger pulse, and subjective rating of sexual arousal. Her results indicated that finger pulse showed no consistent changes across conditions, VPA was correlated with subjective report more so than VBV, and both of these latter measures were fairly stable over a one-week interval, despite a "fatigue effect" within sessions due to habituation.

One final study attesting to the relative superiority of VPA over VBV as an arousal indicator was that of Osborne and Pollack (1977). These researchers found that VPA significantly increased in a group of women exposed to erotic literature, while VBV did not.

About this time, Gillian (1976) presented data suggesting that placement of a vaginal photoplethysmograph could account for varying results within and between subjects. Using a specially designed probe with four spaced photocells, Gillian found that larger changes in response occurred in the lateral lower vagina as compared to the upper vagina. Standardization of placement has continued to be a problem,
since every study to date has followed a research ethic requiring self-placement of the probe in privacy.

Movement of the probe within the vagina after placement has also been a problem. Recently, Bohlen and Held (1979) devised a photoplethysmograph especially constructed to aid in standard placement, so that the head of the device is positioned at the proximal boundary of the pubococcygeus muscle and the base at the introitus. The probe also incorporated a mechanical air-pressure transducer which allowed for the recording of vaginal muscle contraction pressure.

Another fairly new development enabled researchers to sample vaginal pulse measures in a non-laboratory setting (Sarrel, Froddy, & McKinnon, 1977). Using a four-channel medical cassette recorder, Sarrel et al. demonstrated that electrocardiographic (EKG), electroencephalographic (EEG), and vaginal photoplethysmographic measures could be recorded in a subject's home for up to 24 hours. The authors of this study pointed out that psychological reactions to laboratory settings could be avoided through home-monitoring, and that a greater sampling frequency of these measures might be achieved in the subject's home environment since the device was relatively easy to use. Lastly, Sarrel et al. concluded that critical evaluations should still be performed in the lab, as the home-recording device did not exhibit as much precision of measurement as laboratory devices.
Vaginal Response in Various Sample Populations.

Most of the studies reviewed thus far utilizing vaginal photoplethysmograph have assessed the validity and reliability of vaginal response measures by recording these from normal females during erotic versus nonerotic films (Geer et al., 1974; Hoon et al., 1976; Wincze et al., 1977), audio tapes (Heiman, 1977), literature (Osborne & Pollack, 1977), self-generated fantasy (Heiman, 1977), and masturbation (Geer & Quartararo, 1976; Gillan, 1976). The comparison of sexually dysfunctional women to functional women on vaginal measures soon followed, although few studies have been published and sample populations have been quite small. Heiman (1976, cited in Heiman, 1977) was perhaps the first to compare women reporting primary and secondary orgasmic dysfunction (n = 6) with functional women (n = 16) via photoplethysmography during erotic films, fantasies, and audio tapes. Although Heiman gave no description of sample selection criteria, she reported that the sexually dysfunctional group evidenced less VPA response than normal controls during the stimulus conditions.

Wincze, Hoon, and Hoon (1976), in a study which statistically controlled for sexual experience, day in menstrual cycle, and basal levels of VBV, found that VBV levels in groups of six normal and six sexually dysfunctional women significantly differed in response to an erotic film, with dysfunctional women exhibiting consistently less arousal.
The majority of the normal women selected for this study were single college students who reported satisfactory sexual functioning, while the sexually dysfunctional group consisted of slightly older, mostly married women who had requested sex therapy. These women were treated in a subsequent study (Wincze, Hoon, & Hoon, 1978) via behavioral therapy methods, but failed to show significant changes on VBV levels after treatment, alternatively suggesting either constitutional etiologies or ineffective treatment strategies.

Morokoff and Heiman (1980), in a repeated measures study, selected 22 married women, matched for age, who either reported no lack of sexual arousal (n = 11), or had applied for sex therapy due to lack or low frequency of sexual arousal (n = 11). Of the latter group, eight women were nonorgasmic. Recording VPA and heart rate, the authors exposed subjects to several different erotic-stimulus conditions (film, fantasy periods, and audio tapes) during two identical experimental sessions spaced 4 weeks apart. In the interval between experimental sessions, the dysfunctional group received 15 sessions of conjoint sex therapy. Experimental results showed that the dysfunctional group reported less subjective arousal to erotic stimuli during the first experimental session, yet initial physiological measures were not significantly different from the control group. By the second experimental session, both groups were similar on both subjective and physiological measures.
Morokoff and Heiman concluded that both sexually dys-functional and functional women exhibited similar genital responses, a finding which contradicted her earlier results (Heiman, 1976, cited in Heiman, 1977) and the results of Wincze et al. (1976, 1978). The contrasting results were hypothesized to be due to the inherent differences in the dependent measures recorded (VBV versus VPA), or to differences in sample populations. Morokoff and Heiman claimed that married women were less physiologically responsive to erotic stimuli than unmarried women and that this factor was not controlled for in the Wincze et al. studies.

In perhaps the only published study investigating the interaction of both physiological and subjective sexual arousal with emotional states, Heiman (1980) predicted that negative feelings (e.g., guilt, anxiety, or embarrassment) would be associated with lower genital and self-reported arousal levels, and that positive affect states would be associated with higher levels of arousal. She further hypothesized that relationships would be positive between physical response in the laboratory, self-report of arousal, intercourse frequency, and orgasmic response in the subject's current sexual relationship. Reversing an earlier speculation (Morokoff & Heiman, 1980), Heiman also predicted that married women in her study would show relatively greater physical arousal in the laboratory, reflecting higher levels of satisfaction with their sexual responsiveness at home.
Fifty-five women, 27 married and 28 unmarried, were recruited for the study through a newspaper advertisement, with no other apparent criteria used for selection. Subjects completed a personal history questionnaire containing items regarding sexual experiences, relationship satisfaction, and socioeconomic demographics. During two experimental sessions spaced four months apart, subjects' VPA was recorded during an initial 5-min. baseline, then during five erotic conditions consisting of self-generated fantasy, erotic audio tape, fantasy, erotic film, and a final fantasy period. After each erotic stimulus, subjects rated their subjective reactions on five-point arousal scales.

Results of the Heiman study indicated significant differences in VPA between erotic conditions, with only a weak condition by group (married versus unmarried) interaction during the first experimental session. Greater VPA response was observed during the erotic film condition than during fantasy conditions, and married women showed somewhat less arousal to the tape and film than unmarried women during the initial session. In terms of correlations between the vaginal measure and self-reported sexual arousal, only those for unmarried women during tape and film conditions were significant. Subjective sexual arousal was found to be significantly associated with positive feelings and the general patterns of physical and subjective sexual arousal were somewhat similar during the erotic conditions. Again,
only the unmarried group evidenced significant correlations between VPA increases and positive emotional states. Heiman also found surprising negative correlations between VPA and stated arousability, frequency of intercourse, and general enjoyment of sex. Further analysis of scattergrams indicated some independence of laboratory and nonlaboratory sexual arousal, with many subjects reporting high levels of arousal during intercourse but low arousal levels during erotic conditions in the laboratory. In conclusion, Heiman cautioned against the assumption that lab evaluation of arousal reflects nonlaboratory arousability, speculating that lab arousal differed from home arousal on several dimensions, most notably that of solo versus interpersonal context.

Positive affective states were established as conducive to greater subjectively experienced sexual arousal and Heiman posited that subjective and physiological arousal were somewhat independent, with perceived arousal perhaps resulting from a combination of physiological sensation, contextual cues, and cognitive attitude.

**Nocturnal Vaginal Response Measures.**

Genital response in both sexes has been studied not only during waking conditions, but during sleep as well. For many years, it has been known that heart rate, skin conductance, and respiration change dramatically during the stage of sleep associated with dreaming and rapid eye movements (REMs), i.e., stage REM sleep, while remaining relatively more stable
during the other (non-REM) stages of sleep (Foulkes, 1966). While the content of dreams experienced during stage REM sleep might be expected to cause some of these physiological changes, e.g., changes in heart rate associated with a nightmare, it has been observed that similar autonomic activation occurs in the absence of any manifestly arousing dreams (Fisher, 1966). It is therefore not too surprising to find that investigators have been interested in measuring genital response during the stages of sleep, with particular attention given to stage REM sleep. For example, normative data has been published regarding frequency of arousal, duration, and volume of nocturnal penile tumescence (NPT) for several age ranges of males (Fisher, Gross, & Zuch, 1965; Karacan, Williams, Thornby, & Salis, 1975). These studies have led to the evaluation of NPT as a basis for differentiating psychogenic from organogenic impotence in male diabetics (Fisher, Schiavi, Lear, Edwards, Davis, & Witkin, 1975; Karacan, Scott, Salis, Attia, Ware, Altinel, & Williams, 1977).

The evaluation of NPT as an aid to differential diagnosis of impotence has been theoretically interesting, as the presence of normal NPT in a patient exhibiting waking impotence suggests that contributing psychological factors are somehow bypassed during sleep. Indeed, like heart rate, skin conductance, and respiration, NPT has been described as a rather involuntary consequence of the spontaneous activation
of the autonomic nervous system associated with REM sleep and tentatively linked to hypothalamic-limbic mechanisms (Fisher, Schiavi, Edwards, Davis, Reitman, & Fine, 1979). As such, NPT appears only minimally associated with manifestly erotic dream content and seems to be independent of previous daytime phenomena (Fisher, 1966; Fisher et al., 1979; Karacan, Williams, Thornby, & Salis, 1975). Because typical medical examinations do not provide enough accuracy in determining whether impotence is organic or psychogenic in nature, nocturnal evaluation of NPT is thought to be a very important diagnostic procedure.

Since the evaluation of NPT has been of use in distinguishing etiologies in dysfunctional males, it follows that similar assessment procedures might be of benefit to dysfunctional females. Investigative attempts to find an analog of NPT in the female have been made, as noted previously (Cohen & Shapiro, 1970; 1971), with general findings suggestive of nocturnal increases in vaginal vascular response measures during stage REM sleep. Fisher and his associates (e.g., Fisher et al., 1980) have done most of the research in this area thus far, using thermistors to study vaginal blood flow (VBF) in small groups of sexually functional women during varying erotic stimulus conditions and sleep. Preliminary findings of Fisher et al. (1980), as reported in abstract form, indicated that a high percentage of REM periods contained significant increases in VBF. Increases in VBF
were also found during non-rapid-eye-movement (NREM) sleep; in fact, the actual frequency of NREM VBF arousal was higher during NREM than REM sleep, but since NREM periods were much longer than REM periods, the "density" of arousal episodes was much greater during REM periods. Another important finding was that about half of all NREM arousals occurred within 5 to 10 minutes of the onset of REM sleep. This suggests that the autonomic arousal responsible for VBF increases is highly associated with, but not necessarily limited to stage REM sleep as it is currently defined. Spontaneous REM and NREM VBF increases were found to be characteristically similar to those produced by masturbation or erotic film exposure, however masturbation produced increases in heart rate and respiration not generally found in nocturnal periods of VBF increases. The authors claimed to have recorded one orgasm during a REM period, with increases in heart rate and respiration similar to masturbatory levels, but concluded that most nocturnal VBF increases had little to do with sexual excitement.

Since it is known that the human body often moves during sleep, especially during the lighter stages of sleep (Foulkes, 1966), it is important to discriminate movement-produced artifactual changes in VBF. Fisher et al. (1980) failed to mention any precautions taken to discriminate artifactual changes in their vaginal measures, and therefore their findings as to the relative frequency of spontaneous vaginal
arousal events in either REM or NREM sleep can only be viewed as tentative in nature.

Except for several abstracts, only one published report was found regarding nocturnal vaginal responses in females. Focusing on changes in VPA and VBV during REM sleep, Abel, Murphy, Becker, and Bitar (1979) used a vaginal photoplethysmograph similar to that devised by Hoon et al. (1976). Eight females, ranging in age from 23 to 35, served as subjects for two consecutive nights. Little information was provided about subject demographics, although participants apparently completed sexual questionnaires prior to the recording nights and were deemed sexually functional. The investigators intended to compare sexual responses of subjects during self-induced fantasy with their arousal levels during sleep, but were unable to do so because of large variances in waking arousal compared to small variances in sleeping arousal. Using polygraph recordings of eye movement and frontalis muscle tension to determine REM sleep (not a standard practice), the authors found that VPA markedly increased with the onset of REM sleep, while VBV generally decreased. When VBV levels for all subjects during all stage REM periods were averaged together, significant decreases were also found between baseline and stage REM VBV, indicating that VBV was highly variable during stage REM.

In conclusion, Abel et al. stated that normal females exhibited specific vaginal response patterns during sleep,
with phasic increases in VPA and concomitant decreases in VBV during REM sleep. The authors speculated that the magnitude of these changes, regardless of their pattern over the night, might be used to separate psychogenic from organic sexual dysfunction in women.

Although the Abel et al. study appeared to be exploratory in nature and thus not subject to the rigorous demands of specific hypothesis testing, several criticisms appear justified. In a study attempting to elucidate the relationship of vaginal responses and REM sleep, it would seem appropriate for the authors to have determined REM sleep by accepted research procedures, yet Abel et al. (1979) failed to record electroencephalographic (EEG) data essential to the accurate determination of sleep stage. To their credit, the authors acknowledged this, however their use of frontalis electromyography (EMG) in connection with electrooculography (EOG) served as another indication of their apparent unfamiliarity with obtaining acceptable sleep recordings. Not only was the accuracy of their EMG measure compromised by frontalis placement (submental placement is the norm), their use of EMG with EOG alone to determine REM sleep was highly dubious, despite the authors' use of "conservative" scoring techniques. Abel et al. cited Bliwise, Coleman, Bergman, Wincor, Pivik, and Rechtschaffen (1974) as supporting the use of EMG to indicate REM sleep, yet a careful reading of this article indicated that it pertained to submental EMG recordings and
contained a warning that EMG levels alone could not provide positive identification of REM sleep, although EMG decreases in conjunction with EEG changes had a modest predictive value. Thus, future studies could improve upon the work of Abel et al. simply by employing standard recording and scoring methodologies to determine stage REM sleep.

A second critique of the Abel et al. study involves the method of quantification of baseline data from which arousal values were computed. Baseline values were defined as those occurring during a 2-min. period 2 minutes prior to the onset of REM sleep. This meant that measurements were obtained which reflected arousal levels very near to the onset of REM periods. Since the relationship of genital arousal and REM sleep is not a precise one, with arousal often occurring before the onset of REM (Fisher et al., 1980), and since Abel et al. used equivocal methods to determine REM onset, the validity of their "baseline" values may have been greatly compromised by pre-REM-onset arousal levels. Clearly, recording baseline measures during stage 3 or 4 sleep would have been a better method, as arousal in men has been shown to be less associated with these sleep stages.

Finally, the significance of movement-produced increases in Abel et al.'s vaginal measures is unknown, as the authors failed to mention any precautions taken against such artifactual changes. Vaginal photoplethysmography can be very sensitive to lower body movement or sudden changes in
diaphramatic breathing (as discussed in a later section of this paper), and it is well known that both of these phenomena are much more likely to be present during REM sleep than during deeper stages of sleep. Because Abel et al. did not attempt to measure either movement or respiration, it is almost certain that episodes of artifactual changes were included in their measures of VPA and VBV, seriously qualifying their findings.

Research Design and Hypotheses

The present study is a logical extension of the research reviewed above. As such, it offers methodological improvements and focuses on some new areas of interest. In the following paragraphs, the various elements of the experimental design are discussed in the light of current knowledge, leading to a formal statement of the research hypotheses.

Unlike previous studies comparing groups of sexually functional women to groups of sexually dysfunctional women, this study selects groups of low- and high-arousability subjects based upon a standardized scale of sexual arousability, the Sexual Arousal Inventory (SAI), developed by Hoon, Hoon, and Wincze (1976). The SAI consists of 28 items, each describing a potentially arousing experience and instructing the subject to rate her own level of sexual arousal on a seven-point scale, based upon when she had the described experience or how she thought she might feel if she had the experience. The rating scale ranges from slight aversion to
extremely arousing rating levels, and the sum of the ratings for all 28 items are used to arrive at an arousability score for the subject. Normative data for the inventory, based upon the responses of 370 North American women, are used to assign percentile ranks to subjects' raw scores.

According to canonical factor analysis of a 131-item pool (as reported in Hoon, 1979), the 28 items chosen for inclusion in the SAI were correlated most highly with four sexual experience validity criteria: satisfaction with sexual responsivity in general (\( \rho = .30 \)), awareness of nine typical physiologic changes during sexual arousal (\( \rho = .50 \)), the reported frequency of intercourse before marriage (\( \rho = .38 \)), and present reported frequency of intercourse (\( \rho = .40 \)). The inventory has been cross-validated, exhibiting moderate correlation with self-reports of different types of sexual experience (\( \rho = .42 \)) and negative correlations with anxiety scales (\( \rho \) unknown, Burgess and Krop, cited in Hoon, 1979).

Although using the SAI to categorize subjects is a significant departure from the selection criteria employed by earlier researchers, using a standardized measure to form groups offers the advantage of being able to quantitatively define sample populations along the theoretically important dimension of self-reported sexual arousability. Previous investigators have only vaguely described their subject selection criteria, apparently using self-reported orgasmic
frequency (Heiman, 1976, cited in Heiman, 1977), or request for sex therapy (Wincze et al., 1976; 1978; Morokoff & Heiman, 1980). Wincze et al. administered the SAI to both sexually functional and dysfunctional women in his study, but this was done after group formation.

Since lack of sexual arousal is a frequent complaint among women seeking sex therapy (Kaplan, 1974), the low-arousability women selected for the present study could be somewhat similar to the women investigated in the studies cited above. However, since earlier criteria for selection were only qualitative in nature, it is impossible to speculate upon the similarities with any certainty. The lack of precise comparability between sample populations in different studies can only be remedied through the use of standardized selection criteria based upon theoretically important dimensions of sexual functioning. In this regard, the employment of the SAI to form groups is considered an initial step in the right direction.

Although nocturnal vaginal response measures have been recorded in sexually "normal" groups of women during sleep (Abel et al., 1979; Cohen & Shapiro, 1970; 1971; Fisher et al., 1980), no investigators have used nocturnal measures to compare sexually functional women with women reporting low sexual arousability. This study is unique in that waking vaginal response to erotic stimuli and vaginal response during sleep is recorded from low- and high-arousability
females, allowing comparison of waking and sleeping physiological measures. This comparison could be very important as it is not presently known whether VPA levels during any of the sleep stages vary across groups of females differing on waking, self-reported arousability, or whether VPA levels during sleep are similar to those observed under different waking conditions. The findings of this study could therefore provide important information regarding the feasibility of employing waking-sleeping assessment of VPA as an aid to differential diagnosis of female sexual dysfunctioning.

As VPA appears to be a more sensitive indicator of arousal than VBV (Geer et al., 1974; Geer & Quartararo, 1976; Heiman, 1976; Osborne & Pollack, 1977; Sintchak & Geer, 1975), this study employs VPA as the dependent physiological measure. An additional reason for choosing VPA is the relative recording stability of the measure in comparison with VBV. In a pilot study conducted by the author and a colleague (Rogers & Van de Castle, 1982), VPA was found to return quickly to normal levels after movement, while VBV required repeated adjustment (via a variable offset resistor) to return the signal to recordable levels. The authors pointed out that the two measures, VPA and VBV, appeared to measure different aspects of vaginal blood supply. Despite the fact that both measures were derived from the same phototransistor, the VPA component of the signal was electronically filtered to remove low-frequency characteristics and A.C.-coupled to improve
baseline stability. On the other hand, VBV was D.C.-coupled at much lower amplification and filtered to removed high-frequency waveforms. Thus, VBV was considered (a la Geer et al., 1974) to be a general measure of blood pooling in the tissue, and slight repositioning of the photoplethysmograph was thought to result in the sampling of a new area which may not have contained the same amount of diffuse blood. This meant that with movement, VBV levels increased or decreased dramatically. Conversely, VPA was thought to indicated the amount of blood pulsing through tissue capillaries. Although movement of the photoplethysmograph resulted in new areas being sampled, VPA was observed to remain relatively constant over adjacent areas of the vaginal barrel.

In summary, VPA appeared to offer greater sensitivity to arousal-produced changes, while exhibiting relative stability in the face of artifactual changes. To provide the vaginal response measure, a state-of-the-art vaginal photoplethysmograph is used, constructed in Bohlen and Held's laboratory (cf. Bohlen & Held, 1979). This device offers several advantages over previous designs, most notably stability of placement, flexibility which produces less likelihood of vaginal blood vessel occlusion during high arousal episodes, and the ability to measure vaginal muscle contraction pressure.

Vaginal pulse amplitude is recorded somewhat differently than in previous studies, in that the electrical signal from
the photoplethysmograph is integrated over a short period of time (.02 sec.). Integration of the signal provides several attractive recording features. Since the signal can be full-wave rectified, both positive and negative components of the pulsatile vaginal pulse wave can be integrated. Using a small time constant preserves the pulse-like nature of the vaginal measure, while smoothing the extremely rapid fluctuations found in unprocessed recordings of vaginal pulse. This slight smoothing of the wave form allows somewhat easier detection of individual peak amplitudes, especially at the slow chart speeds necessary for all-night recordings.

The recording of vaginal muscle contraction pressure, in combination with EMG recordings of leg muscles, facilitates discrimination of movement-produced changes in VPA, resulting in a much more precise assessment of arousal-produced or spontaneous VPA changes. Although vaginal muscle contractions sometimes indicate the beginning of orgasm in awake females, only limited, anecdotal evidence of nocturnal orgasm during sleep studies in the laboratory has been reported (Fisher et al., 1980). Therefore, for the purposes of this experiment, gross changes in vaginal muscle contraction pressure are considered to be an index of artifactual muscle activity. Preliminary pilot studies (Rogers & Van de Castle, 1982) empirically supported this interpretation of vaginal muscle contraction episodes under these experimental conditions, in that episodes of increased vaginal muscle contraction
pressure were highly associated with either lower body movement or sudden diaphragmatic movements (e.g., coughing or sudden changes in respiration).

An improvement offered by this study, in comparison to that of Abel et al. (1979), is the use of standard procedures regarding the recording of sleep stages (Rechtschaffen & Kales, 1968). Not only are VPA levels reported for stage REM sleep, but also for stage 2 and stages 3 & 4 combined, making this the first study to observe nocturnal VPA levels in such detail.

Finally, calibrations of all physiological measures are presented in full, allowing future researchers greater ease in duplicating the recording of response measures. Previous studies have often failed to report any calibration procedures or recording parameters, making replication impossible.

In conclusion, integrated VPA will be measured in groups of low- and high-arousability women, during waking baseline, erotic film presentation, second baseline, and self-generated erotic fantasy. Additionally, integrated VPA will be recorded during stage 2, stages 3 and 4 combined, and stage REM sleep.

The major hypothesis of the study is that low-arousability females will exhibit VPA levels similar to those exhibited by high-arousability females during both waking erotic conditions and while asleep. This hypothesis of no difference between groups is based upon the assumption that
self-reported low-arousability in the first group is generally of a psychogenic etiology, and not the result of some physiological deficiency. Stated in other terms, retrospective report of arousal and physiological measures of arousal are predicted to be independent of each other.

The value of the nocturnal assessment of genital arousal would be most apparent in the case that waking VPA levels were found to be significantly different between arousability groups. In this situation, differences in nocturnal VPA levels between low- and high-arousability groups would be strongly suggestive of constitutional or organic differences, while the finding of similar nocturnal VPA levels would point to the importance of psychogenic or waking contextual variables (e.g., response to the laboratory environment) in determining physiological arousal.

Secondly, it is hypothesized that the high-arousability group will rate themselves as significantly more aroused during the waking erotic conditions than the low-arousability group. A finding of this nature, in the context of no VPA differences between groups during the same conditions, would suggest that immediate perceptions of arousability are independent of physiological response (i.e., VPA level).

Significant differences in VPA are expected between the various experimental conditions of the research design. Specifically, mean levels of VPA should increase from waking baseline periods to film and fantasy conditions. There
should also be significant differences in VPA among the stages of sleep, with lowest levels predicted to occur during stages 3 and 4 combined, next lowest in stage 2, and highest levels during stage REM. Confirmation of these predictions would support earlier studies claiming significant stage REM increases in vaginal measures of vascular arousal and offer additional information regarding VPA levels during the other stages of sleep, thereby establishing an empirical basis for future research regarding nocturnal evaluation of VPA as a differential diagnostic methodology.

METHOD

Subjects

Potential subjects were recruited from nursing classes and human sexuality classes at the University of Virginia (U.Va.). Of the 45 females completing the SAI, 20 women whose responses placed them either in the bottom third or top third of normalized percentile ranks were selected. The "low-arousability" group (n = 10, mean age = 23.3 yrs.) had a mean SAI normalized percentile rank of 19.41 (SD = 8.79). Of this group, eight women were single and two married. None of the women in this group reported any pregnancies and four were currently using birth control pills. Seven of the ten women in this group answered "false" to the written statement: "Usually, I have a satisfying orgasm with sex". The "high-arousability" group (n = 10, mean age = 26.7 yrs.) had a mean SAI normalized percentile rank of 93.83 (SD = 4.35)
and was composed of five single, three married, and two
divorced women. Seven of the women in this group had never
been pregnant, two had terminated pregnancies, and one had
delivered a child. Two of the women were currently using
birth control pills. Nine of the ten women answered "true"
to the written statement: "Usually, I have a satisfying
orgasm with sex".

In order to rule out the presence of vaginal infection
or any other physiological condition precluding participation,
all subjects received a general physical examination at the
U.Va. Medical Center, including a pelvic exam and a gross
neurological exam. Additionally, each subject received a
peripheral vascular examination, consisting of blood pressure
readings from both arms, thighs, calves, ankles, and metatar-
sal regions. All subjects were found to be of good physical
health. Subjects were paid $50 upon completion of all phases
of the experiment.

**Instruments**

The SAI, as previously described, was used as a classi-
fication instrument. A listing of the items utilized in the
scale is presented in Appendix A. The only other self-report
measures employed in the study were the arousability scales
administered after film and fantasy periods. These scales
were identical in composition, consisting of written scales
ranging from "-1" (adversely affects arousal, unthinkable,
repulsive, distracting) to "+5" (always causes sexual arousal,
extremely arousing). The arousability scales are presented in Appendix B.

The measures of integrated VPA and vaginal muscle contraction pressure were recorded with a photoplethysmograph constructed by Bohlen and Held (see Bohlen & Held, 1979). The device was constructed of clear plastic, with head and base separated by a steel rod, forming a central space which was enclosed by a flexible, clear, rubber membrane. An LED and phototransistor were mounted on the inner surface of this membrane, with signal wires exiting the base of the device. The base of the plethysmograph contained an air-pressure transducer which was capable of recording changes within the hollow central chamber. Wires from the device were coupled via a custom variable voltage offset box to a Grass model 7P3 A.C. wide-band preamplifier (for VPA) and a Grass model 7P1 low level D.C. preamplifier (for the vaginal muscle contraction pressure measure) on a Grass model 78 polygraph. These measures were recorded on channels 10 and 11 of the polygraph. For the integrated VPA channel, the 7P3 function switch was turned to integrator, with the time constant set to 0.02 sec., 1/2 amplifier low frequency set to 0.03 Hz, rectifier switch set to full rectification (thus integrating both positive and negative components of the signal), and 1/2 amplifier high frequency set to 15 Hz. Calibration of the 7P3 was accomplished by setting the calibration switch to 1 mv and adjusting pen deflection equal to 8 mm on the Grass model
70SC oscillograph. Channel width was set to 50 mm by adjusting the baseline position of the pen. For the vaginal muscle contraction pressure channel, the 7P1 was calibrated so that a 10-mv signal resulted in 2 mm of pen deflection at a sensitivity setting of "1". Initial baseline position of the pen was established before subjects inserted the plethysmograph, using a variable voltage offset on the custom coupling box.

Physiological measures to enable the scoring of sleep stages were performed using Grass model 7P511 preamplifiers (channels 1-8) initially calibrated so that a 50-microvolt signal resulted in 1.5 cm of pen deflection at a sensitivity of "5" with all 60 Hz filters on. For the two EOG channels (1-2), sensitivity was set at "7.5", 1/2 amplifier low frequency was set at 1 Hz, 1/2 amplifier high frequency was set at 1 KHz, and pen filters were set at 30 Hz. Submental chin EMG (channel 3) was recorded using a sensitivity of "1.5", 1/2 amplifier low frequency set to 10 Hz, and 1/2 amplifier high frequency set to 0.3 KHz. Three EEG channels were employed to give indications of brainwave activity at frontal vertex (channel 4), cerebral vertex (channel 5), and parietal vertex (channel 6) locations. All recordings were monopolar, with the right ear as reference. For the frontal vertex channel, 1/2 amplifier low frequency was set to 0.3 Hz in order to better detect slow-wave activity. The cerebral vertex channel was set to a 1/2 amplifier low frequency of 1 Hz (standard practice), while the parietal vertex channel was
biased towards faster activity by using a 1/2 amplifier low frequency setting of 3 Hz. All EEG channels were set to a sensitivity of "5", with 1/2 amplifier high frequency settings of 1 KHz and pen filters set at 60 Hz. Finally, two EMG leads (channels 7-8) from medial locations on subjects' adductor longus muscles (both inner thighs) were employed to enable better discrimination of lower body movement and associated artifactual changes in VPA. The settings for these EMG channels were the same as for the submental EMG channel.

The film used as an erotic stimulus in the study was borrowed from the audio-visual department of the U.Va. Medical Center library. This 10-min. film, entitled "Give to Get" (Sutton, 1970), depicted a nude couple progressing from mutual massage to sexual intercourse. The film had been used in several human sexuality classes at U.Va., but had not been previously viewed by any subject in the study.

All physiological recordings sessions took place at the Sleep and Dream Laboratory at the U.Va. Medical Center. The sleep lab consisted of a panelled, carpeted sleeping room with standard bed and an adjoining equipment room. Bioelectrical connections between subjects and recording equipment were made via wall panels.

Procedure

After receiving a complete explanation of the procedures involved in the study, subjects were asked to sign an informed consent document outlining these procedures and advising of
risks and/or benefits inherent in the study (see Appendix C). Subjects were not informed of their SAI scores, nor were they told of group classification. The rationale for requesting their participation was stated in terms of the need for "control" subjects to provide normative data for later studies involving dysfunctional diabetic females. Participants then were scheduled for their physical examinations at the U.Va. Medical Center. During the examination, if subjects were not using birth control pills, they were given a basal temperature chart and instructed to record their oral temperature each morning upon arising for a one-month period. A physician evaluated this record at the end of the month to determine whether subjects were ovulatory. Women using birth control pills were instructed to remain on the same regimen.

In order to control for vascular changes associated with day in menstrual cycle, all-night evaluations were arranged to occur during the first third of the subjects' menstrual cycles, specifically between days 4 and 10 (as long as menstrual flow had ceased), as determined by basal temperature charts. Subjects were required to come to the sleep lab on two consecutive nights, as the first night of sleeping in the lab was considered an "adjustment" night (Williams, Karacan, & Hursch, 1974). On the first night, participants were instructed to be present at the lab at 8:00 p.m. and, upon arriving, were given a tour of the lab. After changing into bed clothes and robe, subjects were prepared for the all-night
recordings. First, EOG, EEG, and EMG electrodes were attached according to standard procedure (Rechtschaffen & Kales, 1968). The female assistant then attached the leg EMG electrodes at a medial site on the adductor longus muscles (inner thigh muscles) on both legs of subjects. Next, the assistant instructed participants in the proper insertion and placement of the vaginal photoplethysmograph and left the room while subjects privately inserted the device.

Following an initial adjustment period, a 20-minute baseline of integrated VPA was obtained with subjects reclining quietly in bed. Next, subjects were instructed to pay attention to their bodily sensations while they viewed a 10-minute erotic film. Immediately after the film, subjects were given a 7-point scale upon which to rate their level of sexual arousal. Another 20-minute baseline period followed, after which subjects were instructed to pay attention to their bodily sensations while they privately fantasized a sexually arousing event or situation for 10 minutes. Immediately after the fantasy period, subjects rated their level of arousal on an identical 7-point scale. Subjects were then allowed to fall asleep, with recordings monitored all night in order to insure accurate data collection. After being awakened at approximately 6:30 a.m., subjects removed the vaginal photoplethysmograph in privacy, then the laboratory assistant removed the other electrodes. Between recording nights, the vaginal probe was washed and then sterilized for
20 minutes in a solution of Cidex-7, a virucidal agent. Similar procedures, with the exception of the film and fantasy periods, were followed the second consecutive lab night.

RESULTS

Quantification of Data

Integrated VPA was quantified by measurement of peak amplitude in millimeters of pen deflection for each 30 seconds of recording during first baseline, film, second baseline, fantasy, and sleep. During each 30-second epoch, for those time periods marked by either leg movement or excessive vaginal muscle contractions, the chart was divided into movement-free segments and integrated VPA measured just from those segments. Only the five highest integrated VPA peaks per 30-second epoch were measured due to time and equipment limitations. These five data points per 30-second epoch were entered into a computer file and later averaged to yield mean integrated VPA amplitude levels per minute for each waking condition, stage 2, stage 3 and 4 combined, and stage REM sleep. Following precedent established in many studies, sleep data from the first night of recordings was not analyzed due to potentially high variability of recording parameters (Williams, Karacan, & Hursch, 1974). Sleep records from the second night of the study were scored for stage 2, stage 3 & 4 combined, and stage REM sleep according to standardized criteria outlined by Rechtschaffen and Kales (1968).
Data Analysis

Data were analyzed at the U.Va. Academic Computing Center, using appropriate programs from the Biomedical Computer Programs P-Series, 1979. First, simple frequency distributions of all variables were obtained in order to check proper data entry. Subsequent analyses were performed in several steps. Initially, simple correlational analyses were performed to find appropriate covariates. Although the variables of age and parity were considered to be potentially important, only one subject was found to differ in parity and no significant correlations between age and integrated VPA levels during any condition were discovered (see Table 1 of Appendix D). Similar correlational analyses revealed significant relationships between initial waking baseline levels of integrated VPA and VPA during all subsequent conditions (see Table 2 of Appendix E). Accordingly, initial waking baseline integrated VPA was chosen as the single covariate in the analysis of covariance computations presented below.

Secondly, since experimental conditions were conceptually divided into waking and sleeping contexts, separate multivariate analyses were executed accordingly (alpha level was set at .025, two-tailed, for each analysis at this stage). For the waking conditions (film, second baseline, and fantasy), initial baseline VPA was used as the covariate in a 2 x 3 analysis of covariance (ANCOVA) design, with the grouping factor divided into low- and high-arousability.
Table 3 of Appendix F presents the cell means adjusted for initial baseline for all treatment levels, while a summary of the ANCOVA results is presented in Table 4 of Appendix G. A test of homogeneity of covariance, compound symmetry (see Winer, 1971, p. 596), revealed no significant differences in covariance matrices between groups. Although the F test for group effects failed to reach significance by a wide margin ($F = .87, \text{df} = 1, 17, p = .36$), the analysis did indicate significant treatment effects ($F = 4.63, \text{df} = 2, 36, p = .02$). The F value for group by treatment interactions was nonsignificant ($F = .22, \text{df} = 2, 36, p = .80$).

Based upon these results, the grouping factor was eliminated and differences between conditions were examined with matched $t$ tests (since the design was repeated measures, a subject's response in one condition was matched with her response in another). The alpha criterion for all posthoc individual comparisons was set at .008, derived by dividing an experimentwise alpha level of .05 (two-tailed) by the total number of individual comparisons performed in the experiment (six). Means, medians, and standard deviations for the waking conditions are presented in Table 5 of Appendix H. These values indicate that mean integrated VPA level during the film condition was higher than during the initial baseline period ($t = 6.28, \text{df} = 19, p < .001$), and that integrated VPA during the fantasy condition was higher than during the second baseline ($t = 3.08, \text{df} = 19, p < .006$).
Two-tailed probabilities are reported for all matched t tests.

Next, a complementary 2 x 3 ANCOVA was computed for both low- and high-arousability groups, using mean integrated VPA levels for the sleeping conditions of stage 2, stages 3 and 4 combined, and stage REM sleep, again employing initial waking baseline integrated VPA level as the covariate. Adjusted cell means for both groups during stage 2, stages 3 and 4 combined, and stage REM are presented in Table 6 of Appendix I, with the results of the ANCOVA presented in Table 7 of Appendix J.

A test of compound symmetry for the above analysis indicated significant differences in covariance matrices between groups (p < .001), ruling against the use of an ANCOVA for comparing cell means. In order to evaluate whether a simple analysis of variance could be validly performed for comparison of VPA between groups during the sleeping conditions, an inspection of group variances was undertaken, revealing somewhat more variability in integrated VPA for the low-arousability group than the high-arousability during stages 3 and 4 combined, and also during stage REM (see Table 8 of Appendix K). F tests were calculated upon group variances for these conditions, with results indicating nonsignificant differences between groups (stages 3 and 4 combined, $F = 1.98, df = 9,9, p = .32$; stage REM, $F = 1.87, df = 9,9, p = .37$).
Since variances between groups were not significantly different, a simple 2 X 3 analysis of variance (ANOVA) was performed. Briefly summarized, the $F$ test for group effects did not approach significance ($F = .13$, $df = 1,18$, $p = .72$), while the $F$ value for treatment effects was highly significant ($F = 26.28$, $df = 2,36$, $p < .0001$). The $F$ value for the group by treatment interaction also failed to reach significance by a wide margin ($F = .42$, $df = 2,36$, $p = .66$). A summary table of the results of this analysis is presented in Table 9 of Appendix L.

Since the ANOVA indicated no difference between groups in terms of mean integrated VPA levels, the group factor was collapsed for multiple post-hoc contrasts between experimental conditions. Integrated VPA levels during stage 2 were not significantly different than during stages 3 and 4 combined ($t = 2.00$, $df = 19$, $p = .06$), but were significantly lower than those during stage REM sleep ($t = 6.32$, $df = 19$, $p < .001$). Mean integrated VPA levels during stages 3 and 4 combined were also significantly lower than those during stage REM sleep ($t = 5.53$, $df = 19$, $p < .001$). Means, medians, and standard deviations for the sleeping conditions are presented in Table 10 of Appendix M.

One comparison was made between waking and sleeping conditions, as the question of possible differences between the film condition and stage REM was thought to be important. The results of this comparison indicated that integrated VPA
levels during the two conditions were not significantly different ($t = -1.08$, $df = 19$, $p = .292$).

A 2 x 2 ANCOVA was performed on the subjective rating scales administered after film and fantasy conditions during the experiment. The cell means, adjusted for the covariate of initial waking baseline integrated VPA, are presented in Table 11 of Appendix N, while a summary of the ANCOVA results is shown in Table 12 of Appendix O, revealing no significant differences between groups on these subjective measures ($F = .19$, $df = 1, 17$, $p = .66$).

Finally, several correlational analyses were performed in order to determine whether SAI scores were related to laboratory arousal ratings, and whether either of these two types of self-report measures were associated with observed VPA levels in either group of subjects. As shown in Table 13 of Appendix P, SAI scores failed to correlate significantly with film or fantasy ratings of subjects in either individual or combined groups. Since the erotic conditions in the laboratory were of a highly visual or fantasied nature, an attempt was made to divide items from the SAI into two subgroups according to content. The first group was characterized as reflecting erotic stimuli of an interpersonal, predominantly tactile (I/PT) nature, while the second group was composed of items of a self-focused, predominantly visual or fantasied (S/PVF) nature. These subgroup scores were used for several correlational analyses.
Table 14 of Appendix Q shows simple linear regression correlations for I/PT by SAI, S/PVF by SAI, and I/PT by S/PVF scores for both individual and combined groups. The I/PT subscores were highly correlated with SAI scores in each group and also for the total sample. The S/PVF subscores were not significantly correlated with SAI scores in either group when considered separately, but the correlation between S/PVF and SAI scores was significant for both groups combined. Lastly, correlations between I/PT and S/PVF subscores were nonsignificantly negative within low- and high-arousability groups, but significantly positive for both groups combined.

Correlations for I/PT subscores by laboratory arousal ratings and S/PVF subscores by laboratory arousal ratings are presented in Table 15 of Appendix R for each group of subjects and both groups combined. An inspection of correlation coefficients for both groups combined revealed no significant associations between either I/PT or S/PVF subscores and film or fantasy ratings; however, fantasy ratings were significantly associated in a negative direction with I/PT subscores within the high-arousability group. Similarly, the negative correlation between S/PVF subscores and film ratings in the low-arousability group was significant.

Simple linear regression coefficients were also computed to determine the relationships between the different self-report measures and VPA changes during the two erotic conditions in the laboratory. Change scores for the VPA
measures were computed by subtracting VPA levels observed during either the film or fantasy conditions from their respective preceding baselines. Coefficients for these correlations are presented in Table 16 of Appendix S. No significant relationships were found between these variables.

DISCUSSION

As hypothesized, VPA levels were found to be similar between low- and high-arousability females during waking erotic stimuli conditions and during the various stages of sleep. Contrary to prediction, the two groups did not differ on perceived arousal during the film and fantasy erotic conditions. With both groups combined, VPA was found to be significantly higher during the waking erotic conditions as compared to the baseline conditions and also higher during stage REM sleep as compared to the other stages of sleep.

Before discussing the implications of the main findings, factors bearing upon their validity must be addressed. For example, it could be argued that the small sample sizes, combined with the variability of experimental measures, could have made it unlikely for statistically significant differences to have been found, biasing the study in favor of the null hypothesis. An inspection of means and standard deviations for VPA levels and arousal ratings does not support this contention. In almost every instance, measures of central tendency were nearly identical between groups, indicating that the findings were not simply the result of
conservative statistical analyses. It should also be noted that the sample sizes employed in this study were similar to, or larger than, other studies using physiological instruments to measure vaginal response (cf. Abel et al., 1979; Heiman, 1976, cited in Heiman, 1977; Morokoff and Heiman, 1980; Wincze et al., 1976, 1978).

"Low" Versus "High" Arousability

Another factor influencing the interpretation of the findings is the use of the SAI to define "low" and "high" arousability. Despite a published report of moderate criterion-related validity (Hoon, 1979), SAI scores were not significantly associated with self-report of arousability during the laboratory conditions of the present investigation. Regardless of group arousability, the SAI exhibited nonsignificant correlations with the film arousal rating scale ($r = -.13$ for the low-arousability subjects, $r = -.03$ for the high-arousability subjects, $r = .01$ for both groups combined), and with the fantasy arousal rating scale ($r = -.09$ for the low-arousability subjects, $r = -.59$ for the high-arousability subjects, $r = -.12$ for both groups combined).

While these correlations should be viewed cautiously, due to the small number of observations upon which they are based, the lack of association between SAI scores and laboratory arousal ratings suggests that the SAI measures dimensions of sexual arousability which are somewhat different than
those measured by subjective ratings of immediate arousal in the laboratory. The ways in which SAI items differ from the laboratory arousal conditions appear to fall into three conceptual categories: temporal aspects regarding self-report of arousal, nature of the erotic stimuli, and demand characteristics of the settings in which arousability is assessed.

Factors Influencing Self-Report of Sexual Arousability

In completing the SAI, subjects retrospectively rated their level of arousal based upon descriptions of sexually stimulating activities. This rating may have been based upon subjects' memory of their typical levels of arousal in such situations, or may have been based upon subjects' imaginary responses to stimuli not actually experienced. Conversely, the film and fantasy conditions in the laboratory presented subjects with specific, immediately experienced erotic stimuli upon which to base their ratings. These temporal differences between occurrence of erotic stimuli and rating of associated sexual arousal might have influenced the levels of arousability reported under the two types of conditions.

Another factor possibly influencing the levels of arousability reported on the SAI and in the laboratory might have been related to the nature of erotic stimuli represented by SAI items and those encountered in the laboratory during the experiment. Most of the items on the SAI were of an interpersonal nature, asking the respondent to judge how
aroused she feels in the context of being stimulated by her sexual partner. Many of the items pertained to tactile stimuli, with only a minority reflecting visually experienced or fantasized erotic stimuli. Conversely, the experience of watching an erotic film or engaging in erotic fantasy in the laboratory was probably more self-focused and predominantly visual or dependent upon the subject's ability to create a vivid fantasy.

Correlational analyses performed using "interpersonal/predominantly tactile" (I/PT) and "self-focused/predominantly visual or fantasied" (S/PVF) items of the SAI offered marginal support for the above speculation. For example, in the sample as a whole, I/PT subscores were more closely associated with SAI scores ($r = .98$) than were S/PVF subscores ($r = .75$). This difference in level of correspondence was even more dramatic within groups. Correlations between I/PT and SAI scores were high for the low-arousability group ($r = .80$) and for high-arousability group ($r = .91$); however, S/PVF subscores were not related to SAI scores in either group ($r = .31$ for the low-arousability group, $r = .29$ for the high-arousability group). These correlations indicate that subjects responded somewhat differently to I/PT and S/PVF items, with SAI total scores representing subjects' responses to interpersonal and tactile stimuli more so than to self-focused, visual, or fantasied stimuli. Since total SAI scores appear to be somewhat biased towards I/PT-type erotic
situations, subjects' SAI scores might not have accurately represented their arousability in S/PVF-type contexts, such as those found in the laboratory.

Theoretically, as differences in the nature of the erotic stimuli should not have been as great between S/PVF items and the laboratory erotic conditions, it was expected that S/PVF subscores might have been more closely associated with laboratory arousal ratings than either I/PT subscores or SAI total scores. As expected, I/PT subscores for the total sample were not correlated with either film ($r = .07$) or fantasy ($r = -.20$) arousal ratings. Unfortunately, S/PVF subscores were similarly unrelated with arousal ratings ($r = -.20$ for film, $r = .17$ for fantasy). Separate correlational analyses for each group of females added little additional information. In the high-arousability group, a single significant correlation was found between I/PT subscores and fantasy ratings ($r = -.74$), suggesting that high responders to I/PT items rated their laboratory fantasies as being relatively unarousing. For the low-arousability group, only the negative correlation between S/PVF and film arousal ratings ($r = -.73$) achieved statistical significance, for the most part reflecting relatively low S/PVF subset scores paired with high film arousal ratings, and suggesting that low-arousability females might have been untypically aroused when confronted with the erotic film employed in the experiment.
The above findings lead to the consideration of possible demand characteristics present in the laboratory which were not active in regard to subjects' responses on the SAI. One such possibility is that women expressed higher arousability in the lab due to their expectations regarding an "appropriate" response. Although subjects were assured that neither high nor low arousal was expected, some females may have nevertheless decided that high arousal was the "correct" response to report. Another factor might have been that the experiment offered a situation in which implicit permission was given to become aroused, focus on this arousal, and report it. In this case, the subjects' perceptions of the experimenter's values and attitudes towards sexual arousal might have been a major factor in determining subjects' subjective report.

**Independence of Arousability Measures**

Since the correlational findings suggest that there were important differences between the SAI and immediate ratings of arousal in the laboratory, it was expected that the relationship between self-report of arousal and VPA levels might also reflect this independence. In this study, none of the correlations between self-report measures and changes in VPA during the film or fantasy periods were significant, whether the self-report measure was the SAI, subset scores on the SAI, or laboratory rating scores. For combined groups, laboratory ratings and VPA correlations appeared to be higher.
than those for the SAI and VPA levels, but neither were significant.

Thus, it appears that subjective perception of arousal (as measured by either retrospective or immediate self-report) was independent of physiological arousal, at least as measured by VPA. Despite generally high levels of physiological arousal during the film and fantasy periods, both groups of women reported levels of subjective arousal ranging from "did not affect sexual arousal" to "was extremely arousing."

Although no subject rated the film or fantasy as "disgusting" or "annoying," negative verbal reactions to the film were observed on some occasions by the investigator. Even in these instances, VPA increased, suggesting that the hypothesis of Wincze et al. (1976), assuming cognitive inhibition of physiological response, was not true for these subjects.

Finally, the correlations between laboratory arousal ratings and VPA levels for each group suggested that neither low- nor high-arousability females exhibited significantly greater accuracy in their perceptions of physiological arousal.

Summary of Arousability Findings

It appears that, in the laboratory at least, SAI-classified low-arousability females responded to film and fantasy erotic conditions in ways similar to high-arousability females. Although temporal aspects of the assessment procedures, type of erotic stimuli, and demand characteristics associated with the experiment itself might partially explain
the laboratory results, we are still left with the question of why a group of females in this study scored so low on the SAI. Apparently, their low-arousability scores either reflected real problems interfering with sexual satisfaction in their experiences outside of the laboratory, or else the "problem" was one of memory or attitude towards their own sexuality and not one of sexual arousability, per se.

Since physiological response seemed to be a very consistent phenomenon in the laboratory, evident during sleep as well as during wakefulness, it seems reasonable to assume that low-arousability females are capable of physiological arousal in their usual environment. Assuming biological response capability, it would be important to determine if low-arousability females exhibit physiological arousal in response to typically encountered erotic stimuli in their own environments. If so, the next step would be to assess whether low-arousability females are aware of their physical arousal, and whether they acknowledge it, or dismiss it, according to their attitudes and beliefs about themselves as sexual beings and the appropriateness or inappropriateness of sexual response in any particular situation.

While the question of physiological arousability in response to naturally occurring stimuli cannot be answered by the present study, there is evidence here that females can exhibit high levels of physiological arousal while reporting no sexual arousal. This finding suggests that psychological
factors are relatively more important than physiological factors in influencing subjects' reports of arousal and that negative attitudes and beliefs may "override" physiological response, so that females recall low levels of arousal despite having experienced normal levels of physiological arousal. 

Recommendations for Future Arousalability Research

In conclusion, it can be pointed out that the lack of association between self-report and laboratory measures appears to be a consistent finding in several studies (cf. Morokoff & Heiman, 1980; Heiman, 1980), raising important questions about the value of laboratory findings in trying to explain low sexual arousability occurring in subjects' natural environment. Certainly, genital measures of sexual arousal appear to be valid, at least to the extent that they change with the onset of generally erotic stimuli and reflect basic organic function. However, women's own perceptions of their sexual arousability seem to be influenced by much more subtle factors than simple presence or absence of physiological response. Therefore, in order to explain why some women self-report low sexual arousability, it appears that future research in this field should concentrate upon achieving greater sophistication in measurement of the cognitive and contextual aspects of sexual arousal, both in the laboratory and in subjects' natural environments.
In terms of self-report measures, the assessment of sexual arousability should take into account temporal aspects of rating response (e.g., retrospective evaluation or immediate report), nature of the erotic stimuli employed (e.g., interpersonal or self-focused; tactile, visual, auditory, or imagined), and the demand characteristics associated with the experiment itself (e.g., subjects' perceptions of experimenter's attitude towards sexual arousability). Additional diagnostic information should include data about subjects' general level of sexual experience and knowledge, relevant sexual attitude scales, general symptom inventories, mood scales, assessment of sexual drive, and current relationship variables.

As it may not be feasible (or ethical) to incorporate interpersonal contexts and varying kinds of sensual erotic stimuli in the laboratory, researchers may have to devise assessment procedures which can be accomplished by subjects in their own environments, employing their normal sexual partners. If the question of adequate physiological arousal was considered important, laboratory measurement of genital response might be required, or the portable recording devise for vaginal photoplethysmographs offered by Sarrel, Froddy, and McKinnon (1977) could be employed. Physiological recordings could be obtained while the subject's partner stimulated her in preassigned ways, so that tactile, visual, and auditory response could be measured. Self-report measures could be
collected before, during, and after experimental sessions to determine temporal differences in subjective perception and correlation with physiological arousal in the subject's natural environment.

**Value of Nocturnal Assessment Procedures**

Every female subject in this study exhibited VPA increases during stage REM sleep which were similar to those which occurred during waking exposure to erotic stimuli and which were significantly higher than VPA levels during the other stages of sleep. Other studies have also reported increases in vaginal response measures during REM sleep (Abel et al., 1979, Cohen & Shapiro, 1970; 1971; Fisher et al., 1980); however, the methodology of previous studies left considerable doubt as to whether spontaneous vaginal vascular arousal or simply movement-produced artifactual changes in vaginal measures were being observed. The present findings indicate that the phenomena of increased VPA during REM sleep is a reliable indicator of general biological arousability. As such, nocturnal assessment of VPA appears to be an alternative manner of assessing physiological capability for arousal, with several attractive features. In comparison to waking assessment paradigms, no erotic stimuli are needed and individual attitudes about being sexually stimulated in the laboratory setting are obviated. In essence, the subject simply sleeps through the evaluation. These aspects of the assessment would probably have a higher "acceptance" rate
among potential subjects, thus allowing a wider representation of females involved in sexual research.

Differential Diagnosis of Sexual Dysfunctions

Although physiological differences between low- and high-arousability females were neither expected nor observed in the present study, the possibility remains of finding VPA differences between other sample populations of females, particularly those exhibiting menstrual cycle irregularities (cf. Palti & Bercovici, 1967), or organic pathologies such as vascular disorders or neuropathies. As is the case with diabetic male populations, it could be expected that some of these women might experience psychological problems, complicating clinical diagnosis. The findings of the present study suggest that nocturnal assessment of VPA might be an effective aid in arriving at differential diagnoses, much in the same way that nocturnal evaluations of penile tumescence have been used in differentiating psychogenic from organogenic impotence in diabetic males.

The potential benefits of finding a reliable differential diagnostic procedure are many. As an example, because differential diagnosis of impotence is currently possible for diabetic males, surgical interventions can be appropriately used in cases of demonstrable organic pathology. Often, these males have experienced considerable anxiety, guilt, and marital disharmony centered upon their loss of sexual functioning. Information provided as a result of evaluation of
genital functioning is thus very valuable as it can reduce feelings of personal responsibility and concurrently offer hope of surgical treatment. On the other hand, if such evaluations show normal genital functioning, psychological treatment recommendations can be made more emphatically, the patient's personal and marital history can be explored in more detail, and chances of improvement exist without the risk of surgery. Should nocturnal evaluations of genital response in the female prove feasible, similar benefits could be anticipated for sexually dysfunctional women. Advancements in medical technology might even provide surgical interventions if the need for such developments could be reliably demonstrated.

Another area which could benefit from the paradigm of nocturnal assessment of VPA is that of drug interactions with sexual arousability. Some medications, most notably hypertensive drugs, are known to affect sexual arousability in males. The demonstration of diminished REM-sleep VPA levels in medicated females would strongly suggest similar drug-produced effects in females, without having to devise appropriate and acceptable waking erotic stimuli to assess genital response capability.

Conclusion

While the literature cited in this paper represents practically every research study in the past 20 years pertaining to physiological measures of sexual response in
the female, it is apparent that we are just beginning to explore the interactions between physiological response and cognitive perception. The findings of the present study, and those of other investigators, appear to offer a good foundation for continued research. Clearly, both waking and nocturnal evaluation of genital response and cognitive variables under various erotic and nonerotic conditions offer the researcher valuable procedures for increasing our knowledge about physiological and cognitive interactions. In the next 20 years, the integration of refined cognitive assessment strategies with state-of-the-art physiological recording methods can be expected to provide major new understandings in this field of endeavor, leading to more effective treatment strategies for sexual dysfunctions.
Appendix A

Sexual Arousability Inventory

The experiences in this inventory may or may not be sexually arousing to you. There are not right or wrong answers. Read each item carefully and then circle the number which indicates how sexually aroused you feel when you have the described experience, or how sexually aroused you think you would feel if you actually experienced it. All respondents remain anonymous.

The meaning of the numbers is given below:

-1 adversely affects arousal, unthinkable, repulsive, distracting.
0 doesn't affect sexual arousal.
1 possibly causes sexual arousal.
2 sometimes causes sexual arousal; slightly arousing.
3 usually causes sexual arousal; moderately arousing.
4 almost always sexually arousing; very arousing.
5 always causes sexual arousal; extremely arousing.

**ANSWER EVERY ITEM** HOW YOU FEEL OR THINK YOU WOULD FEEL IF YOU WERE ACTUALLY INVOLVED IN THIS EXPERIENCE.

1. When a loved one stimulates your genitals with mouth and tongue. -1 0 1 2 3 4 5
2. When a loved one fondles your breasts with his/her hands. -1 0 1 2 3 4 5
3. When you see a loved one nude. -1 0 1 2 3 4 5
4. When a loved one caresses you with his/her eyes. -1 0 1 2 3 4 5
5. When a loved one stimulates your genitals with his/her finger. -1 0 1 2 3 4 5
6. When you are touched or kissed on the inner thighs by a loved one. -1 0 1 2 3 4 5
7. When you caress a loved one's genitals with your fingers -1 0 1 2 3 4 5
8. When you read a pornographic or "dirty" story. -1 0 1 2 3 4 5
9. When a loved one undresses you. -1 0 1 2 3 4 5
10. When you dance with a loved one. -1 0 1 2 3 4 5
11. When you have intercourse with a loved one. -1 0 1 2 3 4 5
12. When a loved one touches or kisses your nipples. -1 0 1 2 3 4 5
13. When you caress a loved one (other than genitals). -1 0 1 2 3 4 5
14. When you see pornographic pictures or slides. -1 0 1 2 3 4 5
15. When you lie in bed with a loved one 1 0 1 2 3 4 5
16. When a loved one kisses you passionately -1 0 1 2 3 4 5
17. When you hear sounds of pleasure during sex. -1 0 1 2 3 4 5
18. When a loved one kisses you with exploring tongue. -1 0 1 2 3 4 5
19. When you read suggestive or pornographic poetry. -1 0 1 2 3 4 5
20. When you see a strip show. -1 0 1 2 3 4 5
21. When you stimulate your partner's genitals with your mouth and tongue. -1 0 1 2 3 4 5
22. When a loved one caresses you (other than genitals). -1 0 1 2 3 4 5
23. When you see a pornographic movie (stag film)  
   -1 0 1 2 3 4 5
24. When you undress a loved one  
   -1 0 1 2 3 4 5
25. When a loved one fondles your breasts with mouth and tongue.  
   -1 0 1 2 3 4 5
26. When you make love in a new or unusual place.  
   -1 0 1 2 3 4 5
27. When you masturbate.  
   -1 0 1 2 3 4 5
28. When your partner has an orgasm.  
   -1 0 1 2 3 4 5
Appendix B

Film and Fantasy Arousal Scales

The film (or fantasy) you just experienced:

-1 negatively affected sexual arousal (annoying, disgusting).
0 did not affect sexual arousal.
1 possibly caused sexual arousal.
2 was slightly arousing.
3 was generally arousing (moderately arousing).
4 was very arousing.
5 was extremely arousing.
Appendix C

Informed Consent Document

The experimental study in which you are being invited to participate is designed to yield both subjective and objective information regarding sexual arousal. The procedures to be employed are outlined below with brief explanations of their purpose. If necessary, additional information will be provided verbally.

1. You will need to have a physical examination, including a pelvic exam, by a physician, in order to determine the presence or absence of any condition which may affect your participation in the study. The exam might include blood tests. At the time of this examination, you will be asked to keep a record of your daily temperature for a period of one month in order to document your ovulatory cycle.

2. You will be asked to have a peripheral vascular examination in order to accurately determine current vascular functioning. This examination will take place at the Vascular Lab of the University Hospital and will consist of taking various blood pressure readings via pressure cuffs and ultrasound techniques before and after light exercise on a treadmill. Blood pressure readings from the legs, as well as the arms, will be recorded.

3. You may be asked to take a glucose tolerance test. This involves fasting overnight, drinking a carbonated glucose solution in the morning, and having your blood drawn at hourly intervals for 3 hours. Urine samples will also be obtained at this time. The entire procedure can be scheduled from 8:30 a.m. to about 12:30 p.m. at the University Hospital. The purpose of glucose tolerance testing is to medically document the absence of a major symptom of diabetes.

4. Information may be obtained from your medical records and/or personal interview. Such information aids us in the selection of subjects with similar characteristics. Any information obtained will be used responsibly and will be protected against release to unauthorized persons.

5. You will be asked to complete a standardized printed inventory containing questions as to the degree and frequency of sexual arousal (Sexual Arousability Inventory). Again, information obtained from this
inventory will be protected as noted above. Experimental data may be reported to physicians directly involved in the study. The findings of this study may be published, however such reports will not contain information that could identify you.

6. You will be expected to spend two consecutive nights at the Sleep and Dream Laboratory in the Behavioral Medicine Center at the Blue Ridge Hospital Complex. This will allow investigators to obtain physiological records about your sleep, physiological records of changes in vaginal blood supply and blood pressure during sleep, and subjective reports regarding dreams. Privacy will be strictly respected, with a female research assistant present at all times.

Recordings will be made of your brain waves (EEG), muscle tension (EMG), and eye movements (EOG) by attaching surface electrodes to scalp and facial areas. Vaginal blood volume, vaginal blood pressure, and vaginal muscle contraction pressure will be recorded with a plastic device (vaginal photoplethysmograph). The operation of this device will be fully explained and insertion of the device, which is very similar to the insertion of a tampon, will be performed by you in privacy. The device will remain in your vagina during sleep and will be removed in the morning by you in privacy.

7. In order to determine the extent of vascular arousal during the waking state, you will be asked to view a film which could be considered sexually arousing. This will briefly precede the sleep recording of the first night. The film will be viewed in privacy at the Sleep and Dream Laboratory after you have inserted the vaginal device and after the electrodes for EEG, EMG, and EOG have been attached. Just after viewing the film, you will be asked to rate the degree of your arousal on a 7-point written scale. Following a brief period of relaxation, you will be asked to privately fantasize a sexually arousing situation of your own choice for 10 minutes. No questions regarding the nature of this fantasy will be asked, but you will be asked to rate the degree of arousal on the same 7-point scale. Sleep monitoring procedures will then begin. After your last early morning dream period, you will be awakened and asked to report any dreams you might have had.

The physiological recordings obtained during the two nights will allow investigators to discover whether arousal responses are different during sleep from those that occur during wakefullness, and whether this sleep
response is more similar to responses produced by an external film or to an internal fantasy. This assessment could potentially influence treatment recommendations for sexually dysfunctional subjects, or may simply be of informative value to participants.

My signature below indicates that I have read and consent to the procedures outlined above. I understand that I may withdraw my consent by oral or written notice at any time and that this will in no way affect my future access to other experiments or treatment. I understand that the rare risk of vaginal irritation or infection may exist, although all equipment utilized in the study will be thoroughly sterilized by clinically accepted techniques. All physiological equipment has been examined for safety by the Biomedical Engineering Department and approved. I understand that in the event of any physical injury directly resulting from research procedures, financial compensation is not available, however medical treatment not covered by my insurance will be provided free of charge.

I have received an unsigned copy of this form.

______________________________  _______________________
Signature                        Witness

______________________________  _______________________
Member of Research Team          Date
Appendix D

Table 1

Age x Integrated Vaginal Pulse Amplitude Correlations for Waking and Sleeping Conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>r (Age)</th>
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<tbody>
<tr>
<td><strong>Waking</strong></td>
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<tr>
<td>Baseline #1</td>
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<tr>
<td>Film</td>
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<td>Baseline #2</td>
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<td>Fantasy</td>
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<tr>
<td><strong>Sleeping</strong></td>
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<tr>
<td>Stage 2</td>
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<tr>
<td>Stages 3 &amp; 4</td>
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</tr>
<tr>
<td>Stage REM</td>
<td>.06</td>
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Appendix E

Table 2
Integrated Vaginal Pulse Amplitude Correlations Between Initial Baseline and Other Experimental Conditions

<table>
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<td>Baseline #2</td>
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<td>Fantasy</td>
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<tr>
<td>Sleeping</td>
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<tr>
<td>Stage 2</td>
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<td>Stages 3 &amp; 4</td>
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<td>Stage REM</td>
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Appendix F

Table 3

Integrated Vaginal Pulse Amplitude Adjusted Cell Means for Waking Conditions

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<th>Group</th>
<th>Condition</th>
<th>Film</th>
<th>Baseline 2</th>
<th>Fantasy</th>
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</thead>
<tbody>
<tr>
<td>Low</td>
<td>Film</td>
<td>20.24</td>
<td>15.68</td>
<td>20.59</td>
</tr>
<tr>
<td>High</td>
<td>Film</td>
<td>20.93</td>
<td>18.35</td>
<td>22.01</td>
</tr>
</tbody>
</table>

a $n = 10$ for each group.

b VPP during the first waking baseline was used as a covariate for all conditions.
## Table 4

### Analysis of Covariance Summary Table for Waking Conditions

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<thead>
<tr>
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<th>MS</th>
<th>F</th>
<th>p</th>
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<td>Group</td>
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<td>.3642</td>
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<td>G x T</td>
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<td>Error within</td>
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\(^a\) All probabilities are two-tailed.
### Appendix H

#### Table 5

**Measures of Central Tendency for Integrated Vaginal Pulse Amplitude During Waking Conditions**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
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</thead>
<tbody>
<tr>
<td>Baseline 1</td>
<td>12.71</td>
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<td>7.97</td>
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<tr>
<td>Film</td>
<td>20.59</td>
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<tr>
<td>Baseline 2</td>
<td>17.02</td>
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</tr>
<tr>
<td>Fantasy</td>
<td>21.30</td>
<td>19.17</td>
<td>11.14</td>
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</table>

\(^a\) \(n = 20\) for each condition.
Appendix I

Table 6
Integrated Vaginal Pulse Amplitude Adjusted Cell Means for Sleeping Conditions

<table>
<thead>
<tr>
<th>Group</th>
<th>Stage 2</th>
<th>Stage 3 &amp; 4</th>
<th>Stage REM</th>
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</thead>
<tbody>
<tr>
<td>Low</td>
<td>14.178</td>
<td>13.520</td>
<td>18.395</td>
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<tr>
<td>High</td>
<td>14.893</td>
<td>13.507</td>
<td>17.886</td>
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</table>

a \( n = 10 \) for each group.
b VPP during the first waking baseline was used as a covariate for all conditions.
### Appendix J

#### Table 7

Analysis of Covariance Summary Table for Sleeping Conditions

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<tr>
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<th>df</th>
<th>MS</th>
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<th>p</th>
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<td>Group</td>
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<td>Error between</td>
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*a* All probabilities are two-tailed.
### Appendix K

#### Table 8

Measures of Central Tendency for Integrated Vaginal Pulse Amplitude During Sleeping Conditions (by Group)

<table>
<thead>
<tr>
<th>Group/Condition</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
</tr>
</thead>
<tbody>
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<td><strong>Low-Arousability</strong></td>
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<tr>
<td>Stage 2</td>
<td>14.65</td>
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<td>Stages 3 &amp; 4</td>
<td>13.99</td>
<td>12.31</td>
<td>7.02</td>
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<tr>
<td>Stage REM</td>
<td>18.87</td>
<td>18.02</td>
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<tr>
<td><strong>High-Arousability</strong></td>
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<tr>
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<td>13.83</td>
<td>5.06</td>
</tr>
<tr>
<td>Stages 3 &amp; 4</td>
<td>13.03</td>
<td>12.29</td>
<td>4.98</td>
</tr>
<tr>
<td>Stage REM</td>
<td>17.40</td>
<td>17.73</td>
<td>4.86</td>
</tr>
</tbody>
</table>
### Table 9

#### Analysis of Variance Summary Table for Sleeping Conditions

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Mean</td>
<td>1</td>
<td>14,223.132</td>
<td>161.21</td>
<td>.0000</td>
</tr>
<tr>
<td>Group</td>
<td>1</td>
<td>11.872</td>
<td>.13</td>
<td>.718</td>
</tr>
<tr>
<td>Error between Treatment</td>
<td>18</td>
<td>88.227</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G x T</td>
<td>2</td>
<td>118.165</td>
<td>26.28</td>
<td>.0000</td>
</tr>
<tr>
<td>Error within</td>
<td>36</td>
<td>4.497</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( a \)

All probabilities are two-tailed.
Appendix M

Table 10

Measures of Central Tendency for Integrated Vaginal Pulse Amplitude During Sleeping Conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean</th>
<th>Median</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage 2</td>
<td>14.54</td>
<td>13.52</td>
<td>4.99</td>
</tr>
<tr>
<td>Stages 3 &amp; 4</td>
<td>13.51</td>
<td>12.31</td>
<td>5.95</td>
</tr>
<tr>
<td>Stage REM</td>
<td>18.14</td>
<td>18.01</td>
<td>5.72</td>
</tr>
</tbody>
</table>

\( n = 20 \) for each condition.
Appendix N

Table 11

Integrated Vaginal Pulse Amplitude Adjusted Cell Means for Film and Fantasy Rating Scales

<table>
<thead>
<tr>
<th>Group</th>
<th>Film Scale</th>
<th>Fantasy Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>2.69</td>
<td>2.09</td>
</tr>
<tr>
<td>High</td>
<td>2.90</td>
<td>2.20</td>
</tr>
</tbody>
</table>

\( n = 10 \) for each group.
### Appendix 0

#### Table 12

Analysis of Covariance Summary Table for Film and Fantasy Rating Scales

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Mean</td>
<td>1</td>
<td>64.596</td>
<td>54.24</td>
<td>.0000*</td>
</tr>
<tr>
<td>Group</td>
<td>1</td>
<td>.227</td>
<td>.19</td>
<td>.6676</td>
</tr>
<tr>
<td>Covariate</td>
<td>1</td>
<td>.002</td>
<td>.00</td>
<td>.9607</td>
</tr>
<tr>
<td>Error between Treatment</td>
<td>17</td>
<td>1.191</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G x T</td>
<td>1</td>
<td>4.225</td>
<td>3.27</td>
<td>.0873</td>
</tr>
<tr>
<td>Error within</td>
<td>18</td>
<td>1.291</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .0001
Appendix P

Table 13

Correlations between Sexual Arousability Inventory and Laboratory Arousal Ratings

<table>
<thead>
<tr>
<th>Arousalability Group</th>
<th>Low</th>
<th>High</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAI by Film Rating</td>
<td>-.13</td>
<td>-.03</td>
<td>.01</td>
</tr>
<tr>
<td>SAI by Fantasy Rating</td>
<td>-.09</td>
<td>-.59</td>
<td>12</td>
</tr>
</tbody>
</table>

Note. None of the above correlations are significant.
Table 14
Sexual Arousability Inventory Subscore Correlations

<table>
<thead>
<tr>
<th>Variables</th>
<th>Low</th>
<th>High</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/PT by SAI</td>
<td>.80*</td>
<td>.91*</td>
<td>.98*</td>
</tr>
<tr>
<td>S/PVF by SAI</td>
<td>.31</td>
<td>.29</td>
<td>.75*</td>
</tr>
<tr>
<td>I/PT by S/PVF</td>
<td>-.32</td>
<td>-.14</td>
<td>.61*</td>
</tr>
</tbody>
</table>

a
I/PT = Interpersonal, predominantly tactile SAI subset.

b
S/PVF = Self-focused, predominantly visual or fantasied SAI subset.

*p<.001
Appendix R

Table 15

Sexual Arousability Subscore Correlations with Laboratory Arousal Ratings

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group Arousalibity</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
<td>Both</td>
<td></td>
</tr>
<tr>
<td>I/PT by Film Rating</td>
<td>.32</td>
<td>-.15</td>
<td>.07</td>
<td></td>
</tr>
<tr>
<td>S/PVF by Film Rating</td>
<td>-.73*</td>
<td>.28</td>
<td>-.20</td>
<td></td>
</tr>
<tr>
<td>I/PT by Fantasy Rating</td>
<td>-.26</td>
<td>-.74**</td>
<td>-.20</td>
<td></td>
</tr>
<tr>
<td>S/PVF by Fantasy Rating</td>
<td>.27</td>
<td>.30</td>
<td>.17</td>
<td></td>
</tr>
</tbody>
</table>

a I/PT = Interpersonal, predominantly tactile SAI subset.

b S/PVF = Self-focused, predominantly visual or fantasied SAI subset.

*p<.05

**p<.001
Appendix S

Table 16

Correlations among Sexual Arousability Inventory Measures, Laboratory Arousal Ratings, and Vaginal Pulse Amplitude Change Scores

<table>
<thead>
<tr>
<th>Variables</th>
<th>Arousalability Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>a SAI by VPA Film Change</td>
<td>-.32</td>
</tr>
<tr>
<td>SAI by VPA Fantasy Change</td>
<td>.41</td>
</tr>
<tr>
<td>b I/PT by VPA Film Change</td>
<td>-.24</td>
</tr>
<tr>
<td>I/PT by VPA Fantasy Change</td>
<td>.32</td>
</tr>
<tr>
<td>c S/PVF by VPA Film Change</td>
<td>-.13</td>
</tr>
<tr>
<td>S/PVF by VPA Fantasy Change</td>
<td>.15</td>
</tr>
<tr>
<td>Film Arousal Rating by VPA Film Change</td>
<td>.36</td>
</tr>
<tr>
<td>Fantasy Arousal Rating by VPA Fantasy Change</td>
<td>-.18</td>
</tr>
</tbody>
</table>

a SAI = Sexual Arousability Inventory (Total Scores).
b I/PT = Interpersonal, predominantly tactile SAI subset.
c S/PVF = Self-focused, predominantly visual or fantasied SAI subset.
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