The Influence of Menstrual Cycle Phase and the Presence of a Sexual Partner on Female Sexual Arousal and the Effects of the Phase on Breast Skin Temperature

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ABSTRACT

The Influence of Menstrual Cycle Phase and the Presence of a Sexual Partner on Female Sexual Arousal and the Effects of the Phase on Breast Skin Temperature

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Female sexual arousal and activity were studied as a function of cycle phase and the presence of a sexual partner. Normally cycling Celibate (N = 5) and Married (N = 5) women, and married oral contraceptive Pill (N = 5) users completed daily questionnaires at home. Levels of perceived sexual arousal and physical sensations in response to a modified version of the Sexual Arousability Inventory (SAI), frequency of sexual activity with a partner, masturbation, and orgasm were reported for one cycle. Breast skin temperature was measured daily in the laboratory for six No-Pill and four Pill women. Basal body temperature was used to estimate the day of ovulation and to establish the menstrual, postmenstrual, preovulatory, ovulatory, and luteal phases.

SAI scores and cycle day were not related, indicating that daily SAI administration did not produce systematic changes due to repeated testing. SAI appeared to measure a behavioral dimension independent of sexual activtiy since the two measures were not related. Since the sexual activity of the Pill Group was the only sexual measure to differ significantly across phases, it appeared that cycle phase had no effect on the sexual responding of normally cycling women. Since SAI scores did not differ among the groups, correlate with sexual activity, or show a postmenstrual increase, no effect was found for the presence of a partner.

Significant phase variations occurred at the breast sites of the No-Pill Group only, and not at the arm site for either group. Since temperatures from the chest control and breast skin correlated, estrogen effects on the breast could not be demonstrated.

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Introduction

The relationship between human female sexual behavior and the ovarian hormones circulating during the menstrual cycle has been studied since the early part of this century. It has been proposed that the gonadal hormones estrogen, androgen, and progestin are related to female sexual behavior in that changes in the circulating levels of these hormones are accompanied by changes in sexual responding (Cavanagh, 1969). In several mammalian species, a clear relationship between fluctuations in ovarian hormones and female sexual activity has been established (Gorski, 1980; Michael, 1980). In the human female however, a similar relationship has not been established conclusively (Bancroft, 1981; McCauley & Ehrhardt, 1976). The purpose of the present study was to re-examine the hormone-behavior relation in women and to clarify whether female sexual behavior fluctuates during the menstrual cycle in a pattern which corresponds to known hormonal variations.

A good animal model for studying the role of ovarian hormones in female sexual behavior is the rhesus monkey. The female of this species has a menstrual cycle which is identical in length and in hormone profile to that of the human. The rhesus female exhibits high rates of sexual responding during midcycle, around the time of ovulation, and exhibits low rates of responding in the latter part of the cycle, after ovulation. Studies with ovariectomized rhesus females have shown that these animals manifest the highest frequencies of desire for sexual activity when androgen and estrogen levels are high (Michael, 1980). Since blood levels of androgen in the form of testosterone and estrogen in the form of estradiol peak just before ovulation, the high rates of female sexual behavior at midcycle have been attributed to testosterone and estradiol. Furthermore, the decline in sexual behavior after ovulation has been attributed to progesterone, which dominates the latter half of the cycle. Clearer evidence about the role of hormones comes from studies in which ovariectomized female rhesus monkeys were given daily injections of estradiol and progesterone in doses that duplicated the plasma levels of a natural menstrual cycle. Under such conditions, the pattern of sexual activity was identical to that shown by an intact female. The pattern of sexual responding also remained the same when ovariectomized females were administered testosterone in addition to the two other hormones. Michael (1980) concluded from these studies that testosterone may not be essential for normal female sexual behavior but that estrogen is.

The findings from human studies, which have shown evidence linking both estrogen and testosterone to female sexual responding, are less conclusive than the findings from animal studies. Waxenberg, Drellich, and Sutherland (1959) studied self-reported levels of sexual desire in women who had undergone mastectomy and oophorectomy in previous years. Due to the greatly reduced levels of estrogen in these women, the researchers expected them to report a decrease in sexual desire since the operation. However, when interviewed, the women recalled no radical change in their sexual desires. Following adrenalectomy, which removed the remaining source of estrogen and androgen, a sudden absence of all sexual desire was reported. Waxenberg et al. concluded that androgen, not estrogen, played an important role in female libido.

Dennerstein, Graham, Wood, and Hyman (1980) studied the effects of estrogen and progesterone in women who had undergone total hysterectomy and bilateral oophorectomy. In their double-blind, placebo controlled, crossover study, the researchers found that when women were administered estrogen, they reported more sexual enjoyment, better vaginal lubrication, and more sexual desire and orgasms than when given progestin or a placebo. Coital rates, however, were not altered by drug type. Sherwin (1982) also found no difference in the frequency of sexual intercourse in a group of similarly operated women who were administered either exogenous androgen, estrogen, estrogen combined with androgen, or placebo. However, sexual desire decreased post-operatively as compared to pre-operative levels in all women except those receiving androgen or estrogen combined with androgen. Furthermore, after three months of treatment, only the group receiving estrogen and androgen did not show a significant decrease in sexual desire as compared to a control group of hysterectomized women with intact ovaries. Sherwin concluded that androgen plays a critical role in self-reported levels of sexual desire.

The preceding studies demonstrated that exogenous estrogen and androgen can prevent the loss of libido in women who can no longer produce these gonadal steroids. Other studies have examined the relationship between endogenous testosterone and levels of sexual responding in normal women. Persky, Charney, Lief, O'Brien, Miller, and strauss (1978) correlated the sexual behavior of women with the levels of their ovarian hormones. The researchers found no relationship between bi-weekly levels of estrogen, testosterone, and the frequency of intercourse. However, in another study, the midcycle levels of testosterone in women were found to be related to the couples' frequency of intercourse throughout the cycle: the higher the level of testosterone, the more sexual intercourse occurred

(Persky, Lief, Strauss, Miller, & O'Brien, 1978). Schreiner-Engel, Schiave, Smith, and White (1981) found a relationship between sexual arousal and testosterone. Women whose average level of testosterone for the entire menstrual cycle was low reported lower feelings of sexual arousal in response to an erotic stimulus than did women whose average level of testosterone was high. Furthermore, measures of vaginal vasocongestion indicated that low testosterone women were less physically aroused and did not stay aroused as long as high testosterone women. Both Persky, Lief, Strauss, Miller, and O'Brien (1978) and Schreiner-Engel et al. (1981) concluded that overall levels of testosterone during the menstrual cycle may influence female sexual responding.

The human studies discussed so far indicate that overall levels of androgen and estrogen affect sexual responding to some extent in both normally cycling and non-cycling women. Another set of studies was conducted which were aimed at a more detailed understanding of the relation between hormones and sexual behavior. Since it has been established that ovarian hormone levels rise and fall predictably during the menstrual cycle, the hypotheses of this other set of studies and that of the present one reflect the notion that cyclic changes in estrogen, androgen, and progestin could induce cyclical variations in women's sexual responding. Before describing the results of these experiments, however, a review of the neuroendocrinology of the menstrual cycle is necessary. In the following discussion special emphasis is placed on the gonadal hormones estrogen in the form of estradiol, androgens in the form of androstenedione and testosterone, and finally progestin as progesterone.

Hormone Profile of the Menstrual Cycle

The neuroendocrine mechanism controlling the menstrual cycle is a complex one. Secretions from the hypothalamus, pituitary, and the ovary interact to establish the cyclic pattern of gonadal hormonal changes which underly ovulation and menses. Positive and negative feedback systems exist between two ovarian hormones, estradiol and progesterone, Gonadotrophin Releasing Hormone (GnRH) from the hypothalamus, and the pituitary gonadotrophins, Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH). The amount of these secretions fluctuates predictably across the cycle so that the typical cycle, median length of 28 days (Yen, 1980), is commonly divided into the following phases: menstrual, postmenstrual or early follicular, preovulatory or late follicular, ovulatory, luteal, and premenstrual phases each characterized by a particular hormone profile (Figure 1).

The beginning of the cycle, known as the menstrual phase, is characterized by low levels of estradiol, progesterone, androgens, and LH. At this time, a rise in FSH stimulates the ovarian follicles to mature and produce increasing levels of estradiol (Speroff, Glass, & Kase, 1973). This estradiol has an inhibitory feedback effect on the secretion of FSH from the pituitary so that with increasing amounts of estradiol FSH gradually decreases.

The next part of the cycle is called the follicular phase because it is at this time that one particular follicle in the ovary matures in preparation for ovulation. During the early follicular or postmenstrual phase FSH, LH, and progesterone remain at low levels, while estradiol and the androgens increase slowly. The

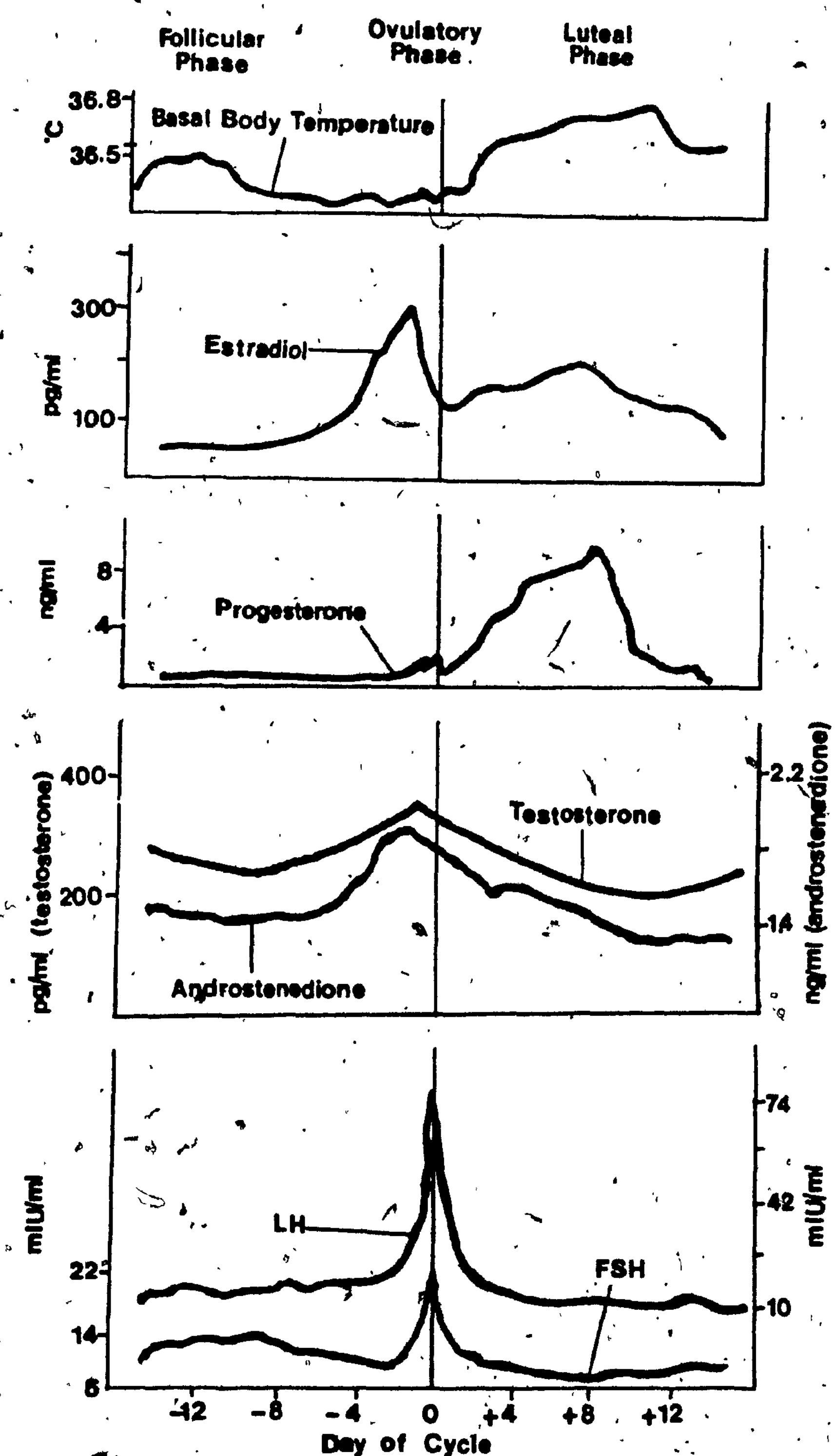

Figure 1. Basal body temperature and plasma levels of the gonadotropins (LH and FSH), and the ovarian steroids (androstenedione, testosterone, progesterone, and estradiol) during the menstrual cycle. Day 0 represents the day ovulation occurs.

latter two hormones increase dramatically during the late part of the follicular phase, known as the preovulatory phase.

The ovulatory phase is considered to be the time when significant endocrine fluctuations occur which result in the expulsion of the mature oocyte from the ovary. Estradiol continues to rise until it reaches and maintains a critically high level for approximately two days (Ferin, Halberg, Richart, & Vande Wiele, 1974). This estradiol peak has a positive feedback effect on the hypothalamus so that approximately 24 hours later a massive release of GnRH from the hypothalamus stimulates the pituitary to release a surge of LH (Moghessi, Snyder, & Evans, 1972). The LH surge stimulates the maturing follicle and ovulation occurs 10 ± 5 hours later (Garcia, Jones, & Wright, 1981). Parallel to the increase in estradiol during the ovulatory phase, androgens also increase until they reach their highest level simultaneously with the estradiol peak. However, the androgens play no role in the feedback system which produces the LH surge. Androgens gradually decline from the peak until the end of the cycle, while estrogen drops dramatically just before the LH surge and increases again after ovulation.

Following the release of the oocyte from the ovary, dramatic hormone fluctuations occur. This part of the cycle is known as the luteal phase. A corpus luteum is formed in the ovary within 38 hours of the LH surge (Siebel, Smith, Levesque, Borten, & Taymor, 1982), and begins to secrete progesterone at increasing levels so that a definite rise in progesterone can be seen 24 hours after ovulation (Garcia et al., 1981). The level of progesterone continues to rise until approximately eight days after the LH surge (Moghessi et al., 1972) when it reaches a peak followed by a slow decline. A simultaneous rise and fall in estrogen occurs during the luteal phase, but the levels are lower than those reached immediately before ovulation. The high levels of progesterone and estrogen during the luteal phase have negative feedback effects on LH and FSH, which fall to their lowest levels and remain low during the rest of the cycle.

Levels of the ovarian hormones and the pituitary gonadotrophins are at their lowest during the final two to four days of the cycle, commonly called the premenstrual phase.

The cyclic hormonal pattern found in normally cycling women does not occur if contraceptive pills are taken (Briggs & Briggs, 1981). The doses of synthetic estrogen and progesterone in the pills vary somewhat, but are usually high enough to prevent an LH surge (Speroff et al., 1973). The hormone profile of oral contraceptive users is marked by a relatively high level of estrogen and progesterone maintained for the 21 days that pills are taken (Cohen & Katz, 1979). These stable hormone levels are followed by a sudden drop when the pills are discontinued, followed by bleeding two or three days later (McCauley & Ehrhardt, 1976).

<u>Cyclic Fluctuations in Hormones and Sexual Behavior</u>

As discussed earlier, research conducted with non-human primates, with ovariectomized women, and with women who had intact ovaries indicated that ovarian hormones had an influence on female sexual behavior. Evidence linked estrogen and androgen to an increase in sexual responding, and progestin to a decrease. Since estrogen and androgen peak just before ovulation, it has been hypothesized that increased sexual activity would most likely occur at this time (Udry & Morris, 1968). Similarly, since progesterone has been linked to decreased responding, it has been hypothesized that sexual activity would decline during the luteal phase when progesterone levels are high. These hypotheses have been tested in numerous studies in which the sexual behaviors of a group of normally cycling women were compared to those of a control group consisting of women taking oral contraceptives (Morris & Udry, 1971; Udry & Morris, 1970). Researchers predicted that any changes in sexual behaviors related to fluctuating hormone levels would be absent in cycles regulated by the high doses of estrogen and progesterone found in oral contraceptives.

The results of these numerous studies have varied enormously and, in general, have conflicted with one another. Some studies found the expected changes in responding in normally cycling women and stable, unfluctuating rates in oral contraceptive users. But the results of many other studies were not able to corroborate these findings. Schreiner-Engel et al. (1981) conducted a review of the literature and identified 32 studies which had found at least one increase in sexual behavior during the cycle, four during menstruation, 18 after menstruation, eight during ovulation, and 17 at premenses.

The major problem in trying to compare the results of the above studies is that different methods were used to determine the phases of the cycle. The only valid way to determine cycle phases is to monitor the hormone changes which underly them. To do this, hormone levels must be measured daily (Udry & Morris, 1977). A recent surge of interest in detecting ovulation in women experiencing fertility problems has produced improved assay methods. There are several methods used to assay hormones, including radioimmunoassay, competitive protein binding, and gas chromatography (Moghessi et al., 1972). However, these methods are very expensive and cumbersome because blood or urine samples must be taken daily in the laboratory by trained technicians. For these reasons, no study to date has used daily measurement of hormones to determine cycle phases.

Instead, most researchers use peripheral indexes, such as the beginning and end of menstrual bleeding, to divide the cycle into phases. The most crucial event of the cycle to be determined is ovulation, because knowing when this occurs makes it possible to divide the remainder of the cycle into the follicular and luteal phases. However, since daily assays are not feasible for menstrual cycle research, less reliable methods have been used to determine the time of ovulation. The three most commonly used but least valid methods are the reverse-cycle method of counting days back from the beginning of the next cycle to an estimated time of ovulation, predicting midcycle from self-reported, retrospective data from previous cycles, and standardizing cycles of different lengths into one standard length. Less commonly used but more valid and cumbersome methods are the recording of daily basal body temperature and cervical mucus.

The merits and shortcomings of each method of determining ovulation and the studies which used these methods are discussed in the following pages.

Reverse-Cycle Method

A large group of researchers rely on a standard length of the luteal phase to determine the time of ovulation. This procedure, known as the reverse-cycle method, typically involves testing a subject during an entire cycle and retroactively determining when ovulation occurred by counting back 14 days from the beginning of the menses of the next cycle. Previous researchers have shown that the best estimate of ovulation is the 14th day before menses (Moghessi, 1980; Speroff et al., 1973) and that this method is correct approximately 70 percent of the time (Rose, 1978). However, it has been found that the luteal phase can vary in length, especially in short or long cycles (McIntosh, Matthews, Crocker, Broom, & Cox, 1980) and in women using an intrauterine birth control device (Faundes, Segal, Adejuwon, Brache, Lion, & Alvarez-Sanches, 1980). Therefore, it is not valid to assume that ovulation occurs on reverse-cycle day 14 regardless of the length of the cycle.

Using the above method, Adams, Gold, and Burt (1978) found a pronounced midcycle peak of autosexual (masturbation) and female-initiated heterosexual activity in normally cycling married women but not in subjects taking oral contraceptives. Critics of the study suggest that the ovulatory peak described by Adams et al. was not a true peak. High levels of sexual activity which occurred on other days were not tested for significance (Persky, O'Brien, Lief, Strauss, & Miller, 1979; Tessman, 1979). Furthermore, some subjects may have had luteal phases longer or shorter than the standard 14 days which would mean that phase determination was incorrect (Kolodny & Bauman, 1979).

Englander-Golden, Chang, Whitmore, and Dienstbier (1980) also used the reverse-cycle method of estimating ovulation in a study where women described daily moods labeled sexy, lustful, passionate, and affectionate. They found that normally cycling women reported higher sexually aroused moods around ovulation, during postmenses, and late menstruation and lower moods during the luteal phase. Although contraceptive pill subjects reported higher overall levels of sexual arousal during the cycle than women not on the pill they did not show any of the fluctuations associated with normally cycling women. Udry and Morris (1968) obtained similar results using the reverse-cycle method. They found a peak in sexual activity and orgasm at ovulation, followed by a decline in activity during the luteal phase, and a second, smaller rise at premenstruum.

It is interesting to note that in all of the reverse-cycle studies, an ovulatory phase increase in sexual responding was found. However, since a luteal phase length of 14 days cannot be reliably predicted, there is some doubt that all of the subjects ovulated on reverse day 14. It is also impossible to assume that all of the cycles were ovulatory, since there were no physiological measures taken that could confirm ovulation.

Retrospective Method

Some researchers have judged midcycle to be the best estimation of the time of ovulation regardless of the length of the cycle. Subjects in this type of study are asked to recall the lengths of their most recent cycles, and based on this information the time of ovulation for the next cycle is predicted. Then cycle phases are assigned accordingly. However, this method of determining ovulation is not valid because of two incorrect assumptions: that information reported from previous cycles by the subjects is correct, and that ovulation always occurs at midcycle. Self-recalled menstrual cycle information has been found to be unreliable when compared to recorded data covering the same period of time. McCance, Luff, and Widdowson (1937) found that women were incorrect in estimating the length of their cycles and could not accurately describe how regularly their cycles occurred. Furthermore, the length of women's cycles varies a few days (one to five) from one cycle to the next

(Presser, 1974). Therefore, retrospective data is not considered a valid method of determining the day of ovulation.

The notion of a midcycle ovulatory phase evolved from findings which showed the average length of the luteal phase to be 14 days. In the typical length cycle of 28 days, this would mean that ovulation occurred at midcycle. However, as it has already been pointed out, the length of the luteal phase may vary considerably, so it is not valid to assume that ovulation occurs at midcycle.

Using the retrospective method, Davis (1929) found that women reported pre- and postmenstrual phase increases in sexual desire. Stopes (1931) found a rise postmenstrually and at midcycle. Hart (1960) asked normally cycling women at what point during the cycle they experienced maximum libido. She found that 59 percent of the women associated maximum libido with menstruation and that only six percent reported maximum libido at midcycle.

Other studies relied on self-reported, retrospective data to determine what cycle phase women were in during a single test session. Luschen and Pierce (1972) found that ovulating women rated sexual arousal in response to erotic pictures as more intense than did women in their premenstrual phase. Abramson, Repczynski, and Merrill (1976) found that normally cycling women showed no peak of sexual arousal in response to reading an erotic story regardless of cycle phase, and that women taking oral contraceptives were most aroused if tested during the menstrual phase.

Studies which used the midcycle method of determining ovulation have much more conflicting results than the group of studies described which used the reverse-cycle method. This is probably because phase determinations were frequently incorrect. Even in cycles of

28 days, it is impossible to predict that ovulation will occur at exactly midcycle, and as the length of the cycle changes, the chances that ovulation will take place at midcycle decrease accordingly.

Cycle Standardization Method

A third procedure for determining the time of ovulation is the cycle standardization method. This involves rearranging information from cycles varying in length from 23 to 45 days so that the data fit into a standard length cycle, usually of 28 days. For example, Udry and Morris (1970) standardized cycles of different length using percentiles so that day three of a 30-day cycle would be at the 10th percentile. Normally cycling women showed midcycle increases in sexual behavior followed by luteal phase decreases, while contraceptive pill users showed no fluctuation. These results are questionable, however, because the standardizing of the cycles increases the length of the luteal phase in long cycles so that the luteal phase in a 36-day cycle standardized to 28 days would reach the highly improbable length of 20 days (Presser, 1974; Spitz, Gold, & Adams, 1975).

MacGriffith and Walker (1975) found that the self-reported sexual arousal of women who were presented erotic slides did not differ during the various phases. However, since MacGriffith and Walker used retrospective reports to determine phases and standardized the group data into one cycle length, it is difficult to assess the significance of their findings.

Spitz et al. (1975) used a different method of standardizing cycles of various lengths. This method was based on a study of estimating ovulation by using conception dates (James, 1972). They found that intercourse rates were highest at postmenses for both normally cycling women and contraceptive pill users. However, once again, the standardization method moved the most likely day of ovulation into the follicular phase, making the luteal phase too long. Therefore, it is hard to determine if any changes in sexual behavior could have taken place during other phases, especially the ovulatory phase.

In a final study which used the cycle standardization method, Moos et al. (1969) found a midcycle peak of sexual arousal in normally cycling women. However, since the cycle was standardized and large gaps in the data existed during the follicular phase, the results of the study cannot be considered conclusive.

Although the three methods of determining ovulation and of establishing the phases of the cycle are the ones most frequently used, it is clear from the results of the above described studies that none of them are totally reliable. The only reliable method of determining if and when ovulation has taken place is to monitor the endocrine changes. However, some researchers compromise the problem of identifying the ovulatory phase without taking daily hormone measurements or relying on one of the three methods of estimating ovulation. They rely on changes in body functions which reflect fluctuations in gonadal hormones. These changes, which provide an index of known menstrual events, are used widely in fertility clinics, but seldom in sexuality research. Two that have been used in studies of female sexual responding are basal body temperature and vaginal mucus.

Basal Body Temperature

Basal body temperature is determined by taking the oral, rectal, or vaginal temperature every morning immediately upon awakening, before getting out of bed or doing any physical activity. An uninterrupted sleep of six to eight hours is considered vital for an accurate basal body temperature reading, as is good general health with no fever present (Moghessi, 1980). In ovulatory cycles, a biphasic pattern is usually seen where temperatures are higher in the second half of the cycle, after ovulation has taken place, then in the first half (see Figure 1). Temperatures remain low during the menstrual and follicular phases of the cycle, and may dip to a thermal nadir on or close to the day of the LH peak (Garcia et al., 1981; Morris, Underwood, & Easterling, 1976). A rise in temperature is seen immediately after ovulation which continues until a peak is reached during the midluteal phase. This temperature rise has been shown to be related to increasing levels of progesterone which characterize the luteal phase (Davis & Fugo, 1948). A gradual decline in temperature to preovulatory levels occurs during the premenstrual phase.

Although the basal body temperature method is considered to be a simple and practical method of birth control, it does present some drawbacks to the researcher using it as a menstrual cycle index of ovulation. Bauman (1981) reported that 12 to 20 percent of ovulatory cycles did not show a biphasic temperature curve. These cycles resemble those of anovulatory cycles with a monophasic pattern. He also found that a team of experienced physicians could correctly determine the day of ovulation on only 22 percent of biphasic basal body temperature charts. This finding may be related to problems encountered in reading the basal body temperature charts. Marshall (1963) has identified three distinct patterns which describe the rise in basal body temperature after ovulation has taken place.

Some profiles shift from low to high with an acute rise in temperature occurring over one or two days. Some profiles show a slow, gradual rise over several days, while others present step-like increases over several days. Due to these different patterns, it is difficult for the researcher to apply one criterion for a luteal phase temperature increase. A standard definition of the biphasic rise defined by the World Health Organization requires that three consecutive daily temperatures be at least 0.2°C higher than they were on the preceding six days. Strict adherence to this criteria would make it almost impossible to identify the correct day of ovulation on temperature profiles with slow or step-wise increases over several days.

Markowitz and Brender (1976) used basal body temperature to determine if and when ovulation occurred in a sample of normally cycling women. They collected data on sexual behavior daily, and found that peak periods of sexual activity, thoughts, fantasies, and orgasms occurred postmenstrually and at midcycle for the first of five consecutive cycles studied. They also found that 10 subjects out of the 24 were considered to be anovulatory by a pair of gynecologists who screened the temperature charts. This finding suggests that other studies which did not use menstrual cycle indexes of ovulation probably included anovulatory women in their normally cycling group. This is important since the hormone fluctuations accompanying ovulation do not take place in anovulatory cycles. The preovulatory peak in estrogen, followed by the LH surge, and the progesterone peak during the luteal phase do not occur in anovulatory cycles. The practice of including anovulatory cycles in research data may have masked a true cyclic change in sexual activity that only occurred in ovulatory cycles.

Hoon, Bruce, and Kinchloe (1982) used basal body temperature charts from previous months to determine the mid-point of five cycle phases. On one day of each phase, normally cycling women were presented an erotic tape or asked to fantasize while physiological genital measures of sexual arousal were taken. The physiological devices, which were designed to measure increased genital vasocongestion resulting from sexual stimulation, are considered to be objective as compared with subjective self-reports of sexual arousal. A vaginal plethysmograph was used which records changes in pooled blood volume and pulse amplitude in the vaginal wall (Geer, Morokoff, & Greenwood, 1974; Sintchak & Geer, 1975). Hoon and associates also used a surface thermistor attached to the labia minora which recorded temperature changes (Henson, Rubin, & Henson, 1978; Henson, Rubin, Henson, & Williams, 1977). Hoon et al. (1982) found no effect for cycle phase, although sexual arousal in response to the erotic stimuli was reliably demonstrated.

Cervical Mucus

Cervical mucus changes in response to increased levels of estrogen in the follicular phase and to increased progesterone in the luteal phase. In the early follicular phase the mucus is scant, thick, and white. As estrogen reaches high levels about six days before ovulation, the mucus becomes thin, watery, transparent, and abundant, and is characterized as having rheological properties including elasticity, spinnbarkeit, and crystallizability (Moghessi, 1980). These characteristics disappear after ovulation when, under the influence of progesterone, the mucus becomes viscous, tacky, white, and scarce.

Daily observation of cervical mucus has been found to be an easily taught and fairly reliable method of birth control (Klein, 1982; World Health Organization, 1981a, 1981b). Women who use the mucus method of birth control are taught to examine mucus for color, quantity, viscosity, and for sensations of wetness so that they will abstain from sexual intercourse during the high estrogen phase. When progestenic mucus appears, abstinence is no longer required.

To date, only one study has used the cervical mucus method of determining ovulation. In Benedek and Rubenstein's (1939a, 1939b) classic study of the sexual interests of a group of neurotic female patients, the ovulatory phase was determined by basal body temperatures and vaginal mucus smears. These physical indexes were examined independently and separately from the texts of psychoanalytic sessions which were examined for erotic content. Benedek and Rubenstein concluded that active heterosexual striving increased when estrogen increased, as determined by the vaginal smears, and decreased when progesterone rose during the luteal phase, as indicated by the upward basal body temperature shifts.

Breast Skin Temperature

Recent endocrine research has revealed that breast skin temperature could be another menstrual cycle index. Research in the area of breast skin temperature began when it was noticed that cancerous breast tissues have higher temperatures than healthy breast tissues. Infrared thermography, which can detect unusually warm skin areas, was the first method employed in detecting breast pathologies. Researchers wondered if hormonal changes during the menstrual cycle could affect thermography results. Preliminary findings were conflicting, as some studies found temperature changes across the menstrual cycle and others did not (Draper & Jones, 1969; Isard & Shilo, 1968; Parry, Freundlich, & Wallace, 1973; Suda & Hirai, 1973). Most of the infrared thermography studies found an increase in breast skin temperature after ovulation, which paralleled basal body temperature rises in response to rising progesterone levels. However, more recent research has been conducted using temperature probes which are taped to the skin on the breast. A breast skin temperature pattern which parallels changes in estrogen levels has been reported.

Nassar and Smith (1975) reported that eight out of ten ovulating subjects showed breast skin temperature peaks one or two days before ovulation, followed by a temperature drop. Breast skin temperature rose again after ovulation simultaneously with basal body temperature. These results were confirmed by a later study in which five out of ten subjects had preovulatory breast skin temperature peaks, three had an elevation, and two showed a peak in one breast only (May & Smith, 1977). Further evidence to support the notion of an estrogen effect on breast skin temperature was shown in a study of sheep where the temperature of the udders was found to increase immediately after the animals were injected with estrogen (Smith, Ingram, & Heath, 1977). Smith, May, and Nassar (1979) concluded that breast skin temperature fluctuated in response to changes in levels of estrogen.

One other study found a midcycle rise in breast skin temperature in one woman whose temperature was measured continuously for one menstrual cycle (Wilson et al., 1979). Wilson and associates concluded that the rise in breast skin temperature could be used as a menstrual cycle index to predict forthcoming ovulation. Although basal body temperature has been used to detect the time of ovulation in fertility clinics for many years, the breast skin temperature method could be superior because it could predict ovulation, unlike basal body temperature which can only describe it retrospectively.

One of the principal goals of the present study was to collect breast skin temperature data from normally cycling women and oral contraceptive users and verify the pattern reported by others. Although the data was not intended for use as a menstrual cycle index in this study, it was analyzed for patterns found in previous research.

Plasma Levels of Gonadal Hormones

Although the menstrual cycle indexes previously described are considered reliable indicators of ovulation, they are rarely used in sexuality research. This is because the techniques are time consuming to teach to subjects and the procedure requires that data be gathered from a complete cycle. Since many researchers prefer to test their subjects once during each phase or once during an entire cycle, collecting data on menstrual cycle indexes wouldn't fit within their designs. However, some contemporary studies have overcome these obstacles by attempting to identify cycle phase by examining plasma levels of gonadal hormones several times during the cycle.

Schreiner-Engel et al. (1981) measured plasma levels of ovarian hormones once during the early follicular, ovulatory, and midluteal phases. Sexual arousal was assessed by self-report and photoplethysmographic recordings of vaginal vasocongestion in response to a sexual fantasy and an erotic tape recording. There was no phase effect for self-reports of sexual arousal, but the mean level of physiological arousal in the ovulatory phase was lower than during the follicular and luteal phases. Although the mean hormonal concentrations for 28 of the 30 subjects seemed to parallel changes indicative of ovulation, it is not possible to determine from one single blood sample that each subject was at the same stage in the cycle when tested. Some further evidence of ovulation, such as basal body temperature or daily blood samples during midcycle, would have provided firmer evidence that the women were tested at corresponding times.

Persky, Charney, Lief, O'Brien, Miller, and Strauss (1978) collected sexual activity information daily and measured plasma levels of gonadal hormones twice weekly for three consecutive menstrual cycles. Ovulation was determined from basal body temperature charts. Persky and associates found no relationship between cycle phase and the frequency of sexual intercourse.

The two studies which measured plasma levels of ovarian hormones found no increase in sexual responding during the ovulatory phase, which may indicate that sexual behavior is not influenced by estrogen or androgen. However, this notion cannot be confirmed without further studies of sexual activity which include plasma hormone determinations taken frequently during the cycle, especially during the preovulatory and ovulatory phases.

Influence of the Partner on Sexual Responding

Several of the studies reviewed in the previous discussion found increases in sexual responding in the pre- and postmenstrual phases (Davis, 1929; Englander-Golden et al., 1980; Markowitz & Brender, 1976; Spitz et al., 1975; Stopes, 1931; Udry & Morris, 1968). The influence of hormones is not considered to be a factor in these findings since estrogen and androgen are at low levels during these phases. Instead, the influence of the presence of a partner has been suggested as a likely factor. Some researchers have hypothesized that male sexual responses have more influence on patterns of sexual behavior during the cycle than do female desires (James, 1971). Since most researchers consider intercourse the key sexual activity, it is obvious that partner influence could confound the results.

Sexual intercourse during menstruation is generally considered taboo in this culture (James, 1971). For this reason, many researchers believe that the pre- and postmenstrual increases in sexual activity are related to sexual abstinence during menses. It is believed that peaks at premenses occur in anticipation of a period of abstinence, and postmenses increases are due to a rebound effect resulting from sexual abstinence during the bleeding period.

McCollough (1973) compared women who abstained from sexual intercourse during menses to those who did not. Her finding that abstainers experienced higher peaks of sexual desire and activity after menses than did the non-abstainers support the notion that postmenstrual peaks could be related to abstinence from sexual intercourse during menses.

Gold and Adams (1981) also found a relation between the degree of abstinence during menses and the frequency of intercourse. They compared female sexual activity during the pre- and postmenstrual phases with activity during the days immediately preceding and following a brief separation from the male partner. They found increases in intercourse rates during both phases in both conditions. They also found an increase in masturbation during menstruation and during the absence of the partner. Gold and Adams concluded that although the evidence was not statistically strong enough to support an expectancy effect for the premenstrual phase increase, they could interpret postmenstrual increases as a rebound effect resulting from sexual abstinence during menses.

The results of the McCollough (1973) and Gold and Adams (1981) studies provide support for the abstinence theory in postmenstrual increases in sexual activity. In doing so they support the notion that the presence of a partner affects the patterns of female sexual behavior. Other researchers have investigated this notion by separating heterosexual activity into a male- and a female-initiated category. In order to study patterns of female responding independent of the influence of a partner, female-initiated sexual behavior and autosexual activity including masturbation and sexual fantasies were examined.

Spitz et al. (1975) found so few female-initiated intercourse experiences in a group of married women that no meaningful changes in the frequency of that behavior could be detected during the cycle. Adams et al. (1978) found that normally cycling married women exhibited a peak in female-initiated heterosexual and autosexual behavior at ovulation. They suggested that previous studies did not find ovulatory peaks because only those sexual activities which included the influence of the male partner were studied.

A more controlled way to study female sexual responding without the influence of a partner is to examine daily levels of sexual desire in celibate women. These women would not be influenced by the presence of a sexual partner. Cavanagh (1969) analyzed descriptions of sexual feelings and dreams in celibate women undergoing psychotherapy. He found that the frequency of reports of sexual desire was high during the first half of the cycle, peaked on day 13, and dropped for the remainder of the cycle. This finding is interesting because the pattern of responding paralleled the rise of estrogen in the first half of the cycle, and was depressed during the second half when the level of progesterone peaks. However, it is impossible to conclude that all of the subjects were in the ovulatory phase on day 13. Therefore, it is not valid to draw any firm conclusions from Cavanagh's results.

Rationale and Predictions for the Present Study

It is clear from the preceding discussion of the research conducted to date that consistent patterns of female sexual responding during the menstrual cycle cannot be demonstrated reliably. Although some studies have found fluctuations in responding which appeared to parallel changes in estrogen, testosterone, and progestin, none produced conclusive evidence of a hormone effect. Nevertheless, researchers continue their studies in this area. The fact that a clear relation between hormones and behavior exists in non-human primates suggests that a similar relation also exists for women. Other sexual activity studies have found increases in sexual activity which have been linked to the presence of a sexual partner. Specifically, postmenstrual peaks in activity are thought to occur because most couples abstain from intercourse during menses. Since most of the previous studies used unreliable methods to identify ovulation, however, firm conclusions about the effects of cycle phase and the presence of a sexual partner on female responding cannot be made.

The purposes of the present study were to re-examine fluctuations in female sexual responding as a function of menstrual cycle phase and the presence of a sexual partner, and to study breast skin temperature changes as they relate to the phases of the cycle. The study differed from earlier research because the methodology used was superior when compared to the methods used in other studies. One important methodological feature was to collect basal body temperature data and vaginal mucus changes, which are two of the most reliable menstrual cycle indexes of ovulation. These measures provided the information necessary to determine the closest possible estimate of the day of ovulation, and based on this day, to partition the cycle into phases. This method made it possible to avoid arbitrarily selecting one day as being ovulatory and to avoid mistakenly including data from anovulatory cycles. Since it has been suggested that breast skin temperature could also be used as a cycle index of ovulation, it was included here in order to investigate the reliability of the pattern of temperature changes reported in earlier research. A second methodological feature concerned the measurement of sexual arousal. The subjects were presented with a sexually stimulating stimulus daily in order to elicit a sexual arousal response which was independent of sexual activity with a partner. This differed from earlier studies in which women were asked to rate their daily levels of arousal which have been shown to be influenced by participation in sexual activity with a partner occurring that day. Furthermore, the women were not only asked to self-report perceived levels of sexual arousal in response to the stimulus, but also to record physical sensations of arousal. The final methodological difference concerned the various sexual activity measures. In addition to recording rates of sexual activity with a partner, women were also asked to report frequencies of masturbation and orgasm occurring daily.

In order to examine the effects of cycle phase and the presence of a sexual partner on female sexual arousal, three groups of women were studied. The first group consisted of normally cycling women who had sexual partners. In order to control for the effects of cycle phase, a group of women who were using oral contraceptives which stabilize hormone levels and prevent ovulation was studied. This group also had sexual partners. In order to control for the effects of the presence of a sexual partner, another group of normally cycling women who did not have sexual partners was also included in the study. Based on the expectation that both cycle phase and the presence of a partner influence sexual arousal, the following predictions were made.

Normally cycling women without partners were expected to show significantly high levels of sexual arousal during the ovulatory phase when levels of estrogen and testosterone are at their highest. Women who took oral contraceptives and who had a sexual partner were not expected to show a hormone effect. However, they were expected to be influenced by an increase in participation in sexual activity occurring postmenstrually, and thus would report significantly increased sexual arousal during that phase. Normally cycling women with partners were expected to be influenced by both hormone levels and participation in sexual activity. Therefore, they were expected to show both a postmenstrual and an ovulatory rise in sexual arousal.

A more general prediction is that the two groups of women who had partners would show a significantly higher overall level of sexual arousal than the group of women without partners. The women with partners would be influenced by participation in sexual activity occurring across the entire cycle and, therefore, would report high levels of sexual arousal more often than women without sexual partners.

In order to verify that sexual arousal in women who had partners was influenced by participation in sexual activity, the patterns of sexual activity also were examined. The predictions were based on findings by previous researchers. Women without partners were expected to show significantly high frequencies of masturbation and orgasm during the ovulatory phase. Women who took oral contraceptives were expected to show a postmenstrual peak in sexual activity with a partner and orgasm, and no peak in the frequency of masturbation. Normally cycling women with partners were expected to show a postmenstrual peak in sexual activity with a partner and orgasm, followed by a second peak in both measures during the ovulatory phase. The highest levels of masturbation were expected to occur during the ovulatory phase for this group.

It was predicted that normally cycling women with partners and oral contraceptive users with partners would not differ in the frequency of sexual activity with a partner. Since women without partners participated in masturbation only, it was predicted that these women would show a significantly higher overall frequency of masturbation than the other two groups. No overall difference in frequency of orgasm was expected among the three groups.

In order to examine fluctuations in breast skin temperature as they relate to phases of the cycle, two groups of women were studied: normally cycling women and women who used oral contraceptives. Normally cycling women were expected to show a preovulatory rise in breast skin temperature, followed by a drop in temperature during the ovulatory phase. Oral contraceptive users were expected to show a relatively stable level of breast skin temperature with no pronounced peaks. Control site temperatures of the two groups were not expected to fluctuate significantly during the cycle.

Method

Subjects

Twenty-one women, aged 20-37 years, participated in the study. Relevant demographic characteristics of these subjects are presented in Table 1.

Women were recruited to participate in a study of female physiology and sexuality through notices placed on bulletin boards located on the campuses of English language universities and in English language local and campus newspapers. Applicants were interviewed by telephone to determine their suitability for participation. Acceptable applicants had to be in good health and not taking any medication. They were admitted into the study if they had regularly occurring menstrual cycles of 24-32 days length and if their menses were not longer than five days as determined by past records. If applicants were using oral contraceptives, they had to be taking combined estrogen and progestin birth control pills for at least three months prior to the beginning of the study and had to continue while participating. Eligible women were expected to be free of gynecological problems and to have no history of breast disorders. It was required that the participants be either married or cohabiting with their sexual partner, or be celibate, that is have no sexual partner. Women were admitted into the study only if they had lived under these conditions for at least three months at the time of the recruitment and they expected to continue in this status for the duration of the study. Women who had a sexual partner but did not live with him were not admitted into the study. Other women were excluded from participation if they were pregnant, breast feeding, or abstaining from sexual intercourse for several days during the

Table 1

Demographic Characteristics of the 21 Subjects.

Demographic Variables	Groups		
	Celibate[a]	Married[b]	Pill[c]
Age: mean	24 yr.	26 yr.	26 yr.
range	20-27 yr.	21-37 yr.	22-30 yr.
Occupation	6 students 2 employed	3 students 4 employed	3 students 3 employed
Years married or co-habiting:			
mean	-	3.2 yr.	5.2 yr.
range	-	1-5 yr.	3mo.-9 yr.
Birth control method	-	2 condom 1 tubal ligation 3 intra-uterine device 1 cervical cap	6 combination estrogen & progesterone oral contraceptive pill

[a]N = 8

[b]N = 7

[c]N = 6

menstrual cycle as a method of birth control. Women were also excluded if they did not have sufficient skills in the English language.

Participation in the study required daily visits to the laboratory for skin temperature measurement and the daily completion of a questionnaire at home for five weeks. Women who were not able to come to the lab every day completed the questionnaire part of the study only. Those participants who completed both the lab and the home routine were paid $75.00. Women who completed the home routine only were paid $25.00.

From a large number of applicants, twenty-five women met the selection criteria and agreed to participate (see consent form in Appendix A). Three groups of subjects were established based on whether or not they had sexual partners or took oral contraceptives. The first group consisted of celibate women who did not take oral contraceptives (Celibate Group, N = 9). The second group was composed of married or cohabiting women not taking oral contraceptives (Married Group, N = 10). The third group also contained women who were married or cohabiting but these women were using oral contraceptives (Pill Group, N = 6). Four subjects withdrew from the study during the first week of their participation because of time constraints. At the completion of the study, there were twenty-one subjects, eight in the Celibate Group, seven in the Married Group, and six in the Pill Group.

Materials

A questionnaire containing three sections was designed for recording menstrual cycle indexes, recording routine and unusual events, and assessing sexual responding (see Appendix B). In order to measure sexual arousal during one menstrual cycle, one questionnaire was to be completed every day for 35 days. An instruction sheet (see Appendix C) and the questionnaires constituted the complete package of materials given to each subject. A description of each of the three sections of the questionnaire follows.

Menstrual cycle indexes. The first section of the questionnaire contained items for recording basal body temperatures, menstruation, vaginal discharge, abdominal pain, and breast changes. A replica of the scale of a basal body temperature thermometer appeared on the questionnaire. The daily temperature was reported by circling the line on the scale where the mercury in the thermometer stopped. The item for reporting menstrual bleeding and vaginal discharge consisted of a check list describing the quantity of menstrual bleeding and the sensation, quantity, and quality of vaginal discharge. The final item in this section consisted of a check list of abdominal and breast sensations.

Routine and unusual events. This section of the questionnaire contained items to elicit information about the quantity and type of food consumed, the amount and quality of sleep, body weight, and any unusual occurrence taking place during the day. The primary function of this section was to reduce the saliency of the fact that the subject participated in a menstrual cycle study. The secondary function of these items was to gather information for future research. However, the data from this section were not analyzed in the present study.

Sexual responding. The last section of the questionnaire contained instruments to measure levels of self-rated sexual arousal and physical sensations in response to written sexual stimuli and to record the frequency of sexual activity. The instrument to measure sexual arousal was adapted from the Sexual Arousability Inventory (SAI) developed by Hoon, Hoon, and Wincze (1976). The original SAI was designed (1) to diagnose and isolate sexual arousal problems in women, (2) to assess the progress of women undergoing therapy for sexual dysfunction, and (3) to be used in research concerning theoretical questions related to erotica, sexual anxiety, and sexual arousability. The SAI is composed of a list of 28 statements describing sexual activities and situations: e.g., "When you see a loved one nude". The inventory is divided into two interchangeable forms, A and B, each containing 14 items. The items are read by the subject and the typical level of sexual arousal reached while experiencing each activity is reported on a nine-point Likert-type scale which ranges from -1 to 7. An SAI score is determined by adding the positive and negative responses and this total score can be compared to norms established in earlier research. Hoon et al. (1976) reported that the SAI had a split-half reliability of .92, test-retest reliability of .69, and concurrent validity with physiological sensations of arousal. These researchers found a statistically significant difference between sexually functional and dysfunctional women.

For the present study, the SAI was modified and adapted for every day use. First, the instructions for completing the daily forms were altered so that the subjects were asked to imagine themselves in each situation and rate the level of arousal they would feel if they were to experience the situations that day. Second, a change in the wording of the items was introduced in order to facilitate imagining each situation with any preferred sexual partner. Thus all references to "loved one" and to gender were deleted and the word "partner" was used instead. Furthermore, the rating scale was extended in the negative direction in order to allow more flexibility in describing the degree of negative responses toward any particular item. The scale contained 11 points, ranging from +5, extremely aroused, through 0, unaroused, to -5, extremely repulsed. Finally, the 14-item forms were assembled into a package in such a way as to prevent the development of a response set which would be expected to occur if identical items, in identical order, were presented every day. For this reason, the split-half forms, A and B, were presented on alternate days, and the order of the 14 items was randomized daily.

The other instrument in this section was a physical sensation scale for reporting the level of sensations experienced while imagining the sexual situations described in the SAI. The physical sensations of general excitement, breast and genital sensations, and vaginal dampness were rated on a four-point scale, ranging from 0 to 3. The final item of this section concerned sexual activity which had occurred during the previous 24 hours. The frequency of masturbation, necking, petting, intercourse, intense sexual activity with a partner not including intercourse (e.g., oral sex, mutual masturbation), and finally orgasm were recorded on a 4-point scale, ranging from 0 sexual activity to activity four or more times per day.

Apparatus

Ovu-Therm Basal Thermometers supplied by Mansfield Medical Distributors Ltd., Montreal were used for measuring basal body temperature. The scale on the thermometer ranged from 35.5° to 38.0°C and was marked in gradients of .05°C.

A temperature controlled room, located in the Hall Building of

Concordia University, was used as a laboratory where the measuring of breast skin temperature took place. The thermostat in the room was set at 26.5°C and the temperature fluctuated ±1.0°C. Room temperature was monitored by two temperature probes manufactured by Yellow Springs Instruments (YSI), Illinois, Model 405 and were attached to a YSI telethermometer, Model T46. One of the probes was suspended two feet and the other six inches above the subject who was lying on a cot. Temperatures of breast skin and control sites were monitored by 14 YSI thermistor probes, eight of Series 421 (3/16 in. diameter) and six of Series 409 (3/8 in. diameter). These probes were attached to a YSI telethermometer, Model TE44.

The probes were secured to the skin with one-inch square pieces of 3M Micropore surgical tape supplied by Mansfield Medical Distributors Ltd. A coiled spring, which could be compressed to a standard length, was used as a pressure gauge. Its purpose was to ensure that an even pressure was exerted on each probe as it was applied to the skin. Cotton gauze pads, soaked in a solution of 75% alcohol, served to cleanse the skin before the probes were applied. The placement of the probes on the breast were marked with a soft marker, using a plastic template to standardize the sites. A fold-away cot, 30" wide, was positioned in the room in such a way that air could circulate around it evenly. The subject rested on this cot with the skin probes attached. The cot was covered with a white sheet. Two pillows, which were placed under the head and shoulders of the subject, were covered with white medical Exam-O-Roll table paper supplied by Ingram and Bell Ltd., Montreal. For sanitary reasons, the paper was replaced after each use from a dispenser attached to the head of the cot. The cot was surrounded by a light gauze in order to prevent cooling of the subject's skin by draft blowing from the ventilation ducts.

Procedure

Women who responded to the advertisements were initially contacted and interviewed by telephone. They were informed that the purpose of the experiment was to study the relationship between physiology and sexual arousal. They were given a brief description of the questionnaire and the procedures. Women who met all the criteria of the study were given an appointment to meet the experimenter for a personal interview.

During the first meeting, a copy of the questionnaire and the instructions were shown to the subjects in order to familiarize them with the materials. The daily procedure for completing the questionnaire was explained and the various terms found on the form, such as orgasm and masturbation, were clarified. Instructions were given on the correct procedure of taking oral temperature and reading the thermometer. The procedures for examing and describing vaginal mucus were explained. Since the subjects had no previous experience in recording mucus changes, a practice form was handed out which was to be completed at home for seven consecutive days. This form was adopted from the daily questionnaire and it contained descriptions of vaginal mucus and instructions for completing the form.

The participants returned for a second meeting with the experimenter approximately seven days before the beginning of their next menses. At this time, the completed practice form for recording vaginal mucus was discussed and the consent form was signed. All subjects, then, were given one package of questionnaires and were asked to start completing them daily on the first day of the next menses. Subjects who participated in the breast skin temperature measurement were asked to contact the experimenter for an appointment on the day menses began. They started reporting to the laboratory the following day. They were asked to bring one questionnaire every day which had been completed the previous day. Subjects who did not participate in the breast skin temperature measurement were instructed to report to the laboratory once a week only and to bring the completed forms from the previous week. During the daily or weekly sessions, the experimenter discussed the questions and problems that the subjects had encountered while completing the questionnaire. The completed forms were placed into a metal collection box by the subjects themselves who were informed that the forms would not be examined until the experiment had been completed.

Breast skin temperature was taken at the same time every day for one complete menstrual cycle. The subjects removed all of their upper garments before lying supine on the cot. The breasts were wiped lightly with a cotton pad soaked in an alcohol solution. Using the template as a guide, six sites were marked on the upper-inner quadrant of each breast. Two large probes and four small probes were taped to the six sites on each breast. A piece of surgical tape was placed lightly on the probes and the coil spring gauge was used to press the tape to the skin. The gauge was compressed to a standard length for each probe in order to ensure even pressure on the probes and to avoid temperature variations due to uneven pressure. Two control sites were selected, one just below the left breast and the other one on the lower left arm adjacent to a superficial vein. One large probe was placed on each site. After the probes were applied, the gauze net surrounding the cot was closed. The experimenter remained in the room, sat at a nearby desk, and monitored the skin and room temperatures at five-minute intervals for 30 minutes.

Scoring and Treatment of Data

Menstrual cycle indexes. The data from the basal body temperature, vaginal mucus, abdominal pain, and breast sensations were used to establish whether the cycles during which the subjects participated were ovulatory and to estimate the day of ovulation. All menstrual cycle indexes for each subject were recorded on a Serena Sympto-Thermo chart (see Appendix D). The charts were evaluated by the experimenter and by two gynecologists working in family planning. In the case of the Celibate and Married subjects, who were expected to ovulate, the criteria for accepting a designated day as the estimated day of ovulation was agreement between any two of the judges. When oral contraceptives are taken and ovulation does not occur, the menstrual cycle indexes do not change. Therefore, in the case of the Pill subjects with a uniform cycle length of 28 days, reverse-cycle day 14 was designated as the day of ovulation. This is the day when ovulation would be expected to occur in a normal, 28-day cycle. For all subjects, the estimated day of ovulation and the menses occurring at the beginning and at the end of the cycle were used to divide the cycle into specific phases.

The menstrual cycle was considered to begin on the first day of the menses and to end on the day before the next menses began. The days of the cycle for each subject were grouped into five consecutive phases: the menstrual, the postmenstrual, the preovulatory, the ovulatory, and the luteal phase. The menstrual phase included the days of bleeding. The postmenstrual phase consisted of the days between the menstrual phase and the preovulatory phase. The latter phase included the three days immediately preceding the ovulatory phase.

The ovulatory phase included the estimated day of ovulation and one day before and after. These additional two days were included in this phase in order to increase the probability that the actual day of ovulation had occurred in the ovulatory phase since predicting the exact day of ovulation is not possible without data on hormone levels. The luteal phase included all the remaining days of the cycle.

Sexual arousal and sexual activity scores. The daily SAI scores were determined by totalling the negative and positive ratings of the 14 items appearing on each day's form. Responses to the four physical sensation items were added to form a daily physical sensation score. A daily sexual activity score was determined for each of the Married and Pill subjects by adding the frequency of intercourse and intense sexual activity not involving intercourse. There were no sexual activity scores for the Celibate subjects since they did not partake in sexual activity with a partner. For these subjects, sexual activity was measured by masturbation and orgasm. The frequency of masturbation and orgasm occurring each day served as the daily masturbation and orgasm scores for all three groups.

The daily scores for each category of sexual responding were distributed into phases established by the previously described method. The mean score for each of the five phases was calculated for each subject. These phase scores were the final scores used in the statistical analyses.

Skin and room temperature scores. A daily breast skin temperature score was established by finding the mean temperature of the 12 breast sites using the final reading of each daily session. From the daily breast skin scores, phase scores were calculated for each subject, and these scores were analyzed statistically.

The daily score for each of the two control sites was the single, final reading taken from each site. Phase scores were established as described previously. Both the daily scores and the phase scores were used in statistical analyses.

The daily room temperature scores were the final temperature readings taken at the end of each testing session. The daily room temperature score and the daily breast temperature scores were used in correlation analyses.

Data Analysis

All sexual responding and body temperature data were analyzed by non-parametric tests. The data from the three groups, Celibate, Married, and Pill, were compared using the Kruskal-Wallis one-way analysis of variance (Siegel, 1956). The Mann-Whitney U test was employed when comparing two groups (Siegel, 1956). The effect of cycle phase on the various measures of sexual responding and skin temperature was evaluated separately for each group using the Friedman two-way analysis of variance by ranks for repeated measures (Siegel, 1956). Nemenyi's test for ordered data was used to determine significance among phases (Linton & Gallo, 1975). Pearson's Product Moment correlation was used to determine the relation between various measures of sexual responding and the relations among breast skin temperature, room, and control site temperatures. Chi square statistic was used to determine whether the frequency of significant and non-significant correlations was due to chance.

Results

Menstrual Cycle Index Data

The examination of the menstrual cycle index charts revealed that the data of only 10 of the 15 normally cycling women showed clearly identifiable biphasic patterns of basal body temperature and accompanying changes in vaginal mucus. Therefore, these 10 subjects were judged to have had an ovulatory cycle. The charts of the remaining five subjects were irregular: two charts indicated anovulatory cycles; one chart indicated that ovulation had occurred but the day of estimated ovulation was not agreed upon by the judges; the data on one chart was questionable as to whether ovulation had occurred; and the data of one subject was considered unreliable. Appendix D contains sample charts of two subjects, one with a cycle classified as ovulatory and the other as anovulatory. The charts of the six Pill subjects were also examined. Five cycles were judged to be anovulatory as would be expected for oral contraceptive users. One chart showed an unexpected ovulatory pattern.

The behavioral data of the six subjects who had irregular cycles, five normal cyclers and one contraceptive user, were not analyzed. Only the data of the remaining 15 subjects were partitioned into phases and analyzed statistically. There were five Celibate, five Married, and five Pill subjects. Table 2 contains information about each subject concerning the length of the menstrual cycle, the day of ovulation, and the length of each phase.

Sexual Arousal Data

Sexual Arousal Inventory (SAI). In order to test the effect of repeated testing on SAI scores, a Pearson product moment correlation was performed for each subject on daily SAI scores and the days of

Table 2

Menstrual Cycle Data for Each Subject in the Three Groups.

Group and Subject	Cycle Length in Days	Day of Ovulation	Number of Days in Each Phase: Menstrual	Post-Menstrual	Pre-Ovulatory	Ovulatory	Luteal
Celibate							
#2	25	16	6	5	3	3	8
#4	32	19	6	8	3	3	12
#6	22	12	6	2	3	3	8
#7	27	15	6	4	3	3	11
#8	31	18	6	7	3	3	12
Married							
#12	30	18	5	8	3	3	11
#14	28	16	8	3	3	3	11
#16	42	30	4	21	3	3	11
#18	28	16	6	5	3	3	11
#19	25	13	5	3	3	3	11
Pill							
#21	28	15	5	5	3	3	12
#22	28	15	5	5	3	3	12
#23	28	15	5	5	3	3	12
#24	29	16	5	6	3	3	12
#27	27	14	5	4	3	3	12

the cycle. Non-significant correlations were found for 14 of the subjects, indicating that no systematic increase or decline in SAI scores occurred during the cycle. A significant negative correlation was found for one Celibate subject, $\underline{r}(30) = -.418$, $\underline{p} < .05$. However, close inspection of the SAI data showed an unusually large score on the first day. It appeared that the subject had not familiarized herself with the material, resulting in an overraction to the sexual stimuli on the first day. When the score of this day was removed, the correlation was no longer significant. A complete list of these correlations appears in Table 3.

The comparison of the overall SAI scores for the three groups did not differentiate between the Celibate, Married, and Pill women. Figure 2A depicts the overall mean SAI acores. Although the Pill Group had a higher mean score than the other two groups, the Kruskal-Wallis test did not reveal significant differences between these means. The general prediction that the Married and Pill subjects would show greater sexual arousal than the Celibate subjects was not supported.

The predictions about the effect of cycle phase on sexual arousal were also not supported. It was expected that both the Celibate and the Married groups would show a high level of sexual arousal during the ovulatory phase. Figures 3a and 3b which represent the mean SAI scores during each phase for the two groups show that the highest SAI scores were indeed obtained by both groups during that phase. Furthermore, contrary to expectations that only the Married Group would demonstrate elevated responding during the postmenstrual phase, it is clear from Figure 3a that the Celibate Group also did. However, the Friedman two-way analysis of variance

Table 3

Pearson Product Moment Correlation Coefficients Between SAI and Day of Cycle, Physical Sensations, Heterosexual Activity, Masturbation, and Orgasm.

Group and Subject	SAI and Day	SAI and Physical Sensations	SAI and Sexual Activity	SAI and Masturbation	SAI and Orgasm
	Correlation Coefficients				
Celibate					
#2	-.128	.890**	-	-[a]	-[b]
#4	-.329	.608**	-	.426*	.426*
#6	-.305	.697**	-	-.095	-.095
#7	.271	.866**	-	.121	.121
#8	.260	.544**	-	-.014	-.043
Married					
#12	.085	.929**	.398*	-.251	.079
#14	.049	.611**	.051	.037	-[b]
#16	.133	.793**	.041	.271	.061
#18	.301	-[c]	.228	-[a]	.032
#19	-.210	.669**	.052	.237	.343
Pill					
#21	.334	-[c]	.238	-[a]	.071
#22	-.249	.737**	-.214	.061	.058
#23	.368	.756**	.361	.252	.469*
#24	.102	.644**	.219	-.103	-.085
#27	.035	.788**	.367	.498**	.397*

*$p < .05$

**$p < .01$

[a]These subjects did not masturbate.

[b]These subjects did not report any orgasms.

[c]These subjects did not complete the physical sensations question according to instructions.

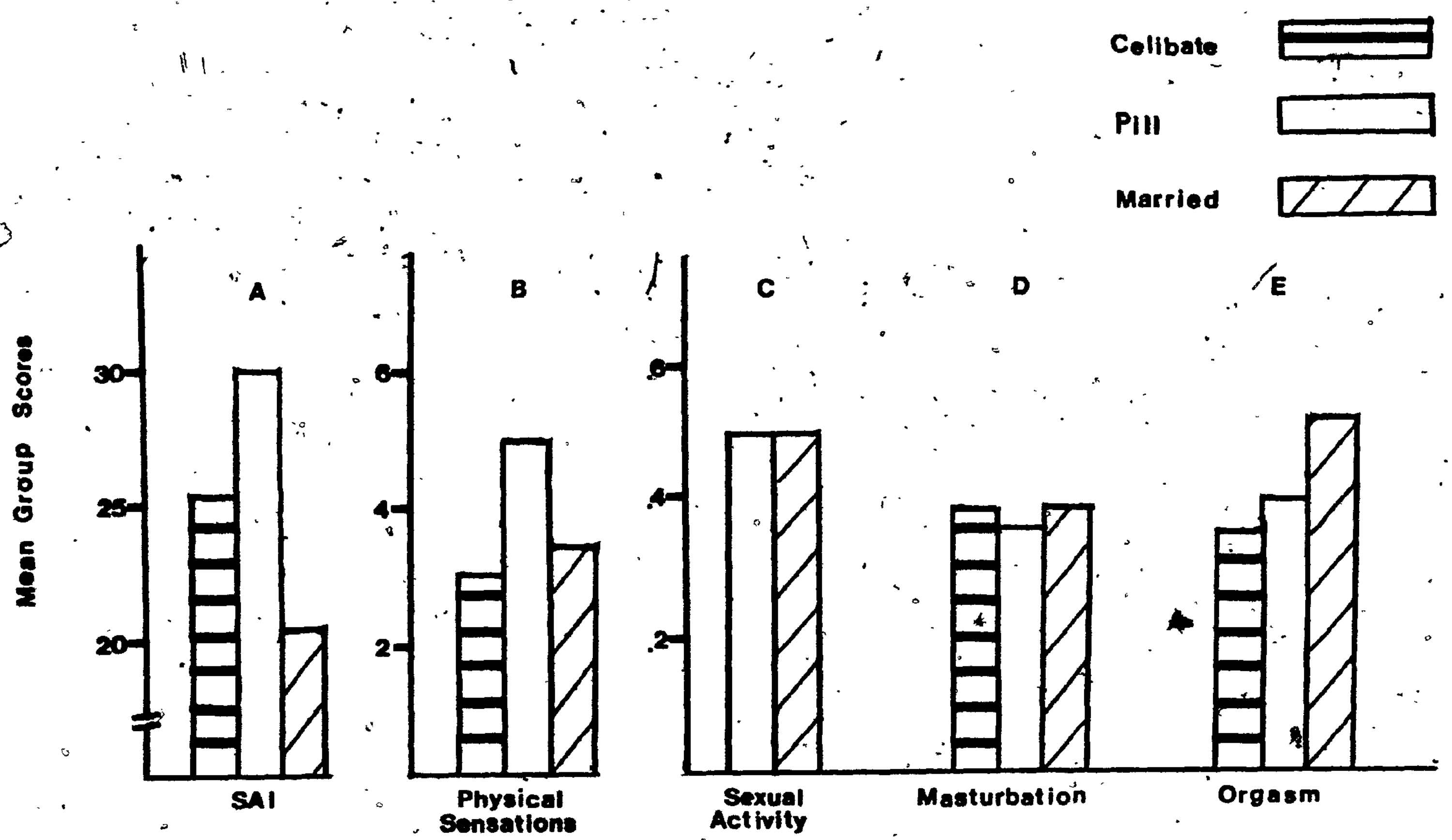

Figure 2. Cycle means for the three groups for SAI, physical sensations, sexual activity, masturbation, and orgasm scores.

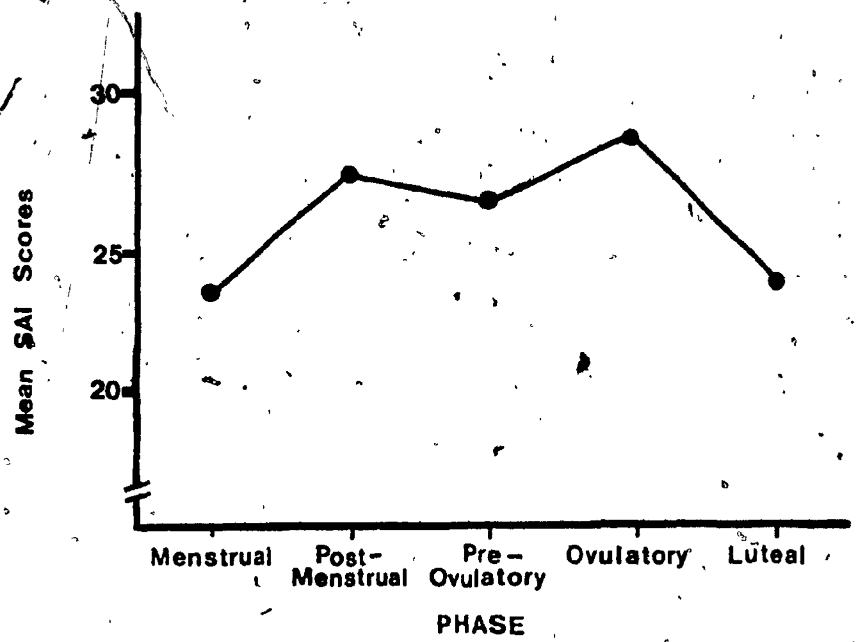

Figure 3a. Mean SAI scores for the Celibate Group during the five phases of the menstrual cycle.

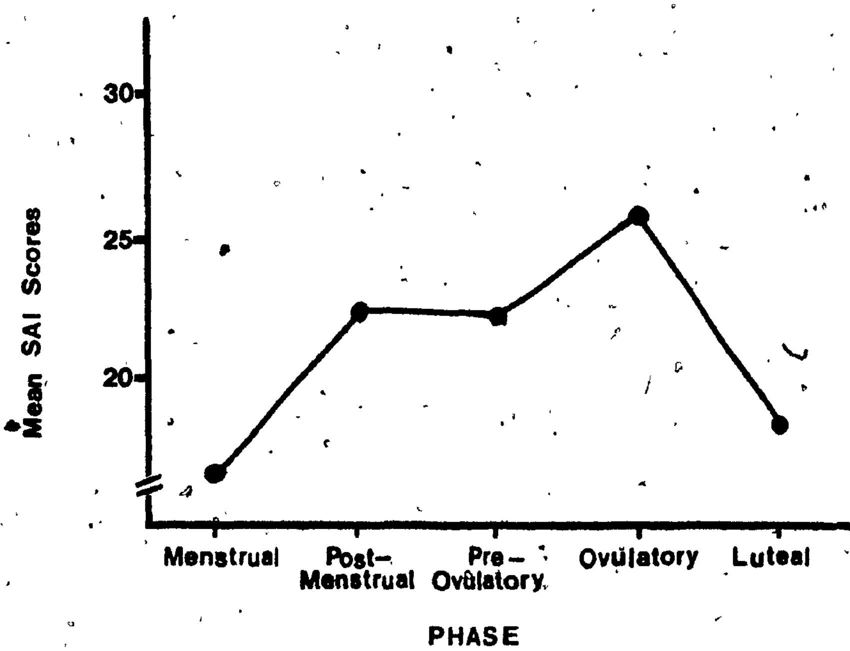

Figure 3b. Mean SAI scores for the Married group during the five phases of the menstrual cycle.

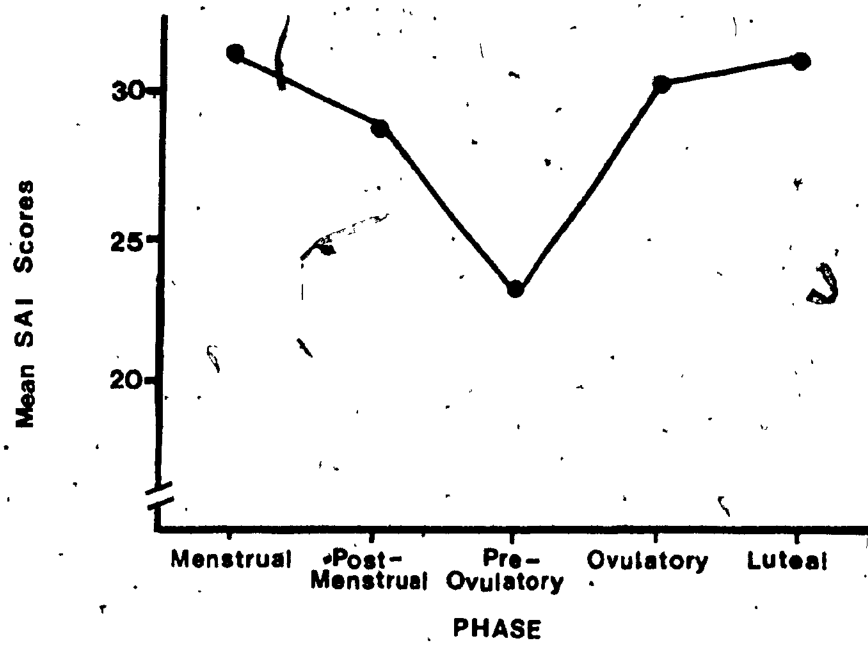

Figure 3c. Mean SAI scores for the Pill Group during the five phases of the menstrual cycle.

performed separately for each group did not reveal statistically significant differences among the phase means.

Regarding the data of the Pill Group, illustrated in Figure 3c, the expected increase in sexual arousal during the postmenstrual phase did not occur. However, there was an unexpected decrease in SAI scores during the preovulatory phase. Again, the Friedman test did not reveal significant differences among the phase means.

Physical sensations scores. Since two subjects, one from the Married and one from the Pill Group, did not correctly complete the physical sensation section of the questionnaire, the analyses conducted on this measure contain data from only four subjects in these groups.

Physical sensation scores, another measure of sexual arousal, were first analyzed for group differences. According to Figure 2B, the Pill Group obtained the highest mean physical sensation scores. However, the Kruskal-Wallis one-way analysis of variance did not show significant differences among the groups.

An analysis for phase effect on this measure did not support the prediction of an ovulatory peak for the Celibate and Married groups and a postmenstrual peak for the Married and Pill groups. Figures 4a, 4b, and 4c clearly indicate that the predicted peaks in physical sensation scores did not occur. Rather, the phase scores appeared to be quite similar across the cycle. The Friedman test, performed separately on each group, confirmed a non-significant difference between phase means.

Sexual Activity Data

Sexual Activity with a partner scores. As expected, the overall mean score of sexual activity for the Pill and Married groups did

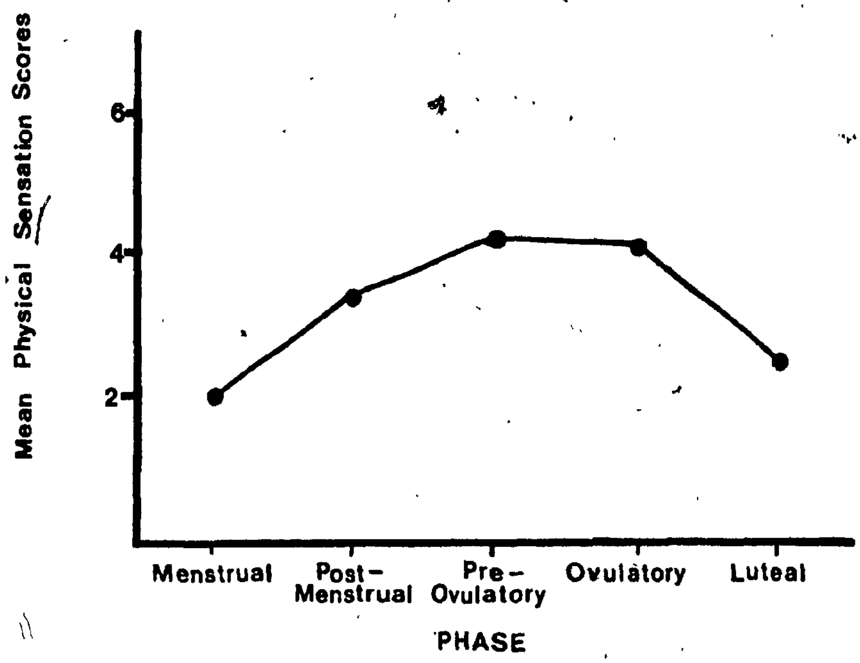

Figure 4a. Mean physical sensation scores for the Celibate Group during the five phases of the menstrual cycle.

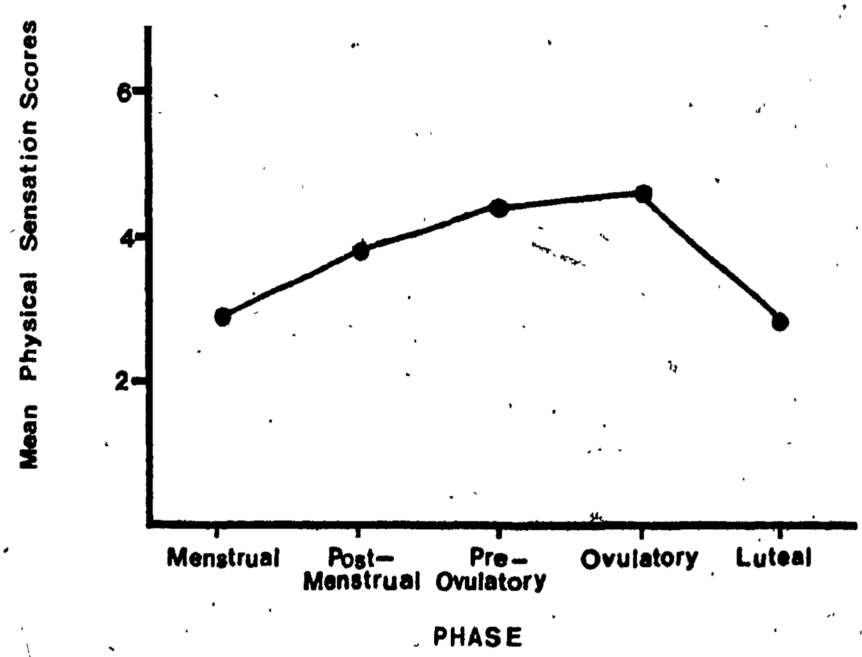

Figure 4b. Mean physical sensation scores for the Married Group during the five phases of the menstrual cycle.

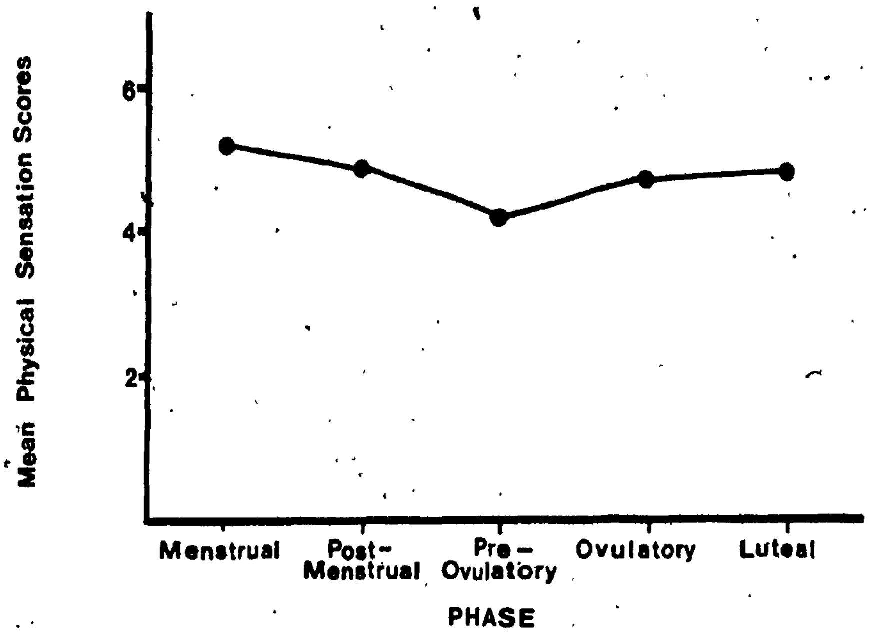

Figure 4c. Mean physical sensation scores for the Pill Group during the five phases of the menstrual cycle.

not differ. Figure 2C shows identical means for both groups, and the statistical analysis, using the Mann-Whitney U test produced a non-significant difference between them.

Regarding the effect of cycle phase on activity with a partner, some support for the prediction of a postmenstrual peak for the groups having sexual partners was found. For the Pill Group, the mean sexual activity scores, depicted in Figure 5a show a pronounced peak during the postmenstrual phase, with a less pronounced rise during the ovulatory phase. Low frequencies of activity occurred during the menstrual and preovulatory phases, with relatively high levels during the luteal phase. Statistical analysis with Friedman's two-way analysis of variance revealed a significant difference among phases, $\underline{X}r^2(4) = 12.3$, $\underline{p} < .05$. However, a post-hoc analysis using Nemenyi's test did not reveal differences between mean ranks. It is hypothesized by the present experimenter that this outcome occurs when the number of experimental conditions equals or exceeds the number of subjects in the group being analyzed.

As predicted, the mean frequency of sexual activity for the Married Group, demonstrated in Figure 5b, shows the highest activity scores occurred during the postmenstrual phase, followed by the ovulatory phase. However, the magnitude of the peak scores during the postmenstrual phase did not prove to be statistically significant when compared to the scores during the other phases.

Masturbation scores. The results of the study contrasted with the prediction that the Celibate Group would have a higher incidence of masturbation than the other two groups. Figure 2D which contains a bar graph depicting the mean masturbation score for each group shows that the Celibate and Married groups had identical means and

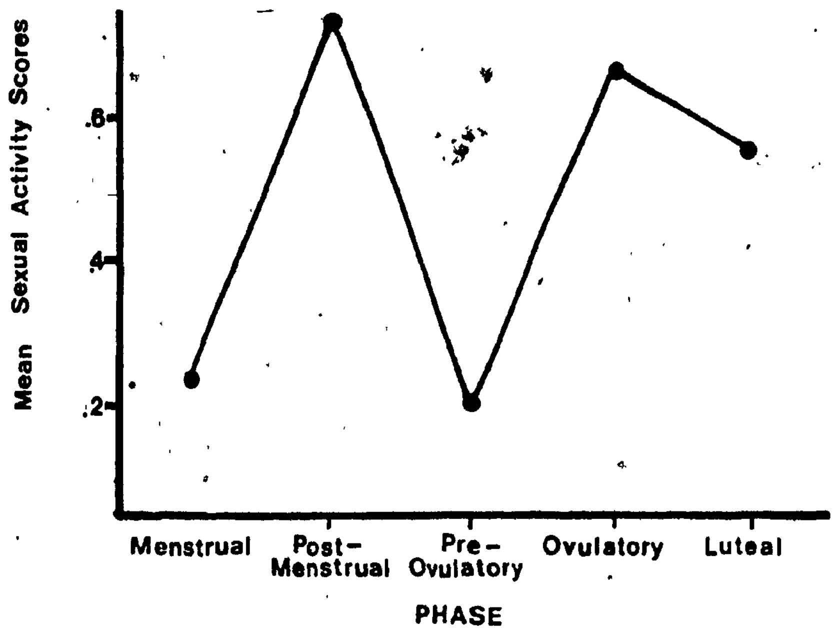

Figure 5a. Mean sexual activity with a partner scores for the Pill Group during the five phases of the menstrual cycle.

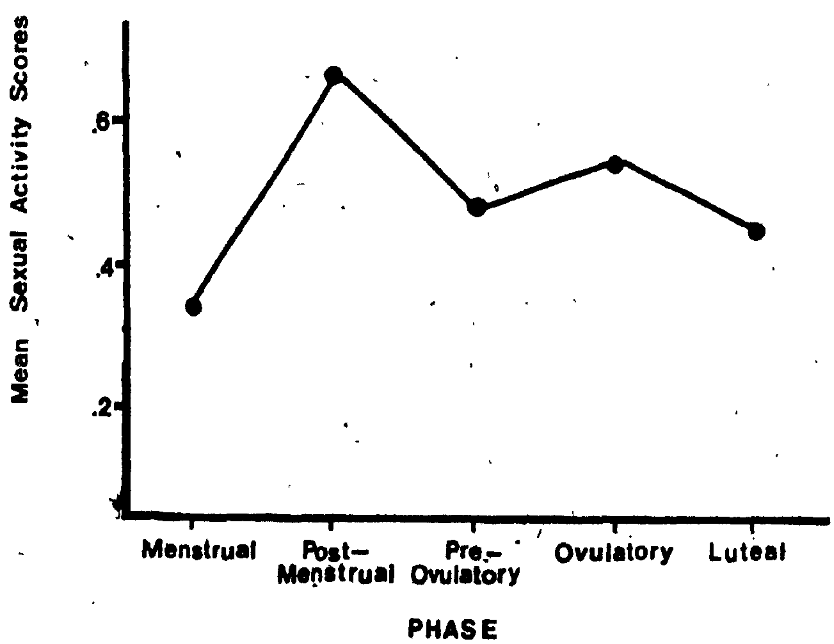

Figure 5b. Mean sexual activity with a partner scores of the Married Group during the five phases of the menstrual cycle.

that the Pill Group had a slightly lower mean. A statistical analysis with the Kruskal-Wallis test revealed non-significant differences among the groups.

The ovulatory rise in masturbation predicted for the Celibate and Married groups was not confirmed statistically. Although Figures 6a and 6b show that the highest level of responding for the Celibate Group occurred during the preovulatory phase, and for the Married Group during the ovulatory phase, Friedman's statistical analyses revealed non-significant differences among the phase means for both groups.

The mean masturbation scores for the Pill Group supported the expectation of no differences among phase means. Although the mean score for the ovulatory phase was higher than for the other phases, as demonstrated in Figure 6c, a Friedman statistical analysis showed that the differences among phase means were non-significant.

Orgasm scores. As predicted, no overall differences in mean orgasm scores among the three groups were found. Figure 2E, which contains a bar graph depicting these data, shows the Married Group had the highest mean score, followed with lower means for the Pill Group and the Celibate Group respectively.

The outcome of the phase analyses of the orgasm scores for the three groups showed no phase effects. The ovulatory phase peak in orgasm predicted for the Celibate Group did not occur. Figure 7a shows that the highest frequency of orgasm occurred during the preovulatory phase. Friedman's statistical analysis showed non-significant phase differences. For the Married Group, the postmenstrual and ovulatory phase increases did not occur either. Figure 7b shows that the highest mean orgasm scores were obtained during the

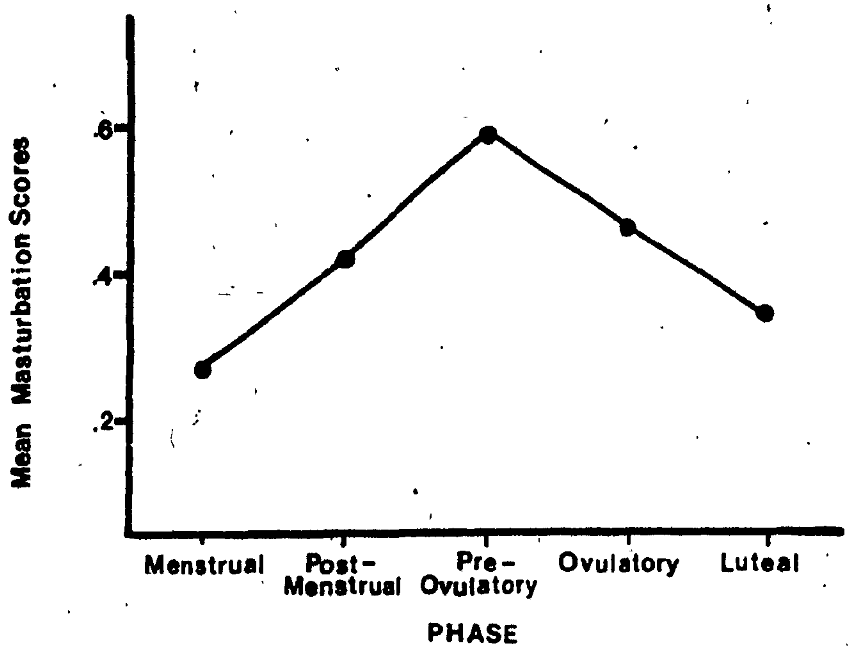

Figure 6a. Mean masturbation scores for the Celibate Group during the five phases of the menstrual cycle.

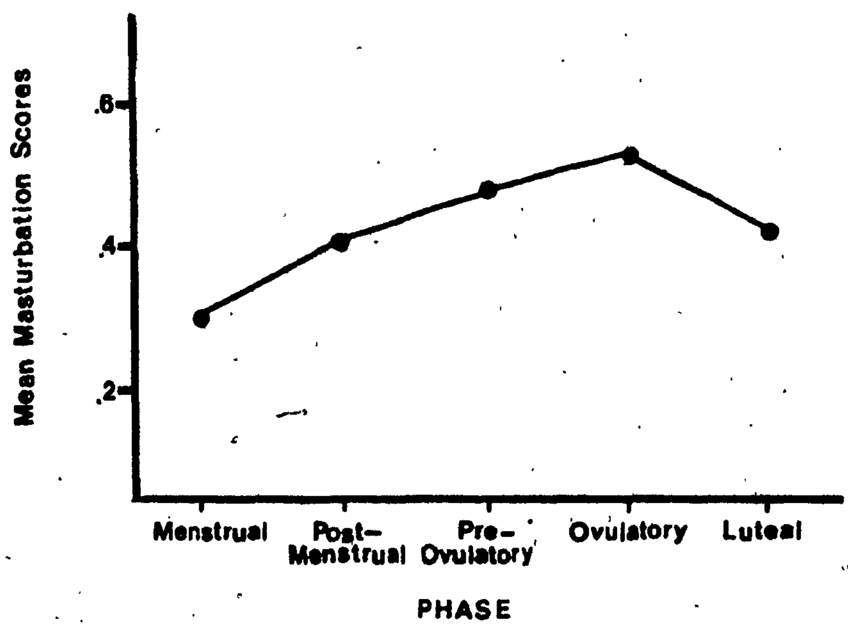

Figure 6b. Mean masturbation scores for the Married Group during the five phases of the menstrual cycle.

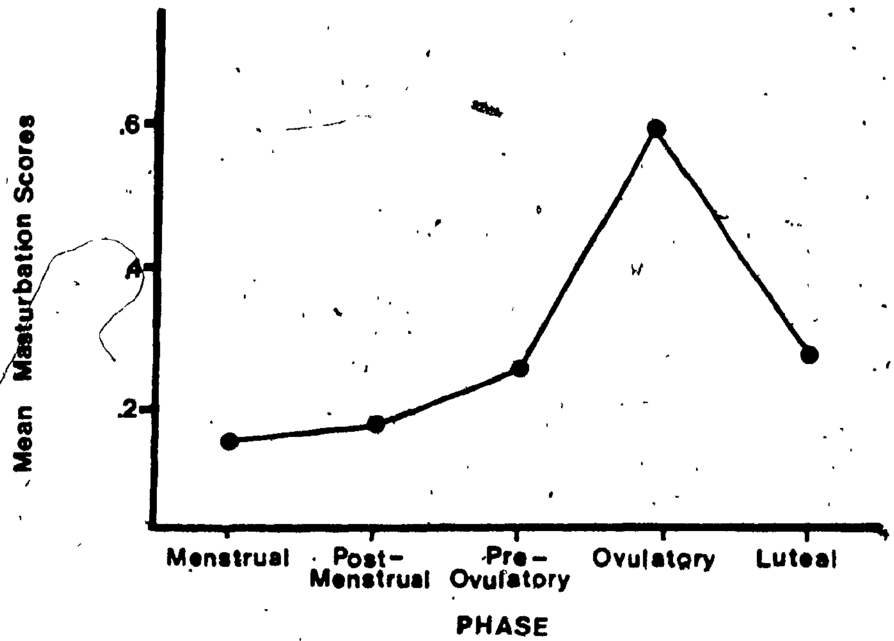

Figure 6c. Mean masturbation scores for the Pill Group during the five phases of the menstrual cycle.

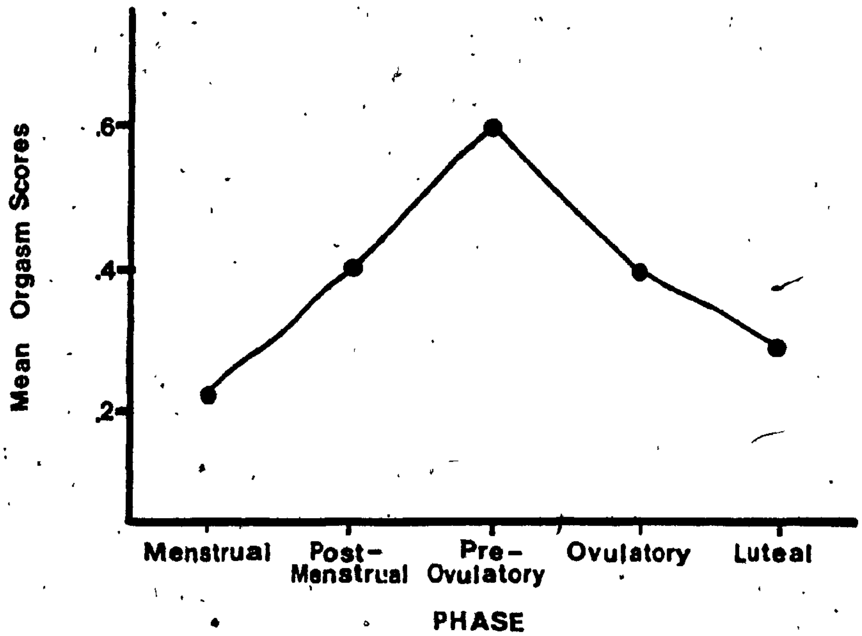

Figure 7a. Mean orgasm scores for the Celibate Group during the five phases of the menstrual cycle.

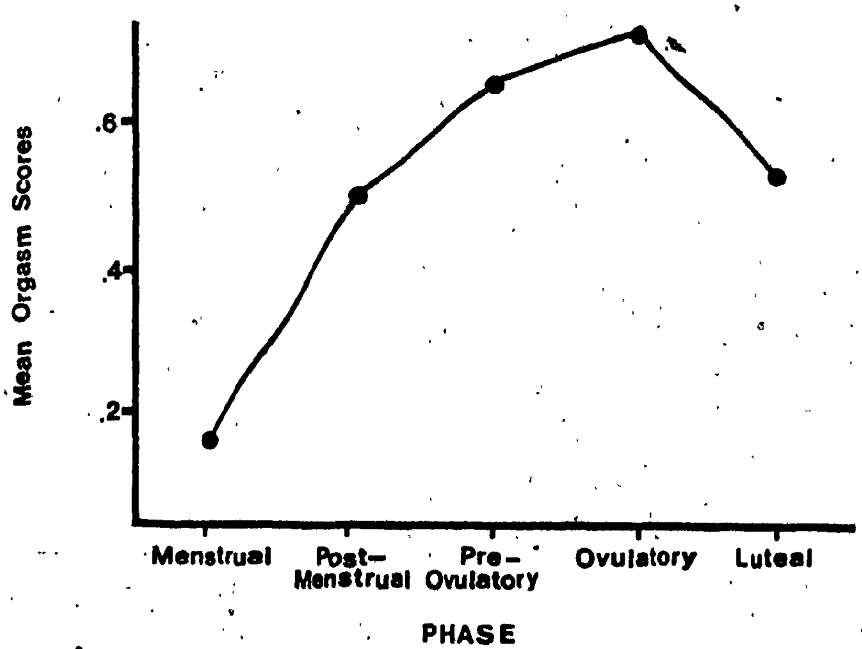

Figure 7b. Mean orgasm scores for the Married Group during the five phases of the menstrual cycle.

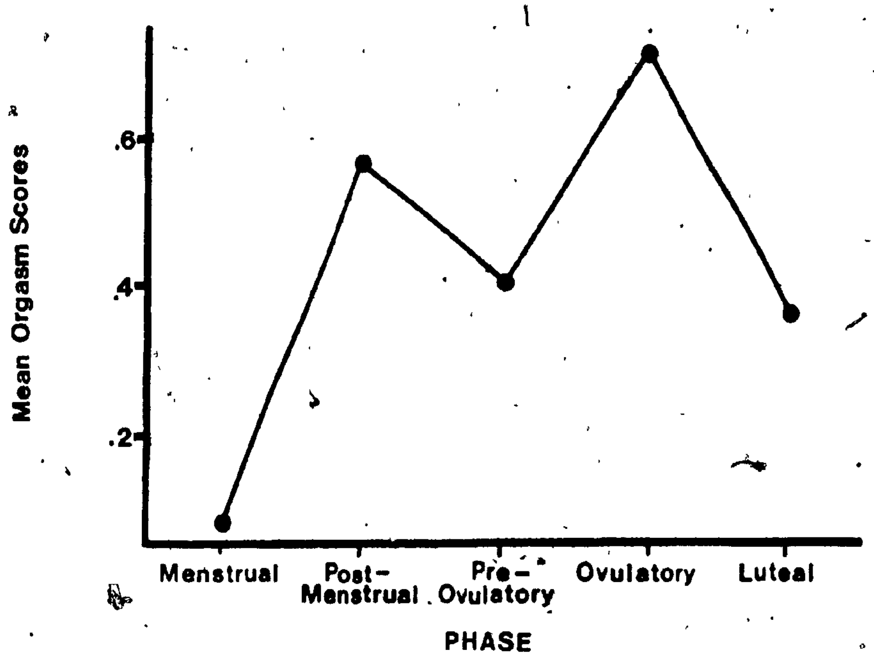

Figure 7c. Mean orgasm scores for the Pill Group during the five phases of the menstrual cycle.

ovulatory phase. However, statistical analysis revealed non-significant differences between phase means. The Pill Group did show the predicted postmenstrual rise in orgasm and an unexpected peak during the ovulatory phase, as depicted in Figure 7c. These means did not prove to be statistically different from each other, however.

Correlated Measures

In order to determine whether the sexual arousal and sexual activity data of each subject were related, correlations between various measures were performed. First, significant positive correlations between the SAI and physical sensation scores were found for all subjects in each group (see Table 3). It was concluded that these two variables measured the same thing. Then, the SAI scores were compared to the sexual activity, the masturbation, and the orgasm scores. Significant positive correlations were found between SAI and sexual activity for one Married subject out of the 10 subjects who had sexual partners. SAI and masturbation scores correlated significantly for two subjects, one from the Celibate and the other from the Pill Group. And finally, three subjects, one Celibate and two Pill, had significant correlations between SAI and orgasm. In order to determine whether the frequency of significant vs. non-significant correlations for any of these comparisons was due to a relation between the variables correlated or whether it was a chance occurrence, a X^2 statistic was calculated for each set of correlations. In all cases, a non-significant X^2 was found. Therefore, sexual arousal as measured by the SAI did not appear to be related to any of the sexual responding measures.

The relations between the three sexual activity measures, sexual activity, masturbation, and orgasm, were also examined for each subject. A summary of the correlations is presented in Table 4. There were no significant correlations between the sexual activity and the masturbation scores for the subjects in the Married and Pill groups. Sexual activity and orgasm were significantly correlated for six out of the nine subjects who had reported orgasm. Masturbation and orgasm, on the other hand, correlated significantly for all the subjects who reported these measures. Therefore, while sexual activity and masturbation were not related to each other, it appeared that both measures were related to orgasm.

Breast Skin Temperature Data

Ten subjects participated in breast skin temperature measurement. There were four Celibate and two Married women who formed a group of normally cycling subjects designated the No-Pill Group (N = 6). The four Pill subjects who provided breast skin temperature data formed the Pill Group (N = 4).

In order to determine if factors other than the hormonal conditions of the participants could have influenced breast skin temperatures, correlations were conducted for each subject between daily breast skin temperature and room temperature. Significant positive correlations between these two measures were found for three subjects only, two from the No-Pill and one from the Pill Group (see Table 5 for a list of these correlations). A chi square analysis was performed on the frequency of significant and non-significant correlations (3 vs. 7). A non-significant X^2 indicated that the breast skin temperature data was not influenced by the temperature of the room.

Although there was no prediction regarding the overall temperature level of the No-Pill Group compared to that of the Pill Group, a statistical analysis was performed with the use of the Mann-Whitney U

Table 4

Pearson Product Moment Correlation Coefficients Between Sexual Activity, Masturbation, and Orgasm.

Group and Subject	Correlation Coefficients: Sexual Activity and Masturbation	Sexual Activity and Orgasm	Masturbation and Orgasm
Celibate			
#2	–	–	–[a]
#4	–	–	1.00**
#6	–	–	1.00**
#7	–	–	1.00**
#8	–	–	.843**
Married			
#12	-.069	.565**	.750**
#14	-.284	–[b]	–
#16	-.076	.427**	.424**
#18	–[a]	.696**	–
#19	-.094	-.148	.674**
Pill			
#21	–[a]	.947**	–
#22	.163	.390**	.471**
#23	.151	.617**	.673**
#24	-.239	.020	.894**
#27	.234	.378	.898**

**$p < .01$

[a]These subjects did not masturbate.

[b]This subject did not report any orgasms.

Table 5

Pearson Product Moment Correlation Coefficients Between Breast Skin Temperature, Room Temperature, and the Control Site on the Chest.

Group and Subject	Correlation Coefficients: Breast skin temperature and room temperature	Correlation Coefficients: Breast skin temperature and chest control site
No-Pill		
#2	-.017	.724**
#4	.473*	.629**
#6	.119	.532**
#7	.279	.588**
#14	.565*	.605**
#19	-.200	.622**
Pill		
#21	.214	.725**
#22	.110	.058
#23	.432*	.649**
#24	-.058	.624**

*$p < .05$

**$p < .01$

test. A non-significant difference between the groups indicated that the overall temperature levels throughout the menstrual cycle were not different for the two groups.

The results of further analyses of breast skin temperature measures supported the expected outcome of significant phase differences for the No-Pill Group, and non-significant differences for the Pill Group. Figure 8a illustrates that the breast temperature of the No-Pill Group fluctuated during the menstrual cycle. The mean temperature was highest during the luteal phase, followed by the menstrual and preovulatory phases respectively. Statistical analysis of the data by Friedman's two-way analysis of variance confirmed significant differences across cycle phases, $\underline{Xr}^2(4) = 17.5$, $\underline{p} < .05$. Furthermore, Nemenyi's test of specific comparisons revealed that the mean temperatures of the menstrual and luteal phases were significantly different from that of the ovulatory phase. However, no significant difference between the preovulatory and ovulatory phases was found.

The pattern of breast skin temperature for the Pill Group is illustrated in Figure 8b. Inspection of the figure shows that, as predicted, temperature levels were stable throughout the cycle, with the exception of the luteal phase, when an unexpected increase in breast temperature was recorded. However, statistical analysis did not reveal significant variations across the cycle.

Contrary to predictions, the temperature of the chest control site fluctuated across the cycle in both groups as depicted in Figures 9a and 9b. Temperature peaks occurred during the preovulatory and luteal phases in the No-Pill Group (Figure 9a). For the Pill Group, chest temperatures were highest during the ovulatory and

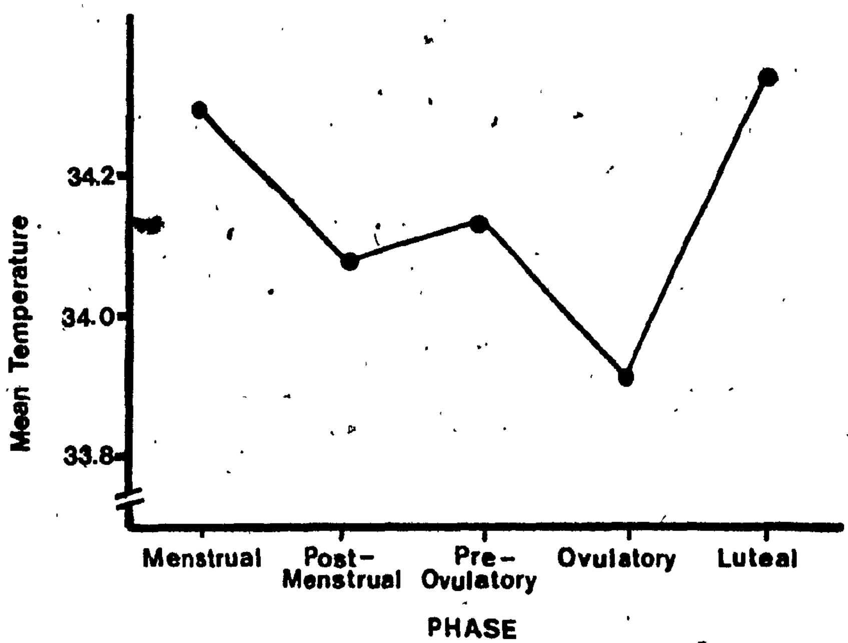

Figure 8a. Mean breast skin temperatures for the No-Pill Group during the five phases of the menstrual cycle.

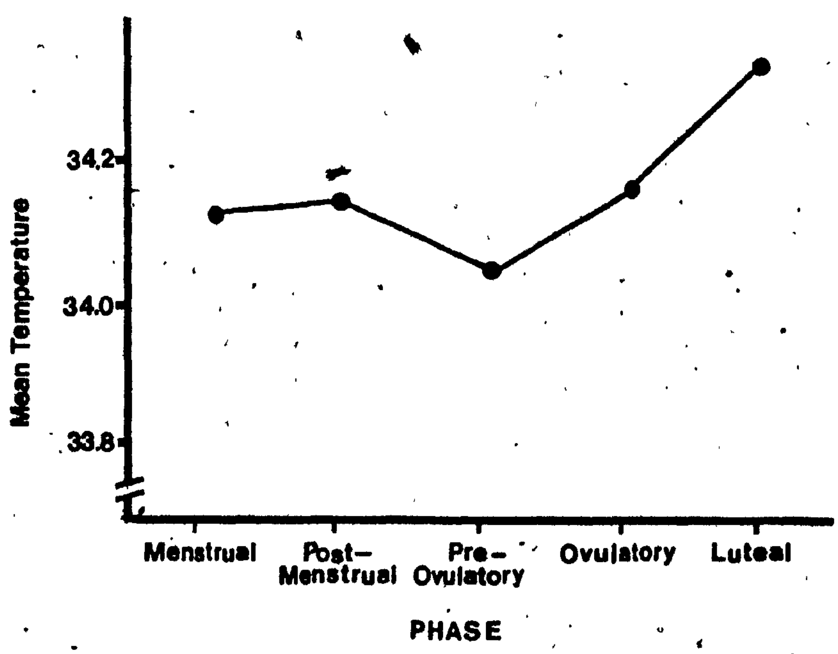

Figure 8b. Mean breast skin temperatures for the Pill Group during the five phases of the menstrual cycle.

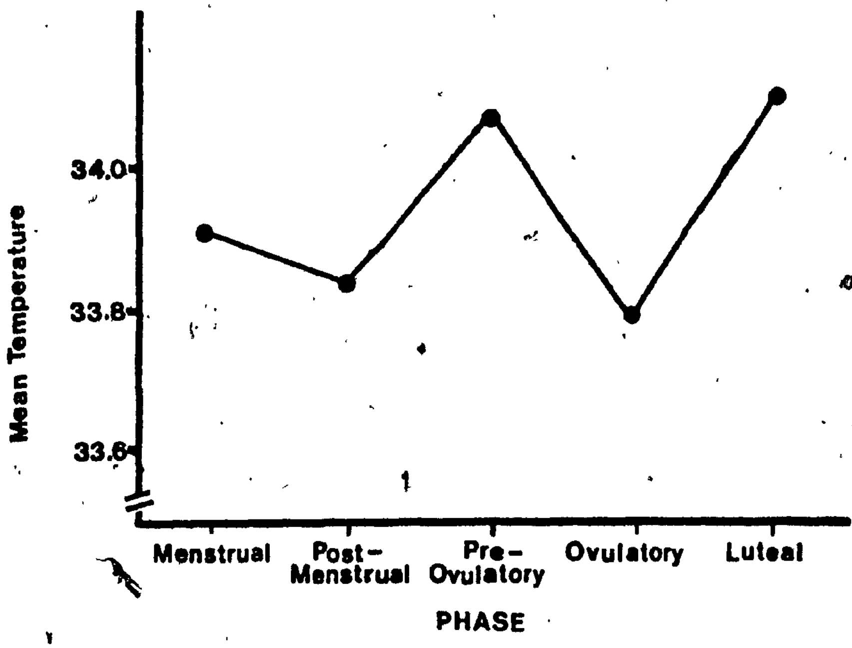

Figure 9a. Mean temperatures for the control site on the chest for the No-Pill Group during the five phases of the menstrual cycle.

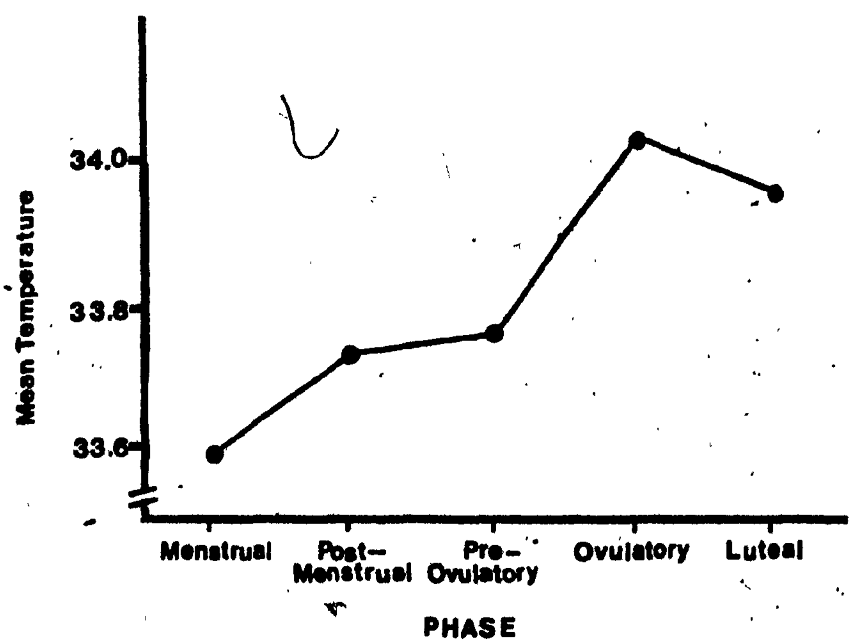

Figure 9b. Mean temperatures for the control site on the chest for the Pill Group during the five phases of the mesntrual cycle.

luteal phases. A statistical analysis of phase effect, performed separately for the two groups, revealed significant differences between the phase means for both groups; No-Pill Group, $\underline{Xr}^2(4) = 14.9$, $\underline{p}<.05$; Pill Group, $\underline{Xr}^2(4) = 13.0$, $\underline{p}<.05$. Nemenyi's test for the No-Pill Group revealed that the mean temperature in the luteal phase was significantly higher than the mean temperature in the postmenstrual and ovulatory phases. Since the Pill Group contained only four subjects, the Nemenyi test did not demonstrate significant differences among the phases.

Since the temperatures of the breast and of the control site on the chest seemed to follow the same pattern across the cycle phases, correlations were performed between the daily scores for each subject. Significant Pearson's correlations were obtained in nine cases, indicating that the breast and chest temperature measures were related (see Table 5 for a list of the correlations).

The results of the analysis of the data from the arm control site supported the prediction that arm temperatures would not fluctuate across the cycle. Figure 10a depicts stable arm temperature levels across the phases for the No-Pill Group. Figure 10b shows that the data of the Pill Group had large variations in temperature across the cycle. However, statistical analysis performed on the mean phase scores did not reveal significant differences among the means.

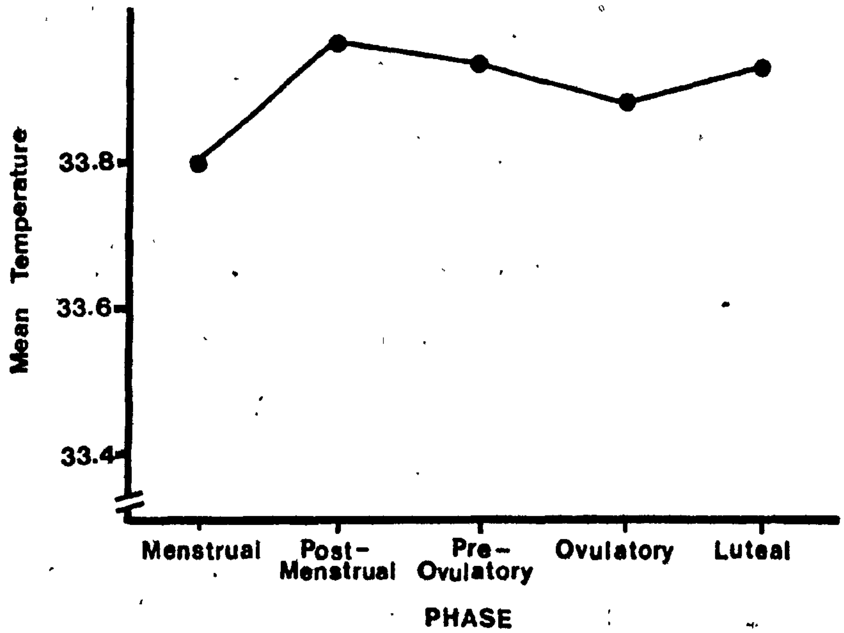

Figure 10a. Mean temperatures for the control site on the arm for the No-Pill Group during the five phases of the menstrual cycle.

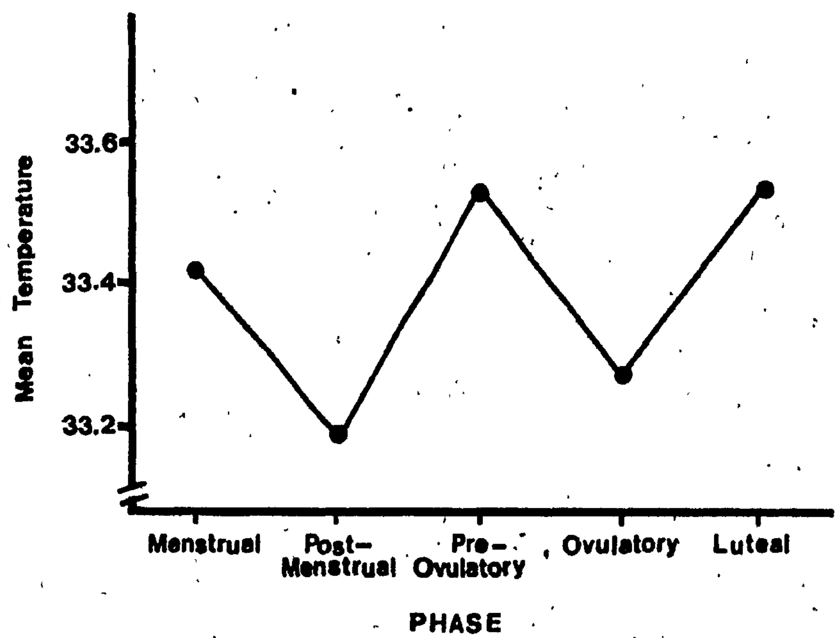

Figure 10b. Mean temperatures for the control site on the arm for the Pill Group during the five phases of the menstrual cycle.

Discussion

The major purpose of this study was to re-examine the effects of cycle phase and the presence of a sexual partner on the sexual arousal of women. The results of the study did not provide statistical support for the predicted hormone and partner effects because most of the analyses found non-significant differences among phases. However, since the methodology of the study was unique compared to the typical sexual behavior study in terms of the method used to determine phases, the sexual stimulus used and the manner in which it was presented, and the inclusion of a group of celibate women, a more detailed examination of the results follows.

Cycle phase determination. As outlined in the introduction, the main problem encountered when comparing the results of similar studies of female sexuality is that unreliable methods, specifically the retrospective, reverse-cycle, and cycle standardization methods, were used to determine the day of ovulation. One methodological improvement in this study was to collect some physical evidence of whether and when ovulation took place, and, in doing so, to avoid arbitrarily selecting a particular day as the one on which ovulation was to have occurred. In order to achieve this, information on the menstrual cycle indexes of basal body temperature and vaginal mucus was collected.

Biphasic basal body temperature charts which indicated that ovulation had occurred, were identified for two-thirds of the normally cycling women. This was considered to be an acceptable rate since Rose (1978) was able to identify ovulatory cycles for 70 percent of his experimental groups. The basal body temperature charts for the remaining one-third of the women could not be identified as being biphasic and were considered non-ovulatory. Unexpectedly, a biphasic pattern was detected for one oral contraceptive user. This phenomenon occurs when oral contraceptives contain doses of artificial steroids so low that they do not reliably prevent maturation of the follicle and ovulation. However, conception is prevented in these cases because the progesterone in the pills exerts a powerful influence on cervical mucus so that the mucus provides an inhospitable environment for sperm survival (Nuttall & Elstein, 1982; Wolf, Blasco, Kahn, & Litt, 1979). The cervical mucus data of the 10 ovulating women did not present the predicted pattern of change. Individual differences in descriptions of cervical mucus were found and it was not possible to discern if the women had learned to recognize changes in their mucus. It would seem that more time is needed for them to learn how to use this method properly.

Using the basal body temperature index to identify the day of ovulation made it possible not only to separate ovulatory from non-ovulatory cycles, but to section the cycles into discrete phases which are characterized by specific hormone profiles. This was the major advantage of the current methodology since other studies could not be certain that the cycles were ovulatory or that the method used to establish the phases was accurate. One of the five phases in the present study was a three-day preovulatory phase partitioned out of the follicular phase. The highest levels of estrogen and testosterone occur during these days (Yen, 1980) rather than during the traditional ovulatory phase. These hormones, in turn, have been identified as the ones most likely to influence female sexual behavior. In most previous studies, the data for the preovulatory phase were included in the data for the follicular phase so that behavior changes specific to the preovulatory phase could not be detected. Only the data from one or two days at midcycle, called the ovulatory phase, were analyzed for hormone effects on sexual responding. The present study used a methodology which permitted the data to be separated into a follicular and a preovulatory phase in addition to the customary ovulatory phase and to analyze these phases separately.

It appears that using menstrual cycle indexes to determine if the cycles were ovulatory, to estimate the day of ovulation, and to partition the cycle into discrete phases characterized by underlying hormone profiles, can be incorporated into studies which span one complete menstrual cycle. It was concluded from the basal body temperature profiles that, except for the occasional day when the temperature was not taken, this measure is a reliable method of obtaining some physical evidence of ovulation. Therefore, it is recommended for future sexual responding studies. However, since the cervical mucus method is difficult to learn and appears to require a practice period longer than one cycle, it is not recommended as a reliable cycle index of ovulation for future studies of one cycle duration.

Sexual arousal. Sexual arousal was measured using two approaches. One involved presenting women with a sexually stimulating list of situations which were rated for level of perceived sexual arousal, and the other required women to record physical sensations of arousal experienced while imagining themselves in these situations. Statistically significant correlations between the data from the two measures indicated that a strong relation existed between them. High levels of perceived arousal were accompanied by strong physical sensations of arousal. It appeared that both the perceived levels of arousal and the actual physical sensations of arousal responded simultaneously to the stimulus material. Therefore, the two cannot be considered separate measures of arousal. It is not recommended that physical sensations be included in future studies of sexual arousal since it does not contribute additional information which differs from that obtained from reports of perceived arousal. In the discussion which follows, only the perceived levels of arousal will be referred to.

In earlier literature there were two common types of research designs used to assess levels of sexual arousal during the cycle. Many researchers have asked women to simply rate the level of sexual arousal experienced during each day (Englander-Golden et al., 1980; Moos et al., 1969; Spitz et al., 1975). This method relies entirely on subjective reports of arousal to unspecified stimuli. In this situation, arousal has been shown to be influenced by the type of sexual activity the women participates in during each day (Spitz et al., 1975). The other commonly used method has been to present sexual stimuli to women once during the entire cycle or once during each of several phases (Abramson et al., 1976; Hoon et al., 1982; MacGriffith & Walker, 1975; Schreiner-Engel et al., 1981). Self-reported ratings or physiological measures of arousal in response to the stimulus are recorded. The second design is considered superior to the first because presenting specific sexual stimuli to evoke arousal circumvents to some extent the influence of the type of sexual activity participated in during the day of testing. However, the problem with this method is that it is not valid to test for phase differences when the phase data were obtained from different groups of women, as is the case when each subject is tested only once during the entire cycle. Furthermore, when a subject is tested once during each phase, it cannot be assumed that the response taken on one day during the phase adequately represents the entire phase. The present study was designed to prevent both of these design weaknesses by presenting women with a sexual stimulus every day of the cycle. Therefore, the phase means were derived from the data of several days and were likely to be representative of typical responses of that particular phase.

Presenting stimuli on a daily basis, however, is difficult since the saliency of the stimuli must be consistent across time. The present researcher considered it to be impossible to select pictorial, auditory, or written sexual stimuli which could be presented on each day of the cycle and be of identical saliency. For this reason, a standard stimulus, the Sexual Arousability Inventory, was selected for every day presentation. It was assumed that the variations in responding would more likely reflect the women's changing responses to the standard stimulus than changes in responding due to variability in the stimulus material. However, the subjects could become habituated to the items and respond at a slightly lower level as each day passes. Or conversely, they could become sensitized to the sexual situations, and report higher levels of sexual arousal across time. To prevent the occurence of either of these manners of responding, the split-half forms of the SAI were alternated and the items were randomized daily. The non-significant results of the correlations between daily SAI scores and cycle day indicated that the subjects did not respond to the stimuli in either of the manners described above. Therefore, it appears that when the modified version of the SAI is presented in this fashion, the daily scores are not influenced by the effects of repeated presentation.

The difference in the hormonal states of the women did not appear to influence the overall sexual arousal scores of the groups. Analysis of the SAI data revealed that the three groups, Celibate, Married, and Pill, did not differ in their overall levels of sexual arousal. Furthermore, sexual arousal did not differ significantly among the phases which are characterized by fluctuations in estrogen, testosterone, and progestin for the Celibate and Married groups. Visual inspection of the data revealed that the highest levels of arousal for the two normally cycling groups occurred during the postmenstrual, preovulatory, and ovulatory phases when levels of estrogen and testosterone are increasing and reach their peak levels. Sexual arousal was lowest during the menstrual phase, when all hormone levels are low, and during the luteal phase when progesterone levels are high. In contrast, the Pill Group showed stable levels of responding during all phases except the preovulatory phase when a decline took place. Since there were no significant differences among the phases for any of the groups, no conclusions concerning the influence of fluctuating hormones on female sexual arousal can be drawn.

The sexual arousal scores appeared to be independent of the effects of sexual activity with a partner for the Married and Pill groups. This was demonstrated by the finding of no difference in overall levels of responding between the Celibate and the two partner groups. If the reported levels of arousal are increased by participation in intercourse, as suggested by Spitz and associates (1975), the two groups with partners would have reported higher overall levels of arousal than the Celibate Group. Furthermore, neither of the groups with partners showed peaks in arousal postmenstrually when the frequency of sexual activity with a partner was highest. More evidence of this was seen in the nonsignificant correlations between sexual arousal and activity with a partner. Therefore, it was concluded that the sexual arousal responses of the women in the Married and Pill groups were not influenced by participation in sexual activity with a partner. Furthermore, nonsignificant correlations between sexual arousal and masturbation and orgasm indicated that sexual arousal was not related to these sexual activities either.

Sexual activity with a partner. Sexual activity for the two partner groups was examined independently of sexual arousal in order to assess whether fluctuating ovarian hormones or the presence of a sexual partner could have influenced the patterns of responding. Since many earlier studies have reported a peak in sexual activity during the postmenstrual phase, which was due to the influence of the partner, this outcome was predicted for both the Married and Pill groups. For the Married Group, an increase in sexual activity was also predicted to occur during the ovulatory phase due to increased levels of estrogen and testosterone. Visual inspection of the data for both groups showed the expected increase during postmenses, but no increase at midcycle for the Married Group. A significant difference among the phases was found for the Pill Group only, but it was not possible to demonstrate statistically that the level of responding for the postmenstrual phase differed from that during menses or the other phases. Therefore, conclusions about the effects of ovarian hormones and the presence of a sexual partner cannot be made based on these findings. Consequently, it was not possible to evaluate the notion of McCollough (1973), Adams and Gold (1981), and Spitz et al. (1975) that a postmenstrual peak in activity occurs in response to a period of abstinence during menses.

It should be pointed out that the pattern of activity for the Pill Group was similar to that found in a study by Adams et al. (1978) in which the sexual activity of women taking oral contraceptives was investigated. Data from both studies showed a postmenstrual peak in activity after a period of low responding. The peak is followed by a trough and a subsequent spurt in responding. The pattern occurs repeatedly across the cycle. Since hormonal factors could not account for the repetitive pattern, it remains to be determined what factors operate to produce this phenomenon.

Masturbation. Since masturbation is the only type of sexual behavior celibate women participate in, it was considered vital that it be examined in this study. The finding that the Celibate Group did not have significantly higher frequencies of masturbation than the other two groups was unexpected. It was assumed that celibate women would compensate for the lack of a sexual partner by engaging in masturbation more often than women with partners. It is not clear why this was not observed.

The frequency of masturbation for the Celibate and Married groups was expected to peak during the ovulatory phase. Although there were no statistically significant differences among the phases, it is clear from the data that the highest frequency of masturbation for the Celibate Group occurred during the preovulatory phase. In contrast, the Married Group showed the highest levels of masturbation occurring during the ovulatory phase. For the Pill Group, a peak in masturbation took place during the ovulatory phase. However, it did not differ significantly from the low levels of responding occurring during the other phases. It is not possible to conclude from these results that masturbation was influenced by hormonal factors.

Orgasm. Orgasm was another aspect of sexual activity examined in this study. Although there were non-significant differences in the overall orgasm scores among the three groups or among the phase scores, the data showed different patterns for each group.

For the Celibate Group, the pattern of orgasm, which showed a pronounced peak during the preovulatory phase, was identical to that for masturbation. As would be expected, high positive correlations were found between the two measures. For the Married Group, increases in orgasm occurred during the postmenstrual and preovulatory phases with the highest level occurring during the ovulatory phase. For the Pill Group, orgasm peaked during the postmenstrual and ovulatory phases. Correlations were performed among the measures of orgasm, masturbation, and sexual activity. While masturbation and sexual activity with a partner were not related, a strong relation was found between masturbation and orgasm for all subjects, and between sexual activity and orgasm for all but three of the subjects. It was concluded that the frequencies of orgasm for the two groups were the result of the cumulative contributions of both sexual activity with a partner and masturbation.

Concluding remarks. The results did not support the notion that cycle phase or the presence of a partner would influence female sexual responding since most of the Friedman analyses produced non-significant differences among the phases. This non-parametric test is conducted by ranking the phase means of each subject within a group. There were large individual differences within the groups in the pattern of responding which resulted in large variations in the ranks. Since the size of the groups was small, these variations did not allow real differences between the phases to be identified. Larger groups would have permitted the use of more powerful parametric analyses. This would be the most appropriate analysis for this type of data because the actual scores would be analyzed rather than the ranks and a Phase x Group analyses of the data would have been possible.

A review of earlier research revealed that the use of limited statistical analysis is common in menstrual cycle reseach. While some studies used analysis of variance, they compared only a limited number of cycle days (Abramson et al., 1976; Adams et al., 1978; Englander-Golden et al., 1980). Others used t-tests to analyze for differences between selected days of the cycle only (Luschen & Pierce, 1972; Udry & Morris, 1968). Still others relied entirely on visual inspection of graphed data (Hart, 1960; McCance et al., 1937; Moos et al., 1969; Morris & Udry, 1977; Udry & Morris, 1969). It is possible that had these researchers analyzed the data by multiple, endocrinologically based phases, as was done in this study, no statistically significant results would have been found. The logical question to ask at this point is whether there is a true menstrual cycle effect on sexual activity, or whether the small non-significant differences between phase means, found in this study, reflect typical fluctuations in sexual behavior.

Many researchers believe that the effects of hormones on sexual behavior, so evident in the primate studies of Michael (1980), are active but are masked in the studies of human sexual responding (Dmowski, Luna, & Scommegna, 1974; Hoon et al., 1982; MacGriffith & Walker, 1975; McCauley & Ehrhardt, [illegible]). Their opinion is that other factors, including environmental, idiosyncratic, situational, sociocultural, and psychological, influence the sexual behaviors of women so that the hormone influences cannot be easily detected. However, other researchers are convinced that hormone influences could be detected if sophisticated procedures, such as daily measurement of plasma hormone levels, were used (Udry & Morris, 1977; Whalen, 1975).

The present researcher concurs with the notion that hormones influence female sexual responding. Some support for this notion appears in the sexual arousal, masturbation, and orgasm data in the present study for the two normally cycling groups. While not statistically significant, a systematic pattern of gradual increase and decline can be seen for all measures, with the lowest levels of behavior occurring during the menstrual and luteal phases, and the highest levels occurring at midcycle. This kind of pattern could be meaningful, since during the first half of the cycle, it seems to parallel the increases in estrogen and testosterone which are known to influence behavior positively. During the second half of the cycle, the pattern declines when progesterone, which is known to have an inhibitory influence on behavior, dominates the cycle. In the future, it may be possible to demonstrate a statistically significant pattern when research is conducted by using improved methodologies similar to those of the present study, by recruiting a larger number of participants, and by using more powerful statistical analyses.

The original SAI was designed to measure sexual arousability. For the present study, it was modified in form and in the manner of presentation so that it was used as a daily sexual stimulus to elicit sexual arousal. Since the scores of the SAI did not correlate with sexual activity, the instrument seems to measure a behavioral dimension which is independent of sexual activity involving a partner. In order to state that the SAI scores represented levels of sexual arousal, the construct validity of the modified instrument has to be established by concurrently measuring sexual arousal with both the SAI and a valid, well-known physiological method.

Breast skin temperature. Another primary purpose of this study was to collect breast skin temperature data from normally cycling women in order to duplicate the pattern of cyclic changes reported in earlier research (May & Smith, 1977; Nasser & Smith, 1975). These studies had shown a peak during the preovulatory phase which had been interpreted as reflecting the dramatic increase in estrogen. Visual inspection of the data for the No-Pill Group showed a similar temperature pattern. Skin temperature was higher in the preovulatory phase than in the phase preceding or following it. However, the preovulatory increase did not differ significantly from the ovulatory phase mean. This finding may have resulted from a slight methodological variation in the present study. The data for the preovulatory phase was collected two days earlier in the cycle than the four to two days before the predicted day of ovulation reported in earlier research. This important methodological difference was considered responsible for the data variations.

The temperatures for the chest control site varied similarly to breast temperature and were shown to correlate with it. It was suggested that this control site was in close proximity to the breast tissue and was probably supplied with blood by the same arteries as the breast. This could account for the parallel temperature fluctuations. Both the breast skin and the chest control site temperatures were similar to the pattern of breast temperature shown in previous studies. However, since the chest site produced a higher temperature during the preovulatory phase than the actual breast site, it is suggested that the upper-inner quadrant of the breast, the site measured in this study, is not the most suitable one. The lower-inner quadrant, the breast site closest to the chest control site, may be a preferred area for temperature measurement because it could produce a more pronounced preovulatory temperature peak.

In contrast to the chest site, the temperature recordings from the arm site of the No-Pill Group were stable across the cycle. Since the variations in arm temperature did not parallel those of the breast, it would appear that cyclic fluctuations in breast skin temperature are unique to that site, and occur independent of body temperature changes at other sites. Furthermore, since the breast skin temperatures of the Pill Group did not differ significantly across the phases, it was concluded that the breast skin temperature pattern of the No-Pill Group was a phenomenon which occurred to normally cycling women only.

Wilson et al. (1979) concluded that breast skin temperature could be used as a cycle index to predict ovulation. Although the results of this study indicated a preovulatory rise in temperature, this measure is not recommended as a cycle index because the preovulatory phase rise was not pronounced enough to warrant using breast skin temperature in clinical practice. As a research tool breast skin temperature presents some serious procedural barriers which limit its use. The most current method of obtaining data is to measure temperature with the thermistor probes taped to the skin of the subject. This requires the exclusive use of a room with elaborate heating equipment, thermistors and telethermometers, and laboratory technicians to arrange the probes and monitor the temperature. Furthermore, because of the prohibitive time commitments, it is difficult to recruit women who are willing to come to the laboratory at the same time every day, including weekends, for one full menstrual cycle. A simpler method of measuring temperature, such as a heat sensitive halter that could be used at home, is needed. The current techniques are not considered feasible for future menstrual cycle research since the above described disadvantages outweigh any advantage breast temperature may provide to menstrual cycle researchers.

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Appendix A

Consent Form

This study is concerned with the relation between changes in the sexual arousal and breast skin temperature of women. Your participation consists of a 15 minute home routine, and a 30 minute laboratory routine every day for approximately five weeks. We have selected the onset of the monthly period as the starting point.

The daily home routine involves the completion of a sexual arousal and activity questionnaire, and the recording of oral temperature (with a thermometer provided by us), vaginal mucus changes, abdominal pain, other physical discomfort during the day, and any unusual happenings (e.g., illness, unusual food desires).

The lab routine involves the measurement of breast skin temperature at the same time every day in a room located in the Hall Building of Concordia University. In a comfortable and relaxing setting, you will be asked to lie on a cot with your upper garments removed. The woman conducting the study will tape several probes on your skin with a gentle, hypoallergenic tape. The probes, which are attached to a temperature recording device, are completely safe. They are sensitive to the temperature of your skin surface, just as a thermometer placed under your tongue is sensitive to your body temperature. You will remain in this position for 30 minutes to allow your body temperature to acclimatize to the room temperature. During this period, the experimenter will record the breast skin temperatures. At no time will anyone else be permitted to enter.

All the data provided by you will be kept confidential, and only the experimenter will know your identity.

At the end of your participation, after you have fulfilled all the requirements of the project as outlined in the Instruction Sheet, you will be paid $75.00, and, you may keep the thermometer for your personal use.

You are free to withdraw from the study at any time you wish. We may ask you to withdraw from the study if, (a) you miss more than one lab session, (b) if you are repeatedly late for your appointments, (c) if you fail to complete and bring your forms to the lab more than once, or (d) if you miss taking your oral temperature daily for more than one day.

If you withdraw or you are asked to withdraw from the study after the third week, you will be paid $15.00. If your participation is terminated earlier, you will not receive any remuneration.

I have read and fully understood the above procedures and terms of participation. I agree to be a participant and will start on

_______________________.

Participant_______________________

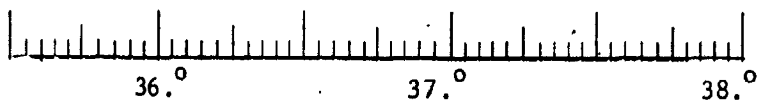
Experimenter_____________________

Date___________________________

Appendix B

Date_______________________ Code no._______________

1. Body Temperature



2. Vaginal Discharge: check the most appropriate ones

Period: heavy bleeding_____ light bleeding_____ brown spotting_____

Genital Sensations of Wetness

_____dry
_____moist
_____sticky
_____wet
_____slippery
_____lubricated

Characteristics of Discharge

1. Color:

_____white
_____yellow
_____transparent
_____cloudy (partially transparent)
_____pink (blood streaked)

2. Consistency:

_____thick
_____liquid (watery)
_____stretchy (consistency of egg white)

3. Quantity:

_____none
_____scant
_____moderate
_____abundant

Other than above due to sexual activity:_______________________

3. Abdominal Pain:

_____abdominal pain
_____abdominal cramp
_____back pain
_____none

4. Breast Changes:

_____heaviness
_____Larger
_____more sensitive
_____painful
_____no change

5. Unusual Food Desires: Yes_____ No_____

If yes, describe____

Quantity of Food Consumed:

_____usual amount

_____more than usual

_____less than usual

6. Any Unusual Happenings: Yes_____ No_____

If yes, describe____

7. Sleep: Slept well_____ Restless_____ How many hours did sleep_____

8. Weight:________

How sexually aroused would you feel if you were to experience this today?

		Repulsed			Unaroused			Aroused			
	Extremely				Mildly		Mildly				Extremely
1 A partner kisses you with an exploring tongue.	-5	-4	-3	-2	-1	0	1	2	3	4	5
2 You make love in a new or unusual place.	-5	-4	-3	-2	-1	0	1	2	3	4	5
3 You read suggestive or pornographic poetry.	-5	-4	-3	-2	-1	0	1	2	3	4	5
4 You see pornographic pictures or slides.	-5	-4	-3	-2	-1	0	1	2	3	4	5
5 A partner fondles your breasts with hands.	-5	-4	-3	-2	-1	0	1	2	3	4	5
6 A partner stimulates your genitals with fingers.	-5	-4	-3	-2	-1	0	1	2	3	4	5
7 You lie in bed with a partner.	-5	-4	-3	-2	-1	0	1	2	3	4	5
8 You dance with a partner.	-5	-4	-3	-2	-1	0	1	2	3	4	5
9 A partner stimulates your genitals with mouth and tongue.	-5	-4	-3	-2	-1	0	1	2	3	4	5
10 You have intercourse with a partner.	-5	-4	-3	-2	-1	0	1	2	3	4	5
11 A partner undresses you.	-5	-4	-3	-2	-1	0	1	2	3	4	5
12 A partner touches or kisses your nipples.	-5	-4	-3	-2	-1	0	1	2	3	4	5
13 You are touched and kissed on the inner thighs by a partner.	-5	-4	-3	-2	-1	0	1	2	3	4	5
14 A partner kisses you passionately.	-5	-4	-3	-2	-1	0	1	2	3	4	5

15. The highest levels of physical sensations I experienced were:

	None	Mild	Moderate	Strong
(a) General excitement	0	1	2	3
(b) Breast sensations	0	1	2	3
(c) Genital sensations	0	1	2	3
(d) Vaginal dampness	0	1	2	3

16. In the past 24 hours I have engaged in: (circle the appropriate number of times)

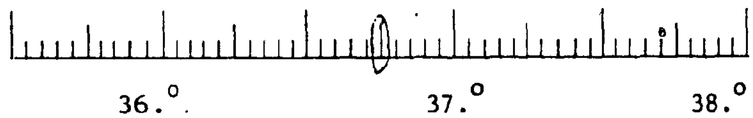
	Zero	Once	Twice	Three times	Four or more times
(a) Masturbation	0	1	2	3	4
(b) Intense sexual activity with a partner not involving intercourse.	0	1	2	3	4
(c) Orgasm	0	1	2	3	4
(d) Intercourse	0	1	2	3	4
(e) Other (petting, necking)	0	1	2	3	4

PLEASE CHECK TO BE SURE YOU HAVE ANSWERED EVERY ITEM

Appendix C

Instructions

1. Take your temperature on waking every morning, before getting out of bed. Sexual activity, drinking, or eating will change your basic body temperature, so please refrain from these activities until after your temperature has been taken. If you have to get up for some reason, like answering a phone or checking the baby, please try to rest for one-half hour before taking your temperature. If even this is impossible, take your temperature anyway and describe the circumstances on the form for that day. To take your temperature, put the thermometer under your tongue and leave it there for seven minutes. Later in the day, record the temperature reading. Using the centigrade scale, circle the line closest to where the mercury in the thermometer stopped. For example-



After recording the temperature, shake the mercury down, and place the thermometer close to your bed for the next day.

2. Starting after your period ends, check your vaginal discharge every day. You can examine the discharge on your underwear, on toilet tissue, or you can take a sample by inserting a finger just inside the vaginal opening. You can expect changes in genital sensations of wetness, and in the quantity, color, and consistency of the discharge during your participation. You will feel a dry sensation at first (not usually noted in IUD users), and find little or no discharge. Then a slight, moist sensation may be felt, accompanied by a scant, sticky white mucus. This is followed by an increasing feeling of wetness, until the vaginal area feels lubricated. The mucus becomes abundant, watery, and transparent. At the same time it may have the appearance and consistency of raw egg white, and may be stretched between two fingers. Streaks of blood may also appear at this time. Then the discharge will become cloudy, and eventually will again become scant, thick, and white. It is best to check the discharge several times a day. Secretions from previous sexual activity (vaginal lubrication or semen), contraceptive foam or cream, and douching will temporarily change the appearance of the discharge. By checking it several times a day, you should be able to determine your regular daily discharge. If you are still uncertain, please explain the circumstances on the form for that day, and indicate the discharge characteristics that seem most appropriate.

3. You may experience lower abdominal pain or cramps, and/or back pain at various times during your participation. You may also experience breast changes in size, sensitivity, or pain. Please record these.

4. Weigh yourself every other day on the same scale and at the same time, if possible. Try to wear the same amount of clothing too.

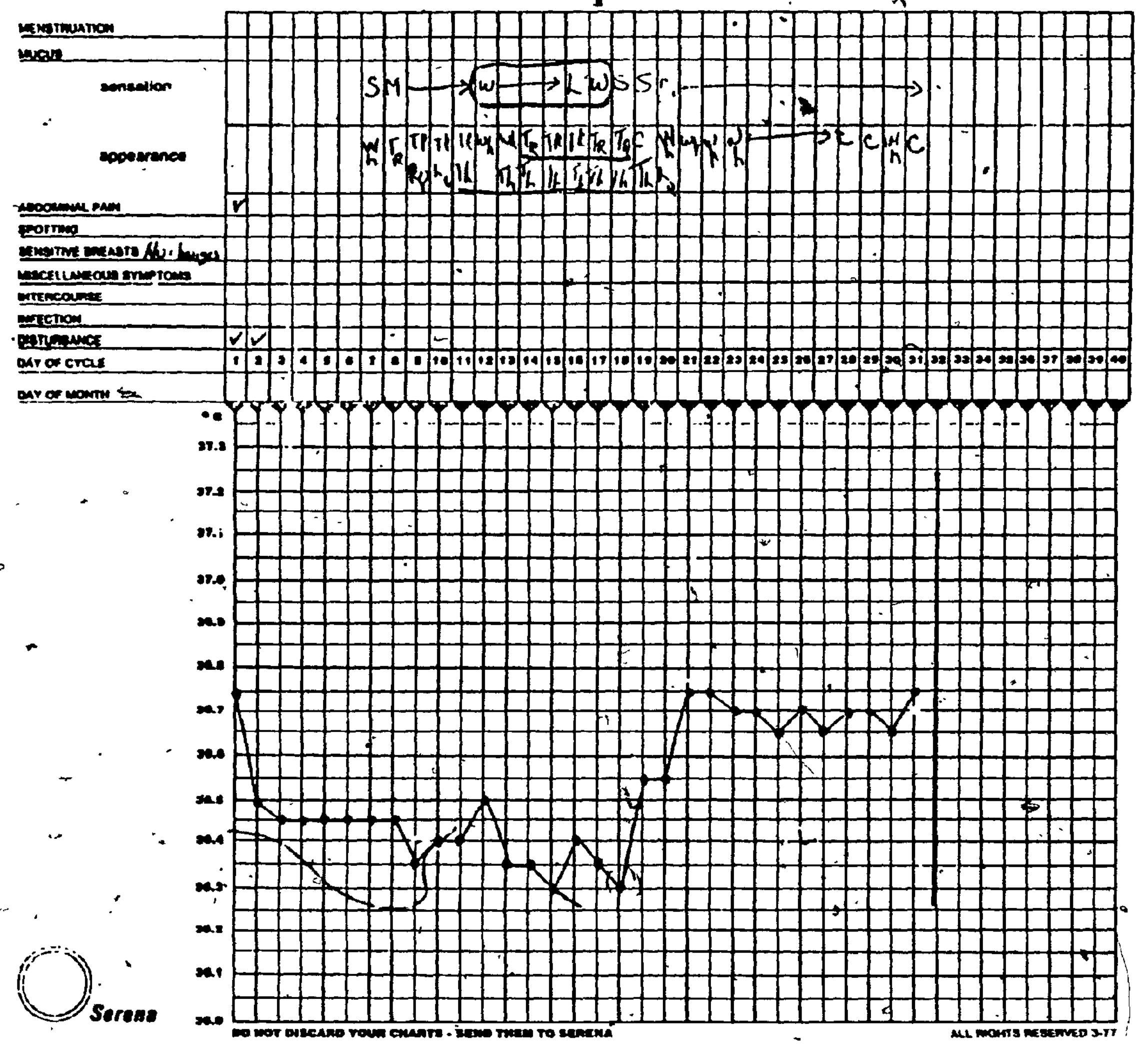
5. Unusual happenings or disturbances involve things such as illness, trauma, injury, upset, elation, or excessive fatigue. These happenings can alter your body temperature, so please record them on the day they occur.

6. Complete the sexual arousal questionnaire every day. The questionnaire contains 16 items which require about ten minutes a day to complete. The items deal with sexuality and, therefore, are highly personal. For this reason, please find a quiet, private place where you can fill out the questionnaire at the same time every day. Items 1 to 14 describe various situations that could or could not be sexually arousing to you today. Please read each item carefully and for a few seconds visualize yourself actively involved in each situation. After you have imagined this, think about how sexually aroused or repulsed you would feel if you were to experience each situation today. Then circle the number that best describes your feelings of arousal. At the same time try to pay attention to the physiological sensations of vaginal dampness, genital sensations, and breast sensations as described in item 15. Please circle the number that best describes the highest level of physical sensation you experienced while imagining yourself in the various situations. Item 16 is concerned with the types of sexual activity you engaged in during the previous 24 hours. Please reply "yes" or "no" to each of the five choices. There are no right of wrong answers to any of the items. If you are not certain about an item, circle the number that seems about right. If you have difficulty answering the questionnaire on any particular day, please write a brief explanation on the bottom of the sexual arousal questionnaire. Be sure to answer every item.

7. Please bring both completed forms to the lab the following day. That is, bring today's completed forms to the lab tomorrow. If you forget to complete any of the questions, please don't guess or try to remember how you would have felt yesterday. Just bring the incomplete form to the lab.

8. Please do not engage in strenuous exercise or consume any hot or cold drinks for at least one-half hour before arriving at the lab for breast temperature measurement.

Appendix D



TEMPERATURE:
VAGINAL ☐
RECTAL ☐
ORAL ☒

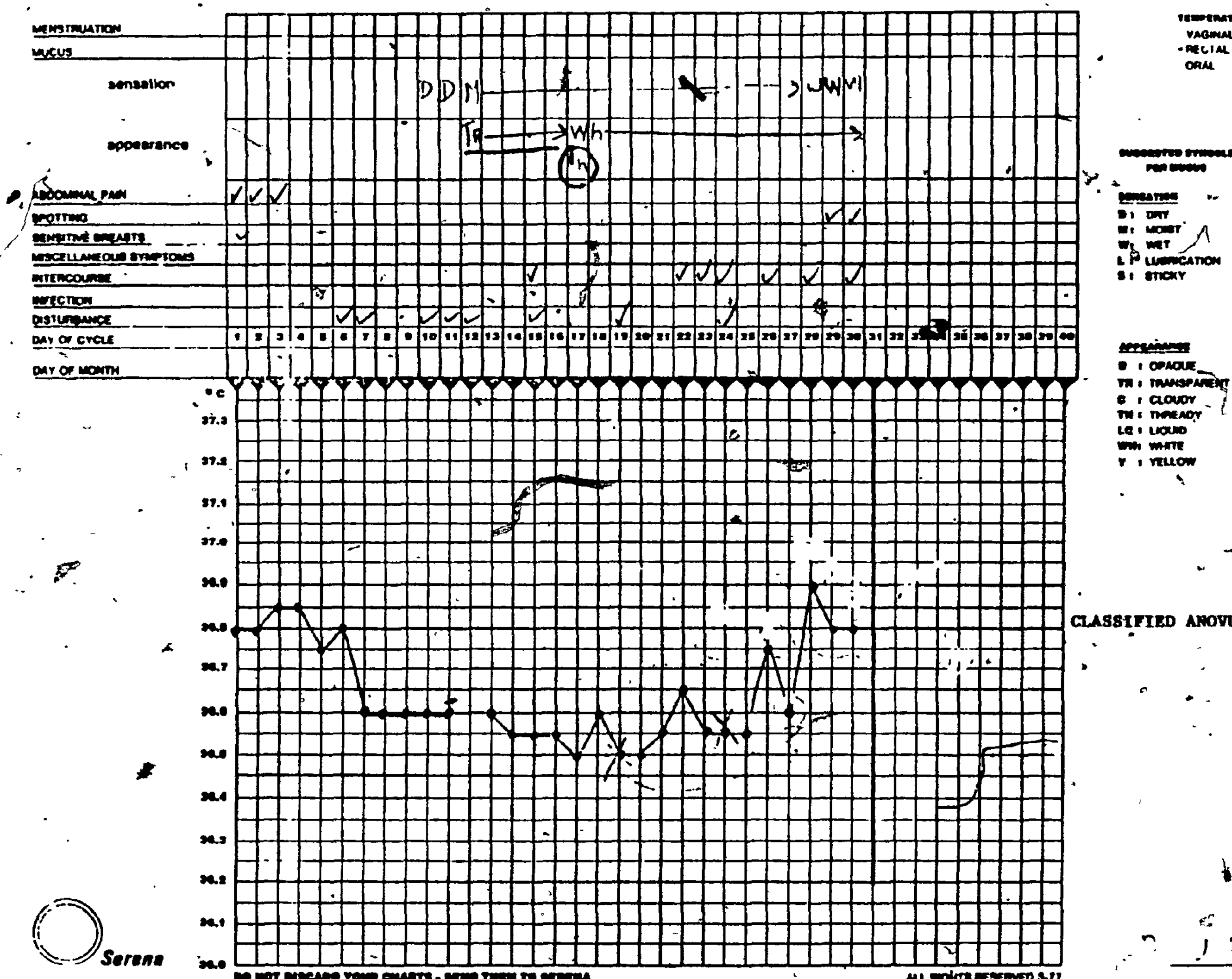
SUGGESTED SYMBOLS FOR MUCUS

SENSATION
D : DRY
M : MOIST
W : WET
L : LUBRICATION
S : STICKY

APPEARANCE
O : OPAQUE
TR : TRANSPARENT
C : CLOUDY
TH : THREADY
LQ : LIQUID
WH : WHITE
Y : YELLOW

CLASSIFIED OVULATORY

NO.



CLASSIFIED ANOVULATORY