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INTERPERSONAL INFLUENCES ON THE MENSTRUAL CYCLE

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INTERPERSONAL INFLUENCES ON THE MENSTRUAL CYCLE

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To Kerry for his inspiration

And to my parents for their love and support

ABSTRACT

The extent to which the interpersonal environment, both male and female, influences the menstrual cycle was explored. One hundred forty women who were dormitory residents of a coeducational university kept monthly records for the spring semester. Both male and female companionship were found to influence the timing of the menstrual cycle. The menstrual cycles of roommates who were not using birth control pills were found to synchronize more closely than the control group of roommates who were on the pill or whose companion was on the pill. Friend pairs who were not using birth control pills also synchronized more than the control group of friend pairs who were influenced by the pill. Roommates who were also friends were found to synchronize more closely than roommates who were not friends and members of friend pairs who felt close to each other were found to synchronize more closely than members of friend pairs who did not feel close. For extraversion and neuroticism, as measured by the Eysenck Personality Inventory, friends who were similar in personality type tended to synchronize more closely. Women who spent more time with males were found to have shorter and more regular menstrual cycles regardless of degree of intimacy. Social-sexual contact with males was identified as a suppressor variable in research on lunar relations with the menstrual cycle. Women with high social-sexual contact with males were found to menstruate further from the full moon, indicating a tendency to ovulate with the full moon. The evolutionary bases of interpersonal influences on the menstrual cycle were suggested. Possible neurological mechanisms involved in such influences were discussed and the emotional contagion theory of menstrual synchrony was presented.

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INTRODUCTION

The menstrual cycle is one of the most easily recognized natural biological rhythms in humans. Although the menstrual cycle has been the focus of much research, the relationship between the behavioral and physiological phenomena is still not completely understood. Since the classic studies of Benedek and Rubinstein (1939a, 1939b) a body of research correlates both subjective mood swings and behavioral changes to periodic variations in the hormone levels occurring with the menstrual cycle. While hormone levels are readily accepted as having an influence on behaviors, the possibility that behavioral events may influence hormone levels is seldom considered. The interpersonal environment may have such an influence on hormones, thus influencing the timing of the menstrual cycle.

The menstrual cycle may be influenced by both male and female companionship. One measure of female companionship influences is menstrual synchrony. Menstrual synchrony refers to the temporal proximity of menstrual cycles between females as measured by the onset of bleeding during menses. No research to date has found a significant correlation between phases of the moon and menstruation; in fact, there is considerable scatter in the timing of menstrual cycles between individual women (Pochobradsky, 1974). Thus, menstrual co-cycling between women is not expected to occur by chance. The menstrual cycles of women may also be influenced by their social-sexual contact with males. Animal research has explored the varied effects of social grouping on reproductive functions, and old-wives tales in humans flourish. Yet the only published research on interpersonal influences on the human menstrual cycle is based on retrospective surveys.

Studies of influences on the menstrual cycle have obvious value when the extent to which this natural rhythmical cycle influences women is considered. The varied effects of the menstrual cycle, too broad to be described here, have been reviewed in detail by others.

Southam and Gonzaga (1965) have summarized the many physiological changes which occur during the menstrual cycle in addition to the well known hormonal variations. This comprehensive catalogue includes changes in body temperature, pulse rate, sodium and water retention, blood chemistry, adrenal and thyroid functioning, basal metabolism, and autonomic nervous system functioning.

The cognitive, emotional, and behavioral changes which occur with the menstrual cycle have been reviewed (Dan, 1976; Dennerstein & Burrows, 1979; Ferdman, 1973; Parlee, 1976) as have cyclical fluctuations in sexual behaviors over the menstrual cycle (Kane, Lipton, & Ewing, 1969; McCauley & Ehrhardt, 1976). Feelings of irritability, anxiety, depression, tiredness, and physical discomfort such as headaches or cramps are some of the premenstrual and menstrual symptoms commonly cited in these reviews, with estimated incidence ranging from 20% to 95% among normal women.

The pioneering work of Benedek and Rubenstein (1939a, 1939b) demonstrates the more subtle influences of the menstrual cycle. During the course of psychoanalysis of nine females diagnosed as neurotic, Benedek was able to predict the phase of the menstrual cycle solely on the basis of changing sexual content in her patients' reports of dreams.

Rubenstein's analysis of vaginal smears independently corroborated these predictions. Benedek and Rubenstein correlated the hormonal changes with the parallel emotional changes to develop the classic somatopsychic model of the sexual cycle in women. More recently, other investigators have confirmed the theory of changing dream content with different phases of the menstrual cycle using EEG sleep laboratory techniques (Hertz & Jensen, 1975; Lewis & Burns, 1975; Swanson & Foulkes, 1968).

Not only does dream content change in conjunction with the menstrual cycle, but actual time spent in the dream state is related to the menstrual cycle as well. Hartmann (1966) found a tendency for an increase in the time spent in dreaming sleep or Rapid Eye Movement (REM) sleep late in the menstrual cycle. The percentage of time spent in REM is fairly constant for young adults but can be influenced by stress or depression. For all seven subjects, REM time increased with the approach of menses although there was no relationship between total sleep and the menstrual cycle. The extent of such subtle changes as dream content or time spent in REM make evident that the menstrual cycle influences women in rhythmical ways even beyond the individuals' conscious awareness.

The works of Katherina Dalton, a physician working in England, are frequently cited to illustrate the dramatic behavioral changes occurring during the menstrual cycle. She has shown that women in their paramenstruum (four days before to four days after the onset of menses) constituted 45% to 52% of all cases of psychiatric admissions, acute medical and surgical admissions, suicide attempts, accidents, and crimes among women (1964). Dalton (1972) later reported a mid-cycle peak in addition to the paramenstruum increase in acute psychiatric disturbance, attempted suicide, and depressive illness.

Although the work of Dalton has been criticized for poor statistical techniques and lack of control procedures (Sherman, 1971; Sommer, 1972), other studies have confirmed her findings of menstrual correlations with suicide attempts and psychiatric admissions. Suicide attempts and ideations have been found to be greatest during paramenstruum followed closely by a mid-cycle peak associated with the hormonal changes of ovulation (Mandell & Mandell, 1967; Tonks, Rack, & Rose, 1968). Studies have also replicated an increase in psychiatric admissions during paramenstruum (Jacobs & Charles, 1970; Janowsky, Gorney, Castelnuovo-Tedesco, & Stone, 1969).

The amount of research validating a wide range of physical, emotional, and behavioral changes in conjunction with the menstrual cycle makes it difficult to dispute that such changes do occur. While this type of research gives credence to the value of studies of influences on the menstrual cycle, it is important to note that rhythmical fluctuations are not exclusively a female phenomenon. Men too have been found to have cyclical variability.

Hersey's (1931) pioneering study found, on the basis of self reports and daily observations of behaviors, cycles of emotionality in males. These cycles were constant and predictable for the individual within one week but varied from three and one-half to nine weeks in length for all men studied. Hersey (1932) later reported not only recurrent emotional fluctuations in twenty-nine men of various occupations but also showed that work production as well as social and home activities were affected by these cycles.

Near-monthly periodicities in men have also been found in muscle strength (Peaks, 1921), behavioral measures (Thommen, 1964), urinary excretion of 17-hydroxycorticosteriods (Curtis, 1974; Halberg, Engeli, Hamburger, & Hillman, 1964), judgments of pitch of tones and reaction times (Wynn, 1973), body weight and grip strength (Kuhl, Lee, Halberg, Gunther, & Knapp, 1974), and testosterone levels (Doering, Kramer, Brodie, & Hamburg, 1975; Harkness, 1974). Records have also shown cyclically recurring symptoms of physical and mental illness (Richter, 1968) and lunar cycle influences in the occurrence of violent crimes in both men and women (Lieber & Sherin, 1972).

Inferences that cyclical variability is exclusively a female experience have obvious ramifications. In the early 1970's, Dr. Edgar F. Berman gained national attention when he stated during a Democratic policy meeting that women are emotionally unfit for high office and decision making jobs because of menstrual periods and menopause. The resulting public outrage forced Dr. Berman to resign from the committee (Winter & Anderson, 1971).

The menstrual cycle has been used to reinforce traditional prejudices against women. The cultural bias towards women is reflected in the common expressions "she has got the curse" or "is on the rag." However, further research can help abolish the mystique and prejudices surrounding the menstrual cycle. When viewing biological rhythms in the larger context of variability for both women and men, women have a distinct advantage in potentially understanding their natural fluctuations. Unlike the rhythms of men, the menstrual cycle is easily recognized. Rather than being helpless victims of the changes occurring in conjunction with the menstrual cycle, with further research women can better understand their natural rhythmical cycles.

While much emphasis has been placed on the extent to which the menstrual cycle influences women, little attention has been given to research of influences on the menstrual cycle. The present study is concerned with the extent to which the interpersonal environment, both male and female, influences the menstrual cycle in women and the mechanisms involved in interpersonal influences.

REVIEW OF THE LITERATURE

Human Synchronization with the Menstrual Cycle

Dalton, who is best known for calling attention to the dramatic behavioral changes occurring during the menstrual cycle, was perhaps the first to note that the behaviors of others in the interpersonal environments of women were in synchrony with the menstrual cycle. She found that during paramenstruum women were more likely to take their children to the doctor for minor coughs and colds (1966) and to a hospital emergency room for more serious problems (1970). Dalton suggested that the endocrine states of women actually affect other people causing their children's need for medical attention. Dalton (1972) further supported this view by showing that coughs and colds in children recurred on a regular monthly basis in conjunction with their mother's menstrual cycle. Furthermore, not only did female job absenteeism and work performance correlate with the woman's cycle, but the husband's work performance was often found to be adversely affected by his wife's cycle as well.

On the basis of a series of retrospective surveys, McClintock (1971) found interpersonal influences on the timing of the menstrual cycles of 135 residents of a women's college dormitory. She showed that roommates and pairs of close friends, as indicated by the amount of time spent together, tended to menstruate simultaneously. When grouped on the basis of arrangement of rooms and close friend groups, no significant increase in menstrual synchrony was found for geographic groups while synchrony was found for friend groups. Although all subjects ate as a group in a common dining room, had similar life patterns and common stress periods, synchrony was not found for random pairs from the dormitory. Synchrony due to a photoperiodic effect was not likely as roommates, who share a common light-dark pattern, did not synchronize more than close friends. The influence of interpersonal relations was further illustrated by McClintock's finding that subjects who estimated that they saw males less than three times per week experienced significantly longer cycles.

Synchronization of body temperature cycles between cohabiting male-female couples has been shown by Henderson (1976). When the woman experienced a mid-cycle temperature drop associated with ovulation, there was a similar temperature fall in the cohabiting male. Following this, the male's body temperature also rose to a higher level for two to five days in synchrony with his female companion's luteal phase (post ovulatory) temperature rise. Body temperature synchrony was also found between homosexual males living together as well as cohabiting male-female pairs. Behavioral synchrony may be suggested by Henderson's findings that men, like women, are more subject to migrane headaches, depressed mood, asthma, and alcoholic bouts during the body temperature rise that occurs premenstrually. Furthermore, interpersonal difficulties were more prevelant when loss of body temperature synchrony occurred. The male temperature cycle was not found when the female companion began taking oral contraceptives or became pregnant.

Dan (1976) revealed behavioral synchronization with couples. To explore the extent to which normal hormonal changes of the menstrual cycle add variability to women's behavior, the daily activity levels of women were compared with that of their husbands. Not only was the variability of activities as great for males as for females, but the activity cycles of husbands were in concurrence with much of the menstrual cycles of their wives. Activity levels dropped for both men and women during menstruation, followed by a peak during the follicular phase, dropped with ovulation, and rose with the luteal phase. Activity levels of couples did not change in concurrence during the premenstrual phase as the number of activities decreased for the women but increased for the men. In spite of this difference, premenstrual activity levels were still higher for women than men as they were throughout the cycle. Women taking oral contraceptives differed from normal women in their activity patterns and also did not show behavioral synchronization with their husbands.

The lack of body temperature and behavioral co-cycling between male-female couples when oral contraceptives are involved may provide a hint about the mechanisms involved in menstrual synchrony between females. As the combination-type pill alters the levels of both estrogen and progesterone, the natural hormonal rhythm and ovulation are lost. Yet, the number of differences between women on oral contraceptives and normal women make it difficult to ascertain which sensory system or systems are responsible for menstrual synchrony.

Women taking oral contraceptives have been shown to differ from normal women in many ways. The normal mood swings associated with the menstrual cycle are not as apparent in women taking oral contraceptives (Grant & Pryse-Davis, 1968; Herzberg & Coopen, 1970; Kutner & Brown, 1972; Moos, 1968; Paige, 1971; Silbergeld, Brast, & Noble, 1971). While visual acuity changes with phases of the menstrual cycle for normal women, there are no cyclical changes for men or for women taking oral contraceptives (Diamond, Diamond, & Mast, 1972). The considerable evidence indicating loss of sex drive with oral contraceptives has been reviewed (Dennerstein & Burrows, 1976) and more recently reaffirmed (Adams, Gold, & Burt, 1978). Women on oral contraceptives also have lower amounts of vaginal secretions of volatile aliphatic acids and do not show rhythmic changes in acid content during the menstrual cycle as do normal women (Michael, 1974). Women not taking oral contraceptives show the highest levels of volatile acids in the pre-ovulatory phase of the menstrual cycle. These pheromones (chemicals secreted by one animal which influence the hormone levels or behaviors of another animal) possess sex attractant properties in the rhesus monkey and stimulate the sexual activity of males via olfactory pathways. While all of these clues to possible influences on menstrual synchrony are tantalizing, the actual mechanisms involved still remain a complex but intriguing mystery.

Non-Menstrual Physiological Synchrony

A better understanding of the possible mechanisms involved in menstrual synchrony may be gained through other studies of socially mediated physiological synchrony. Modifications of physical states may reflect corresponding changes in affective states. The influence of psychological and environmental factors on the endocrine systems is widely accepted. The sensitivity of the pituitary-adrenal cortical system to these influences which alter the emotional state is one of the most thoroughly documented reactions of the endocrine systems. Adrenal cortical hormones are measured by the biochemical levels of seventeen hydroxycorticosteriods (17-OHCS) in blood or urine. Elevation of 17-OHCS levels may reflect emotional arousal or involvement (Mason, 1968).

Mason (1959) has reported evidence that 17-OHCS levels of individuals working or living together tend to cluster in a narrow range. In one study, three groups of five or six men were tested on the day before a period of sleep deprivation. Each of the three groups showed a close cluster in their 17-OHCS levels after living closely together for approximately one week. This effect was not solely the result of stress as all men were tested in the same situation and the mean values for each of the three groups were different. In a second study, a similar phenomenon was also found in three closely working crew members of a B-52 jet on a twenty-two and one-half hours nonstop flight. The three crew members showed remarkably similar 17-OHCS levels, which differed from that of the pilot who had different responsibilities and was located at the front of the jet, separate from the others.

Mason (1964) also found conformity of this hormone response for voluntarily hospitalized normal young adults. Three groups of seven to thirteen college-age adults lived closely together for weeks or months while a variety of tests were made. Urinary 17-OHCS levels were taken on the first day of hospitalization and after each group had lived together for a week or longer. The first two groups, consisting of all females, showed a cluster of 17-OHCS levels after living together and a different mean value for each group. The third group, which was a mixed sex ward, did not show a cluster effect as 17-OHCS levels remained scattered even after five weeks on the ward. Mason cites a study (Fishmann, Hamburg, Handlon, Mason, & Sachar, 1962) which reported higher mean 17-OHCS values for girls in mixed-sex groups as opposed to those in all-girl groups. The difference in cluster effect for groups consisting of the same sex as opposed to mixed sexes suggest that social factors may influence synchrony of 17-OHCS levels.

Other studies support the influence of social interaction on physiological covariation. Several studies have shown simultaneous physiological changes of patient and therapist. DiMascio, Boyd, Greenblatt, and Solomon (1955) reported that the pulse rates of the patient and psychiatrist at times varied together and at times varied inversely from each other. They suggest that this physiological response may be used as a measure of therapeutic rapport.

Coleman, Greenblatt, and Solomon (1956) found that the patient and therapist manifested the same pattern of heart rate response. For both, the heart rate was highest during anxiety, lowest during depression, and intermediate during hostility. The authors viewed the therapist as reacting physiologically to the patient's emotional expression in a similar manner as the patient, suggesting that the physiological relationship reflected psychological empathy. The covariation of heart rate was not found when the therapist was distracted by his own personal concerns which would interfere with a common affective response.

DiMascio, Boyd, and Greenblatt (1957) found that both patient and therapist manifested higher heart rates during periods of tension and lower heart rates during periods of tension release. An exception to this concomitant cardiac functioning was shown during times in which the patient displayed antagonism. At these times the patient's heart rate would slow down and the therapist's would speed up. However, these different physiological reactions may be explained by dissimilar emotional responses. Antagonism may be tension reducing for the patient but tension-inducing for the therapist.

Malmo, Boag, and Smith (1957) found that neck muscle tension was decreased for both the experimenter and patient following the experimenter's praise of the patient, and both displayed an increase in neck muscle tension following the experimenter's criticism of the patient. This simultaneous variation in physiological response may be the result of similar affective states for both individuals. The experimenter would be expected to feel good after giving praise but feel bad after giving criticism. This emotional response would be expected to parallel that of the patient.

The value of emotional influences on physiological covariation have been supported by other findings. Kaplan, Burch, and Bloom (1964) investigated galvic skin response (GSR) changes during standardized interactions among groups of medical students, based on sociometric relationships. In two studies, one using male medical students and the other female nursing students, simultaneous GSR changes were found for groups or pairs of individuals who had either positive or negative feelings for each other. Parallel GSR responses were not found for students who had neutral feelings for each other. Members of negative pairs were significantly more likely to covary in this autonomic response than members of either positive or neutral pairs.

Kaplan and his associates (1963, p. 106) concluded that the index of physiological covariation was "simultaneous and consensual affective investment" during social interaction. Such factors as amount of activity, simultaneity of social acts, or overt expression of negative affect could not account for the difference in physiological covariation between groups. However, affective investment would explain the greater tendency for negative pair members to covary as a result of their greater sensitivity to their own and their partners' behavior. Fewer negative choices were obtained from sociometric questionnaires so that greater intensity of affect would be expected in these relationships. Lack of physiological covariation for neutral pair members might reflect different degrees of meaning or low affective investment.

Nowlin, Eisdorfer, Bogdonoff, and Nichols (1968) found covariation in plasma free fatty acid and heart rate in pairs of subjects during standardized personal interviews. One of each pair was passively listening while the other answered questions. The observer's anticipation of answering questions would not account for his change as he had been informed that the experiment would be over when his partner finished. Post-study interview questionnaires revealed that the passive participants felt involved in the response of their partners. The authors suggested that the physiological covariation was a part of the process of empathy.

A review of the studies of non-menstrual physiological synchrony indicates that physiological covariation is not merely the result of common stress or environment. For humans, emotional involvement seems to be a key mediator for physiological synchrony to take place. During social interactions there seems to be a contagion of emotional communications. When people simultaneously share the same affective arousal, it is reasonable to assume that concomitant physiological changes may occur in unison. However, animal studies of the effects of social environments reveal evidence of the influences of other sensory systems on physiological covariation.

Effects of Social Grouping on Reproductive Functions in Animals

A great deal of research has focused on the effects of social grouping on the reproductive functions of animals. While it is beyond the scope of this paper to extensively review animal research, a brief sampling of major contributions is of value because of the widespread tendency to make inferences from the results of animal studies to human functions.

In a pioneering study, Van der Lee and Boot (1956) found that groups consisting only of female mice became anoestrous or pseudopregnant. The effect is considered to be influenced by olfactory cues because excision of the olfactory bulbs or individual housing prevented this disruption of the estrous cycle. Whitten (1956, 1958) found that the ovarian suppression of all female groups of mice was not only overcome by exposure to a male or the smell of male urine, but that the introduction of the male initiated a new cycle resulting in estrous synchronization among the females of the group.

McClintock (1978) found further evidence of the influence of pheromones on estrous synchrony in rodents. She showed that the sharing of a common air supply between otherwise isolated groups of female rats was sufficient to produce the same level of estrous synchrony found among female rats actually living together. However, Shirley (1978) reported that placement of rats in a new environment also contributed to synchrony of estrous.

Studies of primates have revealed evidence of the influence of social and behavioral cues on estrous synchrony. Rudran (1973) observed primates in their natural habitat and reported breeding synchrony and shortened gestation periods in those groups which underwent replacement of the leader male. The social grouping was considered to be a stronger influence on the sexual cycles of primates than environmental factors because breeding synchrony within several established troops living in the same area occurred at different times of the year.

Rowell (1977) reported that the reproductive cycles of the Talapoin monkey was modificable by social stimuli and suggested that the lower level of social stimulation in captivity may be a contributing factor to the lack of breeding synchrony in captive populations as compared to the wild. Michael and Bonsall (1977) have found peri-ovulatory synchronization of behavior in captive male and female rhesus monkeys but did not identify contributing mechanisms.

Although there is evidence of social and environmental influences on the synchronization of reproductive functions and on reproductive functions in general, much emphasis is placed on olfactory influences in animals. One classic finding often cited is that of the Bruce effect (Bruce, 1959; Parks & Bruce, 1961). These studies showed that if female rats were mated, about 92 percent ordinarily become pregnant. However, if the stud male is removed soon after insemination and the female mice are exposed to a strange male or the smell of a strange male, about 80 percent of the females return to estrous. The female mice failed to develop adequate corpora luteum, suggesting that change in secretion of luteinizing hormone caused the pregnancy block. As in both the Lee-Boot (1956) and Whitten (1956, 1958) effects, the Bruce effect did not occur in females rendered anosmic by destruction of the olfactory bulbs.

Many studies which imply olfactory influences on reproductive functions involve male presence or absence as a variable. A number of studies have found a shortening of the estrous cycle in female rodents exposed to males or the odor of a male. Recently the hormonal mechanisms involved in this effect have been explored (Chateau, Roos, Roser, Roos, & Aron, 1976). Sexual maturation in young female mice has been found to be accelerated by the presence of a male or male urine (Colby & Vandenbergh, 1974; Vandenbergh, 1967) as opposed to the delay of puberty in all female groups and in singly caged females exposed to urine from grouped females (Castro, 1967; Cowley & Wise, 1972; Dickamer, 1974; McIntosh & Dickamer, 1977).

Although there is no doubt that olfactory cues do influence reproductive functions, the possibility is seldom considered that the presence of the male or the odor of male urine may also contribute to emotionality such as sexual excitement or an alarm reaction. However, it is well known that stress influences reproductive functions. Studies of rodents have shown that prolonged stressors such as overcrowding lead to a lowered fertility (Christian, Lloyd, & David, 1964) and that exposure to loud noise results in alterations in estrous patterns, high rates of incompleted pregnancy, and birth defects (Welch & Welch, 1970).

Milligan (1974) found evidence of the influence of behavioral cues on reproduction in barrier field voles. He showed that female voles ovulated when separated from a male by wire mesh, while control females did not ovulate in the absence of males. Behavioral cues may have contributed to the influence by males because fewer voles ovulated when the wire mesh was replaced by a barrier which eliminated tactile contact. The barrier did not eliminate olfactory cues, as replacing the male behind the barrier with another male was effective in inducing ovulation.

The social influence on hormone levels of rhesus monkeys has been illustrated by Rose, Bernstein, and Gordon (1975). In forming a new group the male who became dominant showed an increase in plasma testosterone and the male who became subordinate showed a fall in testosterone from baseline levels. However, little emphasis is placed on the possibility of the influences of social interactions and behavioral cues on reproductive functions in animals, although behavioral correlates of the estrous cycle stages have been found in mice (Guttman & Gross, 1975) and in stages of the menstrual cycle in catarrhine monkeys and apes (Michael, 1975).

The hypothesis that emotions influence endocrine secretion is more readily accepted in more highly developed animals because of the overgrowth of the neocortex. The reduction in size of the rhinencephalic brain structures concerned with olfaction correspond with the phylogenetic scale as one ascends from prosimian to man (Michael, Zumpe, Keverne, & Bronsall, 1972). Although a number of pathways may exist, emotions would be expected to play a more important role in reproductive cycle changes in man.

Physiology of the Menstrual Cycle

A basic understanding of the functioning of the human menstrual cycle is helpful for a better comprehension of possible influences of the interpersonal environment. The hypothalamus, pituitary gland, and ovaries are most immediately involved in the regulation of hormones. The hypothalamus produces "neurohormones" or releasing hormones which begin the cycle. These releasing hormones act on the anterior pituitary,stimulating the synthesis and release of follicle stimulating hormone (FSH) and luteinizing hormone (LH). These pituitary hormones are carried in the blood to the ovaries, where they stimulate the production of estrogen, ovulation, and a large amount of progesterone by the corpus leteum. These steroid hormones are released into the bloodstream providing a complex feedback system to the hypothalamus, which acts as a "relay station" so that the cycle repeats itself in a self-perpetuating rhythmic manner (Diamond, 1968; Dyrenfurth, Jewelewicz, Warren, Ferin, & Vande Wiele, 1974; Speroff & Vande Wiele, 1971).

The menstrual cycle is usually divided into the menstrual, follicular, ovulatory, luteal, and premenstrual phases. Each phase has its own characteristic hormonal changes, although researchers use different methods for determining length of cycle phase. In short, FSH and LH are greatest during the menstrual and follicular phases. Estrogen levels then peak just prior to a surge of LH causing ovulation after which estrogen and progesterone predominate (Speroff and Vande Wiele, 1971; Taymor and Thompson, 1975).

The hypothalamus, which regulates hormones, is responsive to neural stimuli from many parts of the brain and is influenced by the profuse afferent connections from several limbic structures, including the thalamic nuclei, reticular system, and neocortex. The limbic system was once known by the term rhinencephalon or "nose brain" because of its primarily olfactory function in lower animals. Today, the limbic system is considered to control the emotions in man to a great extent (Schwartz, 1973).

Considering the functional connections between the hypothalamus and limbic system, one is not surprised that hormone levels influence olfaction and emotions. However, there is a reverse relationship with these sensory modalities as well; olfaction and emotions also influence hormone levels. It is clear from the literature that sexual behavior, psychopathology, and personality dispositions also bear this reciprocal relationship with the endocrine system. The etiology and pathways of such influences are unknown, but it is generally accepted that a multiplicity of factors are involved in multisensory influences between hormones and behaviors.

<u>Olfactory Influences on the Menstrual Cycle</u>

Throughout history man has been interested in the possible relationship between the human sense of smell and the sexual response. Many cultures value the sensual effects of human body odors. Similarly, the belief that certain odors have aphrodisiac effects are supported by contemporary perfume industries. In recent years, researchers have demonstrated a direct relationship between the olfactory and the reproductive systems.

LeMagnen (1952) was the first to report sex differences in olfactory sensitivity. He found that adult women were particularly sensitive to exaltolide, a musklike lactone secreted in human urine which is used in many perfumes. LeMagnen showed that most sexually mature women perceived the odor of exaltolide as very intense, while young children and adult males could hardly smell it, and about 50% of adult males were anosmic to it. This led LeMagnen to hypothesize that sensitivity to biological odors are determined by sex hormones; estrogens would improve sensitivity, whereas androgens would lower sensitivity.

Recently, Koelega and Koster (1974) have found further support for LeMagnen's initial research. They reported that women were more sensitive than men to odors in general, but that the greatest sex differences found were for biologically meaningful odors. Such differences were not found for prepuberal children and adolescents. Koelega and Koster cite conflicting results of research studying sex differences in olfaction and point out inadequate procedures and methods which might explain the lack of sex differences found in some studies.

There is considerable evidence that olfactory sensitivity to biological odors is related to circulating estrogen levels in women. Olfactory sensitivity in women for exaltolide varies with the menstrual cycle, being highest around ovulation and lowest at the time of menses (Good, Geary, & Engen, 1976; LeMagnen, 1948; Schneider & Wolfe, 1955; Vierling & Rock, 1967).

Further support for the relationship between the sense of smell and reproductive physiology is provided by studies which show abnormalities in gonadal functions in conjunction with abnormal olfaction. Kallmann and associates (Kallmann, Schoenfeld, & Barrera, 1944) first reported "Kallmann's Syndrome" in which absence of the olfactory bulbs results in failure of the gonads to develop to maturity. Schneider (1974) has reviewed studies demonstrating hyposmia (decreased olfactory sensitivity) in women who were hypogonadal (ovariectomized or postmenopausal), had primary amenorrhea, or abnormal menstrual function. The administration of estrogens improved olfactory acuity for hypogonadal women while androgens were found to worsen olfactory abilities (Schneider, Costiloe, Howard, & Wolf, 1958).

Although a relationship between olfaction and reproductive physiology is well documented, to date no direct evidence has been published showing the influence of pheromones on behaviors or hormone levels in humans. Short-chain volatile fatty acids, which are sex-attractant pheromones in higher primates, have been found to vary in levels with the menstrual cycle in vaginal secretions (Michael, Bonsall, & Kutner, 1975; Michael, Bonsall, & Warner, 1974; Huggins & Preti, 1976; Sokolov, Harris, & Hecker, 1976). However, Morris and Udry (1978) are the only researchers to directly explore the possibility of olfactory pheromones in humans. They suggest that the probability of coitus may be influenced by the olfactory communication of the woman's hormone state, independent of behaviors or feelings. The possibility that rubbing a synthetic hypothetical human female pheromone on the wife's chest at bedtime would increase the chances of sexual intercourse was tested in a double-blind control substance procedure. However, no effect was found.

Emotional Influences on the Menstrual Cycle

One explanation for the possible sexual influences on the menstrual cycle is that situations such as rape or limited sexual exposure following sexual abstinence are emotionally laden. It is widely accepted that reproductive functions are affected by social and psychological processes which influence the emotions. Parlee (1976) cites gynecology texts which state that psychological stress may delay menstruation (Lloyd, 1962) or precipitate its onset (Benson, 1964). DeProsse and Keettel (1977) report that if fear of pregnancy is the basis of a missed period, simply reassuring the patient that menstrual extraction is available may bring spontaneous resolution of the problem. The various influences of emotions on the menstrual cycle may be better understood from the perspective that depression, joyful excitement, and fear are examples of different emotional states and may result in different physiological changes.

Amenorrhea, the absence of menstrual bleeding, has been used as evidence in support of psychological influences on the menses. The acceptance of this concept is demonstrated by the common use of the terms psychogenic, neurogenic, or hypothalamic amenorrhea when referring to secondary amenorrhea for which physiological causes have been ruled out. The etiology of secondary amenorrhea is unknown although it is speculated that a dysfunction of the hypothalamus, other limbic, or cerebral cortex processes might be involved.

Secondary amenorrhea has been noted as a concomitant of psychosis in psychiatric literature. Gregory (1951) in a review of the literature reveals the incidence of amenorrhea to be 50 percent or more in institutionalized psychotic women as compared with a normal incidence of about 2 percent. Amenorrhea was found with all types of psychosis but most common in psychoses of acute onset and primarily in patients with strong affective tensions. Normal menses were re-established with both improvement of the mental condition and chronicity.

Drew (1961), in her review on the epidemiology of secondary amenorrhea, noted that the degree of external stress in a given population is related to the extent of amenorrhea. She reported frequency rates of secondary amenorrhea ranging from below 5 percent in college students, 50-70 percent in German and Japanese concentration camps, and 100 percent in condemned prisoners before execution. She concluded that amenorrhea may often be related to separation from home and family, since high incidences occur in populations such as college freshmen and military recruits.

Much attention has been given to the increase in incidence of psychiatric admissions, suicide attempts, accidents, and crimes among women during their paramenstruum. While it is readily accepted that hormonal status caused the behavioral events, an opposing view is that the emotional trauma may have hastened the occurrence of bleeding. Parlee (1975) reviewed Dalton's data which was used to support the view of premenstrual and menstrual influences on behavior. Dalton's data has been used to show that girls taking exams during their paramenstruum received lower grades. The stress of the examination period also caused more girls to have their menses at this time rendering the direction of causality unclear.

Similarly, Blackstrom and Carstensen (1973) have shown that those women who exhibit anxiety as the chief symptom of premenstrual tension have higher levels of estrogen and on certain days lower levels of progesterone in the blood plasma as compared with normal women. While the physiological state was readily accepted as the cause of anxiety, the view that anxiety may have caused the differing physiological state was not considered.

Sexual Influences on the Menstrual Cycle

The idea that sexual stimulation may influence the timing of ovulation in women is an age-old wives' tale which lacks direct experimental evidence. Much of the speculation about the possibility of sexual influences has been inferred from animal studies. In many animal species, coitus may hasten ovulation, while for some reflex ovulators coitus is necessary for ovulation to occur. Although it is widely accepted that many animal species are spontaneous ovulators, the possibility of coitus-induced ovulation in humans is a controversial issue.

The evidence for coitus-induced ovulation in both animals and humans has recently been reviewed in detail (Clark & Zarrow, 1971; Jochle, 1973; Jochle, 1975). Evidence cited in these reviews in support of coitus-induced ovulation in humans include; the possibility of the occurrence of ovulation more than once during the cycle; the variable length of the cycle; duration of pregnancy as evidence for other than mid-cycle conceptions; and conceptions during amenorrhea, or resulting from rape or limited sexual exposure during a "safe" part of the cycle. There is obvious criticism to the use of such circumstantial evidence in support of coitus-induced ovulation in women. Jochle (1975) acknowledges the dispute of the validity of this evidence but supports the need for direct research in this area.

Personality Influences on the Menstrual Cycle

Personality dispositions may influence characteristics of the menstrual cycle such as the length of blood flow, cycle length or regularity, and severity of premenstrual or menstrual symptoms. The broad range of personality influences on the menstrual cycle are more easily comprehended when one considers that covert processes may differ for individuals in reaction to external events or stress. The different covert processes would be expected to cause a diversity of emotional states which would in turn result in various physiological alterations.

Levy (1942) found that women reporting menstrual periods of six or more days viewed themselves as more maternal; for four or fewer days, less maternal. Peskin (1968) found "short menstruation" women were self-assertive in interpersonal situations, while "long menstruation" women were anxious, whiney, and emotionally bland. He concluded that longer menstruating women discharged tension into the interior of the body where as those with flows of shorter duration had tension discharged in the form of action.

Cycle length or regularity may also be influenced by personality types. Coppen and Kessel (1963) found that neuroticism, as measured by Maudsley Personality Inventory, correlated with menstrual irregularity, premenstrual tension, irritability, depression, and headaches but not with dysmenorrhea (menstrual pain). Osofsky and Fisher (1967) found relationships between menstrual irregularity and body-image measures. Hain, Linton, Eber, and Chapman (1969) on the basis of MMPI differences found that women with irregular menstrual cycles were prone to more neurotic symptoms, impulsivity, and difficulties in interpersonal relationships than women with regular cycles.

Severity of premenstrual and menstrual symptoms has been the focus of much study. Shainess (1961) found that women who had no premenstrual tension had been prepared for menarche by their mothers and were pleased at its occurrence. She suggested that premenstrual symptoms were a recapitulation of rejection of femininity. Berry and McGuire (1972) also found a negative relationship between role acceptance and menstrual symptoms. Similarly, Levitt and Lubin (1967) reported that menstrual complaints were characteristic of women having unwholesome menstrual attitude. Scores indicated that these women tended to be emotionally unstable and given to paranoid hypersensitivity.

Recent evidence indicates that psychological factors may influence whether a woman experiences symptoms premenstrually or menstrually. Gruba and Rohrbaugh (1975) found that correlations between MMPI variables and pain symptoms were consistently higher premenstrually than menstrually. May (1976) studied thirty healthy young women and found two distinct mood patterns. Fifty percent had their lowest mood during the premenstrual phase while 40 percent felt worst during the menstrual phase. The members of the premenstrual tension group were from less religious backgrounds, had more positive attitudes toward sex, were more assertive, and viewed menstruation in more negative terms as compared with the menstrual tension group.

It has long been recognized that man is unique in the complex interaction of social and psychological influences on physiological processes. Kiritz and Moos (1974) in their review of the physiological effects of social environments cite studies to support the need for personality differences to be taken into account when studying the effects of social environments on physiological measures. The abundance of research indicating personality influences on the menses make it evident that personality variables should be considered when studying social influences on the menstrual cycle.

Statement of the Problem

In spite of the evidence which supports the possibility of interpersonal influences on the menstrual cycle, little is known about such influences. Much of the speculation about interpersonal influences on the menstrual cycle is inferred from animal studies. To date, McClintock (1971) is the only published study which uses human subjects to investigate interpersonal influences on the menstrual cycle.

However, the McClintock (1971) study has a number of weaknesses. First, McClintock's findings were based on a series of retrospective surveys. At three times during the academic year, each subject was asked to recall the dates of her last and second to last menstrual periods. Furthermore, subjects were asked to estimate the number of times per week that they saw males rather than keeping records. Dan (1976) notes the discrepancy between studies which use retrospective questioning and those which use longitudinal records to obtain menstrual cycle data. Second, McClintock's subjects estimated the number of times per week that they spent time with males but did not differentiate degree of contact. In McClintock's study, spending time with males could mean seeing males casually with a group of people or having intimate sexual contact with a male. Third, McClintock's subjects were all residents of a women's college. There is much evidence in the literature that all-female groups differ in hormonal response from normal groups. McClintock reasoned that simultaneous exposure to males on the weekends was insufficient to explain the menstrual synchrony which occurred among roommates and close friends because synchrony did not occur throughout the dormitory. However, McClintock did not consider that roommates and close friends may have similar patterns of exposure to males which would not be true for the whole dorm. Fourth, McClintock included women using birth control pills in menstrual synchrony measures and did not note the number of women who were on the pill.

The present study makes an important contribution in being the first to explore a wide range of interpersonal influences on the menstrual cycle based on longitudinal records. Subjects were dormitory residents of a coeducational university and women using birth control pills are used as a control group for menstrual synchrony. The sociometric measures of menstrual synchrony go beyond McClintock's research on roommates and close friends. In the present study time together was also used as the criteria for friendship, but further menstrual synchrony comparisons were made. Roommates who were also friends were compared with roommates who were not friends, and friends who felt close were compared with friends who did not feel close. The influences on menstrual synchrony also take into account the personality types of female companions and consider olfactory influences. The social-sexual effects of male companionship on selected menstrual variables were determined while taking into account both degree and frequency of contact with males. Finally, male companionship influences on lunar relations with the menstrual cycle were examined.

METHOD

Subjects

The subjects were 140 female volunteers all living in dormitories on the campus of Appalachian State University. Volunteers were obtained during hall floor meetings of ten floors from three dormitories. One hundred and sixty-three other subjects had also volunteered but were omitted due to incomplete data. Only women who completed records for the last three consecutive months of the academic year were included. The age range of subjects was from eighteen to twenty-six years with a mean of 19.75 years. The academic classes represented were as follows: sixty-one freshmen, thirty-two sophomores, twenty-five juniors, nineteen seniors, and three graduate students. Twenty-seven of the subjects were using birth control pills.

Apparatus

Eysenck Personality Inventory (EPI). The Eysenck Personality Inventory (Eysenck & Eysenck, 1963) was used to measure the personality variables of extraversion and neuroticism. Each parallel form of the EPI consists of fifty-seven "yes-no" items with no repetition of items. A falsification (Lie) scale is provided for the detection of response distortion. The EPI takes approximately ten to fifteen minutes to administer, and can be hand scored in approximately thirty seconds per form (Educational and Industrial Testing Service, 1975).

The EPI (Eysenck & Eysenck, 1968) has been demonstrated to be a useful tool for the measurement of two pervasive, independent dimensions of personality: extraversion - introversion, and neuroticism - stability. Extraversion refers to individuals who are sociable, impulsive, uninhibited, show their feelings, and may lose their tempers quickly. Low extraversion scores indicate introversion which refers to individuals who are quiet, introspective, plan ahead, and keep their feelings under tight control. Neuroticism refers to emotional lability and overreactivity. These individuals tend to be anxious, complain of minor somatic upsets or disagreeable emotional feelings, and develop neurotic disorders under stress. Low neuroticism scores indicate emotional stability. Briefly, extraversion is a measure of sociability while neuroticism is a measure of emotional reactivity.

Satisfactory reliability and validity have been demonstrated for both extraversion and neuroticism scales of the EPI (Eysenck & Eysenck, 1968). The test-retest reliability is between .84 and .94 for the complete test and between .80 and .97 for the separate forms of the test. Validity has been established through factoral validity, construct validity, concurrent validity, and validity by nominated groups and ratings.

Personal Data Form. The personal data form (Appendix A) was developed to obtain pertinent demographic information from the subjects. The fifteen item questionnaire takes about fifteen minutes to administer. Included are questions to determine birth control methods, menstrual history, and female sociometric choices based on time spent together and feelings of closeness. So that the nature of the study would not be revealed, no emphasis was placed on the sociometric information which was elicited along with menstrual information.

Monthly Calendar Packet. Each subject was provided with a packet of calendars for the months of January through May. On the front of each calendar, a standard set of instructions (Appendix B) was developed to explain how to record the menstrual period for each month including the duration and amount of flow. The Monthly Data Form (Appendix C), printed on the back of the calendar for each month, was used to obtain social-sexual information. This five item multiple choice questionnaire elicited information concerning frequency of colds and sinus problems as well as frequency and nature of male companionship. Instructions on the Monthly Data Form request subjects to complete the questionnaire after the last day of menstrual bleeding rather than at the end of the calendar month. This was to assure that information would pertain to the last menstrual cycle rather than the remainder of the monthly calendar.

Procedure

Volunteers were obtained during routine hall floor meetings of ten floors from three female dormitories on the campus of Appalachian State University. Before beginning the collection of data, the experimenter attended meetings of the resident assistants for each of the three dormitories. At these times, ten resident assistants volunteered to help collect the monthly calendars on their floors, determining the floors to be involved in the study. The time involved in collecting data for "a study to learn more about the menstrual cycles of women" was explained to the resident assistants without further revealing the nature of the study. After floors were selected to participate in the study, notices were posted on each floor one week in advance inviting women who were willing to participate in a study on women to stay for refreshments following the business of the hall floor meetings.

At the meetings for each floor, the EPI and Personal Data Form were administered to volunteers and Monthly Calendar Packets were distributed. Again, the time involved for participants in "a study to learn more about the menstrual cycles of women" was explained to all volunteers without further revealing the nature of the study.

To assure anonymity, each subject was assigned the code number which was on each of the monthly calendars in her packet. Subjects were instructed to record this code number on their Personal Data Form on which they had printed their names. Subjects were instructed not to write their names on their monthly calendars. In this way subjects' identity would not be revealed to those collecting the calendars other than the researcher. Subjects were instructed to turn their calendars in each month to the resident assistant for their floor. They were informed that I would collect the monthly data from the resident assistants each month.

The final collection of data was at the end of the month of April just prior to the final exam period for the semester. Data for the first two weeks in May was not included, as stress of the exam period might have influenced the menstrual cycle. At the time of the final collection of data, each resident assistant was verbally debriefed as to the purpose of the study. Subjects had been informed at the onset of the study that they would be able to obtain information about the nature of the study from the resident assistants following the final collection of data.

DEFINITION OF VARIABLES

Female Companionship Influences

Independent Variables

Roommates refers to women who live in the same dormitory room.

Friend pairs refers to women who mutually listed each other first as the female with whom they spend the most time.

Close feeling pairs refers to women who mutually listed each other first as the female with whom they feel closest.

Non-pill roommates and non-pill friends refers to women who were not using birth control pills and were members of a pair relationship in which the other member was also not using birth control pills.

Pill roommates and pill friends refers to women who were either using birth control pills or were members of a pair relationship in which the other member was using birth control pills.

Extraversion refers to extraversion as measured by the EPI.

Neuroticism refers to neuroticism as measured by the EPI.

Nasal obstruction scores were obtained for each subject by rating frequency of colds or sinus problems recorded on the Monthly Data Forms. For each month, subjects reporting colds or sinus problems "hardly any at all" were given a score of one; "some of the time," a score of two; and "much of the time," a score of three. Totaling the last three months of the academic year, each subject was assigned a nasal obstruction score within the range from three to nine.

Smoker status refers to whether the subject smoked cigarettes or was a non-smoker.

Dependent Variable

Menstrual synchrony refers to the number of days difference between onsets of menstrual bleeding for the last menstrual cycle recorded between pairs of women. If this number was greater than fourteen, it was subtracted from twenty-eight to control for synchronization toward the previous menstrual period.

Male Companionship Influences

Independent Variables

Group companionship scores were obtained for each subject by rating frequency of male companionship in groups recorded on the Monthly Data Forms. For each month, subjects reporting that they had been out with males in a group of friends but not matched off as a couple "none this month" were given a score of zero; "some weeks not at all this month," a score of one; "at least once every week this month," a score of two; and "several times every week this month," a score of three. By totaling the last three months of the academic year, within the range from zero to nine was obtained for each subject.

Couple companionship scores were obtained for each subject by rating the frequency of companionship with a male as a couple but without intimate physical contact (heavy petting or sex). Scores were assigned using the same method as for group companionship scores.

Intimate companionship scores were obtained for each subject by rating the frequency of intimate physical contact with a male using the same method as above.

Combined companionship scores were obtained for each subject by combining the scores for group companionship, couple companionship, and intimate companionship, resulting in a score within the range from zero to twenty-seven.

Primary companionship: female or male refers to whether subjects reported spending more time with female or male friends.

Dependent Variables

Average cycle length refers to the average menstrual cycle length for each subject. Each cycle length was obtained by counting the number of days between onsets of menstrual bleeding for each menstrual cycle. The average cycle length was determined by averaging the last three consecutive menstrual cycles of the academic year for each subject.

Menstrual regularity refers to how consistent menstrual cycle lengths were for each subject across time. Using the last three consecutive menstrual cycles for the academic year, these scores were determined for each subject by subtracting the shortest menstrual cycle length from the longest cycle length.

Average days bleeding refers to the average number of days that each subject bled during each menstrual period. The number of days of menstrual bleeding for each menstrual period were counted. The average number of days of menstrual bleeding was determined for the last three consecutive menstrual cycles of the academic year for each subject.

Blood loss refers to the average amount of blood loss during menstruation for each subject. Subjects had been instructed to number each day of menstrual bleeding and to describe the blood flow for each day as spotty (S), light (L), medium (M), or heavy (H). These descriptions were assigned the values of one through four respectively. The values were totaled for all days of blood loss during each menstrual period. The average score for the last three menstrual periods determined the blood loss score for each subject.

Full moon refers to the number of days difference between the onset of menstrual bleeding and the closest full moon. This score was determined for each subject by counting the number of days between the onset of bleeding for the last menstrual period recorded and the closest full moon.

RESULTS

Female Companionship Influences

Menstrual synchrony was used as a measure of the influence of female companionship on the menstrual cycle. The menstrual synchrony scores for roommates who were not using birth control pills were compared with coeds who were using the pill or had roommates who were on the pill. Subjects who were members of a pair relationship in which either of the dyad were using birth control pills were used as control groups as the cycles of the pill users were not free to vary. The analysis of variance presented in Table 1 indicated a significant difference between non-pill roommates and pill roommates, $F\ (1,80) = 43.382$, $p < .001$. The mean synchronization for non-pill roommates ($n = 58$) was 5.51 days as compared to 11.5 days for pill uses ($n = 24$).

Similarly, Table 2 displays the analysis of variance comparing the synchronization scores of members of non-pill friend pairs with members of friend pairs in which either of the friends were using the pill. As expected, a significant difference was found between non-pill and pill friends, $F\ (1,74) = 50.25$, $p < .001$. The mean synchronization for members of friend pairs who were not on the pill ($n = 56$) was 3.67 days; whereas, the mean synchronization for those on the pill ($n = 20$) was 10.20 days. Subjects who were members of a pair relationship in which either of the dyad were using birth control pills were omitted from subsequent tests of synchrony.

TABLE 1

Analysis of Variance for the Effect of Non-Pill Roomate Membership Versus Pill Roommate Membership on Menstrual Synchrony

Source	SS	df	MS	F	p<
Between-groups	607.612	1	607.612	43.382	.001
Within-groups	1120.477	80	14.006		
Total	1728.089	81			

Non-Pill Roommate Membership $\underline{n}$ = 58 $\bar{x}$ = 5.51 days

Pill Roommate Membership $\underline{n}$ - 24 $\bar{x}$ = 11.50 days

TABLE 2

Analysis of Variance for the Effect of Non-Pill Friend Pair Membership Versus Pill Friend Pair Membership on Menstrual Synchrony

Source	SS	df	MS	F	p <
Between-groups	626.74	1	626.74	50.25	.001
Within-groups	923.41	74	12.47		
Total	1550.15	75			

Non-Pill Friend Pair Membership	$\underline{n}$ = 56	$\bar{x}$ = 3.67 days
Pill Friend Pair Membership	$\underline{n}$ = 20	$\bar{x}$ = 10.20 days

When roommates who were also friends were compared with roommates who did not meet the friend pair criteria, a significant difference was found, F (1,56) = 13.17, $p < .001$, as illustrated in the analysis of variance presented on Table 3. The mean synchrony for friend roommates (n = 40) was 4.3 days as compared with 8.22 days for non-friend roommates (n = 18). Friend pair synchrony scores were used for all subsequent tests of synchrony regardless of roommate status.

Members of friend pairs who also met the close feeling criteria were found to synchronize more closely than members of friend pairs who did not meet the close feeling criteria. Table 4 displays the results of the analysis of variance, F (1,54) = 27.319, $p < .001$. Close feeling friend pairs (n = 26) had mean synchrony scores of 1.38 days, whereas non-close feeling friend pairs (n = 30) had mean synchrony scores of 5.66 days.

A comparison of menstrual synchrony was made for members of friend pairs who were both high in extraversion (E); members of friend pairs who were mixed, one having high E and the other low E scores; and members of friend pairs who were both low E. Fourteen subjects were omitted who were members of a pair in which one of the E scores was on the median. Table 5 displays the analysis of variance which indicated a significant difference, F (2,39) = 6.194, $p < .01$. The analysis of variance was repeated as a follow-up test for each of the comparisons to determine which comparisons were significant as summarized in Table 6. Both members of high E friend pairs and members of low E friend pairs were found to synchronize significantly more closely than members of mixed high and low E friend pairs (F (1,39) = 7.413, $p < .025$; F (1,39)

TABLE 3

Analysis of Variance for the Effect of Friend Roommate Membership Versus Non-Friend Roommate Membership on Menstrual Synchrony

Source	SS	df	MS	F	p<
Between-groups	190.972	1	190.972	13.179	.001
Within-groups	811.506	56	14.491		
Total	1002.478	57			

Friend Roommate Membership	n = 40	$\bar{x}$ = 4.30 days
Non-Friend Roommate Membership	n = 18	$\bar{x}$ = 8.22 days

TABLE 4

Analysis of Variance for the Effect of Close Feeling Friend Pair Membership Versus Non-Close Friend Pair Membership on Menstrual Synchrony

Source	SS	df	MS	F	p<
Between-groups	255.394	1	255.394	27.319	.001
Within-groups	504.818	54	9.348		
Total	706.212	55			

Close Feeling Friend Pair Membership $\underline{n} = 26$ $\bar{x} = 1.38$ days

Non-Close Feeling Friend Pair Membership $\underline{n} = 30$ $\bar{x} = 5.66$ days

TABLE 5

Analysis of Variance for the Effects of High Extraversion Friend Pair Membership Versus Mixed, High and Low Extraversion Friend Pair Membership Versus Low Extraversion Friend Pair Membership on Menstrual Synchrony

Source	SS	df	MS	F	p<
Between-groups	140.619	2	70.309	6.194	.01
Within groups	442.715	39	11.351		
Total	583.334	41			

TABLE 6

Summary Table of Follow Up Analysis of Variance Tests for the Effects of High Extraversion Friend Pair Membership (A) Versus Mixed High and Low Extraversion Friend Pair Membership (B) Versus Low Extraversion Friend Pair Membership (C) on Menstrual Synchony

Source	df	MS	F	p<
A Verses B	1,39	84.152	7.413	.025
B Verses C	1,39	122.67	10.806	.005
A Verses C	1,39	6.858	.604	ns

High Extraversion (A)	$\underline{n} = 16$	$\bar{x} = 3.50$ days
Mixed Extraversion (B)	$\underline{n} = 14$	$\bar{x} = 6.85$ days
Low Extraversion (C)	$\underline{n} = 12$	$\bar{x} = 2.50$ days

= 10.801, $p < .005$). However, members of high E friend pairs were not found to synchronize significantly more closely than members of low E friend pairs. Members of high E friend pairs ($n = 16$) had a mean synchronization score of 3.5 days; members of low E friend pairs ($n = 12$), 2.5 days; and members of mixed high and low E friend pairs ($n = 14$), 6.85 days.

Similarly, a comparison of menstrual synchrony was made for members of friend pairs who were both high in neuroticism (N); members of friend pairs who were mixed, one having high N and the other low N scores; and members of friend pairs who were both low N. Twenty-four subjects were omitted who were members of a pair in which one of the N scores was on the median. The analysis of variance indicated a significant difference, $F\ (2,29) = 8.587$, $p < .005$, as illustrated in Table 7. Table 8 displays the summary table of analyses for each of the follow-up comparisons. Members of low N friend pairs were found to synchronize significantly more closely than members of mixed high and low N friend pairs, $F\ (1,29) = 20.801$, $p < .001$. Members of low N friend pairs were also found to synchronize significantly more closely than members of high N friend pairs, $F\ (1,29) = 5.422$, $p < .05$. A significant difference was not found between members of high N friend pairs and members of mixed high and low friend pairs. Members of high N friend pairs ($n = 12$) had a mean synchronization score of 3.83 days; members of mixed high and low friend pairs ($n = 8$), 6.75 days; and members of low N friend pairs ($n = 12$), .83 days.

The possibility was considered that neuroticism might influence menstrual regularity, thus accounting for the effects of N on friend

TABLE 7

Analysis of Variance for the Effects of High Neuroticism Friend Pair Membership Versus Mixed High and Low Neuroticism Friend Pair Membership Versus Low Neuroticism Friend Pair Membership on Menstrual Synchrony

Source	SS	df	MS	F	p<
Between-groups	171.041	2	85.520	8.587	.005
Within-groups	288.834	29	9.959		
Total	459.875	31			

TABLE 8

Summary Table of Follow Up Analysis of Variance Tests for the Effects of High Neuroticism Friend Pair Membership (A) Versus Mixed High and Low Neuroticism Friend Pair Membership (B) Versus Low Neuroticism Friend Pair Membership (C) on Menstrual Synchrony

Source	df	MS	F	$p <$
A Verses B	1,29	40.833	4.100	ns
B Verses C	1,29	168.033	20.801	.001
A Verses C	1,29	54	5.422	.05

High Neuroticism (A)	n = 12	$\bar{x}$ = 3.83 days
Mixed Neuroticism (B)	n = 8	$\bar{x}$ = 6.75 days
Low Neuroticism (C)	n = 12	$\bar{x}$ = .83 days

pair synchrony. However, this is unlikely as no effects were found for analysis of variance tests comparing high and low N subjects for each of the selected menstrual variables of average cycle length, menstrual regularity, average days bleeding, and blood loss.

Nasal obstruction and smoker status were included as rough measures of olfactory influences on menstrual synchrony. Subjects high in nasal obstruction were compared with those who were low in nasal obstruction and cigarette smokers were compared with non-smokers for menstrual synchrony. No effects were found for either of the analysis of variance tests for nasal obstruction or smoker status influences on menstrual synchrony.

Male Companionship Influences

A series of analysis of variance tests were calculated to determine the influences of each of the male companionship variables of group companionship, couple companionship, intimate companionship, combined companionship, and primary companionship on each of the menstrual variables of average cycle length, menstrual regularity, average days bleeding, blood loss, and full moon. Subjects who scored high were compared with subjects who scored low for each of the male companionship variables.

Twenty-seven subjects who were using birth control pills and eight subjects who were members of a friend pair relationship in which the friend was using the pill were not used to test for male companionship influences. These subjects were not used because the cycles of women who use the pill are not free to vary and the influence of having a friend on the pill is unknown. Of the 105 subjects who were free of pill influences, those with median scores for each of the male companionship variables were omitted resulting in differing numbers of subjects for each of the male companionship variables.

Table 9 displays the summary of analysis of variance tests for the effects of male companionship variables on average cycle length. All companionship variables except primary companionship were found to influence average cycle length. Male companionship influences on average cycle length are as follows: group companionship, F (1,66) = 12.214, p < .001; couple companionship, F (1,94) = 9.596, p < .003; intimate companionship, F (1,103 = 7.592, p < .007; and combined companionship, F (1,92) = 15.703, p < .001. The mean average cycle length for women with high scores for each of these male companionship variables as compared with the mean average cycle length for women with low scores for each of these variables are as follows: high group companionship (n = 48) 28.80 days, low group companionship (n = 20) 34.95 days; high couple companionship (n = 49) 29.40 days, low couple companionship (n = 47) 34.01 days; high intimate companionship (n = 48 27.17 days, low intimate companionship (n = 57) 33.22 days; and high combined companionship (n = 50) 28.72 days, low combined companionship (n = 44) 34.26 days.

The effects of male companionship variables on menstrual regularity are shown on Table 10. As with average cycle length, all companionship variables except primary companionship were found in influence menstrual regularity. Male companionship influences on menstrual regularity are as follows: group companionship, F (1,66) = 6.012, p < .01; couple companionship, F (1,94) = 9.855, p < .003; intimate companionship,

TABLE 9

Summary Table of Analysis of Variance Tests for the Effects of Male Companionship Variables on Average Cycle Length

Source	df	MS	F	p<
Group Companionship	1,66	1826.015	12.214	.001
Couple Companionship	1,94	1312.328	9.596	.003
Intimate Companionship	1,103	995.128	7.592	.007
Combined Companionship	1,92	1998.786	15.703	.001
Primary Companionship	1,103	471.048	3.459	ns

	High Male Companionship		Low Male Companionship	
Group	$\underline{n}$ = 48	$\bar{x}$ = 28.80 days	$\underline{n}$ = 20	$\bar{x}$ = 34.95 days
Couple	$\underline{n}$ = 49	$\bar{x}$ = 29.40 days	$\underline{n}$ = 47	$\bar{x}$ = 34.01 days
Intimate	$\underline{n}$ = 48	$\bar{x}$ = 27.17 days	$\underline{n}$ = 57	$\bar{x}$ = 33.22 days
Combined	$\underline{n}$ = 50	$\bar{x}$ = 28.72 days	$\underline{n}$ = 44	$\bar{x}$ = 34.26 days

TABLE 10

Summary Table of Analysis of Variance Tests for the Effects of Male Companionship Variables on Menstrual Regularity

Source	df	MS	F	p<
Group Companionship	1,66	436.820	6.012	.01
Couple Companionship	1,94	579.293	9.855	.003
Intimate Companionship	1,103	213.739	3.660	.05
Combined Companionship	1,92	679.024	11.876	.001
Primary Companionship	1,103	15.073	.250	ns

	High Male Companionship		Low Male Companionship	
Group	_n_ = 48	$\bar{x}$ = 3.93 days	_n_ = 20	$\bar{x}$ = 9.50 days
Couple	_n_ = 49	$\bar{x}$ = 2.95 days	_n_ = 47	$\bar{x}$ = 7.89 days
Intimate	_n_ = 48	$\bar{x}$ = 3.75 days	_n_ = 57	$\bar{x}$ = 6.61 days
Combined	_n_ = 50	$\bar{x}$ = 3.36 days	_n_ = 44	$\bar{x}$ = 8.04 days

F (1,103) = 3.660, *p* < .05; and combined companionship, *F* (1,92) = 11.876, *p* < .001. The mean menstrual regularity scores for women with high scores for each of these male companionship variables as compared with the mean menstrual regularity scores for women with low scores for each of these variables are as follows: high group companionship (*n* = 48) 3.93 days, low group companionship (*n* = 20) 9.50 days; high couple companionship (*n* = 49) 2.95 days, low couple companionship (*n* = 47) 7.89 days; high intimate companionship (*n* = 48) 3.75 days, low intimate companionship (*n* = 57) 6.61 days; and high combined companionship (*n* = 50) 3.36 days, low combined companionship (*n* = 44) 8.04 days.

Analysis of variance tests were calculated to determine the effects of male companionship variables on average days bleeding and blood loss. No effects were found for either of these variables.

Table 11 displays the summary of analysis of variance tests for the effects of male companionship variables on full moon scores. Couple companionship, intimate companionship, and primary companionship variables were found to influence the relationship between the onset of menstrual bleeding and the closest full moon while no effects were found for group companionship or combined companionship. Male companionship influences on full moon scores are as follows: couple companionship, *F* (1,94) = 4.979, *p* < .02; intimate companionship, *F* (1,103) = 4.587, *p* < .03; and primary companionship, *F* (1,103) = 8.659, *p* < .004. The mean full moon scores for women with high scores for each of these male companionship variables as compared with the mean full moon scores for women with low scores for each of these male companionship variables is as follows: high couple companionship (*n* = 49) 8.22 days, low couple companionship

TABLE 11

Summary Table of Analysis of Variance Tests for the Effects of Male Companionship Variables on Full Moon Scores

Source	df	MS	F	p<
Group Companionship	1,66	31.237	1.275	ns
Couple Companionship	1,94	99.152	4.979	.02
Intimate Companionship	1,103	95.505	4.587	.03
Combined Companionship	1,92	58.292	2.594	ns
Primary Companionship	1,103	173.734	8.659	.004

	High Male Companionship		Low Male Companionship	
Couple	n = 49	$\bar{x}$ = 8.22 days	n = 47	$\bar{x}$ = 6.17 days
Intimate	n = 48	$\bar{x}$ = 8.10 days	n = 57	$\bar{x}$ = 6.21 days
Primary	n = 12 (primary male)	$\bar{x}$ = 9.75 days	n = 93 (primary female)	$\bar{x}$ = 6.62 days

(n = 47) 6.17 days; high intimate companionship (n = 48) 8.10 days, low intimate companionship (n = 57) 6.21 days; and male primary companionship (n = 12) 9.75 days, female primary companionship (n = 93) 6.62 days.

DISCUSSION

Female Companionship Influences

The results indicate that the phenomenon of menstrual sychronization between women who spend time together does exist. Unlike McClintock's (1971) study which was conducted in an all female school, the present study was conducted in a coeducational environment where the girls had daily exposure to males. Therefore, simultaneous exposure to males or male pheromones during weekends and social events, paralleling the Whitten effect (1956, 1958) in mice, is not likely to be the cause of menstrual synchronization between female companions.

The menstrual cycles of roommates who were free of birth control pill influences were found to synchronize more closely than the control group of roommates in which one or both of the companions were on the pill. Non-pill members of friend pairs were also found to synchronize more closely than the control group of friend pair members who were using the pill or whose companion was on the pill. This was expected as the menstrual cycles of the pill users were not free to vary.

Roommates who were also friends were found to synchronize more closely than roommates who were not friends, and members of friend pairs who felt close to each other were found to synchronize more closesly than members of friend pairs who did not feel close. However, it is unknown whether the women's feelings for each other can account for this difference as roommates who are also friends may tend to spend more time together just as friends who feel close may also spend more time together.

Many variables are influenced with time. Females who spend time together may engage in similar activities which would simultaneously expose them to mutual external events with corresponding emotional arousals. Women spending more time together may have greater compatibility and ability to influence each other emotionally. Conversely, the synchronization may be the result of greater exposure to the female companion's pheromones with more time together. The significant results with time spent together supports the existence of menstrual synchronization but does not explain the phenomenon.

However, the finding that personality traits influence the degree of synchronization gives strength to the view that interpersonal factors other than time spent together may influence menstrual synchrony. The findings for extraversion, which measures sociability, indicate that if two friends are both introverts or both extraverts, they tend to menstrually synchronize. However, if one of the friends is an introvert and the other an extravert they are not as likely to synchronize menstrually.

The findings for neuroticism, which measures emotional reactivity, indicate that if two friends are low in neuroticism they tend to menstrually synchronize. However, if both friends are high in neuroticism or if one of the friends is low and the other high in neuroticism, they are not as likely to synchronize menstrually.

The combination of two low neuroticism friends resulted in the lowest mean synchrony score (.83 days) of any combination of personality types. Yet, if emotional stability alone contributed to menstrual synchrony, mixed high and low neuroticism pairs would be expected to synchronize more closely than pairs in which both of the friends were high in neuroticism. Although there was no significant difference, there was an opposite trend. High neuroticism friends had a lower mean synchrony score ($\overline{X}$ = 3.83 days) than mixed high and low neuroticism friends ($\overline{X}$ = 6.75 days). The lack of statistical difference may have been due to the small number of subjects ($\underline{n}$ = 8) in the mixed group. Therefore, for both extraversion and neuroticism measures, similarity of personality type may contribute to menstrual synchrony between friends.

Neuroticism was not found to influence any of the selected menstrual variables. Therefore, an influence of neuroticism on cycle length or regularity cannot account for the menstrual synchrony that occurred when both friends were low in neuroticism. This finding does not support the earlier findings of Coppen and Kessel (1963), who found that neuroticism correlated with menstrual irregularity as well as premenstrual tension, irritability, depression, and headaches. However, the findings of Coppen and Kessel were based on a one-time retrospective questionnaire while the present study was based on longitudinal records. Furthermore, Moos, Kopell, Melges, Yalom, Lunde, Clayton, and Hamburg (1969) have found that women who report high premenstrual tension are also high in control symptoms that measure a tendency to complain. The liabilities of the retrospective questionnaire coupled with the possible tendency of neurotics to complain may account for the discrepancy in findings of Coppen and Kessel and the present study.

In contrast to speculation in the literature, no effects were found for olfactory influences on menstrual synchrony. However, this lack of olfactory influences may be due to the crudeness of the olfactory measures of nasal obstruction and smoker status.

Male Companionship Influences

Women who spent more time with males were found to have shorter and more regular menstrual cycles than women who saw males less frequently. The influence of male companionship on cycle length supports the earlier findings of McClintock (1971). Male companionship was not found to influence the amount of blood loss or the number of days bleeding during menstruation.

If degree of intimacy with males was to influence menstrual cycle length or regularity, being with males in a group of friends, being with a male as a couple, and intimate physical contact with a male would be expected to have progressively higher levels of significance. However, this was not true for average cycle length or menstrual regularity. The opposite trend was found for male companionship influences on average cycle length (group $p < .001$, couple $p < .003$, and intimate $p < .007$). Menstrual regularity did not follow a clear progression with the highest level of significance found for the combination of all levels of companionship ($p < .001$), followed by couple ($p < .003$, group ($p < .01$), and intimate companionship ($p < .05$).

As each subject may receive variations of all types of male companionship, each type of companionship was not directly compared. However, the comparison of significance levels does not show a pattern of stronger influences with higher degrees of intimacy with males. Therefore, the physical stimulation of more intimate sexual contact with males may not necessarily influence menstrual length or regularity any more than non-physical contact with males. Perhaps social contact with males, regardless of degree of intimacy, is necessary for normal menses. It may be that lack of contact with males causes the menstrual cycle to be longer and more irregular, paralleling the Lee-Boot effect (1956) in mice.

The present research is the first to find a significant relationship between phases of the moon and menstruation. Women with high levels of couple companionship or intimate sexual companionship with males were found to menstruate further from the full moon than women with low levels of these types of companionship. Women who reported spending more time with males than females were also found to menstruate further from the full moon than women spending time primarily with females. These effects were not found for companionship with males in a group of friends or for the combination of all levels of male companionship.

Through the ages man has searched in vain to discover lunar influences on the menstrual cycle. The length of the average menstrual cycle corresponds with that of the lunar cycle and the term menstrual implies a relationship with the moon. Over the years many researchers have failed to find a significant correlation between the phase of moon and menstruation. Some have found a cluster of menses around the half moon speculating that ovulation occurs with the full moon, but failed to find statistical significance. A recent attempt is that of Prochobradsky (1974), who reported independence of human menstruation on lunar phases and gave references which support this finding.

However, past research efforts have not taken into account social-sexual contact with males. When a cross section of women are studied, there is no relationship between the lunar cycle and menstruation. But when women who are more intimately involved with men are compared with women without this involvement, lunar relationships are found with the menstrual cycle. The present study makes an important contribution in distinguishing social-sexual contact with males as a suppressor variable in research on lunar relations with the menstrual cycle.

It would appear that women with more social-sexual contact with males are more likely to ovulate on the full moon as they were found to menstruate further from the full moon. Support is given to this hypothesis by the findings of Menaker and Menaker (1959). When analyzing 250,000 birth dates, they found that natality was significantly higher on the days of a full moon. They reasoned that ovulation and conception were also more likely around the full moon because the mean length of pregnancy measured from the last menstrual onset is 9.5 synodic months. Since these women gave birth, they were sexually active. A cross section of women would not be as likely to ovulate with the full moon because all women are not sexually active or intimately involved with men. Therefore, if social-sexual contact with males acts as a suppressor variable, considerable scatter would be found in the timing of menstruation for women across the population.

Concluding Theoretical Formulation

While the present study makes evident that the menstrual cycle is influenced by interpersonal factors, several questions are raised. What are the evolutionary bases of interpersonal influences on the menstrual cycle? What are the neurological mechanisms involved in such influences? And what are the practical implications of the current knowledge of interpersonal influences on the menstrual cycle?

Although Rosseinsky and Hall (1974) did not suggest possible mechanisms involved, they have proposed an interesting theory as to the evolutionary basis of menstrual synchrony. They suggested that premenstrual tension helped insure probability of conception by inhibiting sexual relations during an infertile phase of the menstrual cycle so that sexual activity might be increased during the fertile phase. Males who were frustrated by their mates would not be tempted to find sexual gratification from a non-premenstrual female if menstrual synchrony existed in the group. Thus, premenstrual tension and menstrual synchrony may have evolved as a result of the evolutionary value for survival of the species.

The phenomenon of menstrual synchrony may have further survival value during man's early hunting and gathering era. It is reasonable to assume that menstrual synchrony as opposed to scattered cycles would be of benefit to the mobility of the social group. Menstrual synchrony would serve a further advantage for the group by increasing chances that women would give birth at the same time.

Male companionship influences on the menstrual cycle may also serve an important function for survival of the species. It would be expected that men would tend to spend more time with women who had desirable traits. If these women were to have shorter and more regular menstrual cycles, then their opportunity to produce off-spring would be increased. Before modern time, when man was more dependent on the light of the moon, the full moon may have stimulated romantic rituals. If this were true, ovulation with the full moon would have further increased the chance of conception.

So interpersonal influences on the menstrual cycle do have evolutionary value for survival of the species. But, what neurological mechanisms are involved in such influences? The hypothalamus, which regulates hormones, is influenced by profuse afferent connections from several limbic structures. The limbic system primarily has an olfactory function in lower animals but is considered to control the emotions in man to a great extent. A great deal of research supports the influence of olfactory pheromones on estrous cycles in animals. Pheromones in rodents have been found to cause estrous synchronization between females and shortening of estrous with exposure to males. However, while there is much evidence of functional connections between olfactory systems and hormones in humans, there is no direct evidence of pheromonal influences. Perhaps as with lower animals, the menstrual cycle was at one time primarily influenced by olfaction during social interactions. Then, with the overgrowth of the neocortex, emotional influences on the endocrine system may have become more prevalent.

In modern man, emotions may have more of an influence on menstrual synchrony than olfaction. The finding that personality traits influence the degree of synchronization supports this possibility. Research on non-menstrual physiological synchrony indicates that emotional involvement may be a key mediator. A contagion of emotional communications takes place during social interactions. When people simultaneously share the same affective arousal, concomitant physiological changes may occur in unison.

It is well known that women fluctuate both emotionally and behaviorally in cyclical rhythm with their menstrual cycle. It is reasonable to expect that as a woman is feeling happy and cheerful, her female companion may be influenced to be in a good mood as well. Or if a woman is feeling irritable or anxious, her female companion may become more tense. In this way, emotional covariation may produce corresponding hormonal covariation resulting in menstrual synchrony.

This emotional contagion theory of menstrual synchrony is not so far-fetched when one considers the research findings on the menstrual cycle. Stress, psychiatric disorders, sexual stimulation, and personality dispositions all influence emotional states which may in turn result in differing hormonal alterations. The present findings that menstrual synchrony is more likely with similarity of personality type give further credence to this theory. Women with similar personality types may tend to synchronize menstrually because of an ability to synchronize emotionally.

If the emotional contagion theory is valid, consistency in emotional affect from one menstrual cycle to another would be favorable for synchrony to occur. Moos et al. (1969) studied cyclical changes in menstrual symptoms, moods, and sexual arousal for fifteen women over two consecutive menstrual cycles. The women were generally consistent from one cycle to another for these measures especially during intermenstruum. However, high and low premenstrual tension women tended to differ consistently from each other on negative affect throughout the cycle. Women of different personality types may also differ in affective changes during the menstrual cycle. This may account for the higher degree of menstrual synchrony when friends were similar in personality type.

Based on the emotional contagion theory, it would be expected that women who are not consistent in emotional affect from one cycle to another would not synchronize menstrually with their companions. Since neuroticism refers to emotional lability and overreactivity, neurotics would be expected to be less consistent in their moods from month to month and less likely to synchronize menstrually. Since low neuroticism indicates emotional stability, low neurotics would be expected to be more consistent in their moods from month to month and more likely to synchronize menstrually. This may account for the high degree of menstrual synchrony when both friends were low in neuroticism, which resulted in the lowest mean synchrony score of any combination of personality types.

Unlike lower animals, man is complicated by personality influences since he reacts to external stimuli through his emotions rather than his instincts. Although there is much evidence of the influence of pheromones in animals, there is risk involved in generalizing results from animal experiments to humans. For example, in humans estrogens improve sensitivity to the urinoid odor of pentadecanolide, whereas in rats, androgens increase sensitivity to this biological odor (LeMagnen, 1952). Also elimination of the olfactory bulbs has different effects depending upon the species and sex (Davidson & Levine, 1972).

Yet, even if clear influences were found for one sensory modality, one must not discount the possibility of multisensory influences on the menstrual cycle. Many sensory systems are known to influence the hypothalamic-pituitary-ovarian axis. The extent to which variables are interrelated is unknown. One sensory system may have indirect effects on hormone levels by influencing another sensory system.

There are many examples which demonstrate that one sensory system influences another. For instance, olfaction may influence emotional response. It has long been accepted that the sense of smell can trigger emotional response. The fragrance of an old lover's cologne may trigger emotions or the odor of dirty socks may bring back memories of the high school locker room. Emotional state may also influence olfactory thresholds. Subjects under stress fail to show normal olfactory adaptation (failure to perceive) with repetitive testing (Schneider & Costiloe, 1969). Personality type may influence olfactory sensitivity as well. Extraverts and introverts, as measured by the EPI, were found to differ in olfactory sensitivity, although contradictory results were found in a series of experiments (Koelega, 1970).

The possibility of interrelated multisensory influences should be considered when interpreting the results of any research of influences on the menstrual cycle. The findings of the present study cannot be attributed solely to the emotions without considering that change in the emotional state may have corresponding influences on olfactory thresholds. Future research which finds influences on the menstrual cycle for one sensory modality should not discourage the possibility of the influence of other sensory systems. The evolution of multisensory influences between hormones and behaviors has value for survival of the species as opposed to the influence of a single sensory system on reproductive functions.

Regardless of which sensory modalities influence the neuroendocrine systems, interpersonal relations do influence the timing of the human menstrual cycle. These findings have obvious esoteric value as man speculates about the nature of the universe and strives to be in harmony with the cosmos. But, what are the practical implications?

The most obvious practical value of the present findings is its aid in abolishing the mystique of menstrual cycle changes. It is very frightening for many women when their menstrual cycle length changes or becomes irregular. After ruling out physical causes, many gynecologists may leave their patients bewildered as to the causes of their menstrual changes. Simple reassurance that the menstrual cycle is sensitive to many influences, even social ones, and that such influences are normal may take away much of the fear. Therapists may also reassure patients who are anxious due to menstrual cycle changes. Changes in the menstrual cycles of patients may even be used as a rough barometer to assess social adjustment during the course of treatment.

Hopefully, the findings of the present study will stimulate further research on the menstrual cycle. Considering the extent to which this natural biological rhythm influences women, it is shocking that so little is known about influences on the menstrual cycle and the neurological mechanisms involved in such influences. A better understanding of reproductive functions has direct relevance when increased fertility is desired. This field is an open and tantalizing challenge to future researchers.

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APPENDIX A

Personal Data Form

CODE #______

NAME: ____________________ DORM: ____________________

AGE: ____________________ ROOM NUMBER: ____________________

Class (Freshman, Sophomore, etc.) ____________________

1. Do you use birth control pills? Yes ______ No ______

2. If so, how long have you been using them? ____________________

3. If so, what kind? Combination ______ Sequential ______

4. Do you have an IUD? Yes ______ No ______

5. At what age did you start menstruating? 9 10 11 12 13 14 15 16 (Please circle one)

6. How do you feel during the days just before your menstrual period?

   Physically: Under par ______ Emotionally: Under par ______
   Average ______ Average ______
   Good ______ Good ______

7. How do you feel during your menstrual period?

   Physically: Under par ______ Emotionally: Under par ______
   Average ______ Average ______
   Good ______ Good ______

8. How do you feel after your menstrual period?

   Physically: Under par ______ Emotionally: Under par ______
   Average ______ Average ______
   Good ______ Good ______

9. Do you use a feminine hygiene deodorant? Yes ______ No ______

10. Do you use a feminine douche product? Yes ______ No ______

11. List the three females that you spend the most time with in descending order (most listed first).

    1.
    2.
    3.

12. List the three females that you feel closest to in descending order (most listed first).

    1.
    2.
    3.

13. How long have you and your roommate been living together or spending time together? ____

14. Do you spend more time with female or male friends? Female ______ Male ______

15. Do you smoke cigarettes? Yes ______ No ______

APPENDIX B

Instructions for Monthly Calendar Packet

On the front of the calendar please mark the day that you begin your menstrual bleeding with a 1 and number each day that you bleed thereafter. Also, please put a letter down to describe your blood flow for each day as follows:

Spotty flow = S
Light flow = L
Medium flow = M
Heavy flow = H

Example: The subject who filled out the calendar had a menstrual bleeding period of 5 days during the month of December beginning on the 12th day of the month. She had a light flow on her first day followed by a medium flow for 3 days and a spotty flow in the last. She would fill out the calendar as follows:

D E C E M B E R						
SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			1	2	3	4
5	6	7	8	9	10	11
12 1-L	13 2-M	14 3-M	15 4-M	16 5-S	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

APPENDIX C

Monthly Data Form

Please wait until you have finished your period to fill this section out. Do not wait until the end of the month but fill out immediately following your period. If you missed having a period this month, please check after the statement below and leave the front of the calendar blank.

I did not have a period this month. ______

Please circle the letter for the item in each cluster that best describes you.

1. I have had a cold or sinus problems

    a. Hardly any at all this month.
    b. Some of the time this month.
    c. Much of the time this month.

2. This month I have...

    a. been just going along as usual with nothing special happening.
    b. been a little excited because I've started seeing a new fellow.
    c. been a little down because there's nobody I'm interested in dating.
    d. been a little upset because I broke up with a fellow I was seeing.

3. I have been with males in a group of friends but not matched off as a couple.

    a. None this month.
    b. Three times or less this month.
    c. At least once every week this month.
    d. Several times every week this month.

4. I have been with a male friend as a couple but without intimate physical contact (heavy petting or sex).

    a. None this month.
    b. Three times or less this month.
    c. At least once every week this month.
    d. Several times every week this month.

5. I have been with a male and have had intimate physical contact (heavy petting or sex).

    a. None this month.
    b. Three times or less this month.
    c. At least once every week this month.
    d. Several times every week this month.