SHAY, NANCY LYNN. Relationships among Basal Body Temperature, Simple Reaction Time and Movement Time at Six Specific Phases of the Menstrual Cycle. (1976) Directed by: Dr. Alexander McNeill. Pp. 59.

It was the purpose of this study to investigate the relationships among basal body temperature, simple reaction time and movement time at six specific phases of the menstrual cycle. The following questions were posed for this study:

1. Did basal body temperature vary at specific phases of the menstrual cycle?

2. Did simple reaction time change with specific phases of the menstrual cycle?

3. Did movement time change with specific phases of the menstrual cycle?

4. What was the relationship, if any, between basal body temperature and simple reaction time at specific phases of the menstrual cycle?

5. What was the relationship, if any, between basal body temperature and movement time at specific phases of the menstrual cycle?

The subjects for this study were 12 female, student volunteers enrolled at the University of North Carolina at Greensboro during the 1974-75 academic year. The mean age of the subjects was 28 years.

Each subject was required to complete 50 trials for both simple reaction and movement time on each of her six testing days. The equipment used for the collection of data consisted of two basic units, the experimental control unit and the subject response unit.

A two-way ANOVA with one entry per cell design with repeated measures was used to assess the significance of the differences between

basal body temperature measurements, simple reaction time scores, and movement time scores at the six specific phases of the menstrual cycle. The Scheffe' post hoc test was administered to determine where the means were significantly different.

A Pearson product-moment correlation coefficient was determined to indicate the degree of relationship among basal body temperature, simple reaction time and movement time. All statistical comparisons were made at the .05 level of confidence.

Within the limitations of this study and the results obtained from the data collected, the following conclusions seem justified:

1. Basal body temperature does not vary significantly at specific phases of the menstrual cycle.

2. Simple reaction time changes significantly at specific phases of the menstrual cycle.

3. Movement time does not change significantly at specific phases of the menstrual cycle.

4. No significant relationship exists between simple reaction time and basal body temperature.

5. No significant relationship exists between movement time and basal body temperature.

RELATIONSHIPS AMONG BASAL BODY TEMPERATURE SIMPLE REACTION TIME AND MOVEMENT TIME AT SPECIFIC PHASES OF THE MENSTRUAL CYCLE

by

Nancy Lynn Shay

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Approved by

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APPROVAL PAGE

This thesis has been approved by the following committee of the Faculty of the Graduate School at the University of North Carolina at Greensboro.

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7 July 1976

Date of Acceptance by Committee

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CHAPTER I

INTRODUCTION

Heretofore, various social and cultural taboos associated with the menstrual cycle of women have limited the studies relating various physiological parmeters to this normal, cyclic phenomena. As a result of this dearth of studies, there have been many misconceptions and erroneous generalizations relating to women's efficiency in physical skills during their menstrual period.

Recent investigations have yielded findings contrary to many generalizations. For example, there is some question as to whether the female performer is limited physically during specific phases of her menstrual cycle. This investigation was concerned with the fluctuations in basal body temperature that occur during the menstrual cycle and their relationship with simple reaction and movement time.

Dalton (1960) demonstrated that women are much more accident prone prior to and during their menstrual flow. She suggested that this might be due to an increase in reaction time. However, studies by Youngen (1959) and by Pierson & Lockhart (1963) failed to demonstrate any significant changes in either reaction or movement times during menstruation. These findings were further strengthened in a study reported by Burke (1965). She determined that an individual's score in tests of leg reaction time, total body movement time, and patellar reflex time showed no significant variation during the menstrual cycle. In the same year, however, Condon reported significant changes in abdominal reaction time at specific phases of the menstrual cycle. She defined abdominal reaction time as the time for movement of hip flexion as the subject lifts both legs simultaneously.

Findings related to the basal body temperature during the menstrual cycle are in general agreement. The early investigators (Jacobi, 1876; King, 1914; Seward, 1934; and Vande Velde, 1904), supported a wave theory which indicated a tendency towards a pre-menstrual rise in basal body temperature followed by a menstrual drop in basal temperature. Recent studies have determined that there is a shift in body temperature producing a biphasic cycle (Behrman & Gosling, 1966; Hafez & Evans, 1973; Novak, 1970; Page, 1972; and Reid, Ryan & Benirschke, 1972). The fluctuation in basal body temperature is attributed to changes in the levels of circulating progesterone.

Hormonally induced changes in reflex and reaction times, such as those produced by progesterone, have been explored by Okamoto (1960). He has suggested that the periodic inhibitory influence of progesterone resulted in lowered reflex activity and slowed reaction times.

The findings of Kleitman (1963) and Mann, Poeppel & Rutenfranz (1972) were of considerable interest and extremely pertinent to this investigation. Kleitman reported that there was probably no reaction time curve independent of the circadian cycle of basal body temperature. He further stated, "On the contrary, it would appear that reaction time was always connected with body temperature, which, whenever it changed, was accompanied by a change in the opposite direction in reaction time" (Kleitman, 1963, p. 134). These findings were substantiated by Mann, Poeppel & Rutenfranz (1972). They determined that a significant negative correlation existed between basal body temperature and reaction time during the 24-hour circadian temperature rhythm.

It was reasoned by this investigator that significant relationships may exist between reaction time, movement time and basal body temperatures observed during the normal menstrual cycle. It was the intent of this study to explore these possible relationships.

Statement of the Problem

The purpose of this study was to investigate the relationships among basal body temperature, simple reaction time and movement time at specific phases of the menstrual cycle. There were five basic questions examined by this study. The questions were as follows:

1. Did basal body temperature vary at specific phases of the menstrual cycle?

2. Did simple reaction time change with specific phases of the menstrual cycle?

3. Did movement time change with specific phases of the menstrual cycle?

4. What was the relationship, if any, between basal body temperature and simple reaction time at specific phases of the menstrual cycle?

5. What was the relationship, if any, between basal body temperature and movement time at specific phases of the menstrual cycle?

Definition of Terms

Basal body temperature. The internal body temperature, also called core temperature. For purposes of this study it was measured orally.

Circadian rhythm. The endogenous diurnal rhythm, approximately 24 hours (Bunning, 1967, p. 1).

Movement time. This reflects the amount of time taken to complete the actual response after it has been initiated (Robb, 1972, p. 86). For purposes of this study it involved arm and hand movements.

Phase. Some particular point in a cycle. For purposes of this study six specific phases of the menstrual cycle were selected for testing.

Simple reaction time. The name assigned to the delay between the occurrence of a single fixed stimulus and the intiation of a response assigned to it (Fitts & Posner, 1967, p. 95).

A trial. One complete trial consisted of the following: presentation of the visual preparatory stimulus, presentation of the visual response stimulus, release of the reaction key and depression of the target key by the subject.

Basic Assumptions

This investigation made the following assumptions:

1. That the oral temperature, taken by the subject, was an accurate measure of basal body temperature.

2. That the measurements made using the reaction and movement time apparatus were accurate and valid.

3. That each subject responded to the stimuli on every trial as quickly as possible.

4. That variations in subjects' temperatures during their menstrual cycles followed a similar pattern.

Limitations

This study was limited to twelve female volunteers enrolled in classes at the University of North Carolina at Greensboro during the 1974-75 academic year. Further procedural limitations were as follows:

1. Measurements were recorded during only one menstrual cycle.

2. There was a possibility of error since each subject was responsible for taking her own basal body temperature.

3. External variables, such as activity level, minor illness and emotional reactions, may have influenced body temperature.

4. The subject may have had an atypical menstrual cycle.

Rationale for the Study

The behavioral characteristics of the human female are influenced by the menstrual cycle. Whether these manifestations effect physiological changes in function remains largely unknown. The rhythmic occurrence of physiological events during the menstrual cycle, have been overlooked and not, until recently, been considered as fundamental to human athletic performance in females. If indeed there are important periodic processes within an experimental subject, a stimulus at one time may not have the same effect as the same stimulus at another time. The study was based upon the rationale that a temporal relationship may exist between phases of the menstrual cycle and basal body temperature.

The present study attempted to examine the relationships, among basal body temperature, simple reaction time and movement time at six specific phases of the menstrual cycle.

CHAPTER II

REVIEW OF LITERATURE

The Nature of Cyclic Variations During the Menstrual Cycle

Since the end of the 19th Century menstruation and the related physiological processes of women have been investigated. These studies have been conducted to determine the scientific basis for the belief that menstruation has either a positive or negative influence on a woman's athletic performance. Extensive research has revealed a variety of findings which have not always been in agreement.

One of the earliest studies was completed by Jacobi in 1876. Basing her opinion on observations of temperature, pulse, muscular strength and blood pressure, she concluded that the highest value for all of these parameters is reached about two to three days before the beginning of the flow and that the lowest point was observed at the end of the flow with a gradual rise to normal during the intermenstrual period. Further, she stated that efficiency rose and fell in relation to the menstrual cycle. In 1890, support was added to Jacobi's "wave" theory by Van Ott (Seward, 1934). He investigated muscular energy, vital capacity and caloric radiation in relation to reaction time of the knee reflex. Van Ott concluded that the energy functions of the female are augmented before the beginning of the menstrual flow and diminish with its onset.

In a more comprehensive study, Hollingworth (1914), determined the effect of the menstrual cycle on motor performance, fatigue, steadiness, perception, typing and physiological processes. The findings were contrary to earlier studies and Hollingworth concluded:

1. Careful and exact measurement does not reveal a periodic mental or motor inefficiency in normal women;

2. Variability in performance is not affected by physiological periodicity;

3. No regularly recurring period of maximum efficiency within each month is discernible; and

4. No similarity was established between curves for pulse, blood pressure, temperature or caloric radiation and the curve of work for mental and motor traits tested in the study.

The same year, King was concerned with determining whether the periodic rhythm in blood pressure is altered if regular exercise is taken during the menstrual cycle. Her evidence indicated that pulse and temperature showed a rhythmic movement reaching the maximum a few days before menstruation and that blood pressure failed to show any pattern. King concluded that there had been an over-emphasis on the inefficiency of women during their menstrual flow. The findings of Moore & Barker (1923) were consistent with those of King. They concluded that there were periodically recurring variations in the muscular efficiency of women and that the significant phase is the intermenstrual and premenstrual rise and not the menstrual fall which had been over-emphasized by most workers. Moore and Barker further stated that there was no indication of a marked mental depression during normal menstrual flow sufficient to interfere with a female's physical activity.

In a later investigation, Bilhuber (1926), studied the effects of functional periodicity on the motor ability of women. She tested 14 women on skill, speed and accuracy of motion in sports. Her results showed no evidence of periodic inefficiency nor a diminishing of motor ability in normal women. Bilhuber further reported that increased or decreased efficiency during critical periods appeared to be a matter of chance or the effect of external influences other than menstruation.

Subsequently, during the 1930's, more extensive research was conducted to either verify or disprove these previous theories.

Tuttle and Frey (1930), reported the following conclusions:

1. The normal heart rate during the menstrual cycle was relatively constant;

2. Menstruation does not bring about a cyclic rise and fall in physical efficiency; and

3. The variations which occur from time to time during the menstrual cycle are the result of factors other than menstrual flow.

These findings are in agreement with those of Hollingworth (1914) and Bilhuber (1926) in that the variations of physical efficiency during specific phases of the menstrual cycle appeared to be the result of influences other than menstrual flow. Billings (1933), observed a consistent post menstrual burst of activity which gradually declined to the time of the succeeding menstrual period in a study which correlated the periodic variations of motor activity in women with their menstrual cycle and the accompanying changes in estrogenic levels.

In 1960 and 1964, Dalton demonstrated that the female is more accident prone during the premenstruum and menstruum. After surveying

124 women involved in accidents she suggested that these accidents were the result of increased lethargy which impaired judgment and slowed reaction time. However, in contrast, studies by Youngen (1959) and by Pierson and Lockhart (1963) failed to support Dalton's theory. Testing 122 college women for simple reaction time and speed of arm movement, Youngen found no significant changes in either as a result of menstruation. Similarly, Pierson and Lockhart reported no significant changes in reaction time, speed of movement, or the relationship of the two to each other during the menstrual cycle. These findings were supported by Burke in 1965. On the basis of data collected from 21 women she concluded that leg reaction time, total body movement time and patellar reflex demonstrated no cyclic variation during the menstrual cycle. Although, she did note variations in basal oral temperature with significantly higher temperatures existing during the premenstrual phase.

In 1965, Condon compared abdominal and leg reaction times at selected stages of the menstrual cycle and found results contrary to those of Burke. She concluded the following:

1. No significant difference was found between any of the measures of leg reaction; and

2. A pattern of abdominal reaction time exists which shows slower reaction time at the end of the menstrual flow and increasingly slower throughout the mid phase, reaching a peak at the last phase of the cycle.

The evidence concerning relationships between performance and the menstrual cycle varies and is, often times, contradictory.

Redgrove (1971), suggested this may have been due to variations in techniques of investigation and analysis. She further asserted that there may be significant daily changes in performance throughout the cycle, which may be hidden if the cycle is dealt with in too large units. The Pierson and Lockhart study utilized a mean reaction time from all the subjects and was calculated for each day sampled. Redgrove believed that it was possible that the individual differences in the timing of changes cancelled each other out, so that no significant relationship could be observed.

In summary, it would seem that results from investigations that have been interpreted to demonstrate either a cyclic variation or the lack of one between simple reaction time and movement time at specific phases of the menstrual cycle have been inconsistent. It would seem that the field of women's athletics should be profoundly concerned with menstruation and these inconsistencies.

If we have been planning our competitive programs on the assumption that normal women are periodically physical invalids, and our assumption proves to be correct, then our athletic, educational and industrial systems must be cognizant of this fact. If, on the other hand, our assumption proves to be wrong, we must alter our habits of mind regarding menstruation and its effects on the female performer. Because of this evident need for additional data on menstruation, the present study was undertaken to investigate the relationships among basal body temperature, simple reaction time and movement time at specific phases of the menstrual cycle.

Selected References Concerning Simple Reaction And Movement Time

The literature concerning simple reaction time, movement time and the many variables associated with these concepts is extensive. Pertinent to this study are historical reviews and investigations involving the physiological factors of menstruation and basal body temperature as determinants of simple reaction and movement time.

It is only recently that reaction time, man's response to a stimulus, has been considered delayed and relatively slow. Until the 19th Century the rate at which nerve impulses are conducted was considered to be infinite. During the 1850's, Helmholtz demonstrated that the speed of the nerve impulse was relatively slow, although not as slow as reaction time itself (Fitts & Posner, 1967, p. 94). This figure was later confirmed by subsequent investigations.

The findings of Helmholtz supported previous theories held by early astronomers. Bilodeau (1969) discussed early experiments in astronomy and noted that during their observations it was necessary for astronomers to record a star's transit to the nearest tenth of a second. Meskelyne, (Bilodeau, 1969), a noted astronomer, observed a one-second discrepancy between his recordings and those of his assistant. These discrepancies led to further investigations of recording errors at several observatories. Bessel (Bilodeau, 1969) also interested in these errors, attributed them to processes within the observer and termed the discrepancies the "personal equation." He further observed that delays were shorter with the brighter stars and that delays were longer where events were unexpected and when auditory and visual events occurred simultaneously.

This early data, collected by the astronomers, led to Hirsch's development of the Hipp Chronoscope (Woodworth & Schlosberg, 1971). From this device values for simple reaction time were obtained and have remained comparatively standard to the present day. Following the work of Helmholtz, Hirsch and the early astronomers, researchers such as Donders, Exner, Wund, Kulpe, Hipp, and Cattell pioneered work in the study of reaction time (Woodworth & Schlosberg, 1971). A thorough review of studies on simple reaction time was published by Teicher (1954).

More recently, Henry (1952), and Slater-Hammel (1952), investigated the relationship between individual differences in reaction time and in speed of movement. Commonly, it has been believed that reaction and speed of movement times are highly positively correlated functions and that an athlete possessing one trait also possessed the other. Neither Henry nor Slater-Hammel found any relationship between the reaction times and movement times of individuals. Furthermore, Slater-Hammell indicated that measurement of reaction time cannot readily be used to predict speed of movement.

The reaction time of an individual can be affected by several different variables. These variables may be classified as follows:

1. Those dealing with the stimulus; and

2. Those dealing with the individual's condition (Oxendine, 1968; Robb, 1972; Sage, 1971).

A thorough knowledge of those factors pertinent to the present study was necessary for the investigator to get accurate measures.

In pioneer work on reaction time, Cattell (1947), found that the response speed varies with the particular sense organ receiving the stimulus. Rangaza (1957), and Colgate (1968), later corroborated his findings.

A second variable, stimulus intensity, has also been found to be influential in speed of reaction time. In general, each increase in stimulus intensity, up to a point, results in faster reaction time (Cattell, 1947; Rangazas, 1957; Schlosberg, 1954; Teichner, 1954).

The degree of readiness exhibited by the subject is a third factor which may modify reaction time. Researchers have found that the peak of attention does not last indefinitely. If the foreperiod is too long, the readiness will diminish; if the foreperiod is too short, the subject will not have sufficient time to get ready. Recent investigators reported that the shortest reaction times occur when the forewarning period is between one to two seconds (Drouin, 1973; Oxendine, 1968; Robb, 1972; Sage, 1971; Utter, 1974).

A number of workers have investigated the effect of practice as another influence on speed of reaction. In general, it is believed that very little improvement occurs after a period of a few trials (Hodgkins, 1962; Sage, 1971). Movement time, on the other hand, can be significantly affected by practice (Sage, 1971; Tweit, Gallnich & Hearn, 1963).

One more variable may affect reaction time, that being the subject's sex. The majority of the evidence indicates that the reaction and movement times of men have been faster than those of women (Bellis, 1933; Elliot & Louttit, 1948; Henry, 1960; Hodgkins, 1963; Rangazas, 1957; Seashore and Seashore, 1941).

In summary, it appears that reaction time is not a simple phenomenon and that various factors influence this response. Reaction and movement time capabilities may distinguish the outstanding performer from the poor performer in many motor skills. Therefore, numerous studies seem necessary to identify further variables which may influence the performer's speed of response.

The present study was primarily concerned with the basal body temperature at six specific stages of the menstrual cycle and its relation to simple reaction and movement time.

Basal Body Temperature Rhythms

Bio-rhythms, though commonplace in science research, tend to be overlooked and have not, until relatively recently, been considered as fundamental to human performance. Instead, researchers have sought to stabilize the living system they are investigating and study the effect of a stimulus in a controlled, experimental environment. If there are important periodic processes within an experimental subject, it has been suggested that a stimulus at one time will not have the same effect as the same stimulus at another time (Oatley & Goodwin, 1971).

Literature concerning basal body temperature rhythms was relevant to the present study and possibly to future research on the efficiency of human performance. Early investigators supported a wave theory which indicated a premenstrual rise in basal body temperature followed by a menstrual drop. The classic study by Van de Velde in 1904 demonstrated cyclic changes in basal body temperature (Cullis &

Oppenheimer, 1922; Harvey & Crockett, 1932; Seward, 1934), corroborated Van de Velde's wave theory.

In a more comprehensive study, Rubenstein (1938) suggested that the basal metabolic rate fluctuates regularly during the menstrual cycle with the lowest value occurring just before the mid-period. The basal body temperature also varies in the same manner. Rubenstein further indicated that body temperature and basal metabolic rate seemed to be significantly correlated and to be equivalent measures of ovarian activity.

More recently, investigators have determined that there is a shift in body temperature producing a bi-phasic cycle (Behrman & Gosling, 1966; Hafez & Evans, 1973; Johansson, 1972; Marshall, 1963; Novak, 1970; Page, 1972; Willson & Beecham, 1971). During the proliferative phase, the temperature averages about 97.7 degrees Fahrenheit. At ovulation there is a drop of half a degree, followed by a sharp rise of about one degree over a period of 24 hours. During the secretory phase, the temperature averages about 98.4 degrees Fahrenheit (Behrman & Gosling, 1966). Generally these fluctuations in basal body temperature have been attributed to changes in the levels of circulating progesterone.

Hormonally induced changes in reflex and reaction times, such as those produced by progesterone, have been explored extensively by Japanese workers (Furusawa, 1962; Kavakami, 1955; Matsunaga, 1964; Okamoto, 1960). Okamoto suggested that the periodic inhibitory influence of progesterone resulted in lowered reflex activity and slowed reaction times.

Although, the changes in body temperature during the menstrual cycle have been investigated for decades, the thermal shift during the circadian cycle has only recently been fully explored.

Experimenters have demonstrated that the 24-hour body temperature cycle is extremely reliable (Aschoff, 1965; Colquhoun, 1971; Kleitman, 1963; Luce, 1971; Mills, 1966; Strughold, 1971). They all reported maximum values for body temperature at approximately 8:00 P.M. and minimum values in the early morning hours (4:00 A.M.). Since basal body temperature varies throughout the day, and it is generally accepted that many physiological processes exhibit similarly, marked, circadian cycles, Colquhoun (1971) concluded that the functioning of the brain also varied, in that its operation must be supported by some of these processes. Therefore, he contended that there are strong grounds for expecting the speed and accuracy with which activities involving nervous function are executed and that they would fluctuate throughout the day.

Data generated by Kleitman, Titelbaum and Fieveson, 1938; Kleitman and Jackson, 1950; Kleitman, 1963; and Mann, Peoppel and Rutenfranz, 1972, strengthen his theory. From evidence obtained in their research, these workers determined a significant negative correlation between basal body temperature and reaction times during the circadian temperature rhythm. A significant increase in body temperature was accompanied by a concurrent decrease in reaction time.

In summary, certain generalizations may be made from the findings of studies designed to investigate basal body temperature rhythms. The following statements seem congruent with the literature:

1. Body temperature during the menstrual cycle exhibits a biphasic response with an ovulatory peak;

2. The basal metabolic rate exhibits a similar cycle during the menstrual cycle;

3. Basal body temperature fluctuations are attributed to changing levels of progesterone;

4. Progesterone periodically inhibits reaction time; and

5. A significant negative correlation exists between basal body temperature and reaction time during the 24-hour, diurnal rhythm.

It was therefore reasoned by this investigator that significant relationships may exist between simple reaction time, movement time and basal body temperature as observed during the normal menstrual cycle. The present study was designed to explore these possible relationships.

CHAPTER III

PROCEDURES

This study was conducted for the purpose of investigating the relationships among basal body temperature, simple reaction time and movement time at specific phases of the menstrual cycle. For the purpose of assessing these relationships the following procedures were utilized.

Sources of Data

The subjects for this study were 12 female, student volunteers enrolled at the University of North Carolina at Greensboro during the 1974-75 academic year. Their ages ranged from 21 to 40 years of age, with a mean of 28. Their weights ranged from 115 to 195 pounds, with a mean of 140.

Selection was limited to those subjects that met the following criteria:

1. they had menstrual cycles of consistent length,
2. they did not use oral contraceptives, and
3. they did not use prescribed drugs or medication which might influence menstruation or basal body temperature. Care was taken to record the use of any unprescribed drugs, including aspirin which would cause changes in the basal body temperature.

A preliminary study was conducted to determine the nature of the subjects' individual menstrual cycles. Two months prior to the actual testing, each subject was asked to maintain a calendar of her menstrual cycle (Appendix A) and to record twice each day her basal body temperature, once upon awakening and once at 8:00 p.m. In addition to temperature measurements, the subjects were required to record the following:

1. first day of menstrual flow,
2. last day of menstrual flow, and
3. first day of second month's menstrual flow.

Instructions, as to the correct method of measuring basal oral temperature, were given to the subjects (Appendix A). The information obtained from the preliminary study was used to establish each subjects' six specific stages of the menstrual cycle when measurements of simple reaction and movement times would be made.

During the month of actual data gathering each subject recorded her basal body temperature as described previously. An example of these data is presented in Appendix B. The six testing days were determined by examining the subjects' menstrual cycle calendar and the fluctuations of her basal body temperature. The six days selected by the experimenter for testing were as follows:

1. first day of menstrual flow,
2. last day of menstrual flow,
3. day of preovulation, indicated by a slight drop in basal body temperature (Behrman & Gosling, 1966),
4. ovulation, indicated by a sharp rise in basal body temperature (Behrman & Gosling, 1966),
5. 3/4 phase of menstrual cycle, and
6. last day of menstrual cycle.

The rationale for selecting these six testing days was based on the thermal shift in basal body temperature during the menstrual cycle as cited in Behrman & Gosling (1966). These specific stages of the menstrual cycle are accompanied by the greatest variations in basal body temperature.

Equipment

The equipment used for the collection of data consisted of four basic units:

1. the oral thermometer,
2. the stimulus producing unit,
3. the response unit, and
4. the recording unit.

The equipment was located in the Rosenthal Research Laboratory at the University of North Carolina at Greensboro where all testing was conducted.

Oral Thermometer

The oral thermometers used were capable of indicating basal body temperature to the nearest .2 degrees Fahrenheit. The rationale for selecting the oral thermometer was to ease the process of data gathering for the subjects and also because previous investigations had based the basal temperature rhythm on measurements taken orally (Behrman & Gosling, 1966; Hafez & Evans, 1973; Reid & Benirschke, 1972).

Stimulus Producing Unit

The stimulus producing unit (see Figure 1) was a small steel box 4 1/2 X 5 X 4 inches, containing the required control circuits for accuracy

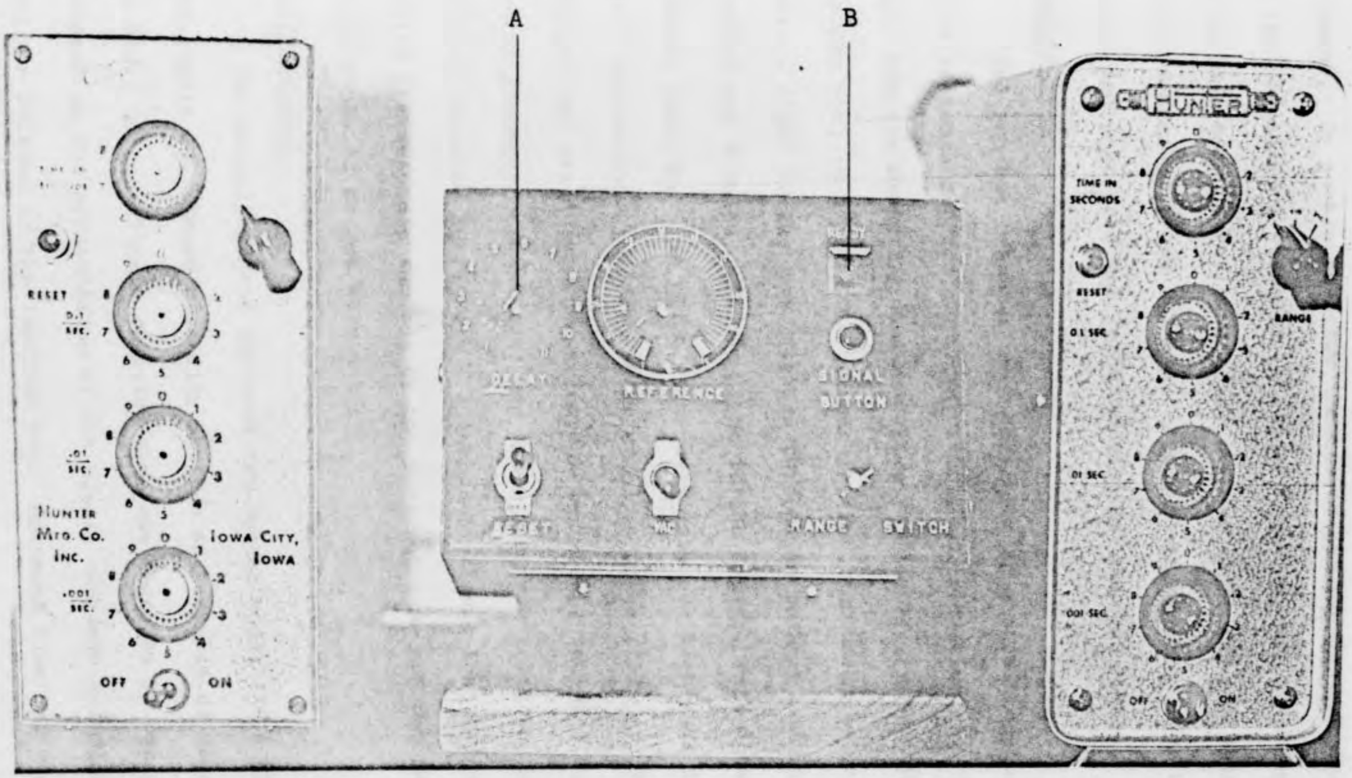

Fig. 1.--Control Unit.

in timing. To enable the experimenter to set the desired duration for the preparatory stimulus, a control knob (A) was adjusted from one to four seconds for each trial. A cue light (B) was also part of the control unit and was used to signal the experimenter when the subject had depressed the reaction time key and was ready.

Response Unit

The subject response unit consisted of a steel response box (A), a response key for measuring simple reaction time (B), and a target key for measuring movement time (C, See Figure 2). The subject response box, 10 1/2 X 8 X 6 inches in size, included: a yellow preparatory light at the top, visible through an opening one inch in diameter and a white response light in the center, with a two inch diameter opening. The use of the white response light was in accord with a suggestion by Woodworth as cited in Utter (1974, p. 33). The reaction key was a standard telegraph key with a response surface one inch in diameter. The target key was a standard telegraph key with a modified response surface, 4 X 2 inches in size. The rationale for enlarging the response surface of the movement time key was to eliminate the variable of target accuracy.

Recording Unit

The recording unit included two Hunter Model 120 A Klockounters (see Figure 1). These recording devices are capable of measuring in one msec. units. Simple reaction time was recorded by one chronometer actuated on the presentation of the visual response stimulus and stopped upon the release of the reaction key. Movement time was recorded by the second chronometer which was activated upon the release of the reaction key and stopped upon the depression of the target key.

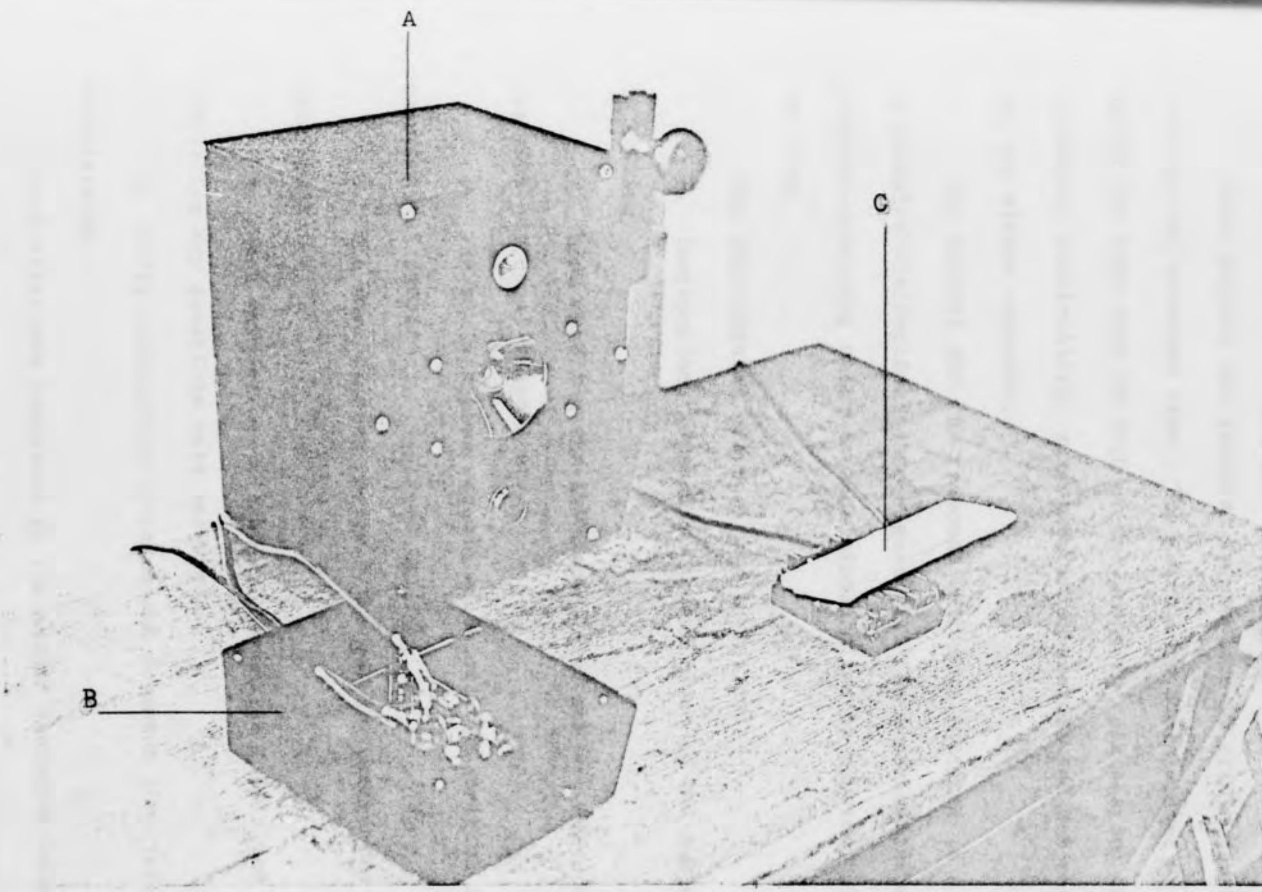

Fig. 2.--Response Unit.

Experimental Conditions

Each subject was required to complete 50 trials for both simple reaction and movement time. The tests were administered at approximately the same time on each of the subjects' six testing days; although laboratory availability, experimenter's schedule and subject schedules did not always coincide.

The subject and the response unit were isolated in a small room to minimize distractions (see Figure 3). The experimenter and the stimulus-producing unit were positioned directly outside this experimental room.

The experimental protocol was as follows:

1. Instructions (Appendix C) were given to the subject prior to testing.

2. Upon entering the laboratory, the subject measured and recorded her basal temperature.

3. The subject then assumed a comfortable position in the experimental room.

4. The investigator reviewed the testing procedures with each subject.

5. Each subject was allowed ten practice trials and upon their completion any questions were answered.

6. Fifty consecutive reaction and movement time trials were administered.

Each trial was completed in the manner described below:

1. The experimenter manually adjusted the necessary dials to set the delay between the onset of the preparative signal and the onset of

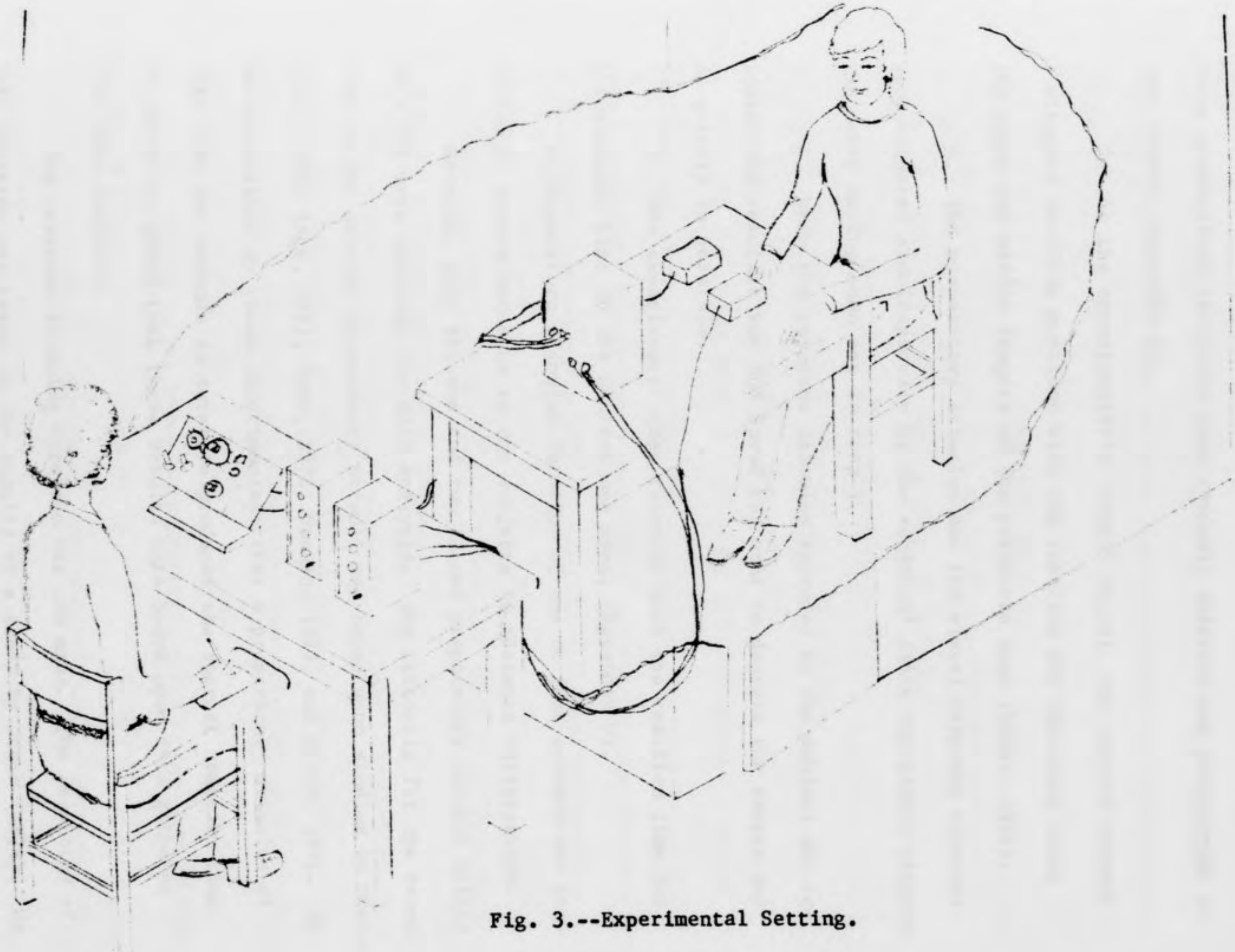

Fig. 3.--Experimental Setting.

the response signal. This time was also used to reset the klockounter. These preparatory intervals were randomly selected and prerecorded on data sheets (Appendix D).

2. At the experimenter's "ready" signal, the subject assumed a standard starting position with the reaction key depressed using the index and middle fingers of the preferred hand (Utter, 1974).

3. The preparatory stimulus and the visual response stimulus were actuated simultaneously by the subjects' index and middle fingers, the delay having been set in step 1.

4. When the response stimulus appeared to the subject she released the reaction key and moved her hand to depress the target key as quickly as possible.

6. The experimenter then recorded both the reaction time and the movement time to the nearest one msec. (Appendix D).

A preparatory stimulus duration of one to four seconds was presented in random sequence to the subjects to minimize anticipation.

However, only the one and two second preparatory stimuli trials (N = 30) were recorded for data analysis. The rationale for the selection of the shorter preparatory stimuli was based upon studies by Oxendine, 1968; Sage, 1971; Robb, 1972; Drouin, 1973; and Utter, 1974. It was determined by these experimenters that a preparatory stimulus of less than two seconds in duration produced the fastest reaction time. It should be noted that these results were based upon data gathered from male subjects.

The response stimulus duration was 100 msec. The selection of this duration was based on the results of a study by Utter (1974). He reported that the shortest reaction time was obtained from the combination of a one second preparatory stimulus and a 100 msec response stimulus. It should again be noted that these data were based on male subjects.

Treatment of Data

The data recorded on each subjects' six testing days were organized into three units and recorded as follows:

1. the basal body temperature measurement,
2. the mean, simple reaction time score, and
3. the mean, movement time score.

A two-way ANOVA with one entry per cell design with repeated measures was used to assess the significance of the differences between basal body temperature measurements, simple reaction time scores, and movement time scores at the six specific phases of the menstrual cycle.

The Scheffe' post hoc test was administered to determine where the means were significantly different.

A Pearson product-moment correlation coefficient was determined to indicate the degree of relationship between the following:

1. the subjects' basal body temperature scores and her simple reaction time scores, and
2. the subjects' basal body temperature scores and her movement time scores.

All statistical comparisons were made at the .05 level of confidence.

CHAPTER IV

DATA AND DISCUSSION

This study examined the relationships among basal body temperature, simple reaction time and movement time at six specific phases of the menstrual cycle. Subjects for the study were 12 female volunteers enrolled in classes at the University of North Carolina at Greensboro. Each subject was required to complete 50 trials for both simple reaction and movement time on each of six testing days representing the six phases of the menstrual cycle.

Analysis of Data

A two-way ANOVA with one entry per cell design with repeated measures (Roscoe, 1969) was used to examine the following questions:

1. Did basal body temperature vary at specific phases of the menstrual cycle? The results support no significant change in body temperature during the six phases of the menstrual cycle (see Table IV).

2. Did simple reaction time change with specific phases of the menstrual cycle? The results substantiate a significant change in the simple reaction times measured at the six phases of the menstrual cycle (see Table IV). The Scheffe' test was administered to the simple reaction time scores to determine where simple main effects were significantly different when a significant $\underline{F}$ value for interaction was found. The results, presented in Table V, illustrate that the largest difference, although not significant, existed between the reaction time scores during Phase I and those during Phase IV.

3. Did movement time change with specific phases of the menstrual cycle? The data support no significant change in the movement times recorded at the six phases of the menstrual cycle, although the degree of differences was approaching significance at the .05 level of confidence (see Table IV).

A Pearson product-moment correlation coefficient was utilized to examine the remaining questions. These questions are presented below:

4. What was the relationship, if any, between basal body temperature and simple reaction time at specific phases of the menstrual cycle? No significant relationship between basal body temperature and simple reaction time was supported by the data of this study. It was observed although, that an insignificant negative correlation (-.46) did exist between simple reaction time and basal body temperature (see Table VI).

5. What was the relationship, if any, between basal body temperature and movement time at specific phases of the menstrual cycle? No significant relationship between basal body temperature and movement time was supported by the results of this study (see Table VI).

The mean reaction time, movement time and basal body temperature measures for each subject at the six phases of the menstrual cycle are presented in Tables I, II, and III respectively. By inspection, it can be observed that the shortest reaction time occurred during the ovulatory phase (IV) of the menstrual cycle, and the shortest movement time occurred during the first day of menstrual flow (phase I). Further, it can be noted that the basal body temperature was lowest during the pre-ovulatory phase (III) and highest during the 3/4 phase (V) of the menstrual cycle.

TABLE I

Mean Scores for Reaction Time

Subjects	Phases of Menstrual Cycle* I	II	III	IV	V	VI
1	170.27	155.50	167.47	180.70	178.90	172.80
2	159.83	163.90	162.83	164.60	141.97	171.23
3	180.57	161.77	162.17	159.37	152.10	170.60
4	178.67	191.80	188.83	197.80	189.07	183.00
5	181.50	166.43	170.40	170.00	180.80	162.20
6	227.27	217.57	241.20	220.87	235.63	221.20
7	186.87	198.53	209.13	172.03	183.63	206.13
8	216.77	178.57	150.93	144.90	146.93	161.93
9	177.67	171.63	168.00	169.33	172.80	188.57
10	212.23	179.83	188.90	174.50	183.77	189.67
11	184.30	177.03	158.27	172.37	168.70	192.70
12	207.20	203.30	194.73	185.23	195.07	202.00
Total Mean	190.26	180.49	180.24	175.98	177.45	185.17

N = 30

*Phase I-First day of flow

Phase II-Last day of flow

Phase III-Day of preovulation

Phase IV-Day of ovulation

Phase V-3/4 phase of cycle

Phase VI-Last day of cycle

TABLE II

Mean Scores for Movement Time

	Phases of Menstrual Cycle					
Subjects	I	II	III	IV	V	VI
1	77.03	132.00	138.70	139.20	146.93	140.63
2	74.00	114.23	113.30	109.60	101.20	91.33
3	115.27	141.40	127.13	138.67	121.90	128.37
4	121.93	112.00	110.23	103.87	83.40	64.50
5	140.77	122.83	129.07	121.17	151.77	121.93
6	149.90	149.13	124.50	126.00	146.63	158.17
7	104.77	169.07	177.67	170.70	159.43	137.03
8	64.43	167.00	94.13	100.17	92.20	80.47
9	134.63	117.03	118.67	107.77	99.77	117.53
10	134.70	102.60	117.50	104.00	107.00	94.27
11	99.97	117.17	103.23	108.07	104.97	102.87
12	123.20	146.27	139.73	125.87	132.83	119.43
Total Mean	111.80	132.56	124.49	121.26	120.67	113.04

N = 30

*Phase I-First day of flow

Phase II-Last day of flow

Phase III-Day of preovulation

Phase IV-Day of ovulation

Phase V-3/4 phase of cycle

Phase VI-Last day of cycle

TABLE III

Basal Body Temperature Measurements

	Phases of Menstrual Cycle					
Subjects	I	II	III	IV	V	VI
1	99.0	98.4	98.4	98.6	98.6	99.0
2	98.2	98.2	97.8	98.0	99.2	98.4
3	98.2	98.4	98.4	97.6	98.4	97.0
4	98.8	101.0	98.6	98.7	98.7	98.6
5	97.2	97.4	98.0	98.2	97.8	98.4
6	98.6	98.0	98.1	97.8	99.2	98.6
7	98.6	98.8	98.0	99.0	99.8	99.0
8	98.4	98.2	98.2	98.0	98.2	97.4
9	98.4	98.0	98.6	98.6	98.6	98.6
10	97.2	97.8	97.4	99.0	99.0	98.0
11	98.2	98.6	98.0	98.8	99.0	98.6
12	98.2	98.4	98.5	98.1	98.6	98.4
Total Mean	98.25	98.43	98.17	98.37	98.76	98.36

*Phase I-First day of flow

Phase II-Last day of flow

Phase III-Day of preovulation

Phase IV-Day of ovulation

Phase V-3/4 phase of cycle

Phase VI-Last day of cycle

When the data for the estimation of variance were submitted to tests for main effects the F values, as shown in Table IV, were obtained.

TABLE IV

ANOVA Summaries

REACTION TIME

Source	df	MS	F	F.05
Subjects	11	2078.11	*14.851	1.98
Phases	5	335.40	* 2.40	2.39
Interaction	55	139.93		
Total	71	453.98		

MOVEMENT TIME

Source	df	MS	F	F.05
Subjects	11	1927.46	* 5.89	1.98
Phases	5	703.54	2.15	2.39
Interaction	55	327.20		
Total	71	601.63		

BASAL BODY TEMPERATURE

Source	df	MS	F	F.05
Subjects	11	.785	*3.12	1.98
Phases	5	.500	1.984	2.39
Interaction	55	.252		
Total	71	.352		

TABLE V

Scheffe' Post Hoc Test: Differences Between Simple Main Effects of the Six Phases

Phases of Menstrual Cycle	Difference	Critical Value .05
Rt phase I and Rt phase II	9.77	16.71
Rt phase I and Rt phase III	10.02	16.71
Rt phase I and Rt phase IV	14.28*	16.71
Rt phase I and Rt phase V	12.81	16.71
Rt phase I and Rt phase VI	5.09	16.71
Rt phase II and Rt phase III	.25	16.71
Rt phase II and Rt phase IV	4.51	16.71
Rt phase II and Rt phase V	3.04	16.71
Rt phase II and Rt phase VI	4.68	16.71
Rt phase III and Rt phase IV	4.26	16.71
Rt phase III and Rt phase V	2.79	16.71
Rt phase III and Rt phase VI	4.93	16.71
Rt phase IV and Rt phase V	1.47	16.71
Rt phase IV and Rt phase VI	9.19	16.71
Rt phase V and Rt phase VI	7.72	16.71

*Phase I-First day of flow
Phase II-Last day of flow
Phase III-Day of preovulation
Phase IV-Day of ovulation
Phase V-3/4 phase of cycle
Phase VI-Last day of cycle

TABLE VI

Pearson Product-Moment Correlations

Phase	Mean Reaction Time	Mean Basal Body Temperature
I	190.26	98.25
II	180.49	98.43
III	180.24	98.17 r = [0.46]
IV	175.98	98.37
V	177.45	98.76 r.05 = [.81]
VI	185.17	98.36

Phase	Mean Movement Time	Mean Basal Body Temperature
I	111.80	98.25
II	132.56	98.43
III	124.49	98.17 r = [.14]
IV	121.26	98.37
V	120.67	98.76 r.05 = [.81]
VI	113.04	98.36

Interpretation and Discussion

The results of this study indicate that there were no statistically significant relationships among basal body temperature, simple reaction time and movement time at specific phases of the menstrual cycle, as demonstrated by the non-significant _r_ correlation coefficients. The evidence did not support the theory that reaction time is significantly negatively correlated with basal body temperature (Colqulhoun, 1971; Kleitman, 1963; Mann, Peoppel & Ruttenfranz, 1972), although an insignificant negative correlation did exist between simple reaction time and basal body temperature. Due to the limitations of the present study, it is the writer's opinion that subsequent research investigating basal body temperature and its relationship with reaction time and movement time, should be conducted with a larger sample and over an extended time period.

The data also indicated that simple reaction time changed significantly at specific phases of the menstrual cycle. The significant main effect found for the menstrual phases is consistent with results obtained by Dalton (1960) and Condan (1965). Although, simple reaction time did not show a significant negative relationship with basal body temperature, it should be noted that the largest differences in reaction time scores existed between Phase I and Phase IV, and that according to recent investigators (Hafez & Evans, 1973; Johansson, 1972; Novak, 1970; Page, 1972) these two phases also exhibit a significant difference in basal body temperature. The ovulatory phase (IV) should generally exhibit a rise of from $1/2^{o}$ to 1^{o} in basal body temperature from that exhibited during the first day of menstrual flow, Phase I. It should be noted that in the present investigation the mean basal body temperature was lowest during the pre-ovulatory phase (III), which is in agreement with recent gynecological studies (Hafez & Evans, 1973; Page, 1972; Willson & Beecham, 1971), but in contradiction with the above investigators, this writer found the basal body temperature to be highest during the 3/4 phase (V) of the menstrual cycle. It is the writer's opinion that the conflicting results of the present study might have been due to external variables influencing the subjects' basal body temperature or the possible inaccuracy of the oral thermometer used to record the subjects' body temperature.

It was observed further, that although movement time was not altered significantly during different phases of the menstrual cycle, the degree of difference was approaching significance at the .05 level of confidence. These observations and the significant changes in reaction time support Dalton's 1960 theory that the female is more accident prone at specific phases of the menstrual cycle. Therefore, it seems warranted that subsequent research investigating changes in movement time during different phases of the menstrual cycle be conducted with a larger sample and over an extended time period.

Previous investigations have drawn varying conclusions concerning the relationships among basal body temperature, simple reaction time and movement time during specific phases of the menstrual cycle. The data from this study demonstrated no significant relationships between body temperature and speed of response and movement. Furthermore, based on the findings of this study, it can be concluded that the reaction time of females is significantly altered at different phases of the mentrual cycle and that this may influence the woman athlete in performance of motor skills.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This investigation examined the relationships among basal body temperature, simple reaction time and movement time at six specific phases of the menstrual cycle. The following questions were posed for this study:

1. Did basal body temperature vary at specific phases of the menstrual cycle?

2. Did simple reaction time change with specific phases of the menstrual cycle?

3. Did movement time change with specific phases of the menstrual cycle?

4. What was the relationship, if any, between basal body temperature and simple reaction time at specific phases of the menstrual cycle?

5. What was the relationship, if any, between basal body temperature and movement time at specific phases of the menstrual cycle?

The subjects for this study were 12 female, student volunteers enrolled at the University of North Carolina at Greensboro during the 1974-75 academic year. The mean age of the subjects was 28 years.

Each subject was required to complete 50 trials for both simple reaction and movement time. The tests were administered in the Rosenthal Laboratory at approximately the same time on each of the subjects' six testing days. The six testing days, selected by the experimenter were based upon the results of a pilot study, and were as follows:

1. first day of menstrual flow,

2. last day of menstrual flow,

3. day of pre-ovulation, indicated by a slight drop in basal body temperature (Behrman & Gosling, 1966),

4. ovulation, indicated by a sharp rise in basal body temperature (Behrman & Gosling, 1966),

5. 3/4 phase of menstrual cycle, and

6. last day of menstrual cycle.

The data recorded on each of the subjects' six testing days were organized into three units and recorded as follows:

1. the basal body temperature measurement,

2. the mean, simple reaction time score, and

3. the mean, movement time score.

A two-way ANOVA with one entry per cell design with repeated measures was used to assess the significance of the differences between basal body temperature measurements, simple reaction time scores, and movement time scores at the six specific phases of the menstrual cycle. The Scheffe' post hoc test was administered to determine where the means were significantly different.

A Pearson product-moment correlation coefficient was determined to indicate the degree of relationship among basal body temperature, simple reaction time and movement time.

All statistical comparisons were made at the .05 level of confidence.

The data supported the contention that simple reaction time changed significantly at specific phases of the menstrual cycle based upon the obtained _F_ value of 2.40. A Scheffe' post hoc test was then run to determine where simple main effects were significantly different for the reaction time scores. The results illustrated that the largest difference existed between the reaction time scores during phase I and those during phase IV.

The two-way ANOVA for repeated measures was also performed to test the effects of the menstrual cycle on speed of hand and arm movement. The analysis revealed that movement time did not change significantly at specific phases of the menstrual cycle.

A correlation coefficient was then determined to indicate the degree of relationship between the following:

1. basal body temperature and simple reaction time, and
2. basal body temperature and movement time.

In both cases, a non-significant _r_ correlation coefficient was obtained. It was concluded that no significant relationship existed between body temperature and reaction or movement time at specific stages of the menstrual cycle.

Conclusions

Within the limitations of this study and the results obtained from the data collected and analyzed, the following conclusions seem justified:

1. Basal body temperature does not vary significantly at specific phases of the menstrual cycle.

2. Simple reaction time changes significantly at specific phases of the menstrual cycle.

3. Movement time does not change significantly at specific phases of the menstrual cycle.

4. No significant relationship exists between simple reaction time and basal body temperature.

5. No significant relationship exists between movement time and basal body temperature.

Recommendations

On the basis of the results of this investigation,the following recommendations for further study are made:

1. Conduct a similar study using a larger sample.

2. Break the menstrual cycle down into more than six stages.

3. Use some type of thermometer capable of recording the body temperature to the nearest .01 of a degree.

4. Modify the movement time test to make it more of a realistic motor skill.

5. Increase the duration of testing to include three or four of the subject's menstrual cycles.

BIBLIOGRAPHY

Abramson, M., & Torghele, J. R. American Journal of Obstetrics and Gynecology, 1961, pp. 223-232.

Aschoff, J. (Ed.). Circadian Clocks. Amsterdam: North Holland Publishing Company, 1965.

Aschoff, J. Circadian rhythms in man. Science, 1965, 148, 1427-1432.

Behrman, S., & Gosling, J. Fundamentals of Gynecology. New York: Oxford University Press, 1966.

Bellis, C. J. Reaction time and chronological age. Proc. Soc. Exp. Biol. Med, 1933, 30, 801-803.

Bergstrom J. A. An experimental study of some of the conditions of mental activity. American Journal of Psychology, 1894, 6, 247-274.

Bilhuber, J. The effect of functional periodicity on the motor ability of women in sports. American Physical Education Review, January 1927, 32, 22-25.

Billings, E. G. The occurrence of cyclic variations in motor activity in relation to the menstrual cycle in the human female. Bulletin, John Hopkins Hospital, June 1934, 54, 440.

Bilodeau, E. A. (Ed.). Acquisition of Skill. New York: Academic Press, 1966.

Bunning, E. The physiological clock. Circadian rhythms and biological chronometry. Heidelberg Science Library (Vol. 1, 3rd ed.). London: The English University Press, Ltd, 1973.

Burke, N. P. Measures of patellar reflex, reaction and body movement times at selected stages of the menstrual cycle. Unpublished doctoral dissertation, University of Iowa, 1965.

Cattell, J. McK. The influence of the intensity of the stimulus on the length of reaction time. Brain, 1947, 512-515.

Colgate, T. P. Reaction and response times of individuals reacting to auditory, visual, and tactile stimuli. Research Quarterly, 1968, 39, 783-784.

Colquhoun, W. P. Biological Rhythms and Human Performance. New York: Academic Press, 1971.

Condon, J. A. A comparison of reaction time at different stages of the menstrual cycle. Unpublished Master's Thesis, University of Iowa, 1965.

Cullis, W., Oppenheimer, E. M., & Ross-Johnson, M. Observations on temperature and other changes in women during the menstrual cycle. Lancet, 1922, 203(954-956, Pt. 2).

Dalton, K. Menstruation and accidents. British Medical Journal, November 12, 1960, 2, 1425-1426.

Dalton, K. The Premenstrual Syndrome. Springfield, Illinois: Charles C. Thomas, 1964.

Dresslor, F. B. Some influences which affect the rapidity of voluntary movements. American Journal of Psychology, 1892, 4, 514-527.

Drouin, D. Classical reaction time and anticipation reaction time in a simple visual reaction time task. Unpublished doctoral dissertation, University of North Carolina at Greensboro, 1973.

Elliot, F. R., & Louttit, C. M. Auto braking reaction times to visual versus auditory warning signals. Proc. Ind. Acad. Sci, 1948, 47, 220-225.

Fairclough, R. H. Transfer of motivated improvement in speed of reaction and movement times. Research Quarterly, May 1951, 22, 141.

Fitts, P. M., & Posner, M. I. Human Performance. Belmont, California: Brooks/Cole, 1967.

Fluhman, F. The Management of Menstrual Disorders. Philadelphia: W. B. Saunders and Company, 1956.

Furusawa, K. Some evidence of hormonal control in activity of skeletal musculature in man. Revue de Canadiane Biologie, 1962, 21, 325-334.

Gosselin, P. T. A study of the effects of heat and cold on reaction time, steadiness, balance, and motor performance. Unpublished Master's Thesis, University of North Carolina at Greensboro, 1961.

Hafez, E., & Evans, T. Human Reproduction. New York: Harper and Row, 1973.

Harvey, O. L., & Crockett, T. Individual difference in temperature changes of women during the course of the menstrual cycle. Human Biology, 1932, 4, 453-468.

Henry, R. Independence of reaction and movement times and equivalence of sensory motivators of foster response. Research Quarterly, March 1952, 23, 45-53.

Henry, F. Stimulus complexity, movement complexity, age and sex in relation to reaction latency and speed in limb movement. Research Quarterly, October 1961, 32, 353-366.

Hodgkins, J. Reaction time and speed of movement in males and females of various ages. Research Quarterly, October 1963, 34, 335-343.

Hollingworth, L. S. Functional periodicity--an experimental study of the mental and motor abilities of women during menstruation. Contributions to Education (No. 69). New York: Bureau of Publication, Teachers College, Columbia University.

Jacobi, M. The question of rest for women during menstruation. Bolyston Price Essay of Harvard University for 1876. New York: Putnam Sons, 1877.

Johansson, E. Monophasic basal body temperature in ovulatory menstrual cycles. American Journal of Obstetrics and Gynecology, 1972, 113 (7), 933-937.

Kavakami, M. Electro-myographic study of sexual and other hormones on skeletal muscles. Japanese Journal of Physiology, 1955, 5, 251-273.

King, J. Concerning the periodic cardio-vascular and temperature varations in women. American Journal of Physiology, 1914, 34, 203-219.

Klein, K. E., Wegmann, H. M., & Brüner, H. Circadian rhythm in indices of human performance, physical fitness and stress resistance. Aerospace Medicine, May 1968, 39, 512-518.

Kleitman, N. Sleep and Wakefulness. Chicago: University of Chicago Press, 1963.

Kleitman, N., & Doktorsky, A. Studies on the physiology of sleep. VII. The effect of the position of the body and of sleep on rectal temperature in man. American Journal of Physiology, 1933, 104, 340-343.

Kleitman, N., & Jackson, D. P. Body temperature and performance under different routines. Journal of Applied Physiology, 1950, 3, 309-328.

Kleitman, N., & Titelbaum, S., & Feiverson, D. The effect of body temperature on reactive time. American Journal of Physiology, 1938, 121, 495-501.

Lawther, J. D. The Learning of Physical Skills. Englewood Cliffs: Prentice Hall, 1948.

Luce, G. G. Body Time. New York: Random House, 1971.

Mann, H., & Peoppel E., & Rutenfranz, J. Circadian rhythms of reaction time. International Archives of Occupational Health, 1972, 29(4), 269-284.

Marshall, J. British Medical Journal, 1963, i, 102-104.

Matsunaga, M. Relations between sexual cycle and physical activities and somatic phenomena of women. Study in progress presented at International Congress of Sports Sciences, Tokyo, Japan, October 3-8, 1964.

Miller, N. F. Recent investigations of the menstrual problem. Research Quarterly, May 1930, 1, 131-141.

Mills, J. N. Human circadian rhythms. Physiological Review, 1966, 46, 128-171.

Moore, L. M., & Barker, L. J. Monthly variations in muscular efficiency in women. American Journal of Physiology, 1923, 64, 405-415.

Morton, J. H. American Journal of Obstetrics and Gynecology, 1950, 60, 343-352.

Mosher, C. Normal menstruation and some of the factors modifying it. John Hopkins Hospital Bulletin, 1901, 12, 178-179.

Novak, E. R., Jones, G. S., & Jones, H. W. Novak's Textbook of Gynecology. Baltimore: The Williams & Wilkins Co., 1970.

Oatley, K., & Goodwin, B. C. The explanation and investigation of biological rhythms. Biological Rhythms and Human Performance, 1971.

Okamoto, M. Sexual hormones and certain reflexes in man. Journal of Medical Sciences, 1960, 6, 105-115.

Oxendine, J. Psychology of Motor Learning. New York: Appleton-Century-Crofts, 1968.

Page, E. W. Human Reproduction. Philadelphia: W. B. Saunders Company, 1972.

Pierson, W., & Lockhart, A. The effect of menstruation on simple reaction time and movement time. British Medical Journal, March 23, 1963, 5333, 796-797.

Pierson, W., & Raasch, P. Determination of a representative score for simple reaction and movement time. Perceptual Motor Skills, June 1959, 9, 107-110.

Rangaza, E. P. A comparative analysis of selected college athletes and non-athletes on several hand-foot reaction time measures. Unpublished thesis, Indiana University, 1957.

Redgrove, J. Work and the menstrual cycle. Unpublished thesis, University of Birmingham, 1968.

Reid, D., Ryan, K., & Benirschke, K. Principles and Management of Human Reproduction. Philadelphia: W. B. Saunders Company, 1972.

Richter, C. Biological Clocks in Medicine and Psychiatry. Springfield, Illinois: Charles C. Thomas, 1965.

Robb, M. The Dynamics of Motor Skill Acquisition. Englewood Cliffs: Prentice Hall, 1972.

Roscoe, J. T. Fundamental Research Statistics for the Behavioral Sciences. New York: Holt, Rinehart and Winston, 1969.

Rubenstein, B. B. Estimation of ovarian activity by the consecutive day study of basal body temperature and basal metabolic rate. Endocrinology, 1938, 22, 41-44.

Sage, G. H. Introduction to Motor Behavior: A Neuro Psychological Approach. Reading Massachusetts: Addison-Wesley, 1971.

Scott, B., & Tuttle, W. The periodic fluctuation in physical efficiency during the menstrual cycle. Research Quarterly, March 1932, 3, 137-144.

Seashore, S. H., & Seashore, R. H. Individual differences in simple auditory reaction times of hands, feet, and jaws. Jour. Exp. Psychology, 1941, 29, 342-345.

Seward, G. The female sex rhythm. Psychological Bulletin, April 1934, 31, 154.

Slater-Hammell, A. T. Reaction time and speed of movement. Perceptual and Motor Skills, September and December 1952, 4, 109-113.

Strughold, H. Your Bodyclock. New York: Scribner, 1971.

Teichner, W. H. Recent studies of simple reaction time. Psychological Bulletin, 1954, 51, 128-149.

Tuttle, W., & Frey, H. Changes of irritability in women during the menstrual cycle. Journal Lab. and Clin. Med, 1930, 11, 60-62.

Tweit, A. H., Gollnick, P. D., & Hearn, G. R. Effect of training program on total body reaction of individuals of low fitness. Research Quarterly, 1963, 34, 508-518.

Utter, W. Effect of selected preparatory and response signal durations on reaction time in a simple reaction time task. Unpublished doctoral dissertation, University of North Carolina at Greensboro, 1974.

Vande Velde, T. H. Über den Zusammenhang zwischen Ovarialfunction, Wellen bewegung, und Menstrualblutung, und Über die Enstehung des sogenannten Mittelshmerzo Haarlem: Bohm, 1904.

Ward, R. R. The Living Clocks. New York: Knopf, 1971.

Wells, G. The effect of external temperature changes on heart rate, blood pressure, physical efficiency, respiration, and body temperature. Research Quarterly, December 1932, 3, 108-121.

Wilkinson, R. T. Evoked response and reaction time. Acta Psychologica, 1967, 27, 235-245.

Willson, J. R., & Beechan, C. T., & Carrington, E. R. Obstetrics and Gynecology. St. Louis: Teh C. V. Mosby Company, 1971.

Woodworth & Schlosberg. Experimental Psychology (Revised ed.). New York: Holt, Rinehardt, and Winston, 1963.

Youngen, L. A comparison of reaction and movement times of women athletes and non-athletes. Research Quarterly, October 1959, 30, 349-355.

APPENDIX A

Preliminary Menstrual Cycle Calendar

Researcher: Nancy Shay

Subject: ___________________________

Each individual subject is asked to maintain a calendar of her menstrual cycle and to record daily basal temperatures. The basal temperature should be recorded at approximately the same times each day, 1. first measurement upon awaking, and 2. second measurement at 8:00 P.M. Instructions for measurement are:

1. Shake down the thermometer grasping only the scale end. This should be repeated until the reading is below 97.0 degrees Fahrenheit.

2. Place the bulb under the rear of the tongue and close mouth.

3. Leave thermometer in mouth for a period of 5 minutes.

4. To read the thermometer stand with back to light, hold scale end so that graduation lines are above and numbers below the mercury column. Looking down upon the instrument, rotate it back and forth slowly until the mercury column is seen. Do not hold bulb while reading.

5. Record the oral temperature to the nearest .2 degrees F.

6. Rinse thermometer in cool water and place in container.

The subject should also indicate on the calendar: 1. first day of flow, 2. last day of flow, and 3. first day of second month's flow.

Date	Measurement	
	A.M.	P.M.
1.	(F.D.F.)	
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		

Date	Measurement	
	A.M.	P.M.
18.		
19.		
20.		
21.		
22.		
23.		
24.		
25.		
26.		
27.		
28.		
29.		
30.		
31.		
32.		
33.		
34.		

APPENDIX B

MENSTRUAL CYCLE CALENDAR

Experimentor: Nancy Shay

Subject: ______________________________

Each individual subject is asked to maintain a calendar of her menstrual cycle and to record 2 daily basal temperatures. The basal temperature should be recorded at approximately the same times each day, once upon awaking and second at approximately 8:00 p.m. in the evening. Instructions for measurement of the basal temperature are the same as those given previously for the preliminary study.

Each subject should indicate on their calendar the following:

1. First day of menstrual flow
2. Last day of menstrual flow
3. First day of second month's menstrual flow.

Date	Time(AM)	Temp.	Time(PM)	Temp.	Notes

Date	Time (AM)	Temp.	Time(PM)	Temp.	Notes

During the month of actual data gathering each subject will record her basal body temperature twice daily, as described previously. The reaction and movement times will be determined in the laboratory for each of the six phases of the menstrual cycle. The six testing days, as determined by the preliminary study, will include:

1. First day of menstrual flow.

2. Last day of menstrual flow.

3. Day of preovulation.

4. Ovulation.

5. 3/4 phase of menstrual cycle.

6. Last day of menstrual cycle.

Further information concerning each subject's specific testing days will be given by the experimentor prior to testing.

APPENDIX C

TESTING INSTRUCTIONS

1. Assume a comfortable position in the experimental room.
2. At the experimenter's "ready" signal, you will assume a standard ready position by depressing the reaction time key using the index and middle fingers of the preferred hand.
3. When the visual response signal (a white light will flash) appears to you, release the reaction time key and move your hand to depress the target key as quickly as possible.
4. The experimentor will then record your reaction and movement times on the data sheet.
5. You must now reset the target key and assume the standard ready position.

APPENDIX D

Name ______________________ Date ______________________

Temp. ______________________

Test ______________________

Trial	PS	RT	MT	Trial	PS	RT	MT
1	3			*21	1		
*2	1			*22	2		
3	4			23	3		
*4	2			*24	1		
*5	1			25	4		
6	3			*26	1		
7	4			*27	1		
*8	1			28	3		
*9	2			*29	2		
*10	1			*30	1		
11	3			*31	1		
12	3			*32	2		
*13	1			33	3		
*14	1			*34	1		
15	4			35	4		
*16	2			*36	2		
*17	1			37	3		
18	3			*38	1		
*19	2			39	4		
20	4			*40	2		

Name ______________________________ Date ______________________

Temp.______________________________

Test ______________________________

Trial	PS	RT	MT	Trial	PS	RT	MT
*41	1						
42	3						
43	4						
*44	1						
45	4						
46	3						
*47	1						
*48	2						
*49	1						
*50	1						

*Measurements used for data analysis.