Variations in Mood and Performance
associated with the Menstrual Cycle

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* * * * *

Abbreviations used in this study.

E	Experimenter
F.S.H.	Follicle Stimulating Hormone
L.H.	Luteinising Hormone
m.c.	menstrual cycle
P.M.T.	Premenstrual Tension
S.P.S.S.	Statistical Package for the Social Sciences
V.A.S.	Verbal Anxiety Scale

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Chapter 1

Review of the Literature

All females of childbearing age are subject to regular physiological changes associated with the reproductive cycle. In humans the cycle begins with the development of an ovum in the ovaries and continues with its release. If pregnancy does not ensue the cycle ends with menstruation.

There are four stages to the menstrual cycle each of which is governed by a different hormone or hormone combination. These are:-

I.   Initially in response to an internal timing mechanism which brings about menarche (the first period), the hypo-thalamus produces neurosecretions which are carried in the blood to the anterior pituitary. The anterior pituitary then produces follicle stimulating hormone (F.S.H.) which causes the growth of follicles in the ovary. The follicles produce estrogen which is carried back to the hypothalamus.

II.   In the hypothalamus estrogen stimulates increased production of neurosecretions that induce the pituitary to secrete luteinising hormone (**L.H.**):it also suppresses F.S.H. secretion.

III.   The L.H. accelerates the growth of the follicle until it finally ruptures, releasing an ovum or egg; mean-while, the higher level of estrogen acts upon the hypothalamus to stimulate the production of luteotrophin by the anterior pituitary. This hormone acts upon the ruptured follicle to produce progesterone along with estrogen.

IV.   The ruptured follicle becomes a corpus luteum and under the influence of increased luteotrophin produces progesterone. If the ovum is not fertilized the corpus luteum regresses and the ensuing fall in progesterone and

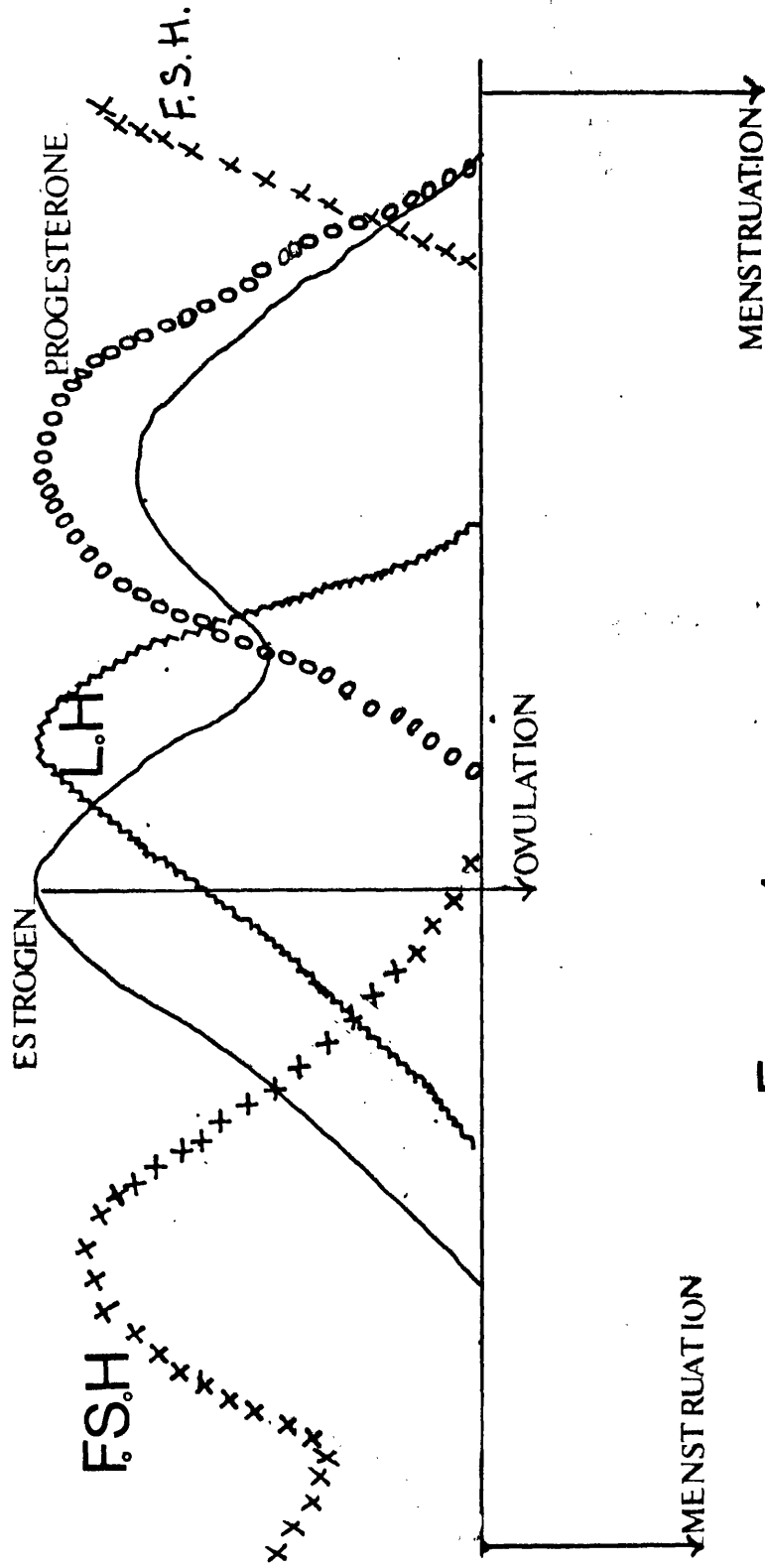THE MENSTRUAL CYCLE; Levels of Hormones

Figure 1

estrogen levels allows another cycle to begin. At this point, that is 3-5 days following the fall in these hormones the corpus luteum and unfertilised ovum are passed out and it is this bleeding which is unique to the menstrual cycle and is not found in the reproductive (or estrous) cycle of lower animals.

Fig. 1 illustrates the hormone levels found during the menstrual cycle in a simplified form. Here it can be clearly seen as a four stage cycle centred on two main events ovulation and menstruation with each stage dominated by a different hormone.

Now hormones especially estrogen and progesterone have other effects than those specifically associated with the m.c.. Behrman and Gosling (1966) list the following 'other' effects of estrogen and progesterone.

Estrogen

a) growth of the mammary duct system as well as pigmentation of the nipples.

b) deposition of vulvar fat and growth of body hair.

c) renal retention of sodium and chloride and decreased urine volume with subsequent increasing blood volume and body weight.

Progesterone

a) it acts on the myometrium to amplify contractions and prolong intervals between them, producing uterine quiescence.

b) it also stimulates acenar growth in the breasts after estrogen priming and thus prepares for lactation.

c) the thermal shift in basal body temperature producing a

biphasic graph, is the result of progesterone secretion,

but the mechanism of this action is not yet clearly understood.

The situation is also complicated by the fact that
estrogen and progesterone are both steroids and can at times
occupy the sites more properly occupied by other steroids of
similar chemical structure and can therefore interfere with
the functioning of systems such as the anti-diuretic hormones
(Bickers and Wood 1951) and the allergens (Dalton 1964).

It is reasonable to believe therefore that since these
hormones are cyclic and have wide ranging effects that these
effects may be found in cyclic changes in the behaviour of
women.

Sommer (1973) claims that "Behaviours related to the
female menstrual cycle have been the stuff of mythology, a basis
of vocational and social discrimination and an apparently
inexhaustible source of speculation and observation." As early
as 60 A.D. Pliny commented in his 'Natural History' "It would be
a difficult matter to find anything which is productive of more
marvellous effects than the menstrual discharge.   On the
approach of a female in this state, musk will become sour,
seeds which are touched by her become sterile, grafts wither
away, garden plants are parched up and the fruit will fall
from the tree beneath which she sits. Her very look even,
will dim the brightness of mirrors, blunt the edge of steel,
and take away the polish from ivory.   A swarm of bees, if
looked upon will die immediately; brass and iron will

instantly become rusty, and emit an offensive odour; while dogs which may have tasted of the matter so discharged are seized with madness and their bite is venomous and incurable."

It is unfortunate that a lot of the research which has been done in this area follows the tone set by Pliny ie. colourful observations based on small samples or spurious statistical significances obtained from badly constructed experiments. The area is fraught with methodological difficulties and it is therefore necessary to look extremely closely at previous research work and assess the evidence for behavioural changes associated with the m.c.. In this study it is intended to concentrate specifically on mood and performance variables.

A. Variations in mood and energy associated with the menstrual cycle

It is in the area of affective changes that the most substantial amount of research has been carried out. This has been largely clinical in nature necessitated by those women whose menstrual cycle incapacitates them to such an extent that they are diagnosed as suffering from premenstrual tension (P.M.T.) or dysmenorrhea (painful periods). It is here also that the methodological difficulties begin since different workers define pre-menstrual tension and dysmenorrhea differently and so different studies are not comparable.

It was Frank (1931) who first described women suffering from a pre-menstrual feeling of "indescribable tension, irritability and a desire to find relief by foolish and ill-considered actions " but since then the definition has been elaborated upon and modified in various different ways. Morton (1950) describes P.M.T. as "the term applied to a symptom-complex which begins about 10-14 days pre-menstrually, reaches its peak shortly before menstruation and disappears dramatically following the onset of menstrual flow. In some instances the symptoms may persist to a lesser degree throughout the cycle." He comments "Unlike the mild pre-menstrual discomfort which almost half of women undergo (and philosophically accept) pre-menstrual tension often causes a distressing impairment of the sufferer's psychic and physical well-being."

This extremely general definition of the syndrome raises a lot of the problems. When is 'pre-menstrual' - the

10-14 days Morton cites could cover half the woman's cycle
and if the "symptoms persist to a lesser degree throughout
the cycle" then some women would appear to suffer
'premenstrually' all the time.   How do you distinguish
between P.M.T. and "mild pre-menstrual discomfort"?   Is
P.M.T. something women refuse to "philosophically accept"?
In which case it could be a function of personality rather
than symptoms experienced.   Then there are the problems of
measuring 'shortly' and 'often' as well as the "impairment
of psychic and 'physical wellbeing'."   There is also the
problem of what constitutes the "symptom complex".   Dalton
(1964) mentions symptoms referrable to almost every bodily
system but perhaps we should be content with the more
restricted catalogue given by Rees (1953b) - "it consists
of nervous tension, irritability, anxiety, depression,
bloated feelings of the abdomen, swelling of fingers and
legs, tightness and itching of the skin, headaches,
dizzyness and palpitations.   Less commonly there occur
hypersomnia, excessive thirst and appetite, increased sex
desire and in some affected subjects an increased tendency
for asthma, migraine, vasomotor rhinitis, urticaria and
epilepsy."   This is a restricted list of symptoms and the
question arises of how many of these and of course how
severely must a subject suffer from each before she is
diagnosed as suffering from P.M.T.   The problem of
dysmenorrhea is not as complex because it is merely a question
of how severely painful a period must be before a woman is
said to suffer from dysmenorrhea.

It is not surprising to find that several investi-
gators have found that dysmenorrhea is significantly

correlated with irritability and depression (Coppen et al, 1963; Kessel et al, 1963). Other investigators have concentrated on mood changes pre- and post-menstrually without fully considering the whole cycle. Golub (1976) looked at the magnitude of pre-menstrual mood changes in 50 parous females who were assessed using a state-trait anxiety inventory, a depression scale and an adjective check list. He found that pre-menstrual state anxiety and depression scores were significantly higher than those found mid-cycle but were much lower than those of patients with psychiatric disorders. Individual differences are apparent since 76% of subjects had higher pre-menstrual depression scores and 64% had higher pre-menstrual anxiety scores.

Menstruation is not the only 'event' of the menstrual cycle. There is also ovulation. Some investigators have compared mood around this point with that found pre-menstrually. Luschen et al. (1972) randomly assigned 48 regularly menstruating women (aged 18-22) to 2 groups, one pre-menstrual and one ovulatory. The pre-menstrual period was assumed to consist of 3-5 days preceding onset of menses, and ovulation was assumed to occur 15 days before the estimated beginning of the subjects' next period. The subjects were presented with words taken from the Gough Adjective Check List randomly selected from the Aggressive, Affiliative, Nurturance and Succourance scales. They were asked to indicate which 10 words best described their present mood and which 10 least fitted it. Luschen et al. found that subjects in the pre-menstrual group used more adjectives which were self-directed

and more negative toward people while those in the ovulatory
group showed higher affiliation and nurturance. In this
study subjects using oral contraceptives were also included
along with normally menstruating subjects. This is an
unacceptable procedure if a researcher wishes to study the
menstrual cycle since women using contraceptive pills do not
have a normal menstrual cycle.

It is important to look closely at the assumptions
which underlie this study since these kinds of assumption
are made in a large number of studies in this area. In
many studies the subjects describe themselves as 'regularly
menstruating' and research workers then assume either i) that
they have 28 day cycles each month or ii) that their cycles
are all the same length as the last cycle they reported.
Treloar et al. (1967) investigated nearly "3000 person years
of menstrual history" and concluded that "enduring
regularity of any length of interval seemed a myth." They
continue "It seems logical to infer that when in giving her
medical history a woman says she menstruates 'regularly'
she uses the term in a broadly relative sense, or she feels
that she is normal and this is her way of saying so, or she
really doesn't know a better answer to give. Indeed all
three may be true concurrently. It is therefore reasonable to
accept the word 'regular' as used by most women in this
connection to mean 'relatively regular as far as I know'." One
of the most irritating aspects of such studies is that not
only do they assume regularity exists and that their subjects
possess it but they fail to apply the simplest of checks –

that of following up subjects and ascertaining exactly when

their next period occurs.   This isn't a new criticism.

Hartman in the 1930s commented ...."these records are scarcely

worth the paper they are written on. The data are basically

false. Consider how they are secured. An assistant who

receives the subject says to her 'Are you regular?' and she

answers that she is, because forsooth, she wants to be and

she usually thinks she is".   Mc.Cance et al (1937) asked

women a series of preliminary questions about their menstrual

cycle and then studied daily changes in mood and symptoms.

Table 1 compares answers obtained from the preliminary records

with actual records obtained from subjects.

Table 1. Comparisons of preliminary statements
          with actual records.

Statement: "Are your periods regular?"		Recorded cycle length in days
Subj. 8	Very regular	34,26,29,29,27,25
18	Very regular	28,27,27,27,27,27
24	Interval varies from 26-30 days	25,29,26,24,26,25
101	No,sometimes 3 weeks others a month	27,28,27,28,30,34
105	Most irregular	28,30,30
124	No,not regular for last few years	23,24,24,24,27,24

Now for certain purposes the word 'regular' may be

sufficient but in studies where it is essential to plot

accurately when menstruation and ovulation occurs it is far

too inaccurate and studies using 'regularly menstruating'

women with no objective checks made to establish menstruation

must be viewed with suspicion.

Similarly ovulation is difficult to establish and can only be accurately determined by using such techniques as daily basal body temperature curves, vaginal smears or hormonal assays. It is not sufficient to assume ovulation occurs "15 days before the onset of the next expected menstrual period." The ovulation to menstruation part of the cycle (the luteal phase) is the more consistent in length but it still varies both within and between individuals, sometimes by a considerable margin. Altman et al (1941) comment, after studying 55 cycles of 10 normal females "Very rarely did the same subject repeat the day of ovulation in consecutive cycles. Irregular spacing of ovulation was far more frequent than irregularities of menstrual bleeding. The average day of ovulation was the 11.8th day of the cycle with a variation from the 5th to the 23rd day". They used vaginal smears, rectal temperature and changes in electrical potentials to accurately determine the day. In the Luschen study the unjustifiable assumptions ensure that the so called ovulatory and pre-menstrual groups will contain subjects who are not in fact at these points in their cycle.

Persky (1974) did a similar study using women screened for psychological and physical abnormalities who were tested during 3 phases of their cycle: days 1-4, 14-18 and 24-28. He found, using psychiatric clinical ratings from interviews, as well as paper and pencil measures that there were no significant differences in state or trait measures of anxiety, depression and hostility. He concluded "not only was mood fluctuation slight in this group of young

females the average values of the psychological variables closely resembled those obtained for a group of male classmates."

The more interesting and hopefully the more accurate studies are those which chart a woman's mood and/or energy throughout the menstrual cycle. May (1976) suggests the following methodological constraints ought to be employed if a study is "to contribute to an understanding of the general relationship between mood and the menstrual cycle" -

(1) Use repeated actual time reports of mood.

It is still an open question whether females' retrospective reports of their cyclic mood changes are accurate. Given the sometimes intense emotional overtones of menstruation and given that there are many family traditions and social stereotypes instructing women in what they should feel before and during menstruation it seems unwise to rely on one-time retrospective reports. Again McCance et al (1937) found that subjects who reported depression pre-menstrually on a preliminary questionnaire showed little evidence of it when they filled in daily reports. May (1976) confirmed this: he concludes: "Retrospective reports of menstrual shifts did not correspond with the actual mood variations and we must ask whether there are factors which actively interfere with a woman's accurate awareness of the relation of her mood to her menstrual cycle."

(2) Analyse moods in terms of each individual's own baseline.

Typical mood levels vary and some people tend to 'complain' more about anything. It is likely that studies based on comparisons across individuals end up telling us more about

consistently tense or depressed women than about women
whose tension or depression peaks at a particular point in
the cycle.

(3) Use a non-patient population. Although clinical groups
may be a focus of interest in their own right a series of
women presenting gynecological problems or a group of
hospitalised schizophrenics is of limited usefullness in
describing normal fluctuations in moods.

(4) Exclude subjects who are pregnant or using contraceptive
pills.

(5) Distinguish between mood changes and other forms of
distress such as physical symptoms. The question of whether
mood changes correlated with or independent of pain and
bodily comfort must be directly tested rather than assumed
or ignored.

These methodological considerations must be borne in
mind when examining the studies which have been carried out
looking at mood changes across the menstrual cycle.

The first major study in this area was that of Benedek
and Rubenstein (1942) who looked at 75 cycles of 9 neurotic
patients who were in psychoanalytic therapy with Benedek.
Rubenstein independently determined the phases of the cycle
and dated ovulation from a record of vaginal smears. Benedek
successfully predicted Rubenstein's findings in 2128 of 2261
instances by reference to the psychoanalytic material alone.
A large amount of raw data has been published and other workers
have commented that for someone familiar with the language of
the unconscious her deductions of cycle points appear quite
reasonable.

Benedek divides the cycle into phases:-

(1) The first or estrogenic phase - an active one with heterosexual libido. General feelings of well being are related to the presence of estrogen.

(2) Prior to ovulation a preovulatory tension is caused by conflicting psychodynamic tendencies which appear to be correlated with an increase in estrogen and incipient progesterone activity.

(3) Ovulation itself is marked by a sudden decrease of active object-directed sexual tendencies. There is an inward turning and relaxation. Benedek noted that the incorporative receptive mood of ovulation is really a sexual orientation but that it may not be recognised as such since it lacks an active quality.

(4) During the progesterone phase, dominant only a few days, the libido turns from the outer world and the individual appears more passive.

(5) During the post-ovulatory phase progesterone levels begin to drop. If estrogen is maintained at a fairly high level a high degree of emotional tension is created which may express itself in heterosexuality though in this phase Benedek states that what appears as sexuality may only be a general nervous irritation and restlessness.

(6) When estrogen drops as it does just prior to menses and in the first days of menstruation the mood is mainly that of depression. Benedek finds this phase characterised by "eliminative pregenital destructive tendencies."

To summarise in the words of Silberman (1950) "the preovulatory phase is psychologically marked by strong hetero-sexual drives either overt or disguised as destructive trends

to injure or to kill. The preovulative tendency is to
acquire a man. After the ovum is on its way and has
arrived in the uterus awaiting fertilization progesterone
prevails and causes as they claim relaxation, passive
receptive tendencies and increased preoccupation with one's
own body. It might be thus called the hormone of male
reception."

Daniels (1943) claims to support Benedek's findings
using normal women, but his sample size was three and his
findings failed to reach significance.

The Benedek and Rubenstein study is one of the better
designed and controlled ones done in this area. Seward
(1946) pointed out that despite the use of a double blind
technique it is possible that the smear taking experience
may have had repercussions in the psychoanalytic sessions and
may have given inadvertant clues as to cycle phase. Of
course the selection of patients whose symptoms and psycho-
analytic revelations indicated a relationship between neurotic
disturbances and ovarian functions was aimed to silhouette
whatever correlations there might be. As the authors were
frank to admit one would not expect the behaviour of normal
women to be so directly influenced by slight shifts in
endocrine balance.

The biggest problem with Benedek+Rubensteins findings is
that they are too simple and too rigid, because the estrogen
distribution and its timing is by no means as simple as these
workers indicate. It is obvious from other studies (eg. Altman,
Knowles and Bull, 1941) that not all women relax during the
post ovulatory phase and the onset of menstruation:some react

with outbursts of both physical and mental activity. The fact that women show different responses to their hormonal productions may either be due to varying levels or to differences in their emotional structures and personalities. The same amounts of hormone may cause varying reactions in individuals of differing emotional make-up. It is simplistic therefore to expect that it is possible simply to correlate mood changes with hormonal changes.

No one has attempted a complete replication of Benedek and Rubenstein's work and it is doubtful that anyone ever will since Benedek herself in 1963 noted the difficulty she experienced in formalising what it was in the records which allowed her to make such precise predictions. The fact that her data are described in terms which are inseparable from her theoretical orientation makes it difficult to specify operationally the procedures by which she was able to infer the phase of the menstrual cycle from the women's reports of their dreams. Lamb et al (1953) studying 5 females suffering from P.M.T. and 5 females who did not, failed to confirm Benedek and Rubenstein's finding. Instead they found that the dreams of normal subjects were characterised by passive receptive tendencies in the pre-menstrual period while dreams reflecting heterosexual drives with related conflicts occurred in the pre-menstrual period.

Two main strategies have been adopted in this area for determining the mood of the subjects, either a) the experimenter assesses the woman's mood from verbal material gathered from interviews or recordings or b) the subject

indicates her own mood by checking a list of adjectives which describe her emotional state using figures to indicate its intensity. Each method has its disadvantages.

Altman et al (1941) studied 10 normal women across 55 menstrual cycles whom they interviewed daily to assess levels of elation, activity and tension (defined as a condition of unspecified anxiety and worry). The subjects were not questioned directly about their moods but were encouraged to talk freely about their daily experiences and reactions. Ovulation was determined using rectal temperatures, vaginal smears and changes in electrical potentials and although these techniques are now more highly developed a high degree of accuracy was reached. Table 2 presents a summary of their results.

Table 2. Phases of cycle in relation to Mood, Activity and Tension.

Ovulation with	elation	67.5%
	activity	85.3%
	tension	31.4%
Pre-menstrual phase with		
	depression	61.5%
	activity	71.8%
	tension	80.0%

Activity means both mental and physical activity and includes both 'mental organising' as well as cleaning and tidying. Activity was not so closely centred about the day of ovulation as the mood of elation. Fatigue however was not found to be cyclic. Unfortunately the authors give no indication of exactly how they arrived at their estimations of mood so this study remains closed to replication.

Gottschalk *et al.* (1962) has tried to develop an objective technique for analysing verbal material which will allow estimates of both hostility and anxiety and she has used it to examine the changing levels of these throughout the menstrual cycle. The Gottschalk Verbal Anxiety State (V.A.S.) allows the scoring of tape recordings for changes in the levels of anxiety and hostility by weighing each grammatical clause for different types of anxiety guilt and death wishes. In a preliminary study using 5 females the authors found no uniformity amongst the women in the patterns of change in these emotional variables during the sexual cycle. Ivey and Bardwick (1968) followed up this study using the same technique (the V.A.S.) but a much larger sample. Unfortunately they did not repeat Gottschalk et al's more careful procedure but contented themselves with merely taking body temperature only 3-4 days before ovulation was expected. It is doubtful that this method would give accurate information about the timing of ovulation. Gottschalk also scored the verbal material obtained and there was a .81 correlation between her scoring and that of the authors. Ivey and Bardwick found that anxiety was lower at ovulation compared with levels found pre-menstrually. A tabulation of the instances of hostility outward and the few instances of hostility inwards (depression) suggested a trend towards higher premenstrual hostility and depression than found at ovulation. Whether or not the V.A.S. actually measures anxiety and hostility we have no means of knowing since it has not been validated against any behavioural phenomenon.

One of the disadvantages of using E's estimation of the subject is that it requires E to see the subject daily,

which is difficult since people tend to work a 5-day week.
In the Gottschalk study where tape recordings are used a
technician was required by 2 of the subjects so even here
records were only obtained on the five working days. Of
course tape recordings and written material could be
effectively used to study mood but 5 recordings a week are
not satisfactory since the missing ones could easily be
those of the more crucial days of the cycle.   If adjective
check lists are used it is easier to obtain daily records of
the subject's mood but these have the disadvantages that the
subject may miss days and leave the Experimenter with either
incomplete records or may try to fill in the back log from
memory with all the resultant distortion this entails.

A number of studies have been carried out using
adjective check lists filled in daily. These include McCance(1937)
Beaumont (1975) Little (1974) Janowsky (1973) Patkai (1974)
and Abramson (1961).   Typical of the work in this area is a
study carried out in 1937 by McCance et al who collected
records covering 780 completed menstrual cycles. The records
noted the daily occurrence of physical and psychological
disturbances.   The subjects were asked to record any definite
change which was felt even if only for a few hours and then
asked to code it either as a change which 'though definitely
present can be overcome with an effort' or 'so marked that it
cannot be thrown off by any effort.' The moods the subjects
rated were:- depression, elation, anxiety and worry, irrit-
ability, tension, tendency to cry, and sudden changes of mood.
Although no attempt was made to establish when ovulation
occurred the cycles were properly normalised and the dates of

menstruation recorded. They discarded cycles which were shorter than 21 days and longer than 37, since they considered them not worth the effort of normalising. They found that "in the majority of women no rhythm was demonstrated during the 6 months they were studied." Periodicity may have been brought out if records were kept for a longer time since large individual differences were apparent. Certain trends were discernable. Fatigue was lowest on the 20th day of the cycle and climbed steadily until the 28th day. On the 1st day the incidence of fatigue was three times that of the 20th day but it declined steadily until the 8-9th day when it stabilised at the intermenstrual level. Depression was not as frequently recorded as fatigue and only 3 individuals showed any definite rhythm. However a tendency to cry did show evidence of cyclicity. Elation however showed no monthly variation and there was no evidence of cyclicity in the subjective reports of tension.

A refinement of the check list questionnaire is the mood scales which Wessman and Ricks (1966) designed for their study. They decided that check lists were inadequate to fully understand mood changes and the relationships between them. Scales were needed and designed which would have the following properties:-

(1) Each scale must be as unidimensional as possible so that it measured only one specific variety of feeling or affect.

(2) Each scale would encompass a wide and graduated range of feeling. It was hoped the graduations would be approximately equal and appropriate descriptive statements were designed so that a uniform progression toward increasingly marked feelings could be obtained.

(3) Each scale position was characterised by a descriptive statement which would allow some degree of cross-subject comparability of responses. These descriptive statements would try and ensure that 2 subjects who checked the same scale position experienced fairly similar degrees of arousal of the particular affect.

(4) Each scale would possess cross-scale comparability so that a '9' on one scale would be approximately as extreme as a 9 on another scale.

So, informed by their knowledge of the literature on affective pathology, by clinical experience and by their own introspective self observation of the variety of feelings, they designed a set of scales. They then used them informally and wives and students who took part in pilot studies suggested improvements which led to further refinement of the instruments.

The final Personal Feeling Scales consisted of a number of 10 point self rating affect scales which an individual could use to give regular reports of his experience of various aspects of mood. A wide range of feelings from highly positive through more neutral to highly negative on each dimension was defined by a series of descriptive statements eg. the elation-depression scale ranged from "Complete elation" through "pretty good O.K." to "utter depression and gloom." The Personal Feeling Scales were designed specifically for long term research studies on mood but were carefully constructed so they were codeable but still of a form which a subject could easily relate to.

Wessman and Ricks (1960) used the scales to investigate mood changes associated with the menstrual cycle. They looked at 19 women, but only over 6 weeks, noting only the days of menstruation and making no attempt to determine the occurrence of ovulation. They found 14 of their subjects had an "average hedonic level lower than their general mean during the 2 days preceding menstruation ($p < .05$) and that 8 of the 19 reached their most depressed period of the entire 6 week study on these 2 days. Of the 19, 11 showed an average hedonic level lower than their mean on the day the menstrual cycle commenced. Thus for most of the women the onset of menstruation was associated with a distinct lowering of mood but this did not alter the otherwise general irregularity of their mood fluctuations in the 6 week period. Wessman and Ricks conclude "over a longer time span the premenstrual period would probably be a recurrent low in most women's records."

May (1976) has also used the Wessman and Ricks' Personal Feelings Scale to assess changes in mood across the menstrual cycle. He used the Elation-Depression Scale which Wessman and Ricks found accounted for the largest part of the variance in their extensive factor analytic study of moods (Wessman & Ricks 1966). May averaged the scores obtained from the 2 cycles he studied and found 50% of a group of healthy young women showed increased depression just before menstruation while another 40% had their most happy mood at this point and their most depressed mood during menses. May did not test daily and since he did not include any procedures which would allow him to pinpoint ovulation no

comparison can be made between mood premenstrually and mood
at ovulation.

From this we may conclude that there are a great many
conflicting findings.   The demonstration of cyclic variations
in mood and energy associated with the menstrual cycle is
heavily dependent upon the methods used to assess mood and
the studies have generally been contaminated by a number of
serious methodological flaws eg. failure to pinpoint accurately
menstruation and ovulation, lack of objective techniques for
assessing interview material, the use of retrospective
questionnaires to assess mood, small sample sizes and the use
of women using the contraceptive pill as subjects.

One other indicator of mood is available for study
and that is the woman's behaviour throughout the cycle. It
is therefore reasonable to look at behaviour clearly indicative
of mood.   A large range of behaviours have in fact been
studied and correlations have been reported for example
between the premenstrual or menstrual phase of the cycle and
commission of violent crimes (Cooke 1945, Dalton 1961, Morton
Additon , Addison, Hunt and Sullivan 1953, Ribiero 1962),
death from accident or suicide (Mackinnon and Mackinnon 1956,
Mandell and Mandell 1967), accidents (Dalton 1960), admission
to hospital with acute psychiatric illness (Dalton 1959,
Janowsky, Gorney, Castelnuovo-Tedesco and Hone 1969), and
taking a child to a clinic (Dalton 1966). There have also
been a number of studies linking sexual activity or arousability
to different phases of the cycle eg. Davis (1926), Diamond et
al (1972), James (1971) and Spitz (1975). However the
connection between these behaviours and any one affective
state is tenuous.   Sexual behaviour is associated with

feelings of well-being by some authors while Benedek and Rubenstein (1942) comment "If estrogen is maintained at a fairly high level a high degree of emotional tension is created which may express itself in heterosexuality though in this phase what appears as sexuality may only be a general nervous irritation and restlessness." Since no research worker is able to distinguish when sexual activity is a measure of well-being or merely an expression of nervous irritation and restlessness, the only behaviours which can be thought to be unequivocally related to negative affect are suicide and parasuicide.

Wetzel et al reviewed the research looking at the relationship between suicide and the menstrual cycle in 1972 and found a mass of contradictory findings. Mackinnon et al (1959), whose study is by far the best in terms of method, report an increased incidence during the luteal phase (they used post-mortems to determine the phase) with the peak in the early and middle luteal phase (days 15-23 in a standard 28 day cycle). It should be noted that although 89.5% of women were found to commit suicide in the luteal phase, 84.1% who died a natural death and 90.0% who died as a result of an accident were also found to be in the luteal phase of the cycle. If this study means anything at all it would seem to indicate that women are more likely to succumb to trauma poisoning or disease during the latter half of the menstrual cycle than at any other time. Ribiero (1962),after performing necropsies on Hindu women,claims that approximately 95% of them were menstruating at the time of their suicide. However

Pilcz (1905) reports an increased risk of suicide in the
follicular phase. Again the differing results seem to be
a product of methodological artefacts.

The usual problems of dating the woman's position
in her cycle are compounded by the fact that she is dead.
Mackinnon et al made a microscopic study of uterine tissue
in all subjects but other studies do not report whether
gross or microscopic examination was used and do not give
their criteria for determining the different phases. Also,
if the woman does not die immediately as the result of her
self-injury she will be placed in a different menstrual
phase group from that she was actually in when the self-
injury took place. In this work most of the samples studied
are not based on random samples of suicides or parasuicides
within the community. Since the studies on completed
suicides require the consent of the next of kin the selection
may be biased for religious, economic (insurance) and social
reasons. Few studies report the total number of suicides
from which the sample was drawn and especially in the earlier
studies religious bias may have operated very strongly to
select the sample. Christian burial in consecrated ground
was possible only if the suicide was thought insane. Since
at the time of some of these studies the concept of menstrual
psychoses was accepted (as it still is in some Continental
countries) burial was granted to a suicide if she had been
menstruating at the time of death. This bias in consenting
to autopsy may have inflated the percentage of menstruating
suicides.

Parasuicides also tend to be nonrandomly selected. Few studies report all attempters seen in emergency rooms. Most deal only with women admitted to hospital, excluding those women with medically less serious attempts, less obvious psychiatric difficulties and with less desire for psychiatric treatment.   Again there are difficulties about the accurate dating of the attempted suicide in relation to the menstrual cycle.   Dalton (1959) examined a sample of parasuicides admitted to a psychiatric hospital after their attempt and found 39% of them were menstruating. However no details were given about the time that had elapsed between the time of admission and the time of the attempt. At the best of times women are not particularly good at accurately remembering the dates of their last period and are apt to round them off to the nearest week.   This creates an artificial dearth of cases occurring between say the 8th and 13th day and the 15th and 20th day of the cycle, as is apparent in a number of studies. Obviously recall problems are compounded when asking a woman who is recovering from a suicide attempt.   The position is further complicated by the fact that the woman's own emotional state can affect her menstrual cycle; anxiety can delay menstruation and the relief of attempting suicide and finding herself alive and being helped in a hospital may allow a delayed menstruation to occur. There is also the possibility that suicide is attempted by women because their period is delayed and they fear pregnancy, this too could help to account for those findings of a preponderance of parasuicides menstruating (Dalton 1959, Thin 1968).   Tonks et al (1968) examined 95 admissions to a

general hospital but made sure they noted the date of the
suicide attempt and analysed their menstrual data accordingly.
They found an excess of attempts during the seven pre-
menstrual days. However this study dealt with cycles longer
than 28 days merely by considering them as 28-day cycles.
They did admit that this created an artifactual peak of
attempts occurring on day 1 of the cycle.

Holding and Minkoff (1973) and Birtchnell and Floyd
(1974) both failed to find a relationship between attempted
suicide and any phase of the menstrual cycle. Neither **are**
without methodological flaw(eg. they neither establish
ovulation but both talk of suicide attempts occurring during
the ovulatory period).

Studies concerned with self-referrals to suicide-
prevention centres or calls to the Samaritans are also
relevant. Mandell and Mandell (1967) analysed data on 87
suicide calls in Los Angeles and observed peaks at the first,
middle and last sevenths of the "standardised menstrual
cycle." Such peaks could be explained however by the fact
that women tend to consider themselves to be at the beginning,
middle or end of the month and might reply to enquiry in this
vague way. Wetzel et al (1971) adopted the same analytical
method with a series of 49 callers in St. Louis but their
results did not deviate significantly from a chance
distribution.

In conclusion the situation is as Birtchnell and
Floyd (1974) have commented "There is scarcely a part of
the menstrual cycle which has not been implicated and
associated with suicide and parasuicide." It is disappointing

that the results are not more clear cut in this area since

presence of suicide or parasuicide is in some ways easier

to measure than mood.   Suicide and parasuicide is an event

of the all-or-none type while mood can have high, low or

medium values which tend to cancel each other out. Thus a

woman of 24 who committed suicide during the premenstrual

period and who had menstruated regularly from the age of 14,

would have experienced approximately 120 pre-menstrual periods

which would not count as she did not commit suicide in them.

If however one were to deal with performance or mood on the

same basis even if she had 30 very bad moods or performances

in the pre-menstrual period there would still be 90 average

ones and there would therefore be a tendency for a mean close

to the overall mean to be recorded.

B. Variations in Performance associated with the Menstrual Cycle

There are a number of studies showing sensory threshold variations and physiological changes relative to the menstrual cycle, but these have not involved much in the way of active performance on the part of the subjects. For example, variations in olfactory acuity for specific substances (Vierling et al 1961), temperature detection threshold changes (Kenshalo 1970), norepinephrine excretion level alteration (Wiener et al 1962) and sublingual temperature changes (Wineman 1971) have been reported. There are also studies which look at incidence of accidents and phase of the menstrual cycle. Whitehead (1934) reports three airplane crashes over a period of eight months in which the women pilots were said to be menstruating at the time of the crash. Dalton (1959) studied accidents admitted to general hospital and found that of the 84 women half of them were either pre-menstrual (in the 4 days preceding menstruation) or menstruating (4 days). There is a difference in the distribution of accidents in parous and nulliparous women, since nulliparous women have them predominantly in the menstrual period while women who have had children suffer accidents in both the premenstrual and menstrual period. A number of criticisms can be advanced against this study:- a) No information is given as to how women whose cycles were greater or less than 28 days were classified (or whether the series contained any). b) Arbitrary decisions were made that the premenstrual and the menstrual period lasted four days. c) Dalton suggests accidents result from physical and judgemental defects. It is curious therefore that there was a similar excess for both accidents in which those injured played an 'active' role and

those in which they were 'passive'. Accidents are however
a gross measure of performance. The remaining performance
studies are best described under three separate headings viz.
gross bodily activity, motor tasks, and measures of intellectual
performance.

I. Gross Bodily Activity and the Menstrual Cycle

Billings (1939) fitted pedometers to 5 psychiatric
patients and the instruments set to the pace of the patients
wearing them. The number of miles registered did not
resemble the number of miles walked but the proportion and
change could be deduced. Billings did not do a statistical
analysis but claimed that the activity graphs he presented
illustrated a consistent postmenstrual burst of activity which
gradually declines to the time of the succeeding menstrual
period. Individual differences were apparent. Morris and
Udry (1970) had 34 women wear pedometers daily with 25 of
the women participating through three or more completed
menstrual cycles. They reported a significant increase in
activity at mid cycle and two lesser peaks menstrually and
premenstrually (days 27 and 2). However the meaning as well
as the validity of these findings is unclear because as the
authors point out there is great variation for each individual
woman from month to month and that curves based on single
cycles showed no cyclic pattern. The pattern emerged after
averaging several cycles together. The researchers adjusted
the data to a standardised 28 day cycle before any effect was
visible. Little in the way of explanation for these 3 peaks
is provided but it is pointed out that increased activity
around presumed ovulation is consistent with findings of
increased activity levels during estrus in other animals.

Stenn and Klinge (1972) took continuous measures of arm movement activity and basal body temperature from 7 females over 17 menstrual cycles and in 3 males over a total of 5 periods of 28 days. Basal body temperature was positively related to arm movement activity in the female but not in male subjects. While no consistency or regularity was observed in arm movement activity of the male subjects, 2 of the 7 female subjects showed differential levels of activity as a function of the menstrual cycle. In female subjects, activity peaks were observed to be least likely to occur during the late luteal phase. It is interesting to note that no menstrual phase differences in activity level were obtained when subject data were pooled.

II. Motor Tasks

The simplest motor task and the one which has received the most attention is simple reaction time (R.T.). Pierson and Lockhart (1963) studied R.T. and movement in 25 college women and failed to find any relationship between those measured and the menstrual cycle. Each subject was tested 4 times, 2 days before menstruation and 2, 8, 18 days after but in the analysis a mean R.T. from all subjects was calculated for each day sampled. In this study it is possible that individual differences in the timing of changes cancelled each other out so that no significant relationships could be observed. They also employed only one measure of cycle phase, flow onset and assumed that all of their subjects had a 28 day cycle. In fact they made no effort to document the fact that their subjects were cycling nore that their cycles were regular.

Loucks and Thompson (1968) measuring simple R.T. on days 1, 3, 6 and 20 also failed to find a cyclic effect. Their selection of days however omitted testing in the premenstrual period. Koppel et al (1969) also report a lack of significant changes in R.T. The only study which claims to find evidence of cyclic changes in R.T. associated with the menstrual cycle is that of Voitsechovsky (1909) which was conducted under the auspices of the Imperial Military Academy St. Petersburg, Russia. It is quoted in Seward (1934) but no details of the methodology are given.

It is possible that simple reaction time is not sensitive to a menstrual cycle-induced performance decrement. Blake (1967) notes that a diurnal increase in body temperature failed to affect an improvement in simple reaction time while other task performance did improve. Sommer (1973) concludes after reviewing some unpublished work that "simple reaction time is open to criticism with respect to a lack of sensitivity to small changes and duration effects."

Zimmerman and Parlee (1973) tested 14 subjects during four phases of the menstrual cycle using both simple and choice reaction times as well as arm-hand steadiness. In this study basal body temperature was used to distinguish the phases of the cycle but the onus to determine ovulation was placed on the subject. They were asked to notify the experimenter when they saw a drop in temperature of $0.2-0.4^{\circ}$ followed by a steady rise for 2 consecutive days. It is doubtful that this procedure will have produced very accurate results. There is no evidence that the temperature data were used properly to normalise the cycle; instead Zimmerman et al report the subjects as "having a fairly regular menstrual cycle (1-3 days variation),"

which means testing days must be considered approximate.
They failed to find any statistically significant fluctuations
over the course of the cycle in either simple or choice R.T.
but did find changes in arm-hand steadiness. They found
significantly greater steadiness in the luteal phase than in
the pre-menstrual phase and there was a tendency for the
menstrual phase to be even steadier.

Diespecter and Kolokotronic (1971) examined vibrotactile
learning, in which electronic pulses were transmitted to the
subject's left wrist, in relation to the menstrual cycle. 27
subjects were categorized into 3 groups: pre-menstrual (within
5 days prior to menstruation) post-menstrual (within 3 days
following cessation) and mid-cycle (day 14). The pre-menstrual
group showed a significantly greater number of errors.
Unfortunately no repeated testing was made to measure within-
subject variation over the menstrual cycle (this is difficult
since a practice effect may occur) and there is no indication
that the three groups were equivalent with respect to other
variables which might affect their performance.

Lewin and Freund (1930) tested 12 subjects in order
to assess the speed and quality of work and the ability to
persist at tedious tasks which included stringing beads,
continuing indefinitely a design for an ornamental motif and
counting dashes. During menstruation the quality of work
remained constant and there was a tendency for speed to
increase although persistence decreased. The authors conclude
that a real decrease in skill is being compensated for with an
increase in effort.

This study underlines one of the most difficult problems
encountered when trying to establish whether performance varies

with the menstrual cycle, viz. - that subjects who know they are menstruating or expecting their periods and expecting to perform badly will exert themselves more in an effort to compensate. It is only in situations where the subject is working to the limits of her capacity that she has no chance to increase her efforts to compensate and these situations are difficult to define. Motivation must be kept constant throughout the cycle if it is not to obscure changes in performance.

Smith (1950) looked at absenteeism and also quality and quantity of production in relation to the menstrual cycle in three factories viz. - an aircraft factory, a parachute factory and a garment factory in the later stages of wartime production. In summarizing the data in all settings on all tasks he concludes that no one phase of the cycle yielded a greater loss in efficiency but he did find that in those tasks which possessed a high level of mental difficulty lowest production occurred pre-menstrually with the highest level menstrually, the latter of such a level as to counteract pre-menstrual losses. However where differences did occur they seemed more related to the situation than the menstrual variables.

III. Tasks measuring Intellectual Performance

Lough (1937) reviews the earlier studies which had investigated 'functional periodicity' and concluded that few conclusions could be confidently drawn from them because of severe methodological flaws. Lough makes the following criticisms of the work:-

(i)   results based on a meagre number of subjects;

(ii)   the subjects represented a wide variety of ages and were not comparable;

(iii)   the groups used were highly selected;

(iv)   men were used as controls;

(v)   non-menstrual subjects were compared with menstrual subjects while each phase of the cycle requires analysis;

(vi)   conclusions were based on inadequate data;

(vii)   the statistical analyses were superficial;

(viii) fluctuations found in all learning curves were not given sufficient consideration;

(ix)   subjects were acquainted with the nature of the experiment and hence open to suggestion.

Lough designed a study which looked at intellectual performance and the menstrual cycles but which did not embody the above flaws.   She administered learning tests on 30 consecutive school days to 65 and on 40 consecutive school days to 31 student teachers.   Results were analysed after having been grouped according to a) the 4 phases of the cycle (pre-menstrual, menstrual, post-menstrual and intermenstrual) and b) to certain specific days namely the first and second days of menstruation, the first day of the post-menstrual period and the mid point of the cycle.   No differences were observed associated with different phases of the cycle but accuracy was found to increase on the second day of menstruation. The women were more accurate on the day many had indicated also

brought the most pain and worry. Lough suggests that since
students had access to their own records competition with
these past records may have initiated compensatory motivation
so that when the students found the tasks most difficult they
overcompensated and produced the best results.

Dalton (1960) reports finding a decline in examination
performance of English schoolgirls in the premenstrual and
menstrual phases (5 days each). She did not provide any
statistical analysis of her results but while 27% of her
schoolgirl's test performance during the premenstrual phase
declined, 17% improved and 56% of the girls' work showed no
change. In the menstrual week, 25% declined, 21% improved
and 44% showed no change.

Dalton (1968) also studied the scores of girls sitting
advanced and ordinary level examinations and reported that
the average mark was 3% lower in the premenstrual and menstrual
phases than in the intermenstrual phases, that the pass rate
was 13% lower comparing premenstrual with intermenstrual phase
and the distinction rate was 9% lower in the premenstrual than
in the intermenstrual phase. No statistical tests were
reported for these results. Further the data were based on
scores on all papers written, instead of on an individual score
for each subject: that is, 34 girls wrote 180 papers - 44 were
written during the menstrual phase, 31 in the premenstrual
phase, and 105 in the intermenstrual phase. Hence the data
for a particular phase may disproportionately represent a
particular individual. This type of confounding continued in
Dalton's analysis of the A level examination results. She
compared the group mean scores of subjects taking examinations
in each of the 3 phases. Based on these averages between

groups of subjects, she concluded that an individual girl suffered a handicap of 5% when taking the examination in question during her paramenstruum (premenstrual and menstrual period combined). She failed to compare the performance of the same individuals at different phases of their cycle. Thus her conclusions extrapolating percentage differences obtained between two different groups to a particular individual within either group are completely unjustified. That the groups compared were equivalent in respect to other pertinent variables was assumed - no justification for comparison was given.

It is difficult to see how results across A and O level examinations can be fruitfully examined in individual terms anyway since A levels, although they do consist of 2-3 papers, inevitably consist of subsections of the study ; for example French may be divided into Literature and Language, Chemistry into Organic and Inorganic etc.. A student may not be equally competent at all aspects of the study she studies and therefore ability will interact with menstrual cycle phases. O level usually consists of one paper hence the comparison is between 2 different subjects and there is no reason to suppose that a girl will be equally good or interested in both. Even if it were possible to look at the actual papers and to try and carry out some kind of split half comparison the attempt would be bedevilled by the fact that students have 'worse' (last) questions.

This is another of the difficulties which beset researchers trying to elucidate the relationship (if any) between intellectual performance and the menstrual cycle. The

tests must be repeatable, must not be affected by practice
so that performance of an individual can be compared across
the different phases of the cycle.

Redgrove (1971),studying speed and accuracy of
typing in 3 female .subjects,dealt with this problem by using
specially prepared accuracy tests by the Royal Society of Arts
who have to design texts of comparable difficulty and
familiarity for their own examinations.   The subjects filled
in daily charts noting both occurrence of periods and their
basal body temperatures.   This enabled Redgrove to predict
ovulation and she also normalised all cycles to a 28 day
standard.   In 2 out of 3 cases a significant relationship
was observed between speed of typing and day of the menstrual
cycle.   Redgrove also looked at the work of punch card
operators and women sorting, marking and pressing white coats
in a laundry; neither of these studies was as well controlled
or designed as the typist study and no significant relationships
were found between performance and the menstrual cycle.

Whickham (1958) studied women in the A.T.S.. There
were 2 groups GpA - 1,525 women with regular menstrual cycles
who had been in the service for at least six months - and
GpB - 1,000 new recruits.   The groups were given a battery
of tests including Progressive Matrices, Mechanical Compre-
hension, Arithmetic Squares Test (spatial test) Mec. Test
(involving the assembly of Meccano parts into a model with the
aid of diagrams) and a Verbal test.   Menstrual cycle data was
obtained.   Group B was retested on the same battery six weeks
later.   The original Matrices grades obtained upon entering
the service were available for subjects in Group A.

GpA scores were grouped on the basis of cycle day on the second time of testing. Using the earlier Matrices test scores (six months prior) which presumably were random with respect to the menstrual cycle phase in which they were taken, Wickham was then able to take each subgroups mean score on the earlier test and subtract it from the overall mean (for all 1,525 subjects) on the second test and get an estimate of expected deviation (thereby controlling for the effect of repeated testing). Another method was used for the other tests as they had not been previously administered. The data were divided into 'period' and 'non-period' ('period' = four days before and after onset of menstruation for 28 day cycle subjects with addition or subtraction of a day for long and short cycle subjects). While slightly lower scores than expected were obtained in the 'period' phase the differences were not statistically significant on any of the tests. When GpB data was analysed in a manner which controlled for practice effects the differences were nonsignificant. Whickham concludes that, for predictive purposes, one need not take into account the menstrual cycle day on which a test is given.

Sommer (1972) gave 89 students, men and women, split halves of 2 matched forms of Watson-Glaser. A subsample of women was then selected out of women not using oral contraceptives whose testing over the four weeks fell into four quarters of the menstrual cycle. (Pre-menstrual, Menstrual, Follicular and Luteal.) In all 11 subjects remained and differences in test performance were not found to be significant. There was no correlation between cycle phase and the poorest test session. The study was repeated using 79 subjects and

again no significant differences were found. Sommer admits
that there was a serious problem about the sensitivity of
the tests used since the Watson-Glaser is constructed so as
not to show day to day fluctuations.

Sommer (1973) summarises her own study of perceptual-
motor performance in 20 women over one menstrual cycle. The
subtests measured aiming, "flexibility and speed of closure,"
number facility, and "visualisation" and were administered on
cycle days 2,6,10,14,18,22 and 27 with adjustments made for
longer and shorter cycles. These days were determined for
each subject on the basis of information given before the
testing began (no mention is made of whether it was checked).
No changes in performance were noted in relation to the
menstrual cycle.

Zimmerman and Parlee (1973), whose methodology has been
discussed under II Motor Tasks, also looked at performance on
digit-symbol substitution and time estimation (these tasks are
both very useful in this type of research since they can be
repeated a number of times without serious practice effects).
No significant differences were found at different phases of
the cycle for the digit-symbol substitution task or in the
time-estimation data.

The evidence reviewed does not allow one to reach a
firm conclusion about whether or not performance or mood varies
with the menstrual cycle. A possible reason why there are so
few consistent positive results in this area is that there are
wide individual differences in the pattern of response to the
menstrual cycle. It may be that only some women exhibit
behavioural changes associated with the menstrual cycle while

the remainder of the population do not. For this distinction to transcend the trivial it will be necessary to identify predictors of whether or not a woman will exhibit such cyclic changes. Behaviourally cyclic women may be of a specific personality type.

Personality variables have been implicated in extreme disturbances of menstruation, for example amenorrhea (Shanan et al. 1964 and Engels et al 1964) and sterility (Wittkower et al 1940). This suggests that personality measures may be good predictors of which women will suffer changes in mood energy and performance associated with the menstrual cycle. There are two main types of study: those which approach personality from a psychoanalytic viewpoint using interviews as a means of assessing personality and those which employ the more objective questionnaire personality tests.

Fortin et al (1958) divided 45 subjects in 2 groups viz. - those who reported both physical and psychological symptoms (the Experimental Group) and those who had no symptoms (20 Controls). The groups were equated for age and marital status. The subjects then underwent seven psychiatrically oriented interviews aimed at elucidating the subject's conscious and unconscious attitudes towards menarche and menstruation. They summarise their findings. "There are 2 types of pre-menstrual tension, a) onset with menarche, usually combined with dysmenorrhea, and b) onset several years afterwards . Type a is characterised by disturbing fantasies regarding menstruation fostered by the mother; by marital tension between the parents; by a hostile dependent relationship to the mother with intense feelings of guilt arising from hostile impulses directed against

her; by repudiation of the feminine role with marked feelings
of envy of the male.

In Type b the onset of the disorder and its
exacerbations are often precipitated by disturbances in the
patient's life history, especially by guilt over sexual
temptation.

The control group demonstrated a better acceptance of
the feminine role and of the inevitable restrictions imposed
on a girl; a reaction of pride to the menarche with emphasis
on the positive aspects of feminity; a dependent relationship
with the mother with fewer hostile features; and a better
sexual adjustment. Their tensions, both internal and external,
were dealt with more successfully. The ratings were subjective,
no statistical analysis was provided and it is not clear
whether the interviewer was aware of the group to which the
subjects belonged.

These authors implicate the family background especially
the girl's relationship with her mother as having a formative
influence on those aspects of personality which underlie a
negative attitude toward menstruation. Paige (1973) provides
evidence that religious orientations may also be formative
influences in determining personality types likely to hold
negative attitudes toward menstruation. She looked at 298
women, 181 Protestants, 54 Jews and 63 Catholics (the latter
groups chosen from people committed to practicing those faiths)
and found that although each religious group was equally likely
to report menstrual symptoms, these symptoms have different
origins and meanings to each religion.

Traditional Jews who think sex during menstruation is
unenjoyable and embarrassing and follow a variety of social and

hygienic rituals during their periods are those most likely
to have menstrual problems whereas the picture for Catholics
is quite different.   Catholics who believe a woman's place
is in the home, who have no personal career ambitions are the
most likely to have severe menstrual symptoms - especially if
they are virgins (virginity or sexual experience had no
effect on menstrual distress for Protestants and Jews). The
Protestants are a more heterogeneous group and did not have
clear cut results. The general conclusion Paige arrived at
after looking at these results in the context of a wider
questionnaire study was that women who have never used tampons,
tend to be religious, virgins, traditional, and follow the
"proper" menstrual rituals, are much more likely to suffer
menstrual distress than those who do not.

Rose (1949) designed her own questionnaire to ascertain
which women felt they suffered in mood and performance and
then administered the Bell Adjustment Inventory to find out
if personality differences distinguished the 2 groups.   The
questionnaire results showed that woman who did not complain
of pain were unconcerned with impairments in efficiency but
women who reported slight pain reported impairments of mood
and performance while women reporting severe pain also mentioned
more severe impairments.   These results are not attributable
just to subjects suffering pain however since women without
pain also indicated all types of impairment. The women without
menstrual pain were remarkably free from depressed feelings,
showed a better than average emotional balance, were lower
in certain aspects of inadequacy feelings which are typical
to the age group studied (college students), had less tendency
to withdraw from reality and most thought of themselves as
being emotionally stable.   The Bell Adjustment Inventory is a

remarkably transparent instrument which it would be very easy
for a subject to 'fake good' on. It is also similar in form
and in content to the questionnaire Rose designed so the
correlations between the two are not startling.

Gruba et al (1975) and Hain et al (1970) both
administered the M.M.P.I. to their subjects. This is an
extremely long and sophisticated personality test which taps
a large number and variety of traits. Hain et al looked at
nurses with regular and irregular periods, the latter group
reporting significantly more symptoms than the former.
Profiles of the 2 groups based on their MMPI scores revealed
the irregular group to be more immature and impulsive with
numerous neurotic symptoms including somatic ones and that
they tended to have more difficulties in interpersonal
relationships. They conclude "Irregularity of the menstrual
cycle is associated with general premenstrual and menstrual
symptoms and with personal maladjustment. It should be
noted however that from the data we cannot draw conclusions
about whether menstrual irregularity results from personality
disturbance or vice versa."

Gruba et al (1975) found that the MMPI variables tended
to correlate with premenstrual pain,negative affect and
behaviour change (lowered work performance, staying at home,
avoiding social activities and decreased efficiency as
reported by the subject). The MMPI scales implicated were
Sc (Schizophrenia) Hs (Hypochrondrias) Hy (Hysteria) and Pt
(Psychasthenia). These results are consistent with Coppen
and Kessel's (1963) finding that premenstrual tension,
irritability and depression correlate with neuroticism. Levitt
and Lubin (1967) using the Guildford-Zimmerman Temperament

Survey and the Edwards Personal Preference Schedule on 190
student nurses suggest . also that menstrual complaints are
related to an unwholesome menstrual attitude, neurotic,
paranoid tendencies, and to a lack of understanding of
motivations and feelings.

There is a statistical difficulty encountered when
the above types of research study are carried out.   Levitt
and Lubin were looking at 75 intercorrelations between
personality variables and the three menstrual indices and
found 14 reached significance at the 5% level or beyond.
They comment "this is probably (their italics) a larger number
of significant coefficients than would be expected by chance
alone, though there is no mathematical way of determining the
exact chance expectancy for non-independent computations." It
is possible therefore that significant results of the studies
reported are due to chance and have a statistical but not a
psychological significance.

It should be noted about the studies reported on
personality variables and changes in symptoms, mood and
behaviour associated with the menstrual cycle that all studies
deal with the subjects self report of changes.   There are no
studies which report actual measured changes in either
behaviour and mood so we can only conclude from the work
reviewed that personality affects self report of cyclic changes
in mood and performance.

Summary

This review of previous literature suggests that contradictory findings regarding variations in mood, energy and performance associated with the menstrual cycle may come about because of the methodological flaws which mar the studies. The studies also suggest that individual differences in the subject's performance may cancel each other out so that group results and graphs mask some individuals cyclicity. These individual responses to the menstrual cycle may be a function of the subject's personality.

The study which follows aims to eliminate some of the methodological flaws while looking at variations in mood, energy and performance across the complete menstrual cycle, taking individual differences into account.

Chapter 2

The aims and rationale of this study

It follows from the comments in the previous chapter that before it is possible to investigate meaningfully relationships between mood, performance and the menstrual cycle, it is necessary to resolve certain methodological issues.   These fall into three main classes:

i)   Identifying accurately the occurrence of ovulation and menstruation and on the basis of this knowledge normalising the subject's cycle so that comparisons are possible both within and between subjects.

ii)   The selection of an instrument to measure mood and energy which can be used daily for long periods and which is self-administered.

iii)   The selection of behavioural tests which will both sample adequately the range of skills that contribute to intellectual performance and yet will be sensitive to fluctuations associated with the menstrual cycle.   These tests must be suitable for repeated use and must be brief enough and interesting enough to maintain the cooperation of subjects over many cycles of testing.

There are two common methods of pinpointing ovulation, one being the use of vaginal smears (Benedek and Rubenstein, 1942) and the other the measurement of basal body temperature (World Health Organization, 1967; Bailey and Marshall, 1970).   Although vaginal smears are more accurate they are unpleasant to undergo and require the subjects either to bring their smears daily to the laboratory for analysis or to attend the laboratory daily to have smears taken.   In a study extending over several months this technique would place an unacceptable burden on subjects, so daily records of basal body temperature present a more acceptable alternative.

In order to investigate the daily mood and energy levels

of the subject the two scales of the Wessman and Ricks Personal Feelings

Scales which accounted for most of the variance in their study of mood

(Wessman and Ricks, 1966) will be used.   They are the Elation <u>versus</u>

Depression Scale and the Energy <u>versus</u> Fatigue Scale.   It has already

been reported in the literature review the advantages that these scales

possess over other methods of measuring mood and energy.

As can be seen from the literature review,changes in intellectual

performance across the menstrual cycle are extremely difficult to

measure.   It is not possible to use standard intelligence tests since

they are designed not to be susceptible to day to day fluctuations

in intellectual performance (Sommer, 1972).   Also, in order to test

subjects weekly over long periods a large number of equivalent forms

of these tests would have been required but are not available.

Examination performance can similarly be ruled out as it is impossible

to test the same subject at different phases of her menstrual cycle.

A more feasible approach to the measurement of intellectual performance

across the menstrual cycle is to break it down into its component

skills and measure these.

Intellectual performance relies on a variety of skills

including: logical inference, concentration, memory and ability to

process information and make decisions quickly. This list is by no

means exhaustive but represents skills amenable to precise quantification

in the laboratory and repeated testing.

(i)   <u>Logical Inference.</u>

In selecting a test of logical inference it is necessary

to choose a measure which will not be confounded by lower level variables

such as speed of decision making.   A test which can be scored in terms

of errors rather than speed of performance is therefore necessary.

The form of concept formation task described by Bruner et al (1956) is a good example of such a test which is also quick and easy to administer and capable of being used in repeated test-sessions. Another advantage of this task is that level of difficulty can be varied easily.

(ii)   Concentration.

The ideal measure of concentration would be a vigilance task (Welford, 1968). However, meaningful measurement of vigilance performance requires test sessions lasting an hour or longer.   In view of the need to maintain the cooperation and interest of the subjects the total test session cannot last longer than thirty minutes, so vigilance tests are ruled out. Rotor pursuit performance, in which the subject has to track a moving light spot with a wand, while not an ideal test of concentration is a test which can register differences in concentration over a relatively brief test session since it embodies a very high rate of signal presentation.

(iii) Memory.

Again the time constraint rules out many of the usual tests of memory because these tasks require a number of trials to establish a representative picture of an individual subject's performance. The digit-symbol substitution subscale of the Wechsler intelligence test (Wechsler, 1955) offers a solution to this problem. Successful performance on this task depends on the subject being able to commit a large number of items to memory over a short period. Administration of this test takes only ninety seconds.   Hundreds of equivalent forms of the digit-symbol substitution task can be prepared, and since Blatt and Allison (1968) and Burik (1950)   report   that learning plays a minor role in the performance of this task it can be used repeatedly.

An additional reason for looking at digit-symbol substitution

performance across the menstrual cycle is provided by an hypothesis

put forward by Broverman et al (1968). A number of studies, for

example Paterson and Andrew (1946), Norman (1953), Gainer (1962),

McNemar (1942), and Bieni et al (1958), report results which

suggest that females surpass males on simple, overlearned, perceptual-

motor tasks while males excell on more complex tasks requiring an

inhibition of immediate responses to obvious stimulus attributes in

favour of responses to less obvious stimulus attributes. Broverman et

al (1968) argue that these sex differences are reflections of differences

in relationships between adrenergic activating and cholinergic inhibitory

neural processes, which in turn are sensitive to the "sex" hormones,

the androgens and estrogens. Digit-symbol substitution is one of

the tasks at which females excel due to their larger amounts of

circulating estrogens and the effects these have on their central nervous

systems (Broverman et al, 1968). It is reasonable then to look at digit-

symbol substitution over the menstrual cycle and the expect fluctuations

in performance to correlate with fluctuations in estrogen level.

(iv)   Information Processing and Speed of Decision Making.

Reaction time is the simplest measure of these skills (Welford,1968).

It is clear from the literature that simple reaction time (R.T.) has

received a lot of attention from previous workers in this area and

conflicting results have been reported. However, there is doubt whether

simple R.T. is a sensitive enough measure to register menstrual cycle-

induced performance decrement (Blake, 1967) so it is proposed to use choice

R.T. instead.

In order to illuminate the effect of individual differences on

mood, energy and performance a Cattell 16 P.F. Scale is also administered

to the subjects. Each subject also provides a menstrual history and keeps

a record of symptoms experienced during the para-menstruum.

One of the problems in this area is how generalisable results are. Methodological constraints have meant that many studies are carried out on psychiatric populations and even with normal subjects there are sampling problems with volunteer subjects (Rosenthal, 1975). In order to determine how representative a sample the volunteer subjects are it is necessary to administer a questionnaire to female students at the University, which will elicit their menstrual history and attitudes as well as details of menarche and of symptoms experienced paramenstrually. This questionnaire will provide a profile of the menstrual experiences of the 'average female student' against which it is possible to assess the profiles of the women studied in detail. The questionnaire will also provide more information about the relation of religious commitment and experiences at menarche to paramenstrual symptomatology.

The experimental hypotheses are that:

(i)   Mood will vary with different phases of the menstrual cycle.

(ii)   Energy levels will vary with different phases of the menstrual cycle

(iii)   Choice R.T. will vary with different phases of the menstrual cycle.

(iv)   Rotor Pursuit performance will vary with different phases of the menstrual cycle.

(v)   Digit-Symbol Substitution performance will vary with the different phases of the menstrual cycle.

(vi)   Concept Formation will vary with the different phases of the menstrual cycle.

Chapter 3

The Questionnaire Study

With a study of this kind it is possible that the subjects who volunteer to take part, do so because they suffer from, or believe themselves to suffer from, some kind of menstrual abnormality. It was therefore necessary to determine how representative the "core subjects" were of the student population to which they belonged.

A questionnaire (see Appendix I) was designed to establish:

a) Basic demographic variables e.g. age and religion.

b) Menstrual history e.g. its regularity and duration of flow.

c) Symptoms suffered paramenstrually.

d) Impairments in i) mood

                ii) academic work

             iii) interpersonal relationships

    suffered paramenstrually.

e) The subject's age at, and experience of menarche.

f) Attitudes towards menstruation.

The questionnaire design was based on a reading of the literature especially studies which employed questionnaire techniques (e.g. Moos et al ,1968 ; Rees , 1953; Coppen and Kessel ,1963; and Greene and Dalton, 1953)and a series of discussions with female students about menstruation and attitudes toward it. Tape recordings of these discussion groups were made and the transcripts served to indicate areas which women felt to be important.

Questionnaires were distributed to 300 nulliparous female students and 234 returned them (78%). The questionnaires were also given to the core subjects (15 at this stage of the experiment).

Analysis of Results

The results provided by the larger University sample were analysed by computer to ascertain the incidence of each symptom. Symptoms whose modes appeared in the 'never' category were discarded since the computer was unable to handle cross-tabulations of all the possible variables.

The questionnaire was answered by students who used oral contraceptives as well as those who did not. Since the core subjects did not use 'the pill' the first operation was to determine those questions which discriminated students who did not use the pill from those who did.

A 'cross tabs' analysis including χ^2 statistic (S.P.S.S.) was performed to compare women using oral contraceptives with those who did not. The following patterns emerged. Women who use the pill have shorter (mean duration 4-6 days compared with 5.5 days for non-users), lighter (slight to moderate '2.7' as opposed to '3.12' moderate of the non-users) and more regular periods. Ninety-eight per cent of women on the pill claimed to be regular while only 60.6% of non-users did. The average interval between period was also longer for non-users, 4.15 weeks as opposed to 3.66 weeks reported by the women using oral contraceptives. The longest intervals ever experienced between periods were also longer for non-pill users. The results were as follows:

	3wks.	4wks.	5wks.	3mths.	6mths.	1yr.	more than 1yr
Pill	1.9%	13.2%	43.4%	30.2%	9.4%	0%	0%
Non Pill	0.6%	5.0%	39.4%	36.7%	11.1%	2.2%	2.8%

N.B. When the figures do not add up to 100% across the tables in this section it means that the 'missing percentage' did not answer that question. All these differences between the two populations were significant at the 0.001 level.

The groups differed significantly on a number of demographic variables. The pill user group was slightly older, 56.6% of them were 20 or over while in the non-users 45% were 20 or older. The groups differed in terms of their religious affiliations. The distribution was as follows:

	R.C.	CofE	Bap- tist	Metho- dist	Agnos- tic	Jew	Chris- tian	None	Cong- reg.
Pill	0	41.5%	0	9.4%	3.8%	1.9%	7.5%	34%	1.9%
Non Pill	6.1%	51.7%	1.7%	8.3%	1.1%	2.8%	12.2%	15%	1.1%

As may have been expected the pill users contained no Roman Catholics and fewer Jews but more agnostics and people having no religion. When the religiosity results (obtained by looking at reports of church attendance) were examined, 73.6% of pill users claimed no commitment to any religion while 42.8% of non-users displayed some degree of religious commitment.

The two groups also differed in whether or not they expected sympathy around menstruation; 69.8% of pill users did while only 43.3% of those not using oral contraceptives made the same claim. When reporting from whom they expected sympathy the results were as follows:

	Boyfriend	Friend	Nobody	Everybody	Family
Pill	43.4%	9.4%	28.3%	17.0%	1.9%
Non Pill	20.0%	11.1%	55.5%	6.7%	7.2%

The two groups did not differ significantly on any of the reported symptoms either before or during menstruation.

The core subjects were then compared (using a S.P.S.S.
'cross-tabs' analysis) with the larger University groups who
did not use the pill. The two groups did not differ signifi-
cantly on any of the major menstrual variables. Both groups
reported the same degree of regularity, heaviness and length
of flow. The average and 'longest ever' intervals between
periods were similar for both groups.

The two groups differed significantly in religious
affiliations but not in terms of religious commitment. The
distribution amongst the various religions was:

	R.C.	CofE	Bap-tist	Metho-dist	Agnos-tic	Jew	Chris-tian	None	Cong-reg.
Core	6.7%	20%	0%	13.3%	13.3%	0%	13.3%	33.3%	0%
Non Pill	6.1%	51.7%	1.7%	8.3%	1.1%	2.8%	12.2%	15.0%	1.1%

The core group had a higher percentage of Agnostics
and 'no religion' than the non pill group. A chi-squared test
on the religious affiliations of the pill group and the core
subjects showed no significant differences. The core group
resembles the pill group in terms of religious affiliation.

There were no other significant differences between the
core subjects and the larger University non pill taking group
except that the core group reported more frequent minor
symptoms viz - aches and pains, acne, and swelling before
periods and dizziness and aching legs during periods.

A cross-tabs analysis (S.P.S.S.) was then performed on
the religious affiliation data to ascertain whether the
difference in religious affiliations contributed to the
differences found in symptomotology. The religious groups did
not differ in their reports of the symptoms reported more

frequently by the core subjects but the groups did differ

significantly in their reports of emotional symptoms

experienced during menstruation.   The reports are divided

into two groups - those reporting 'don't know', 'never' or

'rarely' and those who report 'sometimes' 'frequently' or

'always'.   The results are summarized in the following tables;

Table 3.

Religion	Depression		Irritability		Tension	
	Never etc.	Always etc.	Never etc.	Always etc.	Never etc.	Always etc.
Roman Catholic	45.5%	54.4%	27.3%	72.7%	36.4%	63.6%
Church of England	44.3%	55.7%	47.8%	52.2%	53.1%	46.9%
Baptist	33.3%	66.7%	33.3%	66.7%	66.6%	33.4%
Methodist	30%	70%	40%	60%	50%	50%
Agnostic	25%	75%	25%	75%	50%	50%
Jew	16.7%	83.3%	33.4%	66.6%	50%	50%
Christian	34.5%	65.5%	53.8%	40.2%	61.5%	38.5%
None	31.2%	68.8%	28.9%	71.1%	44.5%	55.5%
Congregationalist	66.7%	33.3%	66.7%	33.3%	66.7%	33.3%

Religion	Emotional Insecurity		Arguments		Crying more easily	
	Never etc.	Always etc.	Never etc.	Always etc.	Never etc.	Always etc.
Roman Catholic	54.6%	45.4%	36.4%	63.6%	45.5%	54.5%
Church of England	60%	40%	60%	40%	48.7%	51.3%
Baptist	100%	0%	66.7%	33.3%	66.7%	33.3%
Methodist	60%	40%	50%	50%	40%	60%
Agnostic	25%	75%	50%	50%	25%	75%
Jew	66.6%	33.4%	66.7%	33.3%	66.6%	34.4%
Christian	73%	27%	73%	27%	53.8%	46.2%
None	57.7%	42.3%	53.3%	46.7%	40%	60%
Congregationalist	66.7%	33.3%	66.7%	33.3%	66.7%	33.3%

Religion	'Getting at others'		'Less inter- ested in work'		'Wash more often'	
	Never etc.	Always etc.	Never etc.	Always etc.	Never etc.	Always etc.
Roman Catholic	27.3%	72.7%	27.3%	72.7%	9.1%	90.9%
Church of England	57.4%	42.6%	51.3%	48.7%	19.2%	80.9%
Baptist	66.7%	33.3%	100%	0%	0%	100%
Methodist	55%	45%	40%	60%	25%	75%
Agnostic	50%	50%	25%	75%	0%	100%
Jew	66.7%	33.3%	66.7%	33.3%	33.3%	67.6%
Christian	69.2%	30.8%	69.3%	30.7%	30.7%	69.2%
None	46.7%	53.3%	51.1%	48.8%	26.7%	73.3%
Congregationalist	66.7%	33.3%	67.3%	33.3%	0%	100%

Inspection of the tables reveals that members of certain religious denominations are either less willing to report emotional symptoms or suffer less from these symptoms than others. Roman Catholics report noticeably more symptoms than the others, complaining of more irritability, tension, arguments, getting at others and of being less interested in work. The subjects who are members of the Church of England are the most equally divided group approximately 50% of them reporting each emotional symptom. A group of churches have members who report few symptoms during menstruation. These are the Baptists, Methodists, Jews and Congregationalists.

Discussion

The primary aim of this questionnaire study was to find out how far the data generated by the core subjects are generalisable to the female population of the University. The analysis performed shows that the core subjects are representative of the wider non pill using University population. The core subjects are representative of the larger University population in terms of age, menstrual parameters, experience of menarche, attitudes towards menstruation and major symptomatology. However the core subjects are more comparable in their religious affiliations with the pill using students. In fact the core subjects tended to fall into two extreme groups on the basis of religion, 47% of them having no religious affiliation while the other 53% subscribed to a variety of religious faiths. However if the religiosity data is considered, approximately 50% of the core subjects attend church regularly. It would seem therefore that the group consisted of women who either had no religion at all or who were very committed to their churches.

The core subjects did complain of more minor symptoms but this was to be expected since these women had been alerted, by taking part in the study, to look more closely at the nuances of menstrual symptomatology. This point is underlined by the fact that the core subjects report more aching legs and dizziness during menstruation, symptoms from which the majority of University women (65% in the case of aching legs and 68% in the case of dizziness) indicated that they either did not know whether they suffered or never suffered.

The pill and non pill users in the University population were separated using a cross-tabulation analysis and the two groups differed along major menstrual parameters. This is as expected. Moos (1968), looking at 420 women using oral contraceptives, reports shorter cycles, shorter flow and more regular cycles. Contraceptive pills are prescribed as medication for women who suffer irregular and heavy periods. Taking the pill for 21 days out of 28 imposes regularity on the cycle and since it prevents ovulation it does not allow a proper period to take place but substitutes a pseudo period of withdrawal bleeding when the drug is discontinued.

It is more unexpected not to find differences in reported symptomatology between the group using oral contraceptives and those not. The literature in this area is however very contradictory. Glick (1967) reviews the work carried out up to that date and points out the contradictions in the reports of women's experiences while taking the pill. Many note a sense of well-being and claim to function better but 1-6% of patients using oral contraceptives feel worse.

Cases of depression associated with use of the drug are uniformly reported. Incidence has ranged from 2-30% depending on the population studied (Lebhertz and Fobes 1961) and Behrman (1964). The patients who became depressed were the ones who either a) felt disappointed in unrealistic expectations they hold of medication or b) reacted to side effects with distress based on an individual ability to tolerate them.

There are two types of contraceptive pill - the combination pills which contain progestin as well as estrogen and is taken throughout the cycle and the sequential pill which

contains estrogen alone for the first fourteen days and then both steroids for the next six days. Moos (1969) found that women on combination pills tended to complain somewhat less of symptoms than women using sequential pills or not taking the pill at all. Women using the sequential pill in fact tended to complain of more symptoms than women in either of the other groups. However the similarity of distribution of symptoms between the two questionnaire groups in this study cannot be explained in terms of the pill group being composed of sequential and combination pill users because although the questionnaire does not ascertain exactly which pill each subject uses, the sequential pills are not prescribed for this type of population (young nulliparous women) in this country. Further evidence that the sample must be pre-dominantly combination pill users is provided by the fact that they have light period flow (period flow differs significantly from the non pill users group $p < 0.001$) while sequential pill users have a heavy flow and resemble the non pill using population in flow and duration of flow parameters (Paige 1971).

In fact research workers seem to be divided on whether to expect more or less reported symptomatology from women using oral contraceptives. Kutner et al (1972) looked at combination and sequential pill users and compared them with non users and people who had discontinued use of oral contraceptives. They confirmed Moos' findings about the two types of pill users but claimed that pill users were no more depressed than "never users". They did however point to the

"survivor" phenomenon that is the fact that some women are
so distressed when they take the pill that they discontinue
its use.   The women who continue to take the pill are
therefore survivors of a larger group who initially began
taking the pill.

Herzberg   and Coppen (1970) looked at 152 women who
were just beginning to take the pill.   They were given
questionnaires detailing menstrual symptoms such as pain,
irritability, depression, tension, headaches, nausea and
energy loss, before they used the pill and then 5 weeks, 5
months and 11 months after they began to take their combination
pills.   The questionnaire allowed women to indicate the
severity and timing of their symptoms which occurred during
the past four weeks.   Women taking the pill reported that
it alleviated premenstrual depression, irritability and
dysmenorrhea.   However it should be noted that during the study
31 women (20.4%) stopped taking the pill.   These 'non-
survivors' gave the following reasons for discontinuing use
of the oral contraceptives:

depression & irritability	9	headaches	13
swelling of hands & feet	6	very tired	5
loss of interest in sex	6	unacceptable weight gain	11
planning pregnancy (only reason)	5		

It can be seen therefore that some women react very
badly to the pill, that it exacerbates paramenstrual symptoms
to such an extent that women are willing to give up the
benefits of oral contraceptives.

Kane et al (1967) interviewed 50 women using contra-
ceptive pills of the combination type.   They had specifically

asked for referrals of women having psychological effects
related to taking progestational agents but also had control
women. Unfortunately they do not specify how many of their
50 women are controls though they do state that 11 are
psychiatric patients.

In the interviews 28 of the women reported undesirable
effects associated with pill taking including one severe
psychotic reaction. Nineteen reported lability of mood with
depression and tearful spells as well as irritability and
loss of interest in their environment while 2 of them reported
suicidal ideation. Others reported such diverse symptoms
as menopausal-like syndromes with hot flushes etc.,
nymphomania and migraine-like headaches with hallucinations
and lethargy. Eleven patients (6 of whom were psychiatric
patients) reported beneficial effects. Seven women reported
increased well being and feelings of vigour while 4 reported
amelioration of their premenstrual syndrome. The remaining
11 subjects reported no change. Kane et al do not report
whether their subjects discontinued taking oral contraceptives.

The picture which emerges from the research is a little
confused but it seems that some women react very badly to oral
contraceptives, so badly that although contraceptive pills
have many advantages they have to give them up. Other women
'the survivors' as Kutner et al call them, benefit from taking
combination contraceptives.

The absence of expected differences in the present study
may have come about for a number of reasons. They are:
i) The two populations may not be discriminable; ii) This
questionnaire measures the frequency of symptoms. In this study
the subject indicated whether she suffered from the symptoms,

never, rarely, sometimes, frequently and always. In Herzberg and Coppen's (1970) study they looked at the intensity of the symptoms experienced during the menstrual cycle and found that women using the combination pill suffered less intense premenstrual symptoms. It is possible therefore that it is the intensity rather than the frequency of symptoms which is affected by taking oral contraceptives; iii) The population was composed of students who were relatively new users of the pill and contained "survivors" who benefited from using oral contraceptives and "non-survivors" who would eventually give up the pill because it intensified their symptoms. There is a period when women are willing to give the pill a trial and to hope that any increase in symptomatology will go away.

Future questionnaire studies should determine how long the subjects have been taking the pill and differentiate between intensity and incidence of symptoms. However a questionnaire study is not appropriate for sorting out the problems in this area. Well controlled longitudinal studies are needed to delineate exactly who benefits from taking contraceptive pills and what forms these benefits take.

The other difference between the pill and non pill using groups was that those on the pill expected sympathy around menstruation, mainly from their boyfriends. Women not using the pill did not expect sympathy, from anybody, to the same extent. An explanation of this difference could lie in the fact that the non pill using group did not have boyfriends around from whom to expect sympathy or that it is only when women have a sexual relationship with men that they expect

sympathy for sufferings related to their sex.   There is no

difference in the symptoms suffered by the two groups nor

is there a common stereotype which would lead pill users to

think they suffered more paramenstrually.

Paige (1973) looked at 56 Protestants, 18 Catholics and

13 Jews and found differences in attitudes even with such a

small group.   Each of these religions has a particular view

of women and sex.   Orthodox Jewish women, for example, are

not supposed to have sex during menstruation and for 7 days

thereafter.   They are considered 'unclean'.   The Catholic

Church too tends to urge abstinence during a woman's period

and historically has promoted a view of woman as an unclean

vessel that tempts the pure man.   Paige (1973) using a larger

sample of 298 women (181 Protestants, 54 Jews and 63 Catholics)

found that among Jews the one dimension most strongly related

to menstrual symptoms was adherence to menstrual taboos and

rituals.   That is Jews who think that sex during menstruation

is unenjoyable and embarrassing, who follow a variety of social

and hygienic rituals during their periods, are those who are

most likely to have menstrual problems.

Catholic women were more likely to consider menstrual

distress as an integral part of the female role.   Thus those

who believe a woman's place is in the home and who have no

personal career ambitions are the most likely to have severe

menstrual symptoms - especially if they are virgins.   The

Protestants were a heterogeneous group it was difficult to say

much about.

In this study the religious groups did not differ in menstrual attitudes and taboos. The sample however only included 6 Jews. The Roman Catholics did report more symptoms than the other religious groups and the Protestants were as stoical as Paige found them with the Baptists, Methodists and Congregationalists reporting fewest symptoms. All groups washed more often but surprisingly the Jews were least likely of all groups to report this. The main point of the cross-tabs analysis on the religious affiliations was to find out if differences in these would account for differences in minor symptomatology experienced by the core subjects. It is quite clear from the results that this is not so. The symptoms associated with different religious affiliations are emotional and psychological symptoms experienced during menstruation while the core subjects suffered more physical symptoms paramenstrually.

Chapter 4

Methodology of Core Study

Each subject was tested weekly at the same time on four tasks viz. - rotor pursuit, choice reaction time, digit-symbol substitution and concept formation. All subjects were given an initial practice session on these tests to reduce possible practice effects. In order to make sure of reducing practice effects as far as possible, the first "official" testing session results were also discarded.

All subjects kept daily records of basal body temperature and filled in charts indicating their highest, lowest and average elation and energy levels for that day. In addition the subjects kept menstrual charts which indicated the days of bleeding and filled in symptom charts in the paramenstruum. The core subjects also completed a Cattell 16 P.F. Scale.

A. Subjects

The subjects were 26 females, all employed by or studying at the University, whose ages ranged from 18-34 years. Their selection was not random since they were either acquaintances of the experimenter or volunteers. The subjects were women who did not use contraceptive pills nor the contraceptive device known as "the coil" since these affect normal menstruation (see questionnaire study for differences between pill and non-pill users).

All the subjects were fully acquainted with the purpose of the study since it would have been impossible to disguise this effectively. Therefore in this study the approach had to be taken of using the subjects as co-experimenters as suggested by Argyris (1968). This means no deception at all was practised in this study but the subjects were encouraged

to be as objective as possible about their behaviour.   In
the testing sessions they were encouraged to work at maximum
capacity to point out anything that was affecting their
reactions and to feel they could comment on all aspects of
the experiment.   For example when the Cattell 16 P.F. was
administered each subject was given details of the results
and asked to write comments both on the test and on their
profiles.   This approach was adopted to encourage the
subjects to be as efficient and persistent as possible in
filling in the required data forms and also to be objective
enough not to tamper with their data (for example going back
and filling in the blank spaces in mood data).

    The subjects were recruited at different times and
either remained in the study until the end or until personal
circumstances caused them to be unsuitable as subjects.
Since the work stretched over sixteen months, few women kept
perfect data records.   This is a summary of the subjects'
history in this study.

Subject	Record length	Reason for leaving the study
A	4 months	started using coil.
B	16 "	–
C	11 "	started using pill.
D	11 "	became pregnant.
E	13 "	–
F	3 "	bored, dropped out.
G	6 "	started using pill.
H	7 "	became pregnant.
I	14 "	–
J	15 "	–
K	15 "	–
L	14 "	–
M	7 "	–
N	6 "	–
O	8 "	–
P	7 "	–
Q	–	did not complete first month's records.
R	7 "	–
S	8 "	–

Subject	Record length	Reason for leaving study
T	– months	did not complete first month's records.
U	7 "	–
V	–	did not complete first month's records.
W	6 "	–
X	7 "	–
Y	–	did not complete first month's records.
Z	7 "	–

B. Apparatus and Procedure.

I. Daily Records

a) Temperature.

The subjects were given a special thermometer (obtained from the Family Planning Clinic) which was clearly marked, with a magnifying glass incorporated into it, so that it was easy to read. They were given special charts and were instructed to take their temperature orally before getting up each morning. They were told to place the thermometers in their mouths under the tongue and keeping their mouths closed to wait 3 minutes (timed by a bedside clock) before reading it. They then recorded their temperature on the chart reading to the nearest 0.1 degree. The subjects began their records on the first day of their next menstrual period.

b) Mood and Energy.

The subjects were given copies of 2 scales of the Wessman and Ricks Personal Feelings Scale; the scales measuring Elation vs. Depression and Energy vs. Fatigue (samples presented in Appendix 2). They were instructed to fill in these scales last thing at night and to indicate the highest, lowest and average mood they experienced that day. They were

especially requested not to go back and fill up the blank
spaces, if they forgot to complete their record any day,
but to leave the records blank.

II. Menstrual Records.

The subjects were provided with menstrual charts (an
example is in Appendix 3) on which to record days of bleeding.
They were also given menstrual symptom charts and asked to
fill them in approximately three days before they began
menstruating (if they knew when this was) and on every day
of bleeding (see Appendix 4).

III. The Performance Measures.

The subjects reported once a week to the laboratory
regardless of the phase of their menstrual cycle and per-
formed the 4 tests in a random order. The opportunity was
also taken to encourage the subjects to keep up with their
record taking, to collect in records, and to sort out any
problems which the subject had with the study. These sessions
usually lasted about half an hour. The subjects were under
strict instructions never to reveal to the experimenter which
phase of their menstrual cycle they were in at the time of
testing; nor were the records analysed at that time, so the
experimenter remained unaware of the subject's menstrual
status. The subjects were asked to work at maximum capacity.
Redgrove (1971) has pointed out the importance of using
highly motivated subjects and her technique of encouraging
the subjects to compete against their previous week's per-
formance was implemented.

Choice Reaction Time Equipment

Figure 2

Hand Rest
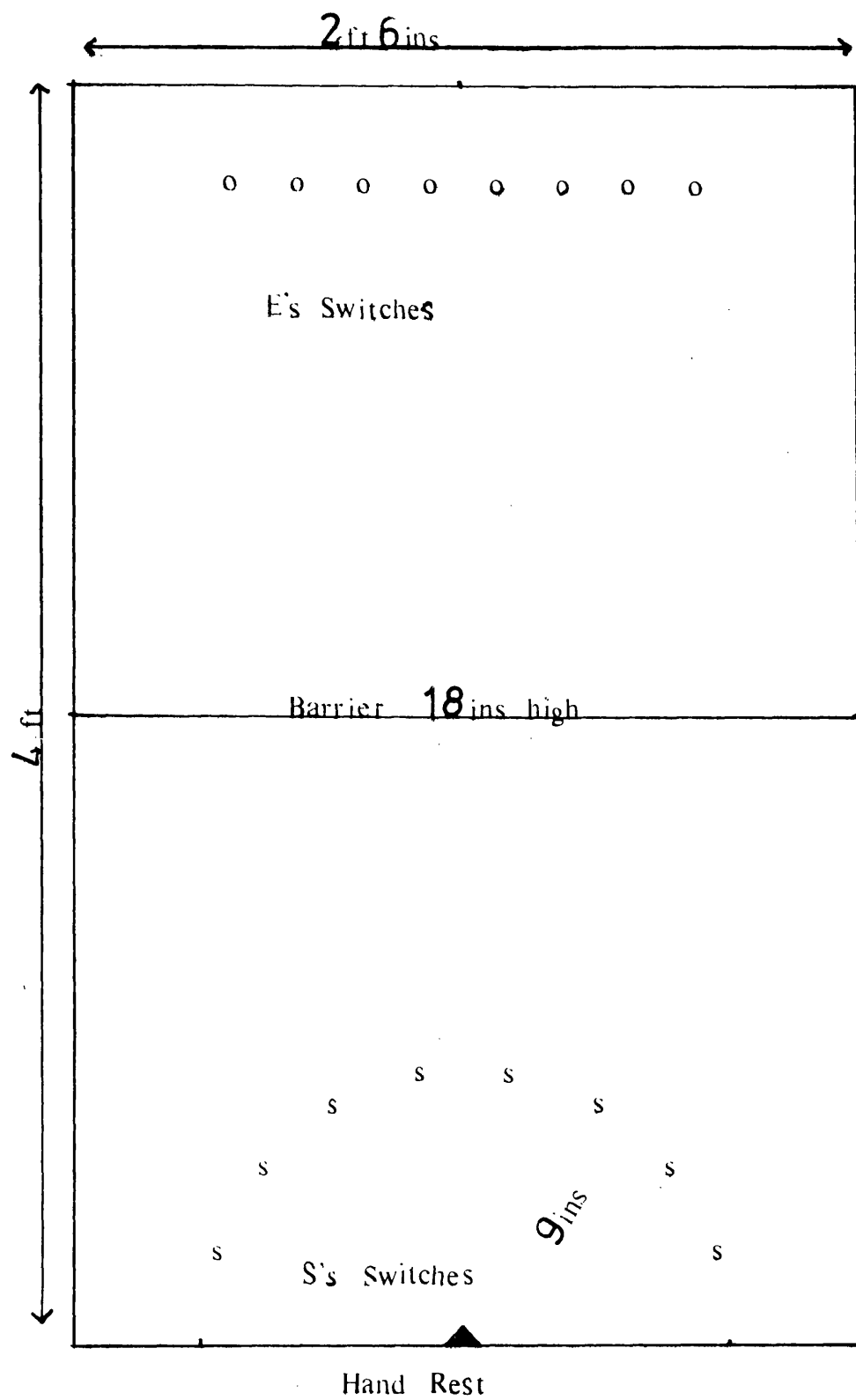
(i) Choice Reaction Time

The subject was positioned in front of a specially designed choice reaction time apparatus (shown in Fig.2) and told to push the switch adjacent to the light in order to turn off, as quickly as possible, whichever one of the eight lights came on. This required the subject to move her whole hand and there was a resting place marked on the board to indicate where the subject had to place her hand before each trial began. This mark was equidistant from each of the eight lights and the experimenter had to ensure that the subject's hand was on this resting mark before each trial began. The experimenter stood on the other side of the equipment, her hands hidden from the subject by a screen. The subject was given 3 practice trials before each session.

The experimenter turned on a light at random, the subject turned off the light as quickly as possible. The experimenter noted the time taken and that the subject's hand was back at the resting position. The experimenter said "Ready" and then switched on the next randomly selected light. Ten trials were recorded.

(ii) Rotor Pursuit

A standard laboratory rotor pursuit machine (Forth Instruments) was used. The subjects was given the wand and asked to follow a light around a star pattern. When the wand made contact with the light it made a buzzing sound and the duration of the contact was automatically recorded by the machine. The light moved at 30 r.p.m. and each trial lasted approximately 20 seconds. At the beginning of each

session the subject was given 2 practice trials the results

of which were discarded.   The subject was then given 5,

20 second trials with approximately 20 seconds rest between

each trial.   The proportion of time the wand made contact

with the light was recorded for each trial.

There are gaps in some subject's records in both

choice reaction time and rotor pursuit because these machines

occasionally broke down.

(iii) Digit-Symbol Substitution

The digit-symbol sub-test of the Wechsler Adult

Intelligence Scale was given according to the instructions

in the manual (Wechsler 1955).   Since the test had to be

repeated a number of times on each subject, 10 equivalent

forms of each symbol had to be generated.   The symbols were

kept in 9 different boxes and before each trial symbols were

chosen at random, one from each box, and then placed above

the digits, 1 to 9, so that the subject could see them clearly.

This means that the subject had a different set of substitutions

to make for the digits each time she did the test thus

reducing the effects of learning and practice.   The subjects

were given a different set of digits (generated from random

number tables) to code each testing session.   There was only

one trial at each session and it lasted 90 seconds.

(iv) Concept Formation

A selection of cards based on the material published

by Bruner, Goodnow and Austin (1956) were used.   The cards

were of 4 different colours printed with either 1, 2, 3, or 4

of four different shapes.   Thus the cards embody 3 different

CONCEPT FORMATION CARDS

RED
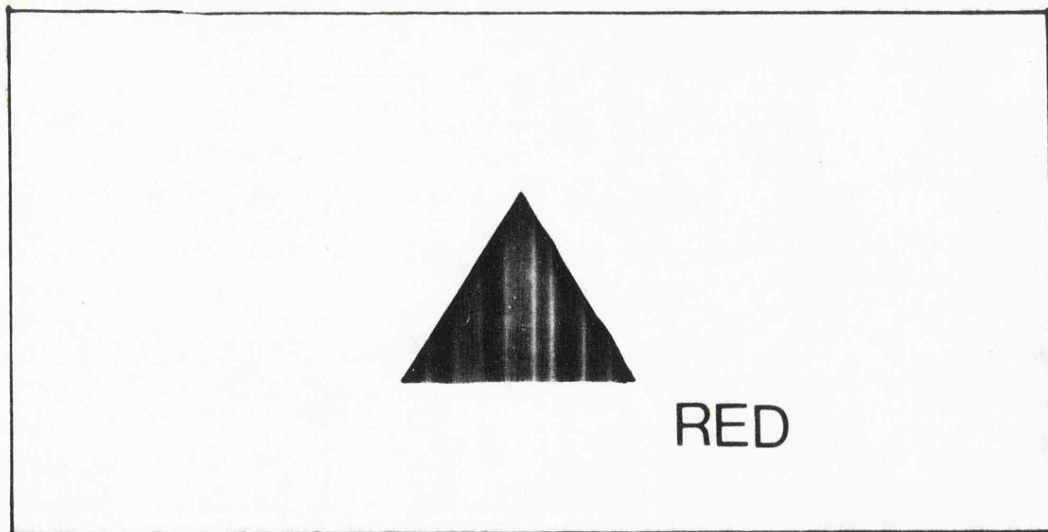
1 RED TRIANGLE
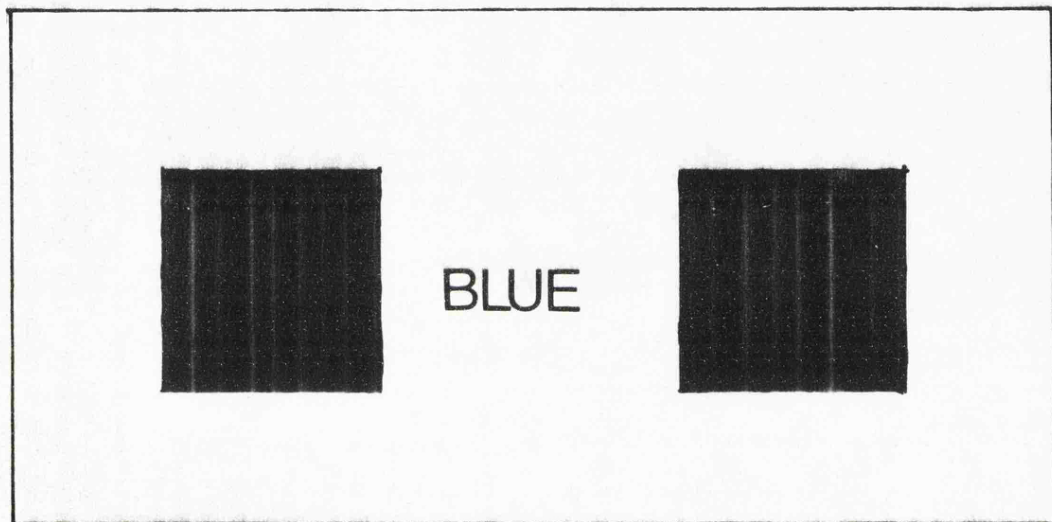
BLUE

2 BLUE SQUARES
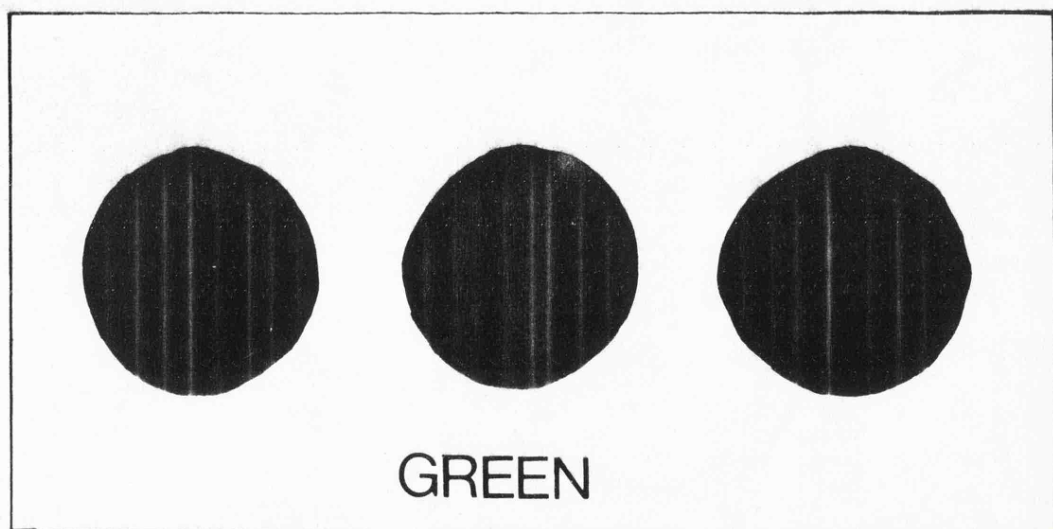
GREEN

3 GREEN CIRCLES

figure 3

dimensions, those of colour, shape and number. Examples of concept formation cards appear in Fig.3.

The subject sat at a table facing the experimenter who held a pack of concept formation cards. There were 3 types of trial varying in difficulty. These were:-

i) Type A. The concept had only 1 dimension either a colour, a shape or a number, e.g. red, or triangle or 4. These were the easiest to deduce.

ii) Type B. Here the concept had 2 attributes e.g. green three, blue stars, or 1 circle. These were more difficult to deduce.

iii) Type C. The concept had 3 attributes, e.g. 3 red triangles, 4 yellow circles or 2 green stars. These were the most difficult to deduce.

The trials were balanced (ABCCBA) for practice and fatigue effects.

When conducting a trial in which the subject was required to deduce a concept of Type A, the experimenter told the subject: "I am looking for only 1 dimension either an example of a colour, a shape or a number. I will place each card before you and say 'yes' if that card embodies the dimension and 'no' if it doesn't. As soon as you know the dimension I am looking for, stop me." The experimenter placed the cards in front of the subject at a constant rate (approximately 20 per minute) saying 'yes' if it embodied the dimension and 'no' if it didn't. When the subject arrived at the concept, the experimenter took a note of the number of cards it took the subjects to deduce the answer. The experimenter also noted any incorrect guesses the subject made

during the course of the trials. The experimenter and
the subject then went back over the cards and worked out
the minimum number of cards the subject could have taken
to logically arrive at the answer (using both positive
and negative information). The score for each trial was the
number of cards actually taken to arrive at the concept
divided by the minimum number the subject could have taken.
One represents a minimum score for each trial. If the
subject guessed and arrived at the concept before the minimum
number of cards required logically, she was also given a
score of one.

The subject was then given a trial with a concept
having 2 attributes (Type B) and one with a concept having 3
attributes (Type C). The instructions to the subject were
slightly modified before these trials so that the subjects
knew exactly how many of the attributes each card possessed.
Now the experimenter said 1, 2 or none as she presented each
card indicating the number of attributes each card embodied.
For example if the experimenter was looking for the concept
1 blue then she would say 'one' when presenting the card
showing 3 blue circles, 2 when presenting 1 blue star and
none when 3 red triangles were shown. When dealing with
Type C concepts the card which embodied all 3 attributes
was removed from the pack.

The results of the 3 sets of trials, 2 each of low,
medium and high levels of difficulty, were dealt with separately.

Personality Test

The subjects reported to the laboratory for a special test session in which the Cattell 16 P.F. Personality Scale was administered as laid down in the manual. The test was scored and each subject was given a copy of her profile and asked for any comments.

Questionnaire Study

The core subjects were also given a copy of the questionnaire administered to the larger group of students and asked to complete it. 15 of these were returned since this was the last part of the study and the core subjects' ranks were most reduced at this point.

Chapter 5

Results: treatment and analysis

Treatment of Results

I. <u>Daily Records</u>.

    a) <u>Basal body temperature</u>.

        These records (sample in Appendix **5**) were used in conjunction with the menstrual charts. The menstrual charts were checked to ascertain the first day of bleeding and then the subject's temperature chart was examined to make sure the dates were the same in both sets of records. This was usually the case but sometimes the subject had taken her temperature in the early morning and filled it in as the 29th day on her temperature chart only to find herself bleeding later that day so that it became day one of the next period. The charts were adjusted to take this into account on the few occasions the subject had failed to make the adjustment herself.

        When day one of menstruation is firmly established the next thing is to determine if and when ovulation occurred. The experimenter inspected the charts and determined ovulation using the definition set **down** by the World Health Organisation (1967) and elaborated by Bailey and Marshall (1970). There are two types of temperature curve, those containing an acute and those containing a slow rise in temperature. Marshall (1963) showed 83% of curves were of the acute type. In order to determine ovulation in these curves it is necessary to pinpoint the day on which a significant rise in temperature occurs. The World Health Organisation (1967) recognises a significant rise as one that occurs in 48 hours or less in which three consecutive daily temperatures are $0.2^{\circ}C$ ($0.36^{\circ}F$ taken as $0.4^{\circ}F$) or more above the

previous six. In the remainder the temperature rose
slowly in a 'staircase' fashion. In these types of curve
the day of the first temperature on the slope or staircase
was taken as the first day of the hyperthermic phase.

A second psychologist using the same criteria inde-
pendently determined ovulation from the charts. The two
sets of records were compared and any dubious cases were
discussed. Where ovulation could not be clearly determined
using the criteria the cycles were declared anovulatory
and were discarded. Some subjects did not keep temperature
records efficiently enough for ovulation to be determined
and their records too had to be discarded. See Appendix 7

The data remaining consisted of cycles where ovulation
had been clearly established. These data are:

Subject	No. of full cycles	No. of half cycles contributed
B	9	1
E	8	3
I	7	2
J	5	1
K	9	1
L	10	1
M	2	2
N	4	2
O	5	2
P	0	2
R	2	2
S	3	3
U	4	2
Z	3	2

Half cycles either from Ovulation to Menstruation or from
Menstruation to Ovulation can be used since two landmarks
in the menstrual cycle have been established.

Each full cycle was then divided into 2 subcycles
A+B. Subcycle A comprises the day of ovulation until the day

before menstruation occurs while subcycle B begins on

the first day of menstruation and ends the day before

ovulation.   Each subcycle was standardised to a 14 day

cycle by converting it into hundredths and then converting

the hundredths into fourteenths.   In the case of a 15 day

cycle the results would look like this:

1	June	17th	1
2		18th	2
3		19th	3
4		20th	4
5		21st	5
6		22nd	6
7		23rd	7
8		24th	7
9		25th	8
10		26th	9
11		27th	10
12		28th	11
13		29th	12
14		30th	13
15	July	1st	14

and the data obtained for June 23rd and 24th would be

averaged and plotted as one point in a fourteen day stan-

dardised cycle.   If the cycle was shorter than 14 days,

for example 12 days, the following would occur:

1	Sept.	3rd	1
2		4th	2
3		5th	3
4		6th	5
5		7th	6
6		8th	7
7		9th	8
8		10th	9
9		11th	10
10		12th	12
11		13th	13
12		14th	14

Here to establish data for days 4 and 11 in the 14 day

cycle the mean of the data for days 3 and 5 and 10 and 12

would be obtained and would be used for days 4 and 11.

This is only appropriate when using daily data.

This normalising procedure produces one standard 28 day cycle with 2 subcycles as described, firmly anchored around menstruation and ovulation. It is now possible to use all ovulatory cycles however long or short and to compare performance mood and energy levels within and between women across menstrual cycles.

b) <u>Mood and Energy Scales</u>

The subject recorded her highest, lowest and average mood and energy level each day. These data were plotted against the normalised cycle for each subject as outlined above. (For an example see Appendix 6). The mean mood and energy score for each subject can then be calculated for each day of the cycle. The mean mood and energy score for the group of subjects can then be obtained for each day of the standardised 28 day cycle.

II. <u>The Menstrual Records</u>

The symptom charts which the subjects filled in during the paramenstruum were scored by giving the symptom a score of 1 if it was slight, 2 if it was moderate and 3 if it was severe. The symptoms fall into 3 categories, 'Emotional Changes', 'Academic Changes' and 'Physical Symptoms'. A mean score for each of these categories was calculated (using all the completed charts) for each subject for 3 points in the cycle viz. a) the pre-menstrual period, b) the first 3 days of the menstrual flow and c) the rest of the flow. All subjects provided data for category b) but some subjects did not know when they were premenstrual so did not provide data in category a) and other subjects had

periods which did not last longer than 3 days so did not

provide data in category c). When subjects did not provide

data in a category they were arbitrarily given a score of

zero.

II. The Performance Measures

Since the subjects did not provide performance data

for each of the 28 days of the normalised cycle, the cycles

were divided into 5 phases viz. Days 15-18 (Menstruation),

Days 27 and 28 (Pre-ovulatory phase), Days 2 and 3 (Post

ovulatory period), Days 11-14 (Pre-menstrual) all other days

(except day 1 which is ovulation) were counted as Inter-

menstrual.

The average performance score was computed for these

5 phases. If a score was not available for a subject for a

particular period then estimates for the missing data were

calculated using a regression technique. The regression

coefficients for performance during the menstrual, pre-

menstrual, pre-ovulatory and post-ovulatory periods as a

function of performance in the inter-menstrual phase were

calculated using only data from those subjects who contributed

a score to each phase of the cycle. These coefficients were

then used to calculate missing data. See Appendix 8

(i) Choice Reaction Time

The median and the range (slowest minus fastest times)

were calculated for each session.

(ii) Pursuit Rotor

The score was the percentage of the 20 seconds that

the wand made contact with the light as automatically recorded

by the machine.   The median and the range were calculated

for each session.

(iii) <u>Digit-Symbol Substitution</u>

Since the subjects did not make any errors the score

was the number of substitutions the subject made in 90

seconds.

(iv) <u>Concept Formation</u>

There were 3 levels of difficulty in this task and

the score was the mean for the 2 trials at each level.   The

number of wrong guesses which the subject made during the 6

trials was also noted.

IV. <u>The Cattell 16 P.F.</u>

The Cattell 16 P.F. was scored as in the manual

giving a score on each of the 16 dimensions.

V.   <u>Questionnaire Data.</u>

The core subjects data are analysed along with the

other questionnaires in Chapter 3.

<u>Analysis of Results</u>

The results obtained from the mood and energy check

lists and the performance on the concept formation task were

analysed using a repeated measures two-way analysis of

variance (Myers 19 66).

The results obtained from the performance on the

choice reaction time, rotor pursuit, digit symbol substitution

and the guesses on the concept formation task were analysed

using a one way analysis of variance (Winer 1970).

Table 4.

Summary of Analysis of Variance on Elation Data

Source of Variance	df	SS	MS	F
levels	2	442.201	221.1	22.938 p < 0.01
days of cycle	27	8.082	0.299	2.12 p < 0.01
subjects	11	235.7	21.427	
levels x days	54	3.418	0.0632	1.1285 N.S.
levels x subjects	22	212.077	9.639	
days x subjects	297	41.993	0.141	
levels x days x subjects	594	33.464	0.056	

Summary of Analysis of Variance on Energy Data

Source of Variance	df	SS	MS	F
levels	2	315.293	157.65	15.47 p < 0.01
days of cycle	27	6.898	0.2555	1.679 p < 0.05
subjects	11	126.056		
levels x days	54	1.222	0.0226	N.S.
levels x subjects	22	224.128	10.19	
days x subjects	297	45.219	0.1522	
levels x days x subjects	594	53.933	0.0907	

Figure 4. Variations in elation in 12 subjects using the Wessman-Ricks Personal Feelings Scale. For meaning of scale values see Appendix 2.
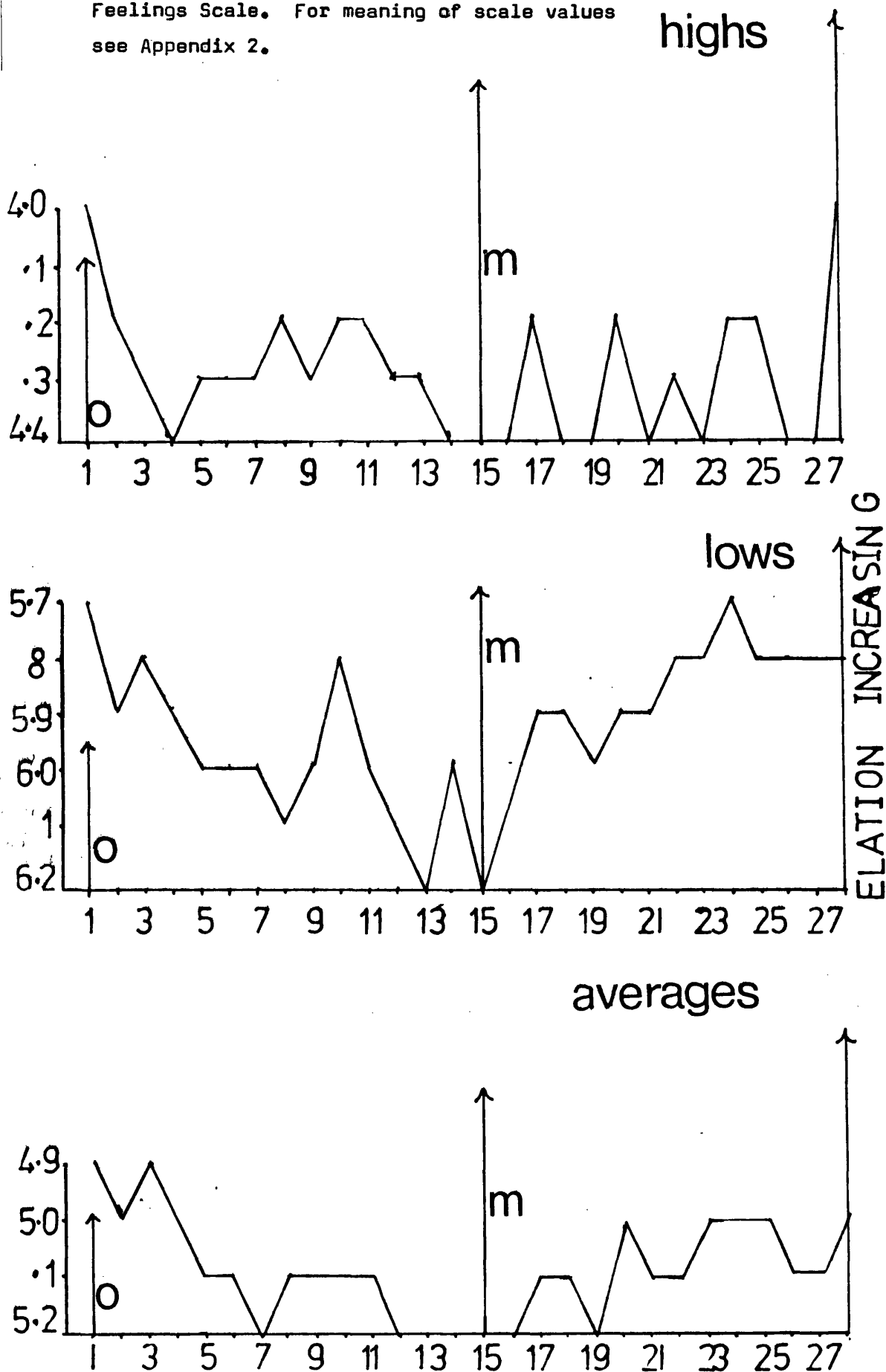
1. <u>Elation vs. Depression.</u>

As can be seen from Table 4 and Figure 4 there was a significant difference between levels of elation reported at different points in the cycle. The interaction between days of the cycle and levels of mood was not significant. Figure 4 shows the curves which are obtained by plotting the groups mean elation score for each of the 3 levels (viz. the highest, lowest and average mood experienced that day). From the graph it can be clearly seen that ovulation (Day 1) is the day of the highest high, the highest low and the highest average mood. (The higher the score the more elated the subject.) The first day of menstruation (Day 15) is the opposite of this, containing the lowest high, the lowest low and the lowest average mood experienced during the cycle. Looking across the cycle menstruation is consistently associated with depressed moods which lighten and brighten before reaching a consistent high around ovulation then gradually declining to a more depressed level pre-menstrually.

2. <u>Energy vs. Fatigue.</u>

As can be seen from Table 4 and Figure 5 there was also a significant difference between the levels of energy reported at different points in the cycle. The interaction between levels of energy and day of the cycle is not significant. Figure 5 shows the curves obtained by plotting the group's mean energy scores for each of the 3 levels. From the graph it can again be clearly seen that ovulation represents a consistent high in energy but the results around

Figure 5. Variations in energy in 12
subjects using the Wessman-Ricks Personal
Feelings Scale. For meaning os scale
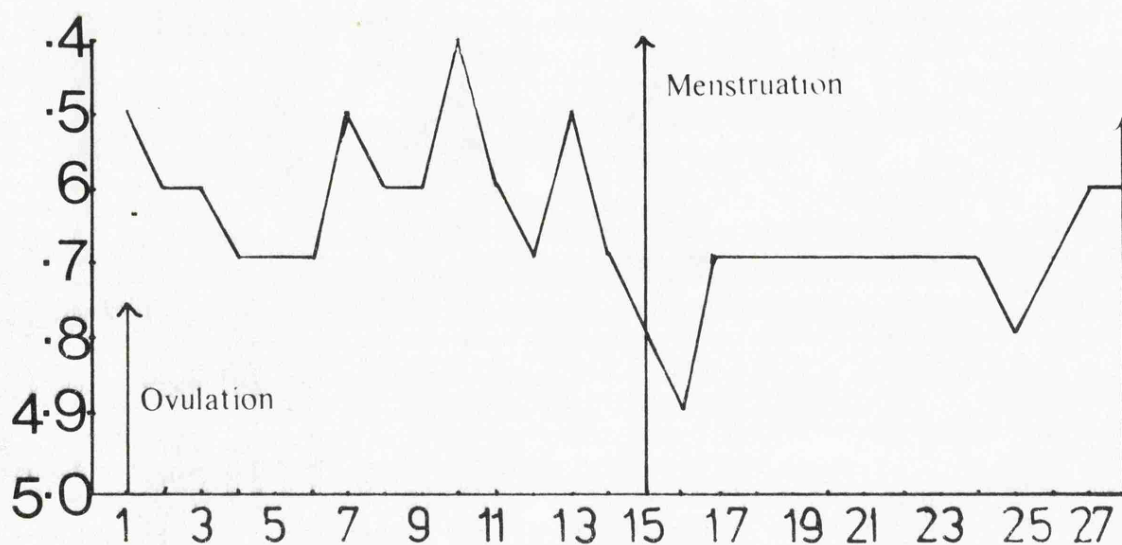values see Appendix 2.

highs

lows
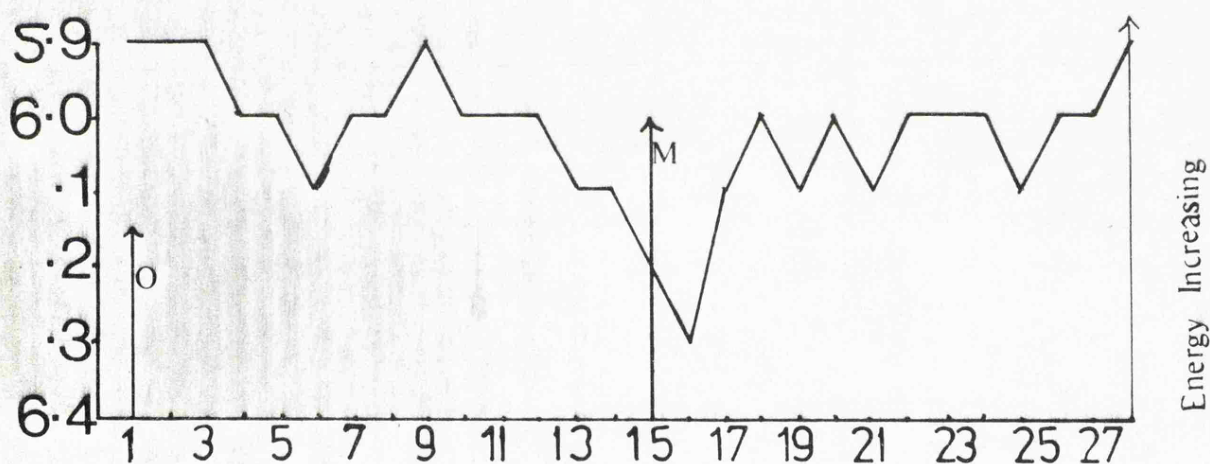
averages
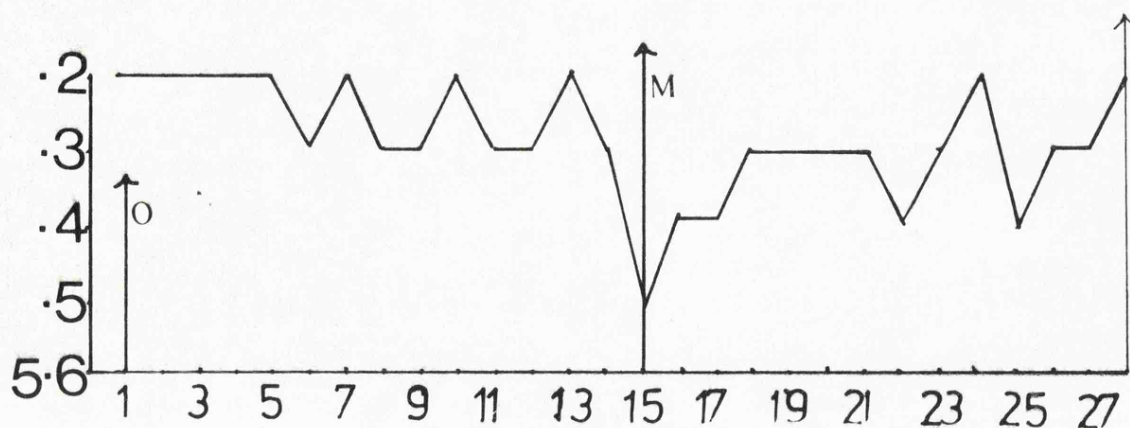
Table 5.

Summary of Analysis of Variance on Concept Formation Data

Source of Variance	df	SS	MS	F
level	2	88.42	44.2	50.80 $p < 0.01$
point in cycle	4	7.84	1.96	2.58 $p < 0.05$
subjects	13	28.74	2.21	
level x point	8	12.60	1.59	1.66 N.S.
level x subjects	26	22.549	0.87	
point x subjects	52	39.661	0.76	
level x point x subjects	104	99.73	0.96	

Summary of Analysis of Variance. Concept Formation. Guesses

Source of Variance	df	SS	MS	F
between subjects	13	296.97		
within subjects	56	234.4		
period	4	24.37	6.09	1.51 N.S.
residual	32	210.02	4.04	
Total	69	531.37		

Figure 6. Mean efficiency scores (total trials/
minimum necessary) in Concept Formation. Results
shown for 14 subjects at three levels of difficulty
over 5 phases of cycle. Guesses per session are
also shown.
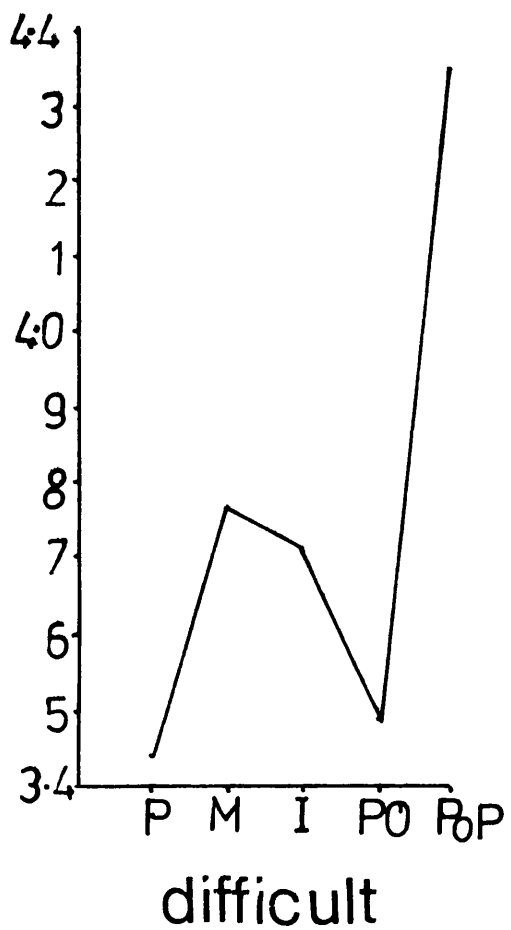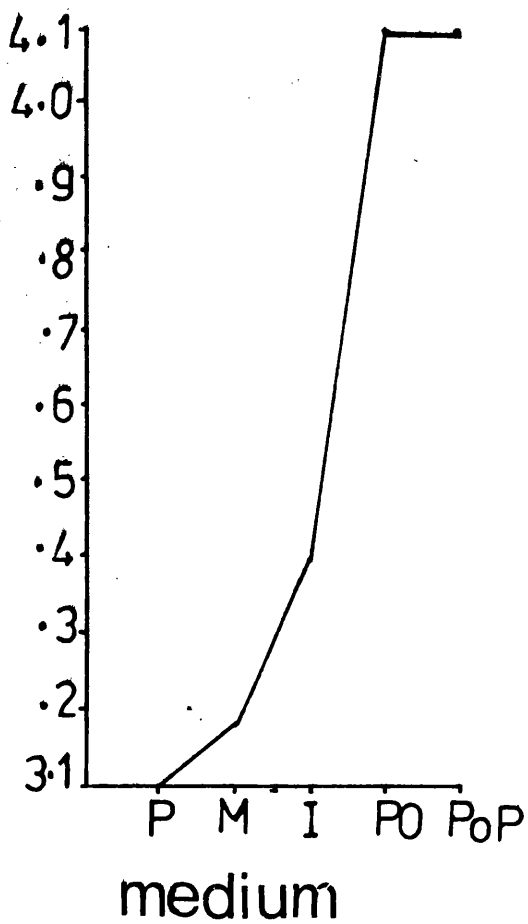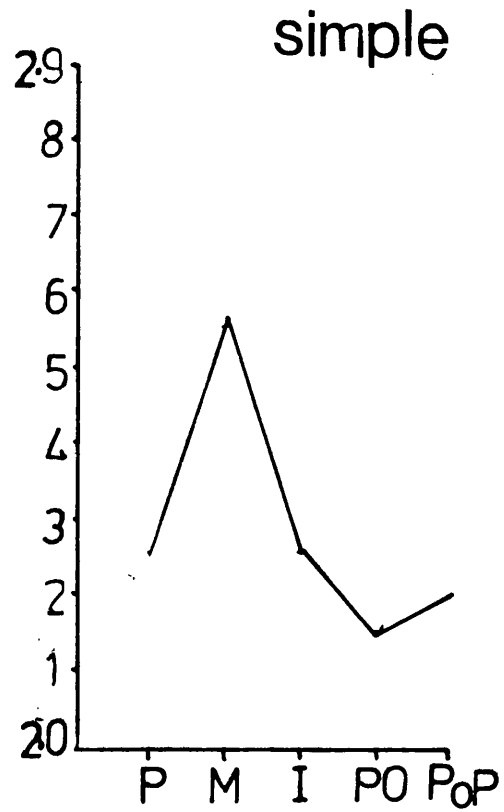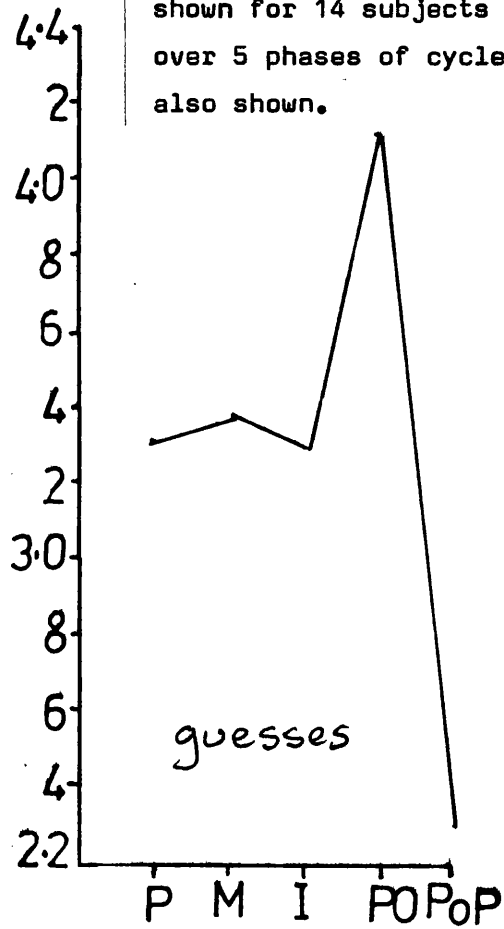
menstruation are more variable. The second day of menstruation represents the lowest high and the lowest low while the lowest average mood occurs on the first day of menstruation. The pre-menstrual period (e.g. Day 14) represents a time of lowered energy but the results are not as clear-cut as the elation data.

Analysis of the concept formation data (see Table 5 and Figure 6) reveals a significant difference between concept formation performance at different phases of the cycle. The absence of a significant interaction between phase and level of difficulty indicates that this difference appears at all levels of difficulty. Figure 6 shows the curves which are obtained from graphing the results at the 3 levels of difficulty against the phases of the menstrual cycle. Looking at the 3 graphs it can be clearly seen that the subjects tend to perform well (the lower the score the better the performance) pre-menstrually and also pre-ovulatory. Menstrual performance is consistently worse than pre-menstrual performance just as post-ovulatory performance tends to be worse than pre-ovulatory.

Examination of the guess data produced during the concept formation sessions (see Table 5 and Figure 6) reveals that the results were not significant, indicating that the number of guesses the subject made did not vary across the cycle. Figure 6 shows the curve produced from graphing the results. The only clear feature is the increase in guesses pre-ovulatory and the decline post-ovulatory.

Table 6.

Summary of Analysis of Variance. Reaction Time. Medians

Source of Variance	df	SS	MS	F
Between subjects	13	3278.58		
Within subjects	56	435		
Period	4	78.78	19.7	2.86 $p < 0.05$
Residual	52	356.42	6.9	
Total		3713.78		

Summary of Analysis of Variance. Reaction Time. Range

Source of Variance	df	SS	MS	F
Between subjects	13	1639.5		
Within subjects	56	7229.6		
Period	4	303.8	79.9	< 1
Residual	52	6925.8	133.2	
Total		8869.1		

Figure 7. Results of Choice Reaction Time
Experiment. Upper figure shows range of reaction
times in ms for the same 14 subjects as in Fig. 6
over 5 phases of cycle. Lower figure shows
mean reaction times in ms.

range
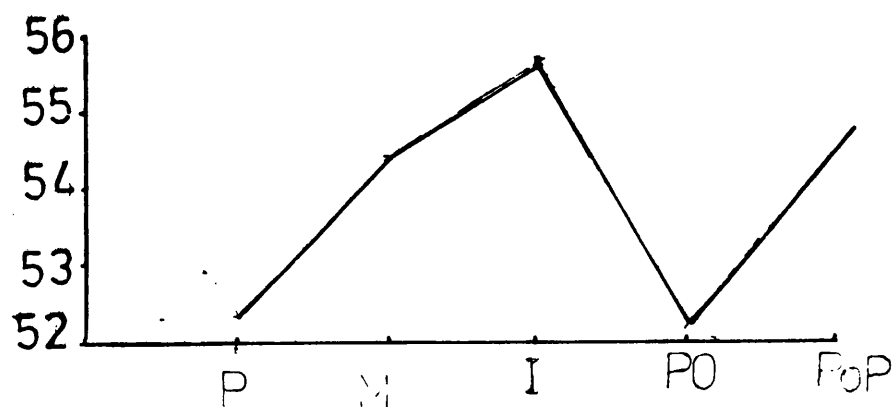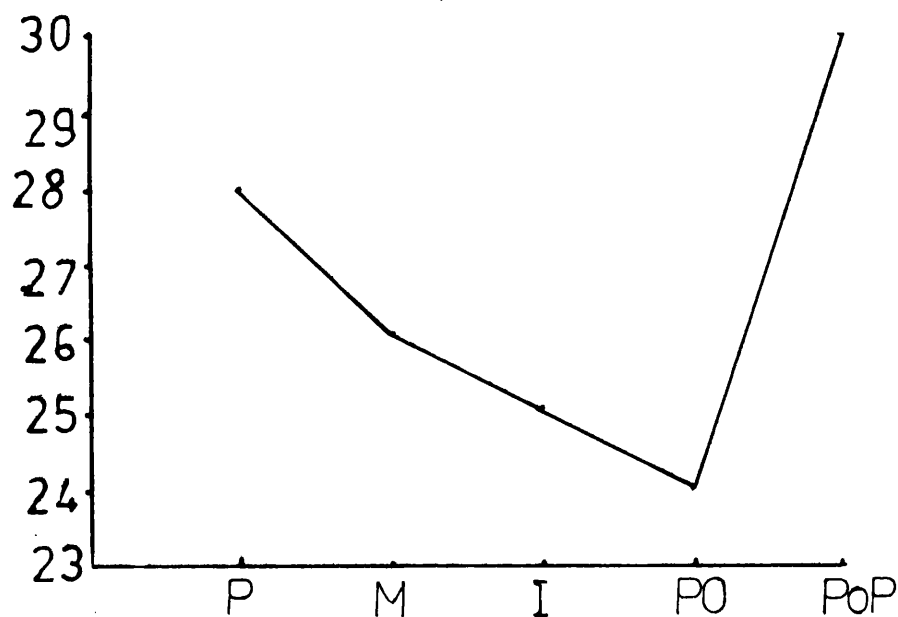
Table 7.

Summary of Analysis of Variance.Pursuit Rotor.Medians

Source of Variance	df	SS	MS	F
Between subjects	13	826.87		
Within subjects	56	2416.00		
Period	4	175.07	43.76	1
Residual	52	2240.93	43.09	
Total		3242.87		

Summary of Analysis of Variance.Pursuit Rotor.Range

Source of Variance	df.	SS	MS	F
Between subjects	13	573.8		
Within subjects	56	623.6		
Period	4	95.5	23.875	2.35 $p > 0.05$
Residual	52	528.1	10.1	
Total		1197.4		

Figure 8. Results of Rotor Pursuit Experiment.
Upper figure shows mean percent time on target
for same 14 subjects as in Fig. 6 over 5 phases
of the cycle. Lower figure shows range of
scores.
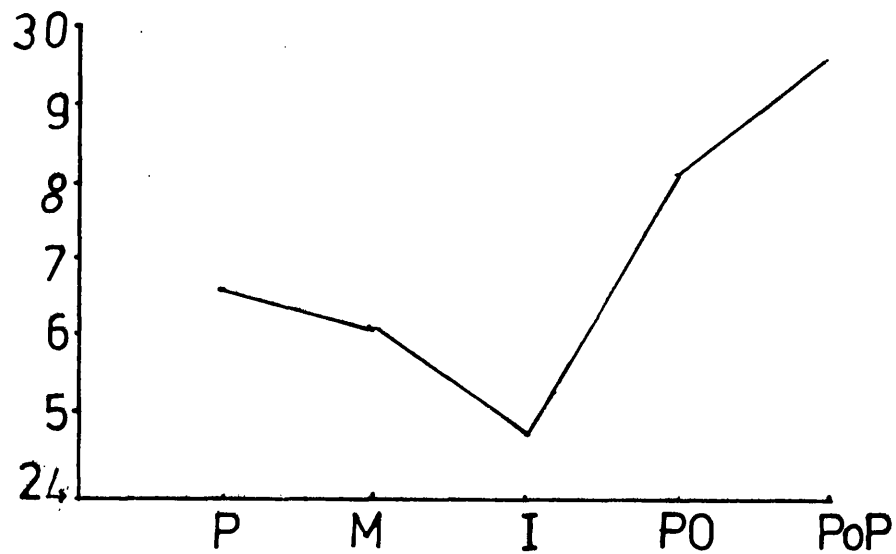
range
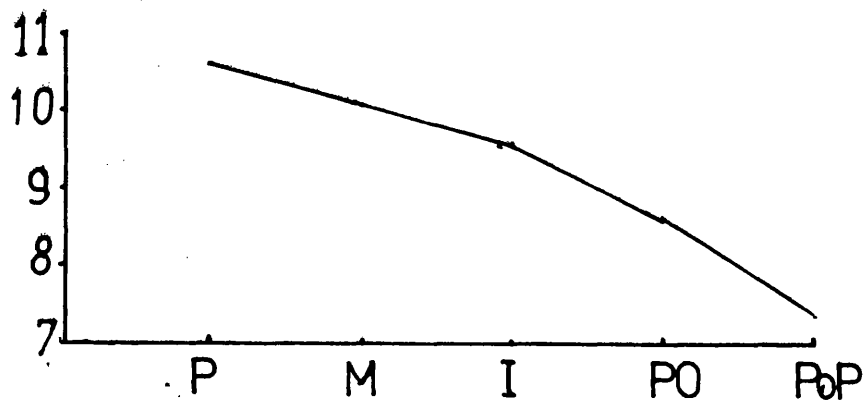
As can be seen from Table **6** and Figure **7** there was a significant difference between median choice reaction times at different phases of the cycle. Figure **7** shows graphically the median choice reaction times across the cycle. Again the best performance (viz. the shortest reaction times) occur pre-menstrually and pre-ovulatory with a decline in performance menstrually and post-ovulatory.

The range of choice reaction times however (see Table **6** and Figure **7**) did not show a significant difference at different phases of the cycle. Figure **7** shows the results graphed. The largest range of responses are made pre-menstrually and post-ovulatory.

As can be seen from Table **7** and Figure **8** there was no significant difference between median pursuit rotor scores at different phases of the menstrual cycle. Examination of Figure **8** suggests that the best scores are obtained post-ovulatory but the tendency to perform better pre-menstrually than menstrually is confirmed.

The range of pursuit rotor scores   (see Table **7** and Figure **8**) did not show a significant difference at different phases of the cycle. The largest range of per-formances are obtained pre-menstrually with the range de-clining across the cycle so that the smallest range is obtained post-ovulatory.

Analysis of the digit symbol substitution data (see Table **8** and Figure **9**) revealed no significant differences in performance at different phases of the menstrual cycle. The graph indicates that the best results are obtained pre-menstrually with a decline menstrually.

See Appendix 9

Figure 9.   Results of Digit Symbol Substitution
Experiment.   It shows mean number of correct
substitutions for the same 14 subjects as in
Fig. 6 over 5 phases of the cycle.   The key at
the bottom is common to Figures 6 to 9.
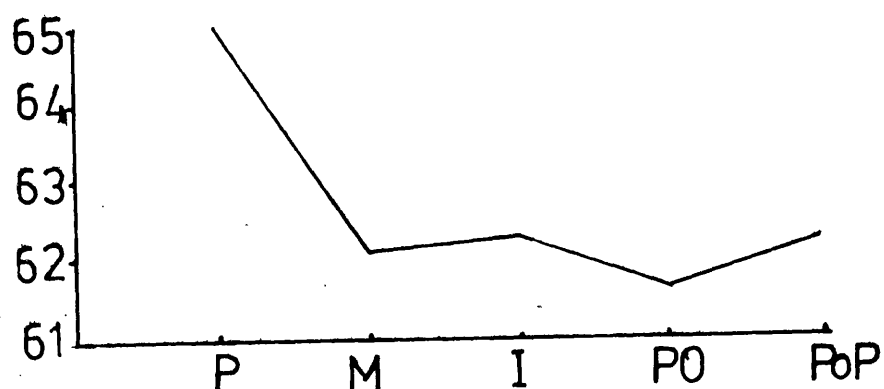
KEY

P   Premenstrual
M   Menstrual
I   Intermenstrual
PO   Preovulatory
PoP   Postovulatory

Table 8.

Summary of Analysis of Variance. Digit-Symbol. Substitution

Source of Variance	df	SS	MS	F
Between subjects	13	4459.95		
Within subjects	56	8487.2		
Period	4	113.72	28.43	< 1
Residual	52	8373.48	161.02	
Total	69	12947.15		

The daily data which are clearly and consistently cyclic over the menstrual cycle are the elation data. These were therefore used to determine whether an individual was cyclic by applying the following procedure. The rank order correlation between each subject's mean daily score and the group mean score was calculated for each half of the cycle. Those subjects whose data correlated significantly $(p < 0.05)$ with the group data over either the first or second halves of the cycle were deemed cyclic. The subjects whose correlations were not significant were deemed noncyclic. This split the 12 subjects (who had provided enough data to be included in the daily ratings of the elation group) into 2 groups of 6 as follows:-

Cyclic	Noncyclic
B	E
I	J
L	K
O	N
R	U
S	Z

The Cattell 16 P.F. personality factors were analysed using a discriminatory analysis (Tatsuoka 1971) to find out if the cyclic and noncyclic subjects could be discriminated in terms of personality traits. The results were not significant. It is therefore not possible to distinguish cyclic and noncyclic subjects on the basis of personality traits.

In order to find out whether it is possible to discriminate between cyclic and noncyclic subjects on the basis of symptoms reported, the paramenstrual data was examined. Data were provided (by most subjects) for 3 phases of the cycle

(viz. the pre-menstrual days, the first 3 days of menstruation and the remaining days of menstruation). A mean was obtained for each type of symptom at each phase of the para-menstruum. A mean symptom score for each subject was obtained and a Mann-Whitney U test was applied to the scores to see if they discriminated between the cyclic and noncyclic subjects. The results were not significant.

The data for the individual symptoms (see Appendix 4) were subsequently reanalysed using a discriminatory analysis (Tatsuoka, 1971). The results were not significant. It was not possible to distinguish between cyclic and non-cyclic subjects on the basis of symptoms occurring during the paramenstruum.

It has been suggested by Wessman and Ricks (1966) and Altman et al (1941) that the longer the subjects keep records the more chance there is of finding cyclicity. A t-test for independent samples was performed on the number of cycles contributed by the cyclic and non-cyclic subjects to the analysis. The difference between the means (6.92 for the cyclic group and 6.42 for the non-cyclic group) was not significant.

Chapter 6

Discussion

The questionnaire study (see Chapter 3) provides a profile of the 'average female student' against which it is possible to assess the profile of the subjects who provided the data in the mood, energy and performance studies.

The core subjects are representative of the larger University population of non-pill users sampled by the questionnaire, in terms of age, menstrual parameters, experience of menarche, attitudes to menstruation and major symptomatology. However, they are more comparable with the pill-using students in their religious affiliations. The core subjects fell into two extreme groups on the basis of religion, 47% of them having no religious affiliation while 53% of them regularly attended the services of a variety of religious denominations.

The core subjects differed from the larger Univeristy population of non-pill users in that they reported more minor symptomatology. This could not be accounted for by referring to the differences in religious affiliations of the two groups. Instead it seems likely that the subjects taking part in a long term study of menstruation were more alert to the minor nuances of menstrual symptomatology. They reported more aching legs and dizziness during menstruation and the larger University sample indicated that they did suffer from, or did not know whether they suffered from, these symptoms.

It is clear from the results obtained from this analysis that the data obtained in the mood, energy and performance studies are representative of the larger student population.

The main findings of this study are that -

1. Mood varies across the menstrual cycle.

Ovulation is consistently the time of the most elated moods while the premenstrual and menstrual periods represent a time of lowered mood.

2. Energy varies across the menstrual cycle.

Ovulation is the time that greatest energy is reported while fatigue is greatest during the paramenstruum.

3. Concept Formation (tested at three levels of difficulty), varies with different phases of the cycle. (These phases are the pre-menstrual, menstrual, intermenstrual, preovulatory and postovulatory.) The best performance is produced pre-menstrually and also preovulatory. Menstrual performance is consistently worse than pre-menstrually just as postovulatory performance tends to be worse than preovulatory. However the number of wrong guesses the subjects made during the sessions did not vary significantly with the different phases of the cycle.

4. Choice Reaction Times vary with different phases of the menstrual cycle. The median reaction times are fastest pre-menstrually and preovulatory but are slower menstrually and during the postovulatory period. The range of reaction times produced did not vary significantly with the phases of the cycle.

5. Rotor Pursuit Performance does not vary significantly with the different phases of the cycle.

6. The digit-symbol substitution scores did not vary significantly with different phases of the cycle.

7. When the subjects were divided into cyclic and noncyclic categories (applying criteria outlined in Chapter 5), these two groups were not discriminable in terms of personality traits as measured by the Cattell 16 P.F. nor on the basis of physical and emotional symptoms reported during the para-menstruum.

These results will now be considered in detail under the headings used in the Literature Review (see Chapter 1).

I. Variations in Mood and Energy associated with the Menstrual Cycle.

a) Mood.

The most interesting aspect of the finding that mood varies with different phases of the menstrual cycle is the clear indication not only of the depressed mood around menstruation but also of the increased elation around ovulation.

May (1976) suggests that it is necessary to distinguish between mood changes and other forms of distress such as physical symptoms. A rank order correlation was run on the physical symptoms reported during the first three days of menstruation (a time for which all subjects provided data) and the mood scores on the Elation vs. Depression Scale for the same period. The correlation was small, negative and failed to reach significance. This shows that the subjects who report the lowest moods are not merely those who suffer the most symptoms. May (1976) also found that low mood and physiological discomfort vary independently, although his study was a retrospective one.

A further study is needed here to find out if ovulation is the most symptom free part of the cycle in case increased elation merely represents freedom from symptoms but a reading of the literature would suggest this is not so. Abraham and Torghele (1961) showed that symptomatology in their 34 subjects peaked three times during the cycle at ovulation, premenstrually and during menstruation. McCance et al (1937) report increased symptomatology at ovulation as do Altman et al (1941), Moos et al (1969a) and Mandell et al (1967).

The findings in this study are consistent over three levels of measurement. Highs are higher at ovulation just as lows and averages are both higher at this time. The opposite is true at menstruation, the lows, highs and averages are all lower. Premenstrually too the mood on all three measures is reported as lower. These data demonstrate quite clearly that ovulation is an important landmark in the menstrual cycle and deserves as much attention as menstruation.

Some authors (e.g. Tiger 1963, Melody 1961, Rogers 1950) have suggested that women are expected to be 'ill' premenstrually and that feeling depressed is a cultural stereotype to which women may feel obliged to conform, to demonstrate their femininity and normality. Koeske and Koeske (1975) and Parlee (1974) have demonstrated experimentally the existence of a paramenstrual stereotype. Thus self-reports may be systematically distorted to conform with the depressed paramenstrual stereotype. It must be pointed out that in this study five of the twelve subjects (the twelve subjects being those who contributed sufficient daily mood ratings to be properly analysed) were irregular and were unable to tell exactly when they were going to menstruate; because of this

they claimed to be unable to fill in the premenstrual symptom charts. It is difficult to see how they could be using their charts which they filled in daily to indicate stereotyped premenstrual depression since they did not know they were premenstrual.

Although they could be conforming to a negative menstrual stereotype during the time of bleeding which is also indicated as a time of depressed mood, it is hoped that by enlisting their aid as co-experimenters and urging and encouraging them to objectivity as suggested by Argyris (1968) that this was avoided.

It is difficult to see how stereotypes would account for the consistent elation at ovulation. Since the subjects were recording their own temperatures, so that the time of ovulation could be pinpointed, it is possible that they were aware, in a general way, that they were ovulating and that this distorted their records. However the literature does not provide any evidence for a consistent stereotype for mood at ovulation. Ovulation is both the time of peak well being and sexual receptivity (Luschen et al, 1972) and of 'Mittelschmerz' and 'crise intermenstruelle'. These terms refer to the pain that some women experience either monthly or bimonthly since it is only ovulation from one of her ovaries that causes pain (McCance et al,1937).

Further, the criteria used for pinpointing ovulation relied on temperature data taken from the immediate post-ovulatory days. For the subjects to have responded according to a stereotype held they would have had to go back and fill in records instead of giving daily accounts as instructed.

There were no indications of any subjects falsifying or altering records. There were sufficient gaps in the records to indicate that the subjects did obey the experimenter's instructions to present accurate records and to resist the temptation to 'look good'.

Many authors have reported evidence of depression paramenstrually e.g. Benedek and Rubenstein (1942), Golub (1976), Altman et al (1941) and May (1976). Changes in mood at ovulation are less well documented because ovulation is more difficult to pinpoint than menstruation. The studies reporting depression paramenstrually all contain methodological flaws as described in Chapter 1. For example using subjects from a psychiatric population, not normalising menstrual cycles or even checking dates of menstruation and not obtaining proper mid-cycle baselines for comparison. However the effect is obviously robust enough for the flaws not to be fatal. Other authors e.g. Persky (1974) and McCance et al (1937) failed to find any cyclicity of moods across the menstrual cycle. This could have been because neither study established ovulation accurately but is also likely to have happened because neither study sampled a sufficiently large number of menstrual cycles from their subjects. McCance et al comment :"Periodicity may have been brought out if the records were kept for a longer time since large individual differences were apparent". Wessman and Ricks (1966), who found that although menstruation was associated with a distinct lowering of mood, the menstrual cycle did not otherwise alter the general irregularity of mood fluctuation, only looked at women for six weeks and

concluded that "over a longer time span the premenstrual period would probably be a recurrent low in most women's records". Subjects should be encouraged to keep records for at least six cycles.

Two points must be underlined here. First, that the only studies which are directly comparable here are those of May (1976) and Wessman and Ricks (1966) since these are the only other studies which have used the same measure of mood i.e. The Elation vs. Depression Scale of the Wessman and Ricks Personal Feelings Scale. The results of this study could be stated in a number of different forms;viz a decrease in elation was found paramenstrually or a lowering of mood occurred paramenstrually or depression occurred paramenstrually. It is this proliferation of available terms describing mood and ways of measuring it that leads to difficulties in making comparisons across studies. This is especially so when some authors (e.g. McCance et al, 1937) merely content themselves with asking subjects "Do you feel more depressed/elated?" while others (e.g. Persky, 1974) use clinical instruments such as the Beck Depression Inventory to determine whether a subject's mood changes paramenstrually. It is necessary to determine which is the most appropriate instrument for measuring mood. Depression is a very difficult mood to measure because it is also a pathological state and so it is possible to confuse trait, pathological state and normal state depression. It is doubtful whether clinical instruments, designed to measure trait or pathological state depression, will be sensitive to more minor fluctuations associated with the paramenstruum. On the other hand merely asking a subject

"Are you depressed?" leaves the question too open to dis-
tortion by the woman's subjective definition of the state.

The advantages of the Wessman and Ricks Personal
Feelings Scale have already been enumerated in Chapter 1.
Briefly these are a) It is unidimensional, b) It has equal
graduations with appropriate descriptive statements so that
a uniform progression toward increasingly marked feelings
can be obtained, c) The descriptive statements allow some
degree of cross-subject comparability of responses. Further-
more the scale has been shown to be sensitive to the fluctu-
ations in mood associated with the menstrual cycle (May,
1976 ; and the present study). The subjects found it easy
to use and could relate easily to the descriptive statements
used to delineate each mood gradient. It is especially use-
ful in studies of menstruation because it was designed for
long-term research studies and the results are easily coded.
It is suggested therefore that the Wessman and Ricks Personal
Feelings Scale is a useful instrument for further research
in this area.

The second point is that the 'hit and run' type of
study where the experimenter tests the women once or twice
on predetermined days of the cycle (e.g. Persky, 1974, who
tested women on days 1-4, 14-18, and 24-28) is not appropriate
in this area. In the present study the increase in elation
takes place on the day of ovulation, if ovulation is not
accurately determined then these changes can be obscured by
data gathered from pre- or postovulatory days.

Paramenstrual changes are only interesting and
interpretable in their proper context which is the complete
menstrual cycle of the subject. In order to understand the

nature of, and the possible reasons for, mood changes during the menstrual cycle it is necessary to study mood change across the whole cycle and to collect sufficient data for the changes to emerge from the background noise.

Luschen et al (1972) found ovulation to be characterised by high affiliation and nurturance. Benedek and Rubenstein (1942) described ovulation as a time of inward turning and relaxation. Altman et al (1941) found evidence of elation in 67.5% of their sample at ovulation. Moos et al (1969), Ivey and Bardwick (1968), Gottschalk et al (1962) also found evidence of more pleasant moods around ovulation. Unfortunately, however, no previous research study has given women an opportunity to indicate their mood daily in a codeable, comparable way so there are no studies which are directly comparable with the present study. The elation data is convincing however with the high highs, high lows and high averages all occurring on the day of ovulation.

b) Energy

The findings on the Elation vs. Depression Scale are echoed by the data on the Energy vs. Fatigue Scale, but the latter are not quite as clear-cut. The ovulation energy levels are clearly the highest experienced during the cycle. The highest lows and highest averages are experienced on the day of ovulation and the highs are among the highest of the cycle. The paramenstrual period is a period of fatigue but the lowest energy occurs on different days during that period depending on which level is considered. The lowest average energy level is on the first day of menstruation but the lowest high and the lowest low occur on the second day of bleeding. The premenstrual period is a time of lowered energy

but it is not as consistent or dramatic a result as the mood data.

There is more variation in the group data around menstruation than ovulation, which clearly emerges as a time of increased energy. The premenstrual period does not emerge clearly as a time of lowered energy as it did as a time of lowered elation. This could be because large individual differences exist. Altman et al (1941) found activity increased in 71.8% of their subjects premenstrually but they found no cyclicity in the subjects' reports of fatigue. McClure et al (1971) found that 26% of their population were unusually active and felt better than usual at some time before at least some of their periods. On the other hand, both Moos (1969) and Little + Zahn. (1974) note lowered energy in their subject populations premenstrually. The energy levels reported premenstrually in these studies are not as low as those found during menstruation. The curves may be the result of combining data from subjects who according to Altman et al (1941) "endure bursts of physical and mental activity in the premenstrual phase". They comment: "In these subjects the activity at this time concerned cleaning, putting in order, or mental organising. In most cases this "tension activity" was accompanied by a critical feeling toward other people and led to conflicts". In his definition of premenstrual tension, Frank (1931) describes women suffering from a premenstrual feeling of "indescribable tension, irritability and a desire to find relief by foolish and ill-considered actions". Altman et al (1941) confirmed the presence of tension in 80% of their subjects and it is possible that the tension which women feel at this time they

express as increased outbursts of physical and mental
activity. This kind of tense energy is not incompatible
with lowered mood, as Altman et al confirm.

Again there are difficulties which come about because
different research workers use different terms and types of
measurement when trying to tap the same basic dimension.
Fatigue may or may not be equivalent to lowered energy in
another study or subject. If a scale like the Wessman and
Ricks Personal Feelings Scale is used then the subject has
guideline statements describing each gradient of feeling.
Statements such as "Fairly fresh. Adequate energy", "Great
fatigue. Sluggish. Can hardly keep going" or "Great energy
and drive" are of the neutral kind which should prevent any
confusion with tension, a state which would seem to have
negative overtones. However, when a subject comes to fill
in the activity scale for the day there are two ways of
approaching it. Either she can use the statements given and
say "Fairly fresh. Adequate energy" is how I feel about my
energy state today or she can look at her behaviour and use
an attribution model to decide her energy level (Kelley, 1967).
Therefore if the subject has been very busy that day she
will decide to record high energy levels. Her feelings then
may be described as either high energy or tension depending
on whether the energy was accompanied by the compulsiveness,
restlessness and discomfort which characterises tension.

The Wessman and Ricks Scale is useful for measuring a
subject's estimation of her energy level that day but greater
care is going to have to be taken in this area in distinguishing
energy from tension and activity. A measure of tension would
be useful just as more systematic studies are needed of

subjects' behaviour during the cycle.

Since neither Wessman and Ricks (1966) nor May (1976) used the energy vs. fatigue scale of the Wessman and Ricks Personal Feelings Scale there are no studies which are directly comparable with this one.

Two sources of comparison are possible though neither of these are ideal. i) The results can be compared with those found in other studies where different measurements of energy have been used and where the word energy may have been defined differently so that we do not know that the researchers are tapping the same dimension; ii) The self reports of energy levels which form the energy data in this study can be compared with measures of activity based on a woman's behaviour across the menstrual cycle. Self report has been shown to differ from actual behaviour (e.g. McCance et al, 1937) however, and in the case of self reports of energy this is understandable since it is possible to feel energetic but for this not to be translated into behaviour due to external circumstances.

Altman et al (1941) while reporting high levels of activity premenstrually and around ovulation distinguish between the two by finding tension in only 31.4% of their subjects at ovulation but in 80% of their subjects pre-menstrually. In their study activity means both mental and physical activity and includes both 'mental organising' as well as cleaning and tidying. Altman et al made subjective estimates of both activity and tension based on interviews with their subjects. Little + Zahn (1974) note a greater Positive Activation Score (i.e. surgency, elation, concen-tration, vigour and social affectation as measured by the Nowlis Adjective Check List) around ovulation which declined

steadily until the premenstrual period where it peaked slightly before a menstrual low. Unfortunately with a composite score such as this it is difficult to say exactly what the authors are measuring. They, like Altman et al (1941), did not find evidence of cyclicity in fatigue. They conclude: "It appears that normal women suffer not so much from pronounced cyclic negative shifts in affect but from lack of positive warmth and energy premenstrually and menstrually". This is certainly confirmed by the results of this study where the range of mood and energy indicated on the group graphs (see Figures 4 and 5) is small. For example the highs of energy vary between 5.0 which is 'Fairly fresh. Considerable energy' and 4.4 which is tending towards 'Very fresh. Considerable energy'. The lows cover 5.9 to 6.4 which means feelings clustering around 'Slightly tired. Indolent. Somewhat lacking in energy', while the averages (5.2-5.6) are centering on 'Fairly fresh. Adequate energy'. The Wessman and Ricks Scale is sensitive to these small changes. It is the fact that the changes are relatively small which may account for the lack of evidence of cyclicity of fatigue since while women may have less energy para-menstrually they are unwilling to report anything so negative and definite as fatigue.

The simplest way to measure behaviourally, activity across the menstrual cycle is to parallel the animal studies and measure gross movement. Billings (1939), using pedometers fitted to 5 psychiatric patients, while not undertaking a statistical analysis claims that the activity graphs he presents illustrate a consistent post menstrual burst of activity which gradually declined to the time of the succeeding

menstrual period.   He said nothing about activity at ovul-
ation because he did not pinpoint its occurrence.

Morris and Udry (1970), also using women wearing
pedometers, report   a significant increase in activity mid
cycle (they too failed to pinpoint ovulation) and also two
lesser peaks, one premenstrually (Day 27) and the other on
the second day of menstruation.   They comment:"The mechanism
producing the mid cycle peak is unknown.   The peak appears
temporally related to ovulation; however it might reflect
some phenomenon occurring immediately before, during, or
immediately after that event.   The meaning of the two lesser
peaks seen at the end of the cycle is even less clear. Their
presence suggests that ovulation per se is not essential for
the production of the observed spurts of activity". Unfortun-
ately this study has a number of methodological flaws including
a standardisation procedure based on the assumption of "the
essential symmetry of the 2 halves of the cycle", so that
the mid cycle peak at least may prove to be artefactual.

Only the mid cycle behavioural peak coincides with
self reports of increased energy found in this study.   The
premenstrual period is a time of individual variation in energy
and Day 2 of the catemenia represents a time of self reports
of lowered energy in this study.

Stenn and Klinge (1972) took continuous measures of
arm movement activity and basal body temperature and found
that basal body temperature was positively related to arm
movement activity.   However no menstrual phase differences in
activity level were obtained when subject data were pooled.

The behavioural data and self report studies in this
area need to be extended before it will become clear how

energy levels, tension and activity interact with the
menstrual cycle.

As with the elation data a rank   order correlation
was used to compare the number of physical symptoms reported
during the first three days of menstruation with the energy
levels reported by the subjects during the same period. The
correlation is small, positive and nonsignificant. This
shows that the subjects who report the lowest energy levels
are not merely those who suffer the most symptoms.

There are not such clear-cut stereotypes about energy
levels during the menstrual cycle as there are about mood so
there is no reason to suppose that stereotypes will account
for the self reports of cyclicity in energy levels. Again
ovulation is a neglected event and there are no studies which
clearly relate **energy**   (carefully measured) to the day of
ovulation.

II. Variations in Performance associated with the
     Menstrual Cycle

The menstrual cycle was divided into 5 phases viz -

a) The menstrual phase - Days 15-18 of a standardised 28 day
   cycle. Using these days meant that all the core subjects
   were actually menstruating for the whole of the menstrual
   phase.

b) The premenstrual phase - Days 12-14 of a standardised 28
   day cycle. Using 3 days made it comparable with the
   menstrual period and ensured that it covered the time the
   core subjects, who could predict that they were premenstrual,
   reported the occurrence of premenstrual symptoms.

c) Preovulatory phase - Days 27 and 28 of a standardised 28

day cycle. Only 2 days long because this made sure of

isolating only preovulatory effects and not extending too

far into the intermenstruum.

d) The post ovulatory phase. Days 2 and 3 of a standardised

28 day cycle. Comparable with the preovulatory period.

e) The intermenstruum. Days 4,5,6,7,8,9,10,11,19,20,21,22,

23,24,25 and 26 of a standardised 28 day cycle.

The remaining day, 1, the day of ovulation, was not

used in the analysis since the subjects had not provided

sufficient data for that particular day. Ovulation is obvi-

ously a unique day in the cycle (see the elation and energy

data) and would obscure effects to be found in either the

preovulatory or postovulatory phases of the cycle if it was

merely counted as part of either phase. It will be necessary

to run a longer and larger study to find out the effects of

ovulation on performance.

i) <u>Reaction Time</u>

The best performance (i.e. the shortest choice

reaction time) was observed premenstrually while the worst

occurred intermenstrually. Just as Reaction Time was far

better premenstrually than menstrually so it was also better

preovulatory than postovulatory.

Most previous studies of reaction time (e.g. Pierson

and Lockhart, 1963 ; Loucks and Thompson, 1968 ; and Koppel

et al, 1969) have used simple reaction times and no-one since

Voitsechovsky (1908) has reported evidence of cyclicity. There

have been suggestions that simple reaction time is not sensitive

to small changes and duration effects (Blake, 1967; and Sommer

1973). Zimmerman and Parlee (1973) used both simple and choice reaction times but failed to find any statistically significant fluctuations over the course of the cycle. The choice reaction time task in this experiment demanded a response to either a red or green light. In the present study eight lights were used. The information load in the present experiment (3 bits) was greater than that in the Zimmerman and Parlee study (1 bit) suggesting that information load is the critical variable in determining whether the differences in performance are associated with different phases of the menstrual cycle.

ii) Concept Formation

The best performance at the simple level of concept formation was at the preovulatory period with slightly poorer performances occurring during the postovulatory, intermenstrual and premenstrual period. The premenstrual performance was better than that in the menstrual phase which was the poorest of the cycle.

The best performance at the medium and difficult levels of concept formation occurs in the premenstrual phase of the cycle. Again premenstrual performance is better than menstrual while preovulatory is better than postovulatory.

ii) Pursuit Rotor

There were no significant differences in pursuit rotor performance associated with the different phases of the menstrual cycle.

iv) <u>Digit-symbol substitution</u>

There were no significant differences in digit symbol substitution performance associated with the different phases of the menstrual cycle. These results fail to support the contention of Broverman et al (1968) that tasks such as the digit symbol substitution, at which women excel, reflect differences in relationships between adrenergic activity and cholinergic inhibitory neural processes, which in turn are sensitive to the "sex" hormones, androgens and estrogens. Broverman et al (1968) produce evidence to demonstrate that estrogen is associated with behavioural activation which is confirmed by the results of this study where the estrogen peak at ovulation coincides with the peak of reported energy and the decline in estrogen levels paramenstrually is reflected in declining energy levels at this time. However behavioural activation and cortical activation are not necessarily correlated. Zimmerman and Parlee (1973) also looked at digit symbol substitution and failed to find any significant differences between performance on the days of the cycle they tested.

The problem now is to account for these differences in performance. The data from the present study indicate that there are differences in higher level functioning (as measured by choice reaction time and concept formation tasks) associated with the menstrual cycle but that tasks measuring concentration and memory do not vary with different phases of the cycle.

A number of explanations could be advanced to account for these findings and these will be considered under three main headings viz -

A. Psychological Factors

B. Physiological Factors

C. Changes in Arousal during the menstrual cycle.

A. Psychological Factors which may Influence Mood and Performance across the Menstrual Cycle

It has long been known that menstruation is susceptible to psychological influences. At the beginning of the century Ekstein (1919), Siegel (1917), and Walthard (1924) (quoted in Engels et al 1964) stressed the importance of psychic factors in amenorrhea and suggested that the then familiar "war amenorrhea" was less attributable to malnutrition than to absence of men. The results of McClintock (1971) support this idea since she found that women with long intervals between periods had less contact with males than those with shorter menstrual cycles. Kroger and Freed (1951), also looking at amenorrhea, cite certain common precipitating causes, such as death of a loved one, especially the father; shock or accident; emotional tension provoked by argument; change of environment or intense desire for pregnancy. In the less serious case of temporary amenorrhea, Osotsky and Fisher (1967) and Shanan et al (1964) note its occurrence in approximately 20% of young women when they changed environment. The fact that premenstrual tension will respond to psycho-therapy indicates that psychological factors are important in its etiology. For instance, Melody (1961) found most enduring improvements in premenstrual tension had been achieved by inducing new insights that gradually modified the patient's image of herself. The psychological factors which may influence mood and performance during the menstrual cycle can be reviewed under a number of distinct headings.

i) The Influence of Stereotypes and Expectations

It has already been pointed out earlier in this chapter that a negative stereotype is widely held about the effect

menstruation has on women's mood and performance.
Rosenthal (1966,1968) has underlined the potent effect
expectations can have on performance and it is possible that
the negative stereotypes and expectations held by the
subjects and others, greatly contribute to the lowered mood
and performance which is found during the menstrual period.

Abramson and Torghele (1961) comment that "a woman's
awareness of her inherent disabilities is thought to create
added mental and in turn physical changes in the total body
response". Beaumont et al (1975) found that normally
menstruating women reported significantly lowered moods
premenstrually and menstrually compared with a control group
of hysterectomised women who were apparently having normal
hormonal changes despite their lack of periods. They con-
cluded "the level of symptomatology is as dependent on the
women's awareness of their position in the menstrual cycle
as it is on any underlying biological change."

Koeske and Koeske (1975) showed that both male and
female students attributed negative but not positive moods
in women to the influence of the menstrual cycle. Attribution
may play an important role in causing lowered mood since
women attribute depression experienced premenstrually to
their biology and may therefore ignore situational factors.
Valins and Nisbett (1971)   argue that a vicious circle
of self condemnation and anxiety may result when negative
behaviour patterns are internally attributed and situational
factors are discarded since if women persist in their belief
in a biological explanation of premenstrual tension it is
unlikely that they will take action to alter upsetting
situations.

The fact that women expect to perform badly para-
menstrually could lead them to try harder in an effort
to compensate for their expected decrement in performance.
Lough (1937) found that least errors were made in a
learning task on the second day of menstruation which was
also the day of greatest worry and pain. She argues that
the results come about because the subjects aware of their
inadequacies at this time make great efforts and over-
compensate.

ii) Menstruation as a Traumatic Experience

Many authors, especially those of a psychoanalytic
orientation have pointed out that menstruation may be a
time of conscious or unconscious trauma. Eichner et al
(1955) point out that at the simplest level certain symptoms
experienced at this time (e.g. weight gain and acne) may be
distressing to a figure conscious woman or an adolescent girl
trying to enjoy a normal social life, while Gill (1943) and
Menninger (1939)   liken menstruation to a badge of
femininity which some women reject as they regard it as a
proof of their deficiency and inferiority. It is this
unconscious repudiation of femininity which gives rise to
the negative emotional tone experienced at this time.

Thomson (1950)   - points out that menses may be
compared with urine and faeces but that they may be more
upsetting since women lack a sphincter muscle to control
them. He quotes Lewin (1930) who reported a woman who had
become very proficient at contracting   the vaginal muscles
so that she obtained some semblance of control over the

quantity of menstrual flow. Lack of control over the menstrual flow makes some women associate it more strongly with habits that are unacceptable and dirty.

The fact that a woman bleeds monthly and that she has no control over this event places her in the paradigm which Seligman (1975) has described as learned helplessness. Seligman argues that depression occurs when a person is placed in a situation where their behaviour cannot alter the frequence of occurrence of rewards or punishments. This may account for the depressed moods experienced para-menstrually.

Cole (1959) states "that evidence has been established that girls may receive a considerable emotional shock from their menstruation whether or not they have been warned of its arrival since there is something understandably terri-fying in a haemorrhage that cannot be stopped". Certainly a traumatic experience of menarche or an unsympathetic reaction on the part of the girl's mother seems to be associ-ated with increased symptomatology in the following menstruations (Silberman, 1950; Paulson et al, 1966; and Shainess, 1961). Unwholesome attitudes towards menstruation whether they are held by an individual (Levitt et al 1967) or a culture (Theano, 1968; and Janiger et al, 1972) have also been found to correlate significantly with increased symptomatology.

iii) **Variations in Pain Thresholds**

This last factor considered is not entirely a psychological one but does have psychological implications.

Tedford et al (1977) using a group of normal women showed lowered aversion thresholds for electric shock paramenstrually with maximum levels at mid cycle. Herren (1933) also reports lowered pain thresholds premenstrually while Diamond et al (1972) report raised pain thresholds around ovulation.

Let us now consider how far these psychological factors can explain the results obtained in this study.

The three main phases of the menstrual cycle are clearly demarcated by the results of this study viz -

a) The menstrual period is characterised by lowered mood and energy and poor performances on both the concept formation and choice reaction time tasks.

b) The premenstrual period is a time of lowered mood and energy but of improved higher level functioning.

c) Ovulation is a time of increased elation and energy. There is another peak of performance on concept formation and choice reaction time tasks preovulatory followed by a deterioration in performance in the post-ovulatory period.

Expectation, stereotyping and attribution can all help to account for lowered mood during the menstrual and premenstrual period (if a woman is aware she is premenstrual) but cannot account for the improved mood which characterises ovulation. Few women are actually aware that they are ovulating and there are no consistent stereotypes provided about feelings or energy levels at this time so there is no scope for expectation or attribution to operate.

Lowered mood, negative expectations and stereotypes may help to account for the poor performance during menstruation on the tasks measured but it is difficult to see why higher level functioning (as measured by concept

formation and choice reaction time) should deteriorate while tasks requiring concentration and memory (rotor pursuit and digit symbol substitution) should remain unaffected.

Lough (1937) has claimed that negative stereotypes and women expecting to perform badly leads to overcompensation in task performance during the menstrual period. In this study menstrual performance deteriorated on the tasks measured but overcompensation may be used to explain improved performance premenstrually. If overcompensation did occur premenstrually then digit symbol substitution and rotor pursuit may not have shown the effect because the subjects were already performing at their ceiling level so there would be no room for improvement. However it is difficult to explain why the subjects should overcompensate and perform well premenstrually but then allow their performance to deteriorate during menstruation. Furthermore some subjects did not know when they were premenstrual so they did not know when to overcompensate. These factors do not explain the preovulatory peak in performance followed by the post-ovulatory deterioration.

Menstruation being a time of distaste and conflict to women would account for the lowered mood encountered at this time. Again it fails to say anything about the changes in mood and performance found around ovulation. Lowered mood cannot account for lowered performance since lowered mood and peak performance are encountered premenstrually and lowered performance an elevated moods postovulatory.

Lowered pain thresholds have been reported para-menstrually (Tedford et al, 1977; and Herren, 1933) while increased pain tolerance is found at ovulation (Tedford et al,

1977;and Diamond et al,1972). This could lead, during the paramenstruum, to women finding noxious, stimuli which they would normally tolerate which could account for the lowered mood reported at this time. The increased pain tolerance at ovulation would make women more tolerant of noxious stimuli either from their environment or of the minor aches and pains from which all people suffer and would account for the more elevated moods noted at this time. Changes in pain tolerance would not explain differences in performance since performance peaks premenstrually and preovulatory while pain tolerance is low at one peak and high at the other.

B. Physiological Factors which may influence
   mood and performance across the menstrual cycle

(i) Fluctuations in hormone levels during the cycle

The literature concerning circulating levels of hormone during the menstrual cycle is very confusing and contradictory, mainly because the results are a function of the techniques used. Many of the studies use bioassays of urine to measure hormones and their metabolites but as Donovan (1970) points out this technique is both insensitive and liable to be inaccurate because urinary hormone levels may not fully reflect circulating hormone levels. The description given here is based on the study of Vande Wiele et al (1970) who used the more accurate and sensitive technique of radioimmunoassay on blood plasma samples.

a) <u>Estrogen</u>

Estrogen levels peak at ovulation and then about seven or eight days later; after this levels of circulating estrogen decline until reaching a minimum a few days before menstruation. The estrogen peak at ovulation coincides with the well defined peak of elation and energy found in the present study at this point and the low levels para-menstrually are associated with low levels of energy and lowered mood reported at this time.   Benedek et al (1939) claim . that the estrogenic phase is usually accompanied by a sense of well being and alertness and animal studies (reported in Broverman et al, 1968) have demonstrated that female rats are most active at the day of estrous when estrogen effects are maximal.

While estrogen fluctuations at ovulation parallel fluctuations in higher level functioning at this time this is not the case at menstruation since estrogen levels are low premenstrually and during menstruation while performance is good premenstrually but deteriorates during menstruation.

However, a number of workers (Frank, 1931; Biskind, 1943;and Israel, 1938) have postulated peaks in unantagonised estrogen premenstrually and have argued that this is responsible for the premenstrual tension (a syndrome which includes lowered affect) suffered by some women. The presence of this estrogen has never been demonstrated in a controlled fashion with the assessors unaware of the diagnosis (Tonks,1968b). If estrogen produces lowered mood and the other features of the premenstrual syndrome then it is

difficult to see why these features are not also reported at ovulation when estrogen production is at a peak.

b) Progesterone

Progesterone is only in evidence in the luteal phase of the cycle reaching a peak four to seven days prior to menstruation. Progesterone has been claimed to produce general anesthesia in animals (as reported in Moos et al, 1969) and drowsiness and decreased anxiety and tension in women (Benedek et al, 1939).

Again, it has been claimed (Gilmore et al,1942) that progesterone is responsible for the symptoms experienced by women suffering from the premenstrual syndrome. There seems little evidence to support this and other workers use progesterone to alleviate premenstrual distress (Kutner et al,1972;and Swanson et al,1964).

The increase in progesterone postovulatory may help to account for the lowered performance at this time if progesterone has an anesthetic effect. The high levels of performance premenstrually and preovulatory would be accounted for by the low levels of progesterone.However progesterone levels are low during menstruation and yet performance at this time is poor.

Progesterone levels do not vary consistently with reported levels of mood and energy and it is difficult to see,even if as Gilmore claims progesterone produces lowered mood,how it could possibly explain the results found in this study.

c) <u>The Gonadotrophins</u>

Follicle Stimulating Hormone (F.S.H.) reaches a peak premenstrually remains high during menstruation before peaking again just before ovulation. It then declines until a few days before menstruation when there is a rapid rise following the drop in levels of estrogen and progesterone. The circulating levels of F.S.H. parallel the changes found in higher level functioning since there is a peak premenstrually followed by a menstrual decline then a preovulatory peak followed by a postovulatory decline.

De Weid (1969) suggests, on the basis of animal studies, that pituitary hormones may influence behaviour directly, independent of their effects on endocrine target organs. Van Riezen et al (1977) have reviewed the effects of A.C.T.H. (adrenocorticotrophic hormone) and its analogs in humans and suggest that A.C.T.H. may activate the reticolimbic circuits which may result in increased motivation and attention. Other pituitary hormones which have been shown to directly influence behaviour include melanocyte-stimulating hormone (M.S.H.) and a study by McGuiness (1961) demonstrated changes in skin pigmentation with increases occurring premenstrually attributed to increased M.S.H. Skin changes around ovulation were not investigated.

As far as the study of A.C.T.H. fragments in humans is concerned studies evaluating their effects on human performance are only beginning to be carried out. There is no direct evidence linking F.S.H. to performance but in view of the studies quoted above it does seem possible that F.S.H. may influence higher level functioning. It may affect tasks

like choice reaction time and concept formation directly
or tasks like rotor pursuit and digit symbol substitution
may have reached their ceilings and have no room to demon-
strate improvements attributable to F.S.H.

The other major gonadotrophin involved in the
menstrual cycle, luteinising hormone (L.H.) peaks around
ovulation and is high in the second part of the cycle but
is low premenstrually and during the follicular phase of
the cycle. Levels of circulating L.H. are not paralleled
by the performance levels and it seems unlikely that
luteinising hormone is the gonadotrophin involved in
influencing performance.

The curves of circulating gonadotrophins do not
parallel those of mood and energy and it is difficult to
see how changes in mood and energy could be explained in
terms of fluctuations of either F.S.H. or L.H.

d) Water Retention

It has been argued (Fortin et al, 1958; Greene and
Dalton,1953;and Bickers and Wood,1951) that lowered mood
and other symptoms experienced premenstrually are the
product of water retention.

Well controlled studies of fluid retention, and
sodium and potassium balance during the menstrual cycle
indicate that there are two peaks of fluid retention, one
at ovulation and a smaller one premenstrually (Thorn et al,
1938;and Bruce et al, 1962). However if increase in fluid
retention and changes in sodium and potassium balance are
responsible for the symptoms associated with the premenstrual
period it is difficult to see why these symptoms do not occur
more severely around ovulation.

However, the curves describing the levels of sodium and potassium during the menstrual cycle parallel those of the performance data on the concept formation and choice reaction time tasks and while a mechanism cannot be postulated changes in sodium and potassium balance may affect higher level functioning. Concentrations of sodium and potassium ions affect nerve conductance (Woodbury 1965) but the cell has elaborate failsafes to ensure that the concentration of the ions inside cells remains stable (Woodbury, 1965), so it is difficult to see how sodium and potassium balance changes could affect higher level functioning. Water retention could affect the physical actions a subject performs when carrying out a task but if this is a factor then why the differential effects of improving concept formation and choice reaction time but not affecting rotor pursuit and digit symbol substitution?

e) Thermal changes during the Menstrual Cycle

The menstrual cycle has a distinct pattern of temperature changes (Marshall 1963 and James 1972) and performance of certain tasks varies with core temperature (Posner 1975). However the temperature at ovulation shows a sharp decrease then a rapid increase and remains high until it drops down paramenstrually, remaining low for the follicular phase of the cycle. This means that while the premenstrual-menstrual drop in temperature is paralleled by the deterioration of performance found during menstruation, at ovulation the preovulatory low temperature is associated with good performance and the postovulatory higher temperature with poorer performance.

C Changes in Arousal during the Menstrual Cycle

Little and Zahn (1974) present some tentative
evidence to suggest that the preovulatory and premenstrual
periods are times of decreased autonomic nervous system
reactivity. Kopell et al (1969), using two-flash threshold
and time estimation, also suggest that the premenstrual
period is a state of lowered arousal. They did not pinpoint
ovulation so provide no data about the state of arousal
at this time. Wineman (1971) found evidence of an increase
in sympathetic tone during the luteal phase of the cycle.
Little and Zahn (1974) point out that arousal is not a
unitary concept and that different conclusions can be drawn
about "arousal" from consideration of different psycho-
physiological measures. There is an added difficulty in
studying psychophysiological changes during the menstrual
cycle since cyclic changes in variables such as water re-
tention and electrolyte balance will affect measures such
as skin conductance and so may obscure other important
changes.

Little and Zahn's (1974) study found changes in the
responsivity of the autonomic system. Falls in autonomic
response levels occur around ovulation and in the premenstrual
period. These falls may represent a reduction in the ability
of the subjects to undergo arousal as a consequence of the
tasks. There is evidence (Bahrick et al,1952; Hockey 1970)
that changes in arousal during task performance affects the
way that subjects distribute their attention to components
of the task. High arousal is usually associated with reducing
the range of stimuli to which the subject attends. If so the
good performance found premenstrually and preovulatory in the

present study, on concept formation and choice reaction time can be explained in terms of a fall in the degree to which the subject is aroused by the task. The fall in arousal allows the subject to attend to all aspects of a complex task such as concept formation and choice reaction time and would account for the improved performance on these tasks while the lowered arousal does not improve performance on digit symbol substitution, rotor pursuit or simple reaction time.

No one factor, either psychological or physiological, will explain both the mood, energy and performance changes found in this study. Changes in the level of circulating estrogen throughout the cycle would seem the best explanation of mood and energy changes but not of performance changes. Although changes in mood and energy are paralleled by changes in pain thresholds as well as estrogen levels, the changes in pain thresholds may not be responsible for variations in mood and energy. Instead both the pain tolerance changes and the fluctuations in mood and energy may be determined by levels of circulating estrogen.

Broverman et al (1968) present evidence that estrogen will elevate the level of monoamines in the central nervous system and recent work on animals (German et al, 1974) has shown that reinforcement is mediated centrally by mono-aminergic nerve pathways (specifically the catecholamines, dopamine and noradrenaline). The heightened energy and elation at ovulation may therefore be a consequence of increased susceptibility to reward. Changes in pain thresholds may also be explained by this mechanism since central

activation of the reward pathways increases pain
thresholds (Rose,1974).

The tasks used in this study which showed differences
in performance associated with the menstrual cycle were
those requiring attention to large amounts of information.
Previous work has shown no differences in simple reaction
time associated with different phases of the cycle and
even choice reaction time using two lights failed to vary
with different phases of the cycle yet choice reaction time
using eight lights does vary showing improvement premenstrually
and preovulatory with a deterioration in performance during
menstruation and after ovulation. This pattern also dis-
tinguished the concept formation data which again required
the subject to pay attention to a large information load in
order to successfully arrive at the concept required. The
choice reaction paradigm is a useful one here since the
information available can be both varied and quantified.
Further information will be gained by systematically varying
the information load in a choice reaction time task by
varying either the number of signals to be responded to or
their probability of occurrence (Welford, 1968).

Not only can information load be altered in perceptual
tasks, it can also be varied in motor tasks (Fitts, 1954).
The task used by Fitts and Petersen (1964) allows the amount
of information available in a motor task to be both varied
and measured. Variation of information load in two disparate
tasks, such as these, will allow a test of the suggestion
that a certain level of information load is necessary in a
task before it will register changes associated with the
menstrual cycle.

The changes in arousal, both absolute and in the reactivity of the autonomic nervous system, need a lot more research before the tentative hypothesis put forward to account for fluctuations in higher level functioning can be substantiated. The concept of arousal is a multidimensional one in psychology and psychophysiological studies may not provide the best measures of the relevant arousal especially since these measures may be contaminated by other changes which take place during the menstrual cycle, for example changes in the electrolyte balance and fluid retention. Easterbrook (1959)*has reviewed evidence which suggests that increased arousal effects performance by limiting the range of cues attended to by the organism.

This hypothesis predicts that tasks requiring attention to a wide range of cues, such as size constancy, will be facilitated at times of lowered arousal while other tasks requiring the selection of a small number of cues from a larger range, such as the Stroop test, will show an impairment. The opposite will occur at times of increased arousal.

However the changes in performance reported may equally be due to direct effect of gonadotrophins (especially F.S.H.) on information processing.

To further elucidate the role of estrogen in mood and energy and of gonadotrophins in changes in performance the obvious thing to do would be to give people small doses of these drugs. However this is not practical since producing sudden peaks of these substances in the blood plasma of subjects tested may produce undesirable side effects such as disruption of the normal menstrual cycle. It will therefore now be valuable to look at women with distinct known hormonal patterns who are not experiencing a normal menstrual cycle,

* See also Kahneman (1973) and Naatanen (1973).

namely women using oral contraceptives, post menopausal
women, **ovariectomised** women and women with naturally occurring
anovulatory cycles. If gonadotrophins influence perform-
ance and estrogen controls mood and energy, then those women
showing high levels of gonadotrophins, namely the post-
menopausal and ovariectomised groups should show better
performance on information processing tasks as outlined above
but lowered mood while those subject to high levels of
estrogen, such as the group taking oral contraceptives, should
demonstrate better mood but lowered performance on such tasks.
Women with naturally occurring anovulatory cycles have a
flattened hormonal pattern which should be reflected in their
mood and performance.

The results of this study demonstrate clearly the
need to pay attention to the two landmarks of the menstrual
cycle, ovulation as well as menstruation. Studies, which do
not pinpoint ovulation and carefully chart changes which occur
at this time, contribute little to our understanding of the
behaviours which are affected by the menstrual cycle, and
will hinder our understanding of the mechanisms responsible
for the changes.

Ovulation is a very important event and since it only
occurs on one day of the cycle, daily testing is essential.
It is a fault of the present study that women were tested
weekly on the same day so that even though they were tested
over a long period of time they were not tested on every cycle
day. One of the consequences of this experimental strategy
is that only certain populations can be reasonably tested,
namely students, inmates of medical and penal institutions
and members of the armed forces. Of these the only ones likely

to provide meaningful results are students since they are
the only group likely to offer full cooperation. Even with
a student population however, it is unlikely that they will
be available for testing each day so the best strategy will
probably be to test as often as possible over as long a
period as the subjects can be persuaded to cooperate for, and
in that way each day of a normalised cycle should contain a
reasonable sample of testing sessions.

The question of variation in symptoms suffered
throughout the menstrual cycle has still not been satis-
factorily investigated. There is need of a study in which
women keep careful records of all symptoms suffered throughout
the cycle along with accurate pinpointing of ovulation so
that symptomatology around this point can be clarified. The
intensity of symptoms suffered will have to be taken into
account and the method used in the questionnaire study which
indicates frequency will not be suitable. The questionnaire
study will provide suitable guidelines for the symptoms to
be included in a study of symtomatology since some of the
symptoms included in the questionnaire had very low frequencies
of occurrence.

This study has demonstrated clearly the significance
of ovulation as a landmark in the menstrual cycle. It has
demonstrated that mood and energy reports do vary across the
menstrual cycle if data are collected for a large enough sample
of cycles and   normalised around ovulation and
menstruation. This study has also demonstrated distinct changes
in performance around ovulation and menstruation has emphasised
the need for daily testing and has proposed tentative hypotheses
to account for the changes in performance observed.

Summary of Conclusions.

Cyclic fluctuations in the levels of circulating sex hormones may, therefore, account for both mood and performance changes observed in this study. Estrogen levels covary with the reported levels of mood and energy during the menstrual cycle, although studies of mood, energy and estrogen levels have yet to be carried out on the same subjects. Follicle Stimulating Hormone (F.S.H.) peaks premenstrually and just prior to ovulation and these peaks coincide with peaks of performance on the concept formation and choice reaction time tasks. F.S.H. may influence behaviour by modulating levels of arousal. On the basis of the results of this study it is postulated that high levels of F.S.H. reduce arousal. Lowered levels of arousal favour performance on tasks presenting a heavy information load or demanding continuous monitoring of a range of sources of information. These hypotheses suggest that future research should concentrate on two lines of investigation.

1) Looking at subjects with normal menstrual cycles to confirm that tasks with high information loads show the most variation in performance across the cycle.

2) Looking at the endocrinological basis of these variations either by carrying out bioassays on women with normal menstrual cycles to confirm that estrogen peaks and reported highs in mood and energy covary and that peaks in F.S. H. and performance on tasks with high information loads do so as well, or by looking at women with abnormal menstrual cycles to determine whether mood and performance vary with the menstrual cycle as predicted by the hormonal hypothesis outlined above.

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Appendices 1 - 9

Appendix 1.

Attitudes towards Menstruation

The following questionnaire is part of a research project investigating attitudes towards menstruation. I would be very grateful if you would fill it in as fully and as honestly as you can. Please omit any questions which are inapplicable or which you do not wish to answer.

There is no need to put your name on the questionnaire as all information will be kept anonymous, but if you would like to add any additional information which you think would be useful, there is a blank sheet at the end of the questions.

Thank you.

General Questions

Please tick answer where appropriate

1)   Age

2)   Age of mother (if you were brought up by a female
                     guardian, please supply information
                     about her)

3) (a) Religion

   (b) Do you attend church or religious meetings
                          (please tick)   YES   NO

   (c) How often do you attend these? (please tick...)
                          Rarely   Sometimes   Frequently

4)   Do you use a contraceptive pill? (please tick) YES   NO

5)   How long does your period usually last?

6)   How heavy is your period (please tick)
                          Slight   Moderate   Heavy

7)   Are your periods regular? (please tick)   YES   NO

8)   What is the average interval between
                     each period? (please tick) :-
      2 weeks,   3 weeks,   4 weeks,   5 weeks,   more than 5 wks.

9)   What is the longest interval you have ever had
                between periods?   (please tick)

      3 wks, 4 wks, 5 wks, 3 mths, 6 mths, 1 yr., more than 1 yr.

The Time Before your Period

A. Physical Symptoms

10(a) If you suffer any discomfort <u>before</u> <u>your</u> <u>period</u>, will you please tick the appropriate squares...

	DONT KNOW	NEVER	RARELY	SOME-TIMES	FRE-QUENTLY	ALWAYS
i) aches & pains						
ii) headache						
iii) backache						
iv) stomach ache						
v) aching legs						
vi) acne						
vii) swelling (water retention)						
viii) diarrhoea						
ix) constipation						
x) changes in temperature (please indicate: hotter colder)						
xi) dizziness						
xii) easily bruised						
xiii) any others - please specify						

10(b) If there are any other signs by which you know your period is about to begin, please specify:

11 At what point prior to your period do these signs or discomforts appear? (please tick)

1 day   2 days   3 days   4 days   more than 4 days

continued.....

B. Emotional Changes

12. Please indicate, by ticking the appropriate square, any emotional changes which occur <u>before</u> your period:

	DON'T KNOW	NEVER	RARELY	SOME-TIMES	FRE-QUENTLY	ALWAYS
i) Do you get depressed?						
ii) Do you become irritable?						
iii) Do you feel emotionally insecure?						
iv) Do you become tense?						
v) Do you have more arguments?						
vi) Do you have more accidents?						
vii) Do you cry more easily?						
viii) In your personal relationships do you find yourself 'getting at' others?						
ix) Do you become sexually aroused more easily?						

C. Behavioural Changes

13. Please indicate, by ticking appropriate square, if any of the changes listed occur in your behaviour <u>before</u> your period:

	DON'T KNOW	NEVER	RARELY	SOME-TIMES	FRE-QUENTLY	ALWAYS
i) Is your academic work affected?						
ii) Do you find you 'push yourself' more to get work done?						
iii) Do you find it more difficult to concentrate?						
iv) Do you find yourself less interested in your work?						
v) Do you find it more difficult to remember things?						
vi) Do you feel more energetic?						
vii) Do you take more exercise?						
viii) Do you eat more?						
ix) Do you drink more fluid?						
x) Do you develop a craving for sweets?						
xi) Do you find it harder to get to sleep?						
xii) If you smoke – do you smoke more?						

DURING YOUR PERIOD

A. Physical Changes

14 If you suffer any discomfort <u>during</u> your period, will
    you please tick the appropriate square:-

	DONT KNOW	NEVER	RARELY	SOME-TIMES	FRE-QUENTLY	ALWAYS
i) aches & pains						
ii) headache						
iii) backache						
iv) stomach ache						
v) aching legs						
vi) acne						
vii) swelling (water retention)						
viii) diarrhoea						
ix) constipation						
x) changes in temperature (please indicate) hotter colder						
xi) dizziness						
xii) easily bruised						
xiii) any others - please specify						

15 If you suffer any discomfort, how long does it last?
                                              (please tick)
    1 day 2 days 3 days 4 days more than 4 days

16 Do any of the physical discomforts which you associate
    with menstruation occur on other days, when you are not
    menstruating? (If they do, will you please state what
    form they take and when they occur) :-

B. Emotional Changes

17 Please indicate by ticking the appropriate square
    any emotional changes which occur <u>during</u> your period:

	DON'T KNOW	NEVER	RARELY	SOME-TIMES	FRE-QUENTLY	ALWAYS
i) Do you get depressed?						
ii) Do you become irritable?						
iii) Do you feel emotionally insecure?						
iv) Do you become tense?						
v) Do you have more arguments?						
vi) Do you have more accidents?						
vii) Do you cry more easily?						
viii) In your personal relationships do you find yourself 'getting at' others?						
ix) Do you become sexually aroused more easily?						

C. Behavioural Changes

18 Please indicate by ticking the appropriate square if
    any of the changes listed below occur in your behaviour
    during your period:-

	DON'T KNOW	NEVER	RARELY	SOME-TIMES	FRE-QUENTLY	ALWAYS
i) Is your academic work affected?						
ii) Do you find you 'push yourself' more to get work done?						
iii) Do you find it more difficult to concentrate?						
iv) Do you find yourself less interested in your work?						
v) Do you find it harder to remember things?						
vi) Do you feel more energetic?						
vii) Do you take more exercise?						
viii) Do you eat more?						
ix) Do you drink more fluid?						
x) Do you develop a craving for sweets?						
xi) Do you find it harder to get to sleep?						
xii) If you smoke - do you smoke more?						

18 continued.....

	DON'T KNOW	NEVER	RARELY	SOME- TIMES	FRE- QUENTLY	ALWAYS
xiii) Do you find it more difficult to go to sleep?						
xiv) Do you wash more often?						
xv) Do you bath more often?						
xvi) Do you use hotter water in your bath?						
xvii) Do you wash your hair?						

19 Do you take any pills or medicines to help you through
                          your periods?   YES   NO

20 If you do, what do you use, of what dosage, and
                          for how long?

21 Are there any things <u>you do</u> because you are having a
    period (apart from using sanitary towels?)

22 Are there any things <u>you will not do</u> (e.g. swimming,
    washing your hair, etc.) because you are menstruating?

23 Do you expect sympathy during this time?

24 From whom do you expect sympathy?

Your First Period

25 At what age did you have your first period?

26 How did you react to this? (please tick appropriately) -

with fear / with shame / with unconcern / with pleasure /

with relief.

27 Do you think you were 'properly prepared' for
menstruation?　　　YES　　　NO

28 What were your sources of information?

29 How were you taught to deal with the situation?

30 What did your mother/female guardian tell you about
menstruation?

31 How did your mother react to the approach of your first
period?

Miscellaneous Questions

32(a) Can you detect any differences in your friends'
behaviour which allow you to predict that they
are about to have a period?

(b) How do you do this?

33(a) Are your friends able to tell from your behaviour that
you are about to have a period?

(b) How do they do this?

34 Why do you think that there is so much secrecy and
embarrassment about this subject?

35 People tend to develop a private language when talking
about menstruation: in your experience, what sorts of
words and expressions do they use?

36 What do men think of menstruation (in your opinion)?

37 Do you think periods have any symbolic meaning for people?

38 What do they signify for you?

ENERGY vs. FATIGUE (how energetic, or tired and weary,
you felt today)

1. Limitless zeal. Surging with energy. Vitality spilling over.

2. Exuberant vitality. Tremendous energy. Great zest for
activity.

3. Great energy and drive.

4. Very fresh. Considerable energy.

5. Fairly fresh. Adequate energy.

6. Slight tired. Indolent. Somewhat lacking in energy.

7. Rather tired. Lethargic. Not much energy.

8. Great fatigue. Sluggish. Can hardly keep going. Meagre
resources.

9. Tremendously weary. Nearly worn out, practically at a
standstill. Almost no resources.

10. Utterly exhausted. Entirely worn out. Completely
incapable of even the slightest effort.

ELATION vs. DEPRESSION (how elated or depressed, happy or
unhappy, you felt today)

1. Complete elation. Rapturous joy and soaring ecstasy.

2. Very elated, in very high spirits. Tremendous delight
and buoyancy.

3. Elated and in high spirits.

4. Feeling very good and cheerful.

5. Feeling pretty good - 'O K'

6. Feeling a bit low. Just so-so.

7. Spirits low, somewhat 'blue'.

8. Depressed and feeling very low. Definitely 'blue'.

9. Tremendously depressed. Terribly miserable. 'Just awful'.

10. Utter depression and gloom. Completely down. All is
black and leaden.

Appendix 3.

Menstrual Chart

	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
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26												
27												
28												
29												
30												
31												

Please mark with an X the days of bleeding.

Date ....

Please indicate, by ticking the appropriate square, which of the following changes in your emotions occur, and the degree to which you display them.

	Slight	Moderate	Severe
1) Feelings of irritation			
2) Feelings of emotional insecurity			
3) Feelings of tenseness			
4) Feeling argumentative			
5) Crying easily			
6) "Getting at others"			

Please indicate, by ticking in the appropriate square, the degree to which the following changes in behaviour occur:

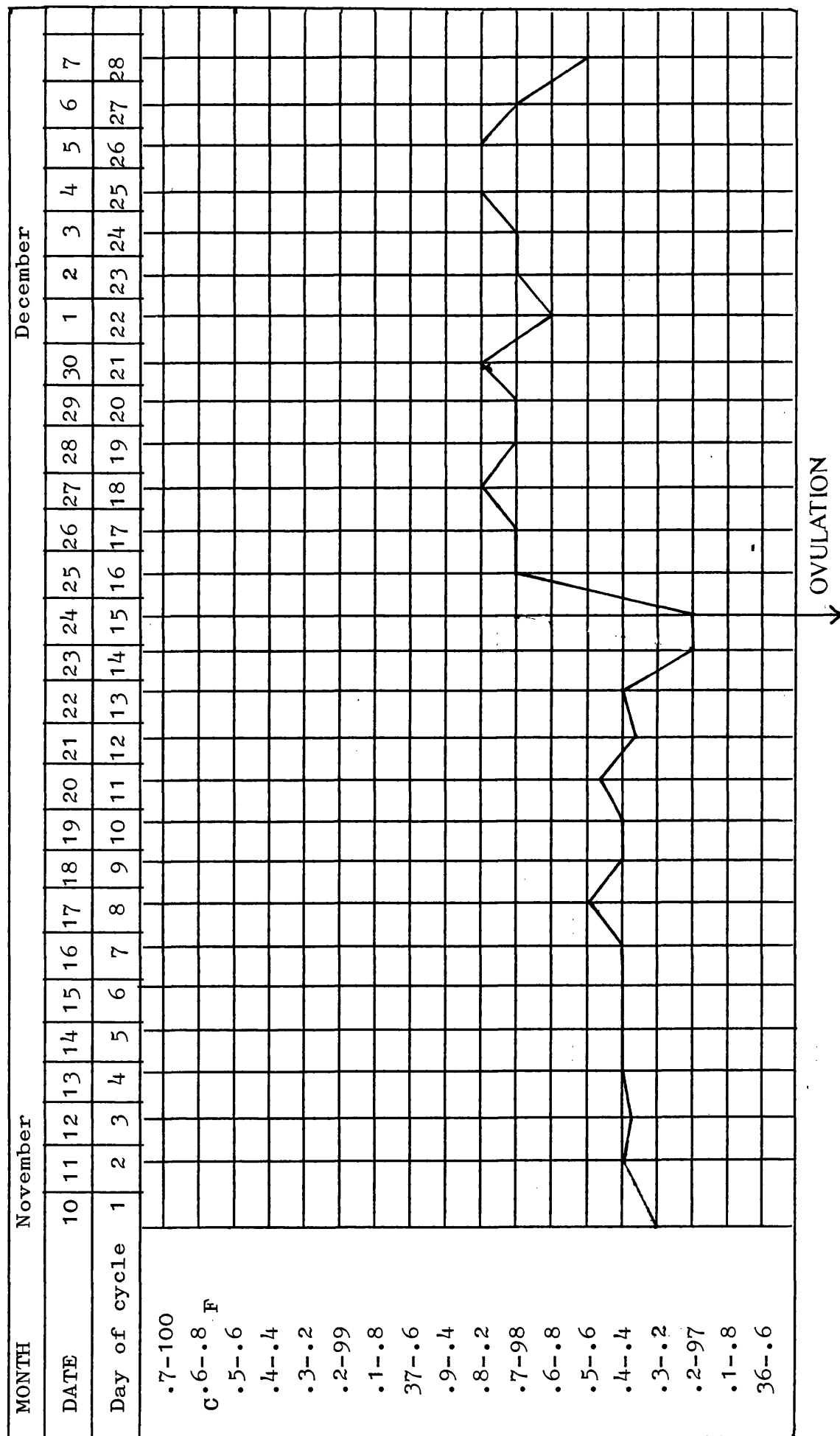|	Slight	Moderate	Severe
1) Is your academic work affected?			
2) Do you find yourself pushing yourself more?			
3) Do you find it more difficult to concentrate?			
4) Do you find you are less interested in your work?			
5) Do you find it more difficult to remember things?			

Physical Symptoms

Please indicate, by ticking the appropriate square, which of the following discomforts you suffer from and how intense the discomfort is:

	Slight	Moderate	Severe
(1) General aches & pains - - -			
(2) Headache - - - - - - - - -			
(3) Backache - - - - - - - - -			
(4) Stomach ache - - - - - - -			
(5) Aching legs - - - - - - -			
(6) Acne - - - - - - - - - - -			
(7) Swelling (water retention)			
(8) Diarrhoea - - - - - - - - -			
(9) Constipation - - - - - - -			
(10) Changes in temperature hotter colder			
(11) Dizziness - - - - - - - -			
(12) Easily bruised - - - - -			
(13) Any others (please specify)			

Appendix 5

166

MONTH: November | December

DATE: 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 1 2 3 4 5 6 7

Day of cycle: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

.7–100
C .6–.8 F
.5–.6
.4–.4
.3–.2
.2–99
.1–.8
37–.6
.9–.4
.8–.2
.7–98
.6–.8
.5–.6
.4–.4
.3–.2
.2–97
.1–.8
36–.6

→ OVULATION

Appendix 6.

Actual no. of days			Norma-lised	Energy			Elation		
				High	Low	Av.	High	Low	Av.
1	June	17th	1	1	6	7	6	4	6	6
2		18th	2	2	5	7	7	5	7	6
3		19th	3	3	5	6	5	5	6	5
4		20th	4	4	5	7	6	4	7	6
5		21st	5	5	5	7	6	6	7	6
6		22nd	6	6	5	6	6	5	7	6
7		23rd	7	7	5	7	6	5	7	6
8		24th	7	8	6	7	7	6	7	6
9		25th	8	9	5	7	6	5	7	6
10		26th	9	10	5	6	6	4	6	5
11		27th	10	11	5	6	5	5	7	6
12		28th	11	12	6	7	6	6	6	6
13		29th	12	13	5	7	6	6	6	6
14		30th	13	14	5	7	6	5	7	6
15	July	1st	14							

Appendix 7.

The study started with 26 subjects. Of these 4 failed to complete the first month's records and 6 failed to stay in the study long enough to take part in the performance tasks. Their mood and energy data were not used in this study. Only mood and energy data provided by subjects who took part in the performance studies were analysed. The mood and energy data were collected in parallel with the performance data and came from the same subjects. It was impossible to pinpoint ovulation in the records of two subjects so their data were discarded. The remaining 14 subjects provided performance data but two of them failed to keep adequate mood and energy records, so only 12 subjects contributed to this analysis. In summary, the results for the performance measures are based on data provided by 14 of the original 26 subjects. The results of the mood and energy measures are based on data provided by 12 of these 14 subjects. Some S's provided data from more cycles than others. Therefore it must be emphasised that data reduction was carried out in such a way that each subject contributed only one score per cell in the analyses of variance presented.

Appendix 8.

The regression technique assumes a linear correlation between performance at one phase of the cycle and performance at any other phase of the cycle. On the basis of this assumption estimates for the slope of the regression line (m) and the value of the intercept (c) for the regression of the performance during the menstrual, premenstrual, pre-ovulatory or post-ovulatory periods on performance in the inter-menstrual period were calculated using standard formulae. Missing data were generated by applying the formula $y = mx + c$, where m is the slope of the regression line, c is the intercept and x is the score for that

subject in the inter-menstrual period. A check on the validity of this technique is provided by the fact that the performance of those subjects who provided data for all phases of the cycle closely resembled the performance curves obtained from the group data after substitution of missing values.

Appendix 9.

Individual comparisons were carried out, using the Newman-Keuls procedure (Winer, 1970), on the results for which overall significant F-ratios had been obtained.

1) **Analysis of the Elation Data (See Figure 4).**

Mood was significantly higher on the day of ovulation (day 1) than on paramenstrual days 12, 13, 14, 15, 16, and 19. Mood on the pre-ovulatory day (day 28) was significantly higher than mood on the first day of menstruation (day 15) and so was mood on cycle day 24.

2) **Analysis of the Energy Data (see Figure 5).**

Energy on the day of ovulation (day 1) was significantly greater than on the first and second days of menstruation (days 15 and 16), as was energy on the pre-ovulatory day (day 28). Energy on day 10 was also significantly higher than on the first and second days of menstruation.

3) **Analysis of Performance Data .**

a. Concept Formation (See Figure 6).

According to the Newman-Keuls procedure performance during the premenstrual period was significantly better than performance during the post-ovulatory period. However, the Newman-Keuls procedure is extremely conservative since it takes all possible comparisons into account, hence it may detect only extreme differences. To elucidate further the sources of the significant main effect the premenstrual performance was compared with the menstrual, and the pre-ovulatory with the post-ovulatory, using the procedure of orthogonal comparisons (Winer, 1970). This analysis

revealed that premenstrual performance was significantly better than

menstrual and pre-ovulatory performance was significantly better than

post-ovulatory (p 0.05 for both comparisons).

    b. Reaction Time (see Figure 7).

        Reaction time data were similarly analysed using the Newman-

Keuls procedure.   No individual comparisons were statistically significant.

When the orthogonal comparisons procedure was used menstrual performance

was found to be significantly worse than premenstrual and post-ovulatory

performance was significantly worse than pre-ovulatory.

Variations in Mood and Performance associated with the Menstrual Cycle

Ph.D. Thesis   **1977**

University of Leicester

M. Carey

A group of women, who were not using oral contraceptives, kept daily records of basal body temperature, mood and energy for periods varying from six months to two years. The women reported to the laboratory weekly at the same time to be tested on concept formation, digit symbol substitution, choice reaction time and rotor pursuit tasks. The mood, energy and performance data were normalised to a standard 28 day cycle firmly anchored around menstruation and ovulation, which was pinpointed by using the temperature curves.

Mood and energy were both found to be high around ovulation but low paramenstrually. No significant differences associated with different phases of the menstrual cycle, were found in performance on the digit symbol substitution and rotor pursuit tasks but performance on concept formation and choice reaction time was found to be good premenstrually and preovulatory but deteriorated following ovulation and during menstruation.

It is hypothesised that changes in estrogen levels may be responsible for the mood and energy levels observed; that the changes in performance are a function of the information load of the task and that this may be due to fluctuations in arousal across the cycle or to the direct effect of gonadotrophins upon information processing.

The generalisability of the data obtained from the sample studied was investigated using a menstrual questionnaire which was administered to 300 students.

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