HORMONES AND BEHAVIOUR DURING THE MENSTRUAL CYCLE

by

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Notice outside a temple
in Indonesia

"For to women, life itself is cyclic. The life force ebbs and flows in her actual experience, not only in nightly and daily rhythm as it does for a man but also in moon cycles, quarter phase, half phase, full moon, decline and so round to dark moon. These two changes together produce a rhythm which is like the moon's changes and also like the tides whose larger monthly cycle works itself out concurrently with the diurnal changes, sometimes increasing the swing of the tides and at others working against the tidal movement, the whole producing a complex rhythm hard to understand. In the course of one complete cycle, which most strangely corresponds to the moon's revolution, the woman's energy waxes, shines full and wanes again. These energy changes affect her, not only in her physical and sexual life but in her psychic life as well. Life in her ebbs and flows, so that she is dependent on her inner rhythm."

M. Esther Harding

"Woman's Mysteries"

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DECLARATION OF THE AUTHORS PARTICIPATION IN THE WORK SUBMITTED.

The composition of this thesis is that of the author, who was assisted in the design of the studies by Dr. J.H.J. Bancroft. The author was responsible for the organisation of the research, the design and testing of the rating scales and questionnaires, recruiting the volunteers, collecting the blood and urine samples and analysis of the data.

Radioimmunoassay of plasma LH and FSH was performed by H. Lothian. R. Leask performed the oestradiol and progesterone assays, D.W. Davidson and I. Cooper, the androgen assays, although the author assisted with this work.

C.T. Bäckström assisted with recruiting women from the Gynaecology Outpatients Clinic.

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ABSTRACT

The research described in this thesis aimed to investigate emotional and sexual variations experienced by women during the Menstrual Cycle including the phenomenon of "Premenstrual Tension", and relate such changes to the sex steroids, Oestradiol, Progesterone and Androgens.

An extensive and critical review of the literature indicates that confusing and conflicting evidence in the area of hormone-behaviour relationships in women relates primarily to methodological issues. In this study particular attention was paid to distinguishing women with different experiences of cyclical mood changes and to the measurement of hormones and behaviour.

The study involved a group of 55 women with normal regular menstrual cycles. One third of these were recruited from a gynaecology clinic after complaining of severe Premenstrual Tension, the "Clinic" Group. The rest were volunteers recruited from various sources. Half of these women also experienced cyclical changes, the "Report PMT" Group. The others, the "No PMT" Group, noticed no cyclical variations in wellbeing.

The women completed daily ratings of their moods, physical health, sexual feelings and sexual activities over one menstrual cycle. Frequent blood samples were taken and levels of Oestradiol, Progesterone, Testosterone and Androstenedione were measured using radioimmunoassay. The hormone measures were used firstly, to distinguish normal ovulatory cycles from those which were endocrinologically unusual or anovulatory; secondly, oestradiol and progesterone levels were used to divide each cycle into six

phases in order to relate behaviour to hormonally defined stages of the cycle; and thirdly to examine correlations between levels of hormones and ratings of moods and sexuality.

1. Moods and Premenstrual Tension.

The emotional and physical changes observed were consistent with the women's initial reports. The "Clinic" group showed significant changes in their wellbeing across the cycle phases. These women's moods and energy began to decline after ovulation, reaching the lowest point in the premenstrual phase. The volunteers who reported premenstrual tension showed a similar but less pronounced pattern, although their wellbeing declined later, in the mid luteal phase. As expected, there were no significant cyclical changes in moods in the women with no PMT : however, mild breast tenderness before menstruation was common.

PMT may be a more marked version of common and less problematical cyclical changes. A longer and more pronounced deterioration of moods and energy in the luteal phase with a decline in sexual interest characterised the clinical extreme of PMT.

The relationship between PMT and hormones was examined by endocrinological comparison of the three groups. There were no significant differences in levels of oestradiol, progesterone, or the ratio of oestradiol to progesterone. There were slight differences in the pattern of hormonal changes in the luteal phase:- in the "Clinic" group progesterone levels started to fall earlier and there was a greater drop in levels of oestradiol and progesterone in comparison with the other women.

Correlations between hormones and behaviour in the "Clinic" group indicated that low progesterone and changing levels in the luteal phase were related to lack of wellbeing, low energy and

physical distress. There was little relationship between oestradiol and moods although physical distress was related to low levels in the premenstrual phase. There were some correlations between androgens and energy.

The "Clinic" group differed from the other women in that they frequently had histories of adverse reactions to oral contraceptive agents and many of these women had experienced problems during and after pregnancy. This suggests that sensitivity to hormones may be an important factor in the aetiology of Premenstrual Tension.

The relationship between androgens and Premenstrual Tension was also examined and indicated some complex links. Women in the "Clinic" group appeared to have low androgen levels but further analysis revealed that this was related to their marital status and occupation rather than premenstrual tension. This leads to interesting speculations regarding the interrelationships between hormones, cyclical mood changes and social and situational factors.

2. Sexuality, Hormones and the Menstrual Cycle.

There was no evidence of any mid-cycle increase in any aspects of these women's sexuality. The main pattern was related to menstruation with a peak of sexual interest, feelings and woman-initiated activities after menstruation, in the mid follicular phase. Partner-initiated activities peaked after ovulation.

The pattern of sexual interest and activities was influenced by general wellbeing and energy. Women with a pronounced deterioration in wellbeing before menstruation were less sexually interested or active at this time but statistical analysis indicated that this was predominately related to general mood changes, particularly lack of energy.

Correlations between hormones and sexuality revealed some interesting and complex links. Oestradiol was not obviously related to sexual interest or activities but there were suggestions that Progesterone had an inhibitory influence. Correlations between Testosterone and sexuality were significant but negative. However for those women who masturbated, frequency of sexual activities was positively correlated with testosterone levels.

The implications of these hormone-behaviour correlations are discussed in a framework of interactions between social, psychological and hormonal factors contributing to behavioural changes during the menstrual cycle.

CHAPTER 1

GENERAL INTRODUCTION AND THE RELATIONSHIP BETWEEN HORMONES AND BEHAVIOUR

1. GENERAL INTRODUCTION AND THE RELATIONSHIP BETWEEN HORMONES AND BEHAVIOUR.

1.1 INTRODUCTION

The Menstrual Cycle has received much attention in academic and medical research for several reasons. One focus of interest is the physiological and endocrine mechanisms underlying female reproduction. This has been stimulated both by the need for fertility regulation and by the necessity for improved understanding and treatment of dysfunctions of the cycle such as infertility, amenorrhoea and dysmenorrhoea.

In recent years much needed attention has also been focussed on the more subjective aspects of women's experiences throughout the cycle. Mood and behavioural variations have frequently been remarked upon in the literature and are commonly accepted experiences amongst women themselves but there has been insufficient systematic investigation of this important area of women's lives. In part this is due to methodological difficulties inherent in research where rigorous control of all the variables is simply not possible. But, given the widespread folklore and frequent observations of cyclical changes in women, it is also likely that the poverty of our understanding reflects other factors such as taboos surrounding the discussion of emotions and sexuality and negative attitudes towards menstruation.

The work described in this thesis is an attempt to provide more description of cyclical behavioural changes in women, encompassing moods, sexuality and the phenomenon of "Premenstrual Tension" and relate such variations to the sex steroid hormones involved in the menstrual cycle.

1.1.1 The Importance of Studying Cyclical Changes in Women's Behaviour

(a) Cyclical Changes and Premenstrual Tension

Many women experience cyclical variations in how they feel, emotionally and sexually. Whilst for some, such variability is an

acceptable and enjoyable part of their lives, for other women the changes are distressing. The term "Premenstrual Tension" (PMT) has been coined to describe a state of psychological and physical discomfort which occurs regularly before menstruation. More seriously it is alleged that such incidents as suicides, examination failures, crimes, accidents and baby battering are influenced by this time of the cycle (Dalton, 1977).

It is important to evaluate the extent, nature and hormonal basis of cyclical changes and premenstrual tension, not only to understand the complexities and intricacies of our experiences as women, but for two other reasons. Firstly, women are gradually moving towards changing their role in society and competing in what traditionally have been seen as male spheres. There is much interest in our capabilities to fulfil this new role and especially the effects of those biological functions which distinguish us from men. Women are undoubtedly different, in that we have the potential for regular menstrual cycles, pregnancy and lactation, and undergo marked endocrine changes at the menopause. Some women clearly experience problems related to these events, but it is debatable and controversial whether such changes are either necessarily problematical to the majority of women or in any way incompatible with a variety of social roles.(1)

Secondly, given that a certain proportion of women do experience

Footnote (1) Harrison (1978) presents an interesting analysis of how women's biological functions were used in anti-suffrage arguments, claiming that women were unfit to have the vote (pp. 60-64). In an address to the Obstetrical Society of London in 1874 on the reasons for not allowing women into medical training: "Women are unfit to bear the physical fatigues and mental anxieties of obstetrical practice at menstrual periods, during pregnancy and puerperality." Unfortunately a century later the attitude still echoes in the statement of a Baltimore physician, Dr. E.F. Berman: "If you had an investment in a bank, you wouldn't want the president of your bank making a loan under those raging hormonal influences of that particular period" (Barnes, 1971). Other examples are given by Ruble et al, (1980), Tiger (1970) and Tavris and Offir (1977).

distressing changes associated with their cycles it is important to provide more description and definition of PMT, evaluate the role of hormones and use such knowledge to develop non-harmful and acceptable methods to alleviate these women's distress.

(b) The menstrual cycle in the context of fertility regulation

It has been suggested that the number of menstrual cycles experienced by women today is a "side effect" of technological and cultural evolution brought about by factors such as earlier menarche and a decline in the number of pregnancies and duration of lactation (Short, 1976). One approach to controlling fertility is therefore aimed at abolishing menstrual cycles and menstruation (Louden et al, 1977). It would seem important to consider all the advantages and disadvantages of the menstrual cycle, including women's own attitudes towards their cyclical variability (Miller and Smith, 1975) in evaluating such an approach to fertility control.

(c) The medical use of steroid hormones

There is an increasing use of natural and synthetic sex steroids for fertility regulation and therapies for a variety of problems such as premenstrual or postmenopausal distress, adverse effects of surgical ovariectomy and adrenalectomy and treatment of cancers (Fedor-Freybergh, 1974; Seaman and Seaman, 1978). Although we are assured that "medical" risks (e.g. thromboembolism or cancer) of oral contraceptives and hormone treatments are carefully scrutinised (e.g. Royal College of General Practitioners, 1974, 1977; Vessey and Doll, 1976) it is also important to evaluate how these agents effect women's emotional well-being and sexuality. Possible changes in these, although not medically dangerous, are nevertheless distressing and unacceptable side effects. Information about hormone–behaviour relationships during the menstrual

cycle will contribute to such an evaluation of these steroid hormones and their influences on more subjective aspects of health.

1.1.2 The Relationship between Hormones and Women's Behaviour: A Neglected Area?

The present thesis concerns the three groups of steroid hormones whose principal function in women is the regulation of the reproductive cycle. Oestrogens, Progestagens and Androgens are secreted mainly by the ovaries and adrenal glands in women. These hormones, their functions and variations throughout the menstrual cycle are detailed in the Appendix.

It is useful to distinguish two roles of the sex hormones: their role in sexual differentiation or "Organisational" effects and their role in maintenance and control of functions in the adult or "Activating" effects. For the former, hormones, mainly androgens, act at certain critical stages of development: this has been reviewed (Money and Ehrhardt, 1972; Money and Musaph, 1977). The concern here is with the second, activating role, which depends on the continued or recurrent presence of hormones. But these two roles are closely linked as the "organising" effects of a hormone may influence the tissue response to later "activating" effects of the same hormone.

Following sexual differentiation, hormones continue to control physiology, morphology and reproductive functions. Oestrogens, Progestagens and to a lesser extent, Androgens, regulate the structure and functioning of women's reproductive system, including ovulation and menstruation, fertilisation, pregnancy, birth and lactation.

But to what extent is behaviour, namely actions, thoughts, feelings and sexuality, controlled or influenced by hormones?

In recent years there has been an expansion in research and general interest in this area, obvious not only to those familiar with

the academic and medical literature but also from the popular press (Dalton, 1977, 1978, 1980; Lever, 1979; Reitz, 1979; Seaman and Seaman, 1978; Shuttle and Redgrove, 1978; Weideger, 1978; Wellburn, 1980). Even with this growth of interest our knowledge about hormone-behaviour relationships in women is limited.

There are several reasons for this. Firstly, the methodology used to investigate this area is, ethically and practically, limited. For example, much work on animals has involved experimental manipulation of the endocrine environment using surgical techniques and infusion or implantation of hormones (Davidson and Levine, 1972), techniques which cannot justifiably be used for humans. Instead we rely on studies of hormone fluctuations at different stages of life or "natural experiments" including surgical or medical interventions.

Such situations provide a rich source of information as to hormone-behaviour relationships in women and may well yield far more valuable data concerning real life than is obtained from the numerous laboratory experiments on animals.

However, only recently have we seen a move towards the development of techniques to measure both hormones and behaviour and many of these are still in their infancy. It is clear from the literature described below that the poor understanding in the area is often due to these methodological inadequacies. In the last 15 years radioimmunoassay techniques have been developed for the analysis of oestrogens, progestagens and androgens in large numbers of plasma samples, as described in the Appendix Section 2 . Radioimmunoassay replaces earlier methods involving bioassays, gas chromatography, protein saturation and displacement, which, whilst quite flexible, specific and accurate, were time consuming and required large volumes of plasma and so have hardly been used for work on humans. Instead

much research attempting to relate hormones to behaviour has relied on indirect and less accurate techniques of hormonal assessment.

Using radioimmunoassay it is now possible to make rapid and accurate hormone assessments on a large number of small samples of plasma. However, such techniques are relatively expensive and not always accessible and are only just beginning to be incorporated into the design of research on hormone-behaviour relationships.

The measurement of behaviour is a further difficulty for studies in this area. Human behaviour, particularly subjective aspects of our emotions and sexuality is of course complex and not easily observed or quantified. It is neither practical nor realistic to study such behaviour under controlled or restricted conditions, although psychophysiological techniques for laboratory assessments are gradually being developed (Heiman, 1975; Martin and Venables, 1980).(1) Instead we rely on the development of appropriate, reliable and valid measuring techniques such as questionnaires, interviews and self ratings to assess behaviour in real life.

A second reason for the lack of knowledge concerning hormone-behaviour relationships in women concerns social taboos about the discussion or investigation of "sensitive" areas such as emotions and sexuality. Rigorous investigations of human sexuality awaited the pioneering work of Kinsey et al (1953) and Masters and Johnson (1966) but subjective states have received little attention. There are comparatively few women doing research, and it is possible that this has led to a neglect of such issues as cyclical emotional and sexual changes and how these relate to hormones (Shuttle and Redgrove, 1978).

A third reason concerns the division of opinion as to the

Footnote (1). Appendix III gives details about psychophysiological techniques for the assessment of human sexuality

determinants of human behaviour. Obviously we are complex creatures and many factors will influence how we feel or act. The effects of early experience, learning, individual differences and social, cultural and environmental factors can be seen to override any possible hormonal influences. Many have assumed that hormones must therefore be irrelevant and have sought alternate explanations.

Clearly the relationship between hormones and behaviour is a complicated one and even in animals where the control of some behaviour patterns appears clear-cut, it is often hard to separate out biological from experiential and situational and social effects, especially as the complexity of the animal increases. Nevertheless the basic neurophysiological and endocrine mechanisms underlying the reproductive cycle are obviously vital to any understanding of behavioural variations, both within and between individuals. This is not to say that human actions can ever be reduced to a physiological level of explanation but more that these mechanisms are an integral part of the processes underlying behaviour.

When the subject of study is ourselves, we are dealing with real life and its complexities, but this should not deter us from asking the right questions about the influence of hormones on our behaviour and seeking the answers using appropriate methodological techniques. This research is an attempt to go further in this direction.

1.2 THE INFLUENCE OF SEX HORMONES ON EMOTIONS AND SEXUALITY

Considering the situation for women, although there are methodological, ethical and conceptual restrictions, there are several lines of evidence, to be discussed in this thesis, that hormones are important in their activating effects on behaviour. Women's endocrine processes are complex, and this complexity can lead to important and interesting data on hormone-behaviour relationships.

During pregnancy, lactation and at the menopause, there are substantial endocrine changes. Throughout the reproductive years, women's hormones change in a regular and predictable manner during the menstrual cycle. For a number of medical reasons some women undergo surgical removal of endocrine glands, and ovariectomy, adrenalectomy or hypophysectomy may have behavioural consequences. Hormones are often taken following such operations to counteract hormone deficiencies. In addition there is an increasing use of hormones, taken by women at the menopause and as oral contraceptive agents. Careful study of these hormonal variations and concommitant behavioural changes are vital for the understanding of how steroids influence women's emotions and sexuality.

Before reviewing these areas I shall discuss the work on animals, especially non-human primates, indicating areas of interest and concepts useful in the later evaluation of hormone-behaviour relationships.

1.2.1 Studies of Animals: Non Primates and Primates

Most work on non-human animals has concentrated on sexual behaviour and its relationship both to times of hormonal change and to specific hormones.

In Non-Primates, sexual behaviour is very much under hormonal control. The female will only be sexually active at particular stages of her hormonal cycle corresponding to ovulation when she is "on heat" or shows "oestrus" behaviour. Studies of removing endocrine glands and replacement of sex hormones have demonstrated the importance of oestrogens and progestagens. If the ovaries are removed sexual behaviour declines markedly. The pattern of the hormones involved varies between species. Female carnivores require oestrogens alone; in rodents oestrus is induced by oestrogens followed by large doses of progesterone; ungulates, in contrast, require oestrogens, preceded

by progesterone. The topic is reviewed by Eayers et al (1977), Fedor (1977) and Lisk (1973).

As the similarity of the animal to humans increases, the relevance of animal studies to elucidate the human situation increases. The hormonal cycles of many female primates is similar to the menstrual cycle of women and so it is of interest to consider the evidence for periodic sexual activity related to particular stages of the cycle. Whilst it is generally agreed that the sexual activity of species of primates such as the prosimians is strictly limited by the female cycle (Evans and Goy, 1968) there is less consensus about Old and New World Monkeys and the Great Apes. Social, individual and environmental factors play an increasingly important role in determining behaviour, masking endocrine influences or making them more variable. There are discrepant findings between free or captive animals and those studied in laboratory situations in the extent to which behaviour is hormonally controlled. Available information is also incomplete in that only relatively few species have been studied, and there are important differences between species which makes generalisations impossible (Rowell, 1974).

For some primates, such as the rhesus macaque, baboon and chimpanzee , the time of ovulation is marked by a degree of swelling, tumenescence and colour change of the female's external genitalia. This is the so-called sexual swelling and is obvious not only to the female and male, to whom it possibly has some sexual signalling function, but also to those making studies of cyclical behaviour in wild or captive animals where endocrine assessments are impossible.

The Rhesus monkey has been extensively investigated both in the wild and in laboratory studies. Although copulation has been observed all through the cycle, levels of sexual activity are generally higher

in the follicular phase, peak at ovulation at the time of maximal sexual swelling or colour change and decline during the luteal phase (Carpenter, 1942, 1964; Conaway and Koford, 1965; Keverne, 1976; Luttge, 1971; Michael et al 1972; Michael and Bonsall, 1977). A second peak has been observed prior to menstruation (Loy, 1970, 1971) and there are reports of oestrus periods in early pregnancy (Loy, 1970).

Baboons also have an external midcycle swelling which deflates 2 days after ovulation. The time-course of the swelling coincides with a period of intense heterosexual activity. During the luteal phase, sexual interactions are minimal (Hall, 1962; Rowell, 1967; Saayman, 1970; Seyforth, 1978). In Talopoin monkeys, similarly, mating occurs during sexual swelling (Rowell and Dixson, 1975; Scruton and Herbert, 1972).

In general monkey species that do not exhibit swelling provide less evidence that cyclical behaviour is related to hormonal changes. For example oestrus behaviour is commonly seen in languar females when they are actively seeking out males and mating but this may not necessarily be coincident with ovulation (Rowell and Hartwell, 1978).

The Great Apes also show some rhythmic changes in sexual behaviour although the patterns differ between species depending on factors such as the social composition of the group (Short, 1980). Chimpanzees for example live in mixed sex groups and sexual activity is maximal for a period of 10-16 days when sexual swelling is pronounced. Ovulation occurs towards the end of this time (McGinnis, 1979; Savage-Rumbaugh and Wilkerson, 1978; Tutin and McGrew, 1973; Van Lawick Goodall, 1968; Yerkes, 1939; Young and Orbison, 1944). Compare this with the situation in Orang-Utangs where males and females live separately for most of the time. At ovulation the female will seek out a male for sexual interactions, but avoids the males at other

times (Galdikas, 1979; MacKinnon, 1979; Nadler, 1980a). Gorillas live in groups composed of one male and a few females and sexual activities also depend on initiation by the females, the males being sexually disinterested most of the time. Initiation of mating fluctuates with the cycle and is maximal near ovulation (Harcourt et al, 1980; Nadler, 1980b).

Only a few studies have shown that the menstrual cycle affects any aspects of behaviour other than male-female relations and mating. Rowell (1963) records some cyclical changes in aggressive behaviour in rhesus macaques. The females are both more aggressive and more likely to get beaten up around menstruation. Homosexual behaviour may be related to the cycle with variations in female-female relations and mounting in rhesus monkeys (Ackers and Conaway, 1979) and gorillas (Nadler, 1980b).

The role of hormones in primates' sexual behaviour has been studied by observing the effects of removal of endocrine glands and replacement of various hormones (reviewed by Herbert, 1974, 1977; Keverne, 1976; Luttge, 1971). In the rhesus, ovariectomy results in diminished sexual activities which can be reinstated by giving exogenous oestrogen (Herbert, 1970; Zumpe and Michael, 1970). If progestagens are also given to oestrogen-treated females, sexual activities decline, mimicking the luteal decline (Herbert, 1974). Androgens given to ovariectomised females increases their activities but are not necessary for resumption of sexual behaviour following ovariectomy if oestrogens and progestagens are given in physiological doses (Michael et al, 1978). Adrenalectomised and ovariectomised animals, however, require both oestrogens and small doses of androgens for reinstatement of sexual activities (Everitt et al, 1971).

We have little information about how hormones influence sexual behaviour in the great apes although there are reports that

chimpanzees' sexual behaviour decreases after ovariectomy (Young and Orbison, 1944).

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Turning to the situation for humans, what is the evidence that womens' emotional wellbeing and sexuality are influenced by times of hormonal changes?

1.2.2 The Influence of Pregnancy, the Post-Partum Period and Lactation on Women's Emotional Wellbeing and Sexuality.

At these times, women experience significant changes in their hormones and it is of relevance to consider whether these are related to behavioural changes.

During pregnancy there is a massive increase in progesterone and oestrogen. Levels of these steroids fall dramatically after delivery and remain low during lactation until the resumption of menstrual cycles McNeilly et al, 1980; West and McNeilly, 1979). Prolactin levels are elevated during pregnancy and remain high throughout lactation.

Emotional variations during pregnancy have received little attention. One study of 93 women (Lubin et al, 1975) reports that they experienced more anxiety towards the end of pregnancy related, not surprisingly, mainly to physiological changes at this time. In the middle trimester these women reported less anxiety and greater emotional wellbeing, also found in the group studied by Baker (1967). There is more known about emotional changes after birth (Dalton, 1980; Kendell et al, 1976; Oakley, 1980; Pitt, 1968; Sandler, 1978; Treadway et al, 1969; Wellburn, 1980). A number of women experience a time of emotional upset or vulnerability following delivery characterised by mild depression, anxiety and emotional lability (Hamilton, 1962; Pitt, 1968; Yalom et al, 1968). For

some these "Baby Blues" continue for a longer time after birth and a small number experience major distress (Kaij and Nilsson, 1972). Interestingly, it is possible that such emotional changes occur some time after delivery and after the major hormone changes: women may experience the greatest depression, for example, 5 days after birth and the onset of any major emotional distress usually occurs after this (Cox and Kendell, personal communication).

There has been a number of retrospective and prospective studies of sexuality during and after pregnancy (Christensen and Hertoft, 1980; Falicov, 1973; Kenny, 1973; Lumley, 1978; Masters and Johnson, 1966; Morris, 1975; Robson et al, 1980; Solberg et al, 1973; Tolor and DiGrazia, 1976). The general impression is that women's sexual interest and activities decline as pregnancy progresses, the greatest change being a comparative loss of libido and sexual enjoyment in the third trimester. After birth some time may elapse before women feel that their sexuality is back to normal or prepregnancy levels (Christensen and Hertoft, 1980; Falicov, 1973; Kenny, 1973; Lumley, 1978; Robson et al, 1980). Indeed in Robson et al's group of 119 women comparing pre- and post-pregnancy frequencies of sexual activities, 91 reported a reduced rate at 3 months postnatally and 24 women reported this was still the case one year after birth.

Breastfeeding has received insufficient attention. Robson et al and Kenny (1973) did not find lactation to markedly influence sexuality, in contrast to the views of Newton and Newton (1972). In Masters and Johnson's group of 101 women, although 47 reported low sexual interest and responsiveness after birth, none of the 24 women who breastfed were in this group.

These studies of pregnancy, postpartum and lactation frequently make note of the marked individual differences in women's emotions and

sexuality at these times. Given such variability it is tempting to conclude that altered life-style, physiological consequences of pregnancy and physical wellbeing or discomfort will primarily influence womens moods and sexuality (Oakley, 1980; Wellburn, 1980). Other powerful factors include taboos against sexual activities during and after pregnancy (Ford and Beach, 1951; Murdock, 1967), often reinforced by professional "advice" (Limner, 1969).

However, given the large hormonal changes at these times it is possible that they influence womens' emotional or sexual wellbeing. Unfortunately there is little evidence with which to evaluate endocrinological effects, mainly because few studies have actually measured hormones and related these to appropriate assessments of behaviour. One exception is Nott et al (1976), who found little relationship between hormones and puerperal depression. They compared hormone levels before and after delivery in 13 women who experienced postnatal "blues" and 14 who did not. There was no differences in levels of oestradiol or progesterone or the oestradiol: progesterone ratio and no correlations between hormones and emotional lability, poor sleep or irritability. These findings do not support other theories:- Dalton (1971, 1980) is a keen proponent of the theory that the rapid progesterone drop and lack of adaptation to such hormonal changes are responsible for postnatal depression and severe emotional disorders. She also advocates treatment with progesterone and claims success for a number of women. Such, however, remain only theories, since there is no appropriate work to test these hypotheses.

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From this research 2 possibilities as to how hormones may influence emotional changes can be suggested. Firstly, some women may experience

some kind of withdrawal response to the rapid drop in hormones at birth, and secondly, there is a possibility that some kind of time lag is involved in the effect of a hormone change on emotions, suggested by Cox and Kendell's reports.

Considering the links between sexuality and hormones, no attempt has been made to relate sexual changes to hormone variables and the influence of hormones after delivery remains unclear.

1.2.3 The Menopause, Ovariectomy and Hormone Replacement

Towards the end of her reproductive years, between the ages of 40-60 a woman's menstrual cycles and endocrine pattern changes and eventually menstruation ceases at the menopause. Around this time cycles become shorter and ovulation stops. In the postmenopausal years the endocrine pattern is stable, marked mainly by a decline in levels of circulating oestrogens, although the extent of the decline varies considerably between different women (McLennan and McLennan, 1971). Since ovulation does not occur, progesterone levels remain low but androgen production from the ovaries and adrenals continues (Studd, Chakravarti and Collins, 1978).

This time of changes in plasma levels of sex steroids may be a period when some women feel different, emotionally and sexually, and the menopausal and postmenopausal years are acknowledged to be difficult for a proportion of these individuals. Studies have reported on the incidence of emotional problems (Campbell and Whitehead, 1977; Hallstrom, 1973; Jaszmann et al, 1969; Studd, Chakravarti and Oram, 1977; Utian, 1972, 1975). Emotional difficulties such as decreased wellbeing, fatigue and depression are more likely to be experienced prior to the menopause, with an improvement in the year or two after menstruation ceases (Ballinger, 1976; Bungay et al, 1980; Hallstrom, 1973; Jaszmann et al, 1969). There is little evidence that

this time is associated with an increase in serious emotional difficulties (Ballinger, 1975; Weissman and Klerman, 1977) although interestingly, general practice studies indicate that there is an increase in prescription of psychotropic drugs for women in the peri- and post-menopausal age group (Shepherd et al, 1966; Skegg et al, 1977).

There is evidence that some women experience a decrease in their sexual interest and activities after the menopause (Hallstrom, 1973; Pfeiffer and Verwoerdt, 1972) but vaginal dryness is commonly reported by these women (Utian, 1972) and so it is hard to establish whether sexual interest or libido per se declines or whether this is consequent on vaginal changes which make heterosexual activities less enjoyable. In contrast, there are reports that some women's interest in and enjoyment of sex increases after the menopause (Kaplan, 1974; Masters and Johnson, 1966; Kinsey et al, 1953). This could relate to many factors, one being freedom from the possibility of pregnancy. In addition if a woman has experienced marked emotional distress around the menopause, an improvement in her emotional wellbeing in the more stable postmenopausal years can also mean she feels more sexually interested.

It is by no means simple to evaluate possible hormonal influences on emotions and sexuality in the peri- and post-menopausal years and many of the hormonal, emotional and sexual changes interrelate in a complex fashion, such as the effects of mood changes and vaginal dryness on a woman's sexuality. However, attempts have been made to evaluate the influence of hormones in 2 ways. One is to relate hormone levels to associated behavioural changes; another involves examination of the effectiveness of hormone-replacement.

Studies relating women's hormone levels to emotional and sexual

changes have indicated that only vaginal dryness is linked consistently to lowered oestrogen levels, other emotional or sexual changes being secondary or more linked to other factors (e.g. Chakravarti et al, 1979; Dennerstein, Wood, Hudson and Burrows, 1978).

Consideration of the effectiveness of hormone replacement is a useful source of information (reviewed by Campbell, 1976; Schiff and Ryan, 1980). A few studies have made controlled comparisons of hormones with placebo (Bakke, 1965; Campbell and Whitehead, 1977; Dennerstein et al, 1978, 1979, 1980; Utian, 1972). There are varying reports as to beneficial effects on emotional wellbeing, one problem being that women experience emotional changes in the time preceding the menopause when cycles are irregular or abnormal, suggesting that fluctuating hormones rather than low levels may be involved (Ballinger, 1975). Hence one would not necessarily expect hormone replacement to be effective at this time. Controlled studies of oestrogens taken by perimenopausal women have not, with one exception (Fedor-Freybergh, 1977), found any significant sexual effect on vaginal dryness (Campbell, 1976; Campbell and Whitehead, 1977; Utian, 1972). Oestrogens are undoubtedly essential for maintaining a healthy vaginal epithelium but there is less certainty as to their effects on wider aspects of women's sexuality after the menopause.

Although women experience a small decrease in circulating androgens postmenopausally, their effects on moods and sexuality are unclear. Androgens have been reported to help women with loss of sexual interest (Studd et al, 1977) but this is hard to interpret given that testosterone is an important source of oestrogen after the menopause.

An important consideration in studies in this area is that the

menopausal years may be accompanied by significant changes in life. Social and cultural attitudes towards the ending of fertility and older women may well effect how a woman feels about herself and her sexuality (Reitz, 1979). One way to control for some of these factors is to evaluate the effects of surgical menopause. Although different from the menopause in several important ways, bilateral ovariectomy results in more clear-cut endocrine change (Dennerstein, Wood, Hudson and Burrows, 1978; Studd, Chakravarti and Collins, 1978). Adrenal production of oestrogens and androgens continues but the effects of removing the source of all ovarian steroids is to reduce circulating levels to below those of postmenopausal women.

After bilateral ovariectomy the changes women report are similar to those of the natural menopause: thus one response to the decline in oestrogens is vaginal dryness (Dennerstein, Wood, Hudson and Burrows, 1978; Utian, 1972) and emotional distress, depression and irritability are also experienced by a proportion of women (Rauramo et al, 1975). Apart from vaginal changes, the effects on sexuality appear more variable and there are conflicting reports in the literature. Some studies indicate that little decline in women's sexual interest, enjoyment or activities occurs after ovariectomy (Filler and Drezner, 1944; Kinsey et al, 1953; Schon and Sutherland, 1960; Utian, 1975; Waxenberg et al, 1959, 1960). In contrast, Dennerstein, Wood and Burrows (1977) found that 32 out of 89 women reported decreased sexual interest and activities as well as vaginal dryness following hysterectomy and bilateral ovariectomy, although it is not clear whether loss of sexual interest was secondary to the vaginal changes. A later report involving correlations between hormone levels and emotional, physical and sexual changes after ovariectomy (Dennerstein

et al, 1978, 1980) indicated that low oestrogens are associated only with vaginal changes, not with other aspects of physical, emotional or sexual wellbeing.

Some interesting findings emerge from controlled studies of hormone replacement following ovariectomy. Utian (1972) reports that oestrogens have a beneficial effect on overall wellbeing. Dennerstein (et al, 1978, 1980) has evaluated the influences of oestrogens and progestagens. She found that oestrogens enhanced women's emotional wellbeing, sexual desire and enjoyment, vaginal lubrication and orgasm frequency, effects which were decreased by a combination of oestrogens and progestagens. Progestagens alone tended to have opposite mood-lowering and sexually-inhibiting effects. A positive association was found between emotional and sexual wellbeing, but this association did not fully account for the influence of hormones on either aspect.

So it would seem that oestrogens and possibly progestagens are involved to some extent in women's wellbeing and sexuality after ovariectomy. This contrasts with the lack of predictable effects of exogenous steroids after the menopause, a difference which may relate to the fact that in comparison with the menopause, ovariectomy has a more dramatic effect on levels of circulating hormones since the main ovarian source is removed by the operation. Levels below a certain "threshold" will both influence how a woman feels and mean that small doses of exogenous steroids can exert behavioural effects. Above this threshold both the level of circulating hormones and exogenous hormones are less influential, although it may well be that this varies considerably between individuals.

These studies of hormone-replacement after ovariectomy have also indicated how specific hormones, namely oestrogens and progestagens,

may influence wellbeing and sexuality (Dennerstein et al, 1980) and it seems that progestagens somehow modulate the effectiveness of oestrogens / whereas progestagens alone have an opposite inhibitory effect.

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The widespread use of oral contraceptive agents for fertility control has provided a further source of information on the effects of exogenous oestrogens and progestagens on women's emotional and sexual wellbeing.

1.2.4 The Effects of Oral Contraceptives on Women's Emotions and Sexuality

An increasing number of women are using steroid preparations for fertility control (Diamond and Korenbrot, 1978) and although systemic effects and medical risks have been well documented (Royal College of General Practitioners, 1974, 1977; Vessey and Doll, 1976) there is less information as to how these agents influence more subjective aspects of wellbeing.

The oestrogens and progestagens in the combined oral contraceptive[1] result in suppression of endogenous oestrogens and progestagens but a high level of synthetic hormones. Endogenous androgen levels are also lowered (Ferin et al, 1978; Bancroft et al, 1980). Levels of the synthetic hormones are lowered on the pill-free days so there is cyclical withdrawal bleeding and on these days, endogenous oestrogens and androgens rise again, but are lowered again after the first day or two of the next pill cycle. Different preparations of combined pill vary in their dosage of oestrogens and progestagens, and also in the extent to which endogenous hormone levels are suppressed.

Footnote (1). There is little relevant research on sequential, triphasic or progestagen-only preparations so these will not be discussed here.

A certain proportion of women experience adverse emotional changes whilst taking the combined pill, such as feelings of depression, iritability, lethargy and mood swings. Estimates of incidence vary between 0-50% of pill users depending on the groups of women studied, types of preparation and criteria used to assess "adverse emotional changes" (Bardwick, 1976; Borland, 1972; Carey, 1971; Cullberg et al, 1969; Cullberg, 1972; Glick, 1967; Grant, 1970; Grant and Pryse-Davies, 1968; Grounds et al, 1970; Herzberg et al, 1970; Kane, 1968; 1976; Kane et al, 1967, 1969; Leeton, 1973; Leeton et al, 1978; Nilson and Almgren, 1968; Parry and Rush, 1979). Also some women may notice emotional changes on withdrawal of oral contraceptives (Bakke, 1965; Grounds et al, 1970; Kane, 1968; Kane et al, 1969).

However, there is much individual variability in responses to the pill, and there is also evidence that some women find it beneficial: pill-users report a lower incidence of PMT than non-users (Glick, 1967; Goldheizer et al, 1971; Grant and Pryse-Davies, 1968; Herzberg and Coppen, 1970; Kutner and Brown, 1972; Moos, 1968a).

There are a few controlled studies comparing the effects of a variety of pills with placebo (reviewed by Cullberg, 1972; Leeton, 1973; Silbergeld et al, 1971; Weissman and Slaby, 1973), necessary in evaluating hormonal influences unconfounded by the pills' contraceptive effects. Some studies suggest that emotional reactions, especially depression, are greater for women taking progestagen-dominant pills (Bakke , 1965; Grant and Pryse-Davies, 1968; Lewis and Hoghughi, 1969), which would be in agreement with Dennerstein et al's studies of ovariectomy and hormone replacement. However, this is not substantiated by Cullberg's (1972) well controlled trial. He compared placebo with 3 types of combined pills containing various doses of progestagens. More women reacted

adversely to the active compounds indicating that the steroids have some influence over and above a placebo effect. But there was no evidence of a progestagen-dose effect: on the contrary, there was a trend towards improvement of previous distressing cyclical emotional changes with the high progestagen doses and a higher frequency of distressing changes was apparent in the women taking oestrogen-dominant pills. This was also reported by Goldzeiher et al (1971).

One finding of particular interest from Cullberg's study was that only women with a history of PMT, mainly irritability prior to menstruation, noticed adverse changes on the oestrogen-dominant pills, and these women felt better taking the more progestagenic agents. Many studies do report that woman with a predisposition towards depression or emotional difficulties are more likely to react badly to the pill (Herzberg et al, 1970; Leeton, 1973; Weissman and Slaby, 1973). It could be that the pill's effects are dependent both on the steroids and on a woman's sensitivity to hormone changes possibly manifested as PMT or predisposition towards depression prior to taking the pill. But, there is, unfortunately, insufficient data with which to evaluate this important and interesting possibility.

Turning to the effects of oral contraception on women's sexuality there is also a somewhat confused and conflicting picture.

A number of women report alterations in their sexual desire, interest, activities and capacity for orgasm whilst taking oral contraceptives (Bancroft, 1974, 1977, 1978, 1980; Bragonier, 1976; Glick, 1967; Grant and Mears, 1967; Grant and Pryse-Davies, 1968; Herzberg et al, 1971; Kane, 1968; Kane et al, 1967). In a small double-blind cross-over trial of a combined pill versus placebo, Leeton, McMaster and Worsley (1978) found the active pill was associated with a decrease in sexual interest, not related to

emotional changes or depression. On the other hand a large proportion of users experience no apparent adverse effects and of course the contraceptive efficiency of the pill will undoubtedly influence a woman's sexual activities (Westoff, Bumpass and Ryder, 1969). Cullberg (1972) in the controlled trial described above, reported that loss of sexual interest was only secondary to mood changes experienced by some women and not influenced per se by the steroids.

In contrast, some studies have found adverse sexual effects to occur more often in women using strongly progestational agents (Carey, 1971; Dennerstein and Burrows, 1976; Grant and Mears, 1967; Grant and Pryse-Davies, 1968; Grounds et al, 1970; Kane, 1968; McCauley and Ehrhardt, 1976) which would be in agreement with what is already known about progestagens' effects, from the discussion of hormone-replacement (Dennerstein et al, 1980). However, given the conflicting findings it is unclear whether any sexual changes are due to the effects of the steroid or whether other mechanisms are involved, such as loss of libido being secondary to mood changes.

An alternative is to consider the influence of the decline in endogenous hormone levels consequent on taking oral contraceptive agents. This has only been considered in one study to date. Bancroft et al (1980) compared 20 women with sexual difficulties attributed to the pill with a matched group of woman with no problems and found androgen levels to be identical in the 2 groups. Attempts to improve the womens' sexual interest with exogenous androstenedione met with poor results in all but one woman. However, an interesting finding to emerge from this study was that several woman reported feeling more sexual in their pill-free week which coincided with substantial rises in endogenous oestrogens and androgens. This

sexual improvement on pill-free days was also reported by Adams, Gold and Burt (1978). This could be interpreted either as a result of rising endogenous hormones at the end of the pill cycle or as a release from any inhibitory or adverse effects of the synthetic constituents of the pill.

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So, although a certain proportion of women do experience problematical distressing sexual changes whilst on the pill, the contribution of hormones is unclear. It is debatable whether such sexual changes are secondary to emotional consequences of the pill or whether the steroids themselves exert a libido dampening effect in some women. Of interest are studies indicating that strongly progestational agents are more likely to cause problems which is in agreement with other data described in this chapter. If this is the case then the increase in sexual interest in the pill free days may represent release from these inhibitory effects of progestagens. Alternatively the effects of the constituents of the pill on women's endogenous steroid levels cannot be disregarded.

1.3 SUMMARY: THE RELATIONSHIP BETWEEN HORMONES AND BEHAVIOUR IN WOMEN

The relationship between hormones and behaviour in women is an interesting and important but neglected area and the available data tends to be confused and contradictory. Although studies of non-human animals have indicated that the sex steroid hormones, oestrogens, progestagens and androgens, play a role in activating or controlling adult behaviour, especially reproductive behaviour, the situation is less clear for humans, for various reasons. Firstly, we are only just beginning to see the development of the methodology appropriate to this area; secondly, taboos surrounding the investigation

of sensitive and subjective areas such as emotions and sexuality have meant that questions have simply not been asked concerning the involvement of hormones; and thirdly, many other factors serve to mask or obscure the influence of hormones and one must always allow for the social, cultural and individual determinants of our behaviour. There are, however, several lines of evidence that hormones may influence women's behaviour. Both the complexity of our natural endocrine processes and the increasing degree of medical intervention in the form of surgical and hormonal manipulation lead to a rich but unexploited source of data on hormone-behaviour relationships. The area can be approached by asking whether times of hormonal changes are accompanied by behaviour variations and what the contribution of hormones is to such behavioural changes.

There is little doubt that at least some women do experience alterations in their emotional and sexual wellbeing at times when marked hormonal changes occur, but since we are dealing with the complexities of human behaviour in a social context such changes are neither predictable nor common to the majority of women and there are substantial differences between individuals. Nonetheless the literature yields intriguing possibilities and directions for further questions and research.

Considering which hormones might contribute to behavioural changes certain themes emerge from the literature which indicates that hormones may indeed influence some women. This literature also stimula further interest in specific directions. Studies of primates demonstrate that oestrogens and androgens are involved in promoting sexual behaviour whereas progestagens have an inhibitory influence. There is some indication that this may be the case for women from the literature on hormone replacement following ovariectomy

and the effects of oral contraceptive agents.

It is possible that specific steroids influence womens' emotional wellbeing, oestrogens having a mood-enhacing effect, progestagens tending to cause depression but these effects are neither clear-cut nor predictable. An individual's sensitivity to hormones and her own endogenous hormone levels may be involved in her response to exogenous steroids. The level of exogenous hormone itself may not always be the crucial factor in mediating its effects, but rather the change in exogenous or endogenous steroids.

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In the next chapter I turn to the literature on the menstrual cycle and evaluate cyclical emotional and sexual changes in women and how these relate to the sex steroids.

CHAPTER 2

THE MENSTRUAL CYCLE: EMOTIONS AND SEXUALITY AND THE RELATIONSHIP TO SEX STEROID HORMONES

2. THE MENSTRUAL CYCLE: EMOTIONS AND SEXUALITY AND THE RELATIONSHIP TO SEX STEROID HORMONES

2.1 EMOTIONAL VARIATIONS DURING THE MENSTRUAL CYCLE

"Varium et mutabile semper femina"

Virgil

"The fault was Nature's fault
not thine,
Which made thee fickle as
thou art...."

Lord Byron
"To a youthful friend"

2.1.1 Introduction

It is clear from common knowledge and experience that at least some women notice that their moods change in a predictable cyclical manner. Generally the time prior to menstruation will, for these women, be marked by a "negative" mood state in contrast to more optimistic, cheerful and energetic feelings after menstruation. To the majority such mood changes are by no means a problem but more a part of our individual variability. However a number of women experience more extreme and distressing moods in the days before menstruation, often accompanied by physical discomfort. The combination of emotional and physical changes is known as "Premenstrual Tension" (PMT). As well as being an example of the complex interactions between physiological or endocrine processes and psychological functions, the area is important in presenting a problem of significance to those concerned with treating PMT and experimental reports appear as far back as the 1930s (Frank, 1931; McCance et al, 1937; Benedek and Rubenstein, 1939a,b).

Many aspects of women's behaviour have been studied in relation to the menstrual cycle, as summarised in Table 1. The discussion here will be restricted to emotional variations during the cycle and

Table 1

ASPECTS OF BEHAVIOUR MEASURED IN RELATION TO THE MENSTRUAL CYCLE

I Emotional Changes

Happiness & Wellbeing	Tension
Energy	Irritability
Euphoria	Anxiety
Sociability	Depression
	Tiredness

(Reviewed by:- Bardwick, 1971, 1974, 1976; Dennerstein & Burrows, 1979; Messent, 1976; Moos, 1968b, 1969; Neu & DiMascio, 1974; O'Connor, Shelley & Stern, 1974; Parlee, 1973, Shuttle & Redgrove, 1978; Smith, 1975, 1976)

II Performance

Typing skills	Performance on Laboratory Tasks
Production in factories	Self reports of concentration & efficiency
Absenteeism rate	Athletic performance
Examination performance	Ability to walk the tightrope

(Reviewed by Gambergale et al, 1975; Redgrove, 1971; Sommer, 1973)

III Behavioural Changes

Crimes	Exacerbation of psychological disturbances
Accidents	Admission to psychiatric institutions
Suicides	Misbehaviour at school
Examination failures	Volunteering for research projects

(Reviewed by Dalton, 1977)

IV/

Table 1 (contd.)

IV Physical Changes

Hormones in blood & urine	Endometrial & cervical changes
Breast tenderness	Asthma
Swelling	Allergies
Headaches or Migraine	Rashes
Fluid retention	Acne
Body weight	Epileptic attacks
Sulphur compounds in the breath	Blood glucose levels
Breast Volume	Sleep patterns

(Reviewed by Southam & Gonzaga, 1965; Smith, 1975)

V Sensory Changes

Taste	Temperature sensitivity
Touch	Breast sensitivity
Visual Acuity	Changes in the Autonomic Nervous System
Sweetness Preference	
Sensitivity to sounds	
	Sexual arousal

(Reviewed by Henkin, 1974; Little & Zahn, 1974)

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the relationship to hormones.

Despite many anecdotal reports on mood changes and the wealth of folklore and superstition concerning womens variability, the literature presents a rather confused and conflicting picture. Several reviews of mood and behavioural changes during the menstrual cycle have appeared recently (Abplanalp et al, 1980; Bardwick, 1971, 1974; Dennerstein and Burrows, 1979; May, 1976; Melges and Hamburg, 1977; Moos and Leiderman, 1978; Parlee, 1973; Smith, 1975, 1976; Sommer, 1973). Although these authors have attempted to draw conclusions as to the nature and extent of cyclical emotional changes in women, such attempts have generally been inconclusive in that studies aimed at measuring these phenomena either conclude that cycle-related variability is pronounced or incapacitating for the majority of women or have failed to demonstrate that mood changes bear any relationship to the phase of the cycle.

The methodology and results of these studies are summarised in Table 2. Various conceptual and methodological issues in this area of research lead to the positive and negative reports of emotional changes and the menstrual cycle.

2.1.2 Conceptual and Methodological Issues

2.1.2.1 The distinction between mood changes and PMT

In the studies cited in Table 2, it is often unclear which aspects of cycle related changes are of interest, an unresolved issue being the lack of distinction between "normal" or non-problematical mood changes and those which are defined as PMT.

It seems that many studies under the rubric of "moods and the menstrual cycle" have often been concerned more with PMT. This has several consequences. One is that the women acting as subjects in these experimental investigations experience many different degrees or

Legend to Table 2

Summary of studies assessing women's moods during the menstrual cycle showing peaks of moods in relation to menstrual cycle phases.

For ease of tabulation, phases were assigned as follows:-

Cycle Phases

PM - Premenstrual: week preceeding menstruation

M - Menstrual: week beginning with onset of menstruation

F - Follicular: week following menstrual week

O - Ovulatory or Midcycle: days 14-15

L - Luteal: week following midcycle

Arrow pointing up (↑) indicates increasing mood

Arrow pointing down (↓) indicates decreased mood

N = Number of Cycles

types of emotional variations. This is further confounded by the frequent use of self-selected populations and it is possible that women who are aware of their own changability are more likely to volunteer for research on the menstrual cycle. Few studies of normal or non-problematical mood variations have properly attempted to screen for women with pronounced or distressing changes and include only women with no obvious disturbances, exceptions being Abplanalp et al, (1979a,b), Ivey and Bardwick (1968) and Wilcoxon et al, (1976).

Another consequence is that major consideration has been given to the gloomy emotions such as depression, irritability, tension and anxiety. Unfortunately the philosophy underlying much research in this area is a "medical model" and hence a focus on pain, discomfort and bad moods. This is to overlook the fact that the menstrual cycle is bound to be experienced by about half the world's population at some time in their lives. To take concepts derived from the medical study of illness affecting a minority of people is to put women's experiences into a very narrow framework. Guided by this model we end up with a large amount of research dealing with negative mood states. Further, many workers have concentrated only on the premenstrual phase rather than studying women's changes in the context of the entire cycle (exceptions being Abplanalp et al, 1979a,b; Bardwick, 1973; Gottschalk et al, 1962; Oakes, 1970; Paige, 1969, 1971; Wilcoxon et al, 1976).

2.1.2.2 Definitions of moods and methods of assessment

As shown in Table 1, many different aspects of physical state and behaviour have been measured in relation to the cycle. Physiological changes are directly observable or readily quantifiable using appropriate psychophysiological techniques (Martin and Venables, 1980); and performance on tasks is also relatively easy to objectify

and measure. Some of the more concrete evidence for women's cyclical variations has therefore come from measures of physical state or propensity to perform certain actions.

However subjective emotional states are not readily defined, observed or measured. The moods of interest, such as "difficulty in concentrating", "feeling down" or "increased tension" can be described in many ways and definitions are as numerous as the studies, making comparisons or generalisations impossible.

A variety of different techniques have been used to assess emotional changes and these will be considered in some detail.

(a) Thematic or content analysis of speech

This is an interesting method which has been used in several studies of the menstrual cycle. Women talk into a tape recorder about "any life experience" and the experimenter analyses the content of the soliloquy for levels of "hostility directed outwards" or "anxiety" or any themes of interest (Gottschalk et al, 1962; used by Ivey and Bardwick, 1968; Paige, 1969, 1971).

Benedek and Rubenstein's classic studies (Benedek and Rubenstein, 1939a,b) also involved similar "content analysis". They looked for emotional themes in discussion of dreams during analytic sessions with a group of women undergoing long term psychoanalysis. Although claiming to be able to predict the stage of the women's cycle (independently assessed using vaginal cytology) solely on the basis of dream reports, Benedek (1963) later noted the difficulty she had in formalising what it was in the records which allowed such precise predictions. Lack of operational definitions, combined with the unusual group of women studied, makes it hard either to repeat such work or make direct comparisons with others.

(b) Many studies have used Retrospective Questionnaires or Interviews to correlate emotional changes or behaviour with menstrual cycle phases, examples being Coppen and Kessel (1963) and Sutherland and Stewart (1965). Questionnaires used in these studies are not considered to be well-developed psychometric instruments since no data on their reliability or validity is available.

The Moos "Menstrual Distress Questionnaire" (M.D.Q.), consists of 48 items describing "a symptom that women sometimes experience", rated along a 6-point scale of severity. The items fall into scales labelled "pain", "water retention","arousal", "behavioural change", "negative affect", "concentration", "autonomic reactions" (Moos, 1968b, 1969).

The M.D.Q. is the most comprehensive available and has been widely used, both retrospectively and daily (e.g. Sampson and Jenner, 1977; Silbergeld et al, 1971) as evidence for cycle-related changes in these dimensions of women's experiences.

There are three criticisms of such a questionnaire (Parlee, 1974). Firstly, it concentrates too much on the negative and ignores the positive aspects of emotional life and as such is more applicable to the assessment of PMT rather than general mood changes. Secondly, it may measure more stereotype beliefs and expectations about cycle-related changes rather than women's actual experiences, especially when used retrospectively. There is much evidence to indicate that "demand characteristics" and "subject-expectations" can influence the results of research (Rosenthal and Rosnow, 1969). One can debate the idea that subjects will claim to experience phenomena which are not in fact observable merely because she or the experimenter expects her to do so. But one cannot ignore the powers of expectations and suggestions especially within the "experimental context" (for an illustration, see

Ruble, 1977). For example it is reported that whilst self-reports indicate that women experience an impairment in their cognitive abilities during and before menstruation, objective performance measures have failed to demonstrate such changes (Sommer, 1973).

This leads to the third criticism, which is a general point about retrospective questionnaires. It is possible that memory may influence the accuracy of responses to questionnaires, and McCance (1937) points out that the discrepancy between retrospective and daily reports is "so frequent that they throw considerable doubt upon the value of any work on this subject based on history or questionnaire". Several other studies (e.g. Abplanalp et al, 1979a,b; Brockway, 1975) have also described such a discrepancy.

Unfortunately retrospective questionnaires have been a large source of evidence for behavioural changes during the menstrual cycle and their methodological soundness should be carefully considered in evaluating the relevance of such data.

(c) Daily self-reports of emotional state

In comparison with others this method is a more appropriate way of assessing day to day variations of moods. It is no doubt more accurate to assess moods over a short time span such as one day rather than attempt to recall over a longer time. Common sense, reports from subjects attempting to use both methods in assessments of moods (Mackay, 1980) and discrepancies between daily and retrospective questionnaires described above testify to this (Brockway, 1975).

The issue of whether daily questionnaires are influenced by the individual's expectations or attempts to fulfil the "experimenter's hypothesis" is a complex point. No doubt individuals can respond inaccurately or in a biased way to questionnaires but when completing daily records it would be necessary to continue to do so over a longer

time and it would therefore be less likely that daily or frequently-used questionnaires would be influenced by this effect.

Two studies have indicated that responses to daily questionnaires are both accurate and more reliable than retrospective reports. In the first, Udry and Morris (1967) collected daily records of sexual activities from a group of women over several months. The accuracy of the women's reports was corroborated by independent checks involving sperm searches in urine samples. In a second study (Bäckström et al, 1981), a group of 7 women completed daily ratings of their physical and emotional wellbeing before and after hysterectomy. Cyclical changes experienced by all the women before the operation were found to persist afterwards, even though they were unaware of the stage of their ovarian cycle and hence anticipation of menstruation could not have influenced the daily ratings. 5 of these women were unaware of th persistence of such cyclicity after the operation.

Some of the studies in Table 2 have used daily assessments of moods although interpretation and comparison of the results is confounded by the diversity of techniques used. Tests include those designed to assess "clinical" states of anxiety or depression, those assessing a range of moods and ones devised by individual researchers (reviewed by Dennerstein and Burrows, 1979).

2.1.2.3 The Definition of Cycle Phases

A further difficulty in research relating emotions to the menstrual cycle is that of specification of cycle phases corresponding to known hormonal changes. Generally researchers are interested in events during menstruation when levels of steroids are low; or at ovulation corresponding to the peak of oestrogens; during the luteal phase when oestrogens and progesterone are elevated; or during the

premenstrual phase when hormone levels fall. As shown in Table 2, the definitions of such phases are not consistent between studies, often ambiguous and usually not objectively or physiologically determined. The menstrual cycle is very variable in length, duration of phases and levels of hormones (Cargille, Ross and Yoshimi, 1969; Dyrenfurth et al, 1974; Treolar et al, 1967; Vollman, 1977) so that precise specification of the timing of principal endocrine events is only possible with direct physiological data, preferably using appropriate measurements of these hormones of interest.

However in this area of research we find that cycle phases have frequently been assessed only by reference to dates of menstruation, which, whilst appropriate for the analysis of events near this time is not sufficiently accurate for hormonal changes during the rest of the cycle. For example, ovulation does not always occur at a fixed 14 days before menstruation, contrary to usually held assumption, but may be more variable across individuals (Landgren, Unden and Diczfalusy, 1980).

Also the incidence of anovulatory or unusual cycles may be quite high, especially in younger women (Metcalfe and MacKenzie, 1980; Döring, 1969; Sherman and Korenman, 1974) and it is possible that a number of these may be classified as and included with normal ovulatory cycles. The effects of such endocrine patterns on women's emotional variability is uncertain (Smith, 1975; Adamopoulos et al, 1972).

After ovulation, basal body temperature rises and this has been used to time ovulation and to define cycle phases. Whilst better than calendar dates alone, it may not be a sufficiently accurate predictor: not all women show the thermal rise during an ovulatory cycle (Oster, 1972; Johansson et al, 1972) and Lenton et al (1977) could accurately assess ovulation by this method in only 34% of cycles known to be

ovulatory. Another indirect method is the measurement of oestrogens using cytological indices of vaginal smears, used by Benedek and Rubenstein (1939a,b). Before the introduction of assay techniques this was an advanced method and its use demonstrated awareness of the necessity for hormone measurement in research on the menstrual cycle. However, as for the thermal rise at ovulation, it is not a consistently reliable method.

Unfortunately such vague and inaccurate methods have been used in many studies of the menstrual cycle, leading to difficulties in interpreting the data. Udry and Morris (1977) have demonstrated that the method used to divide the cycle into phases can influence the patterns of behavioural change observed, also commented upon by Doty (1979) and it is important to distinguish anovulatory or unusual from normal, ovulatory cycles.

Hence to make valid correlations between behaviour and cycle phases it is necessary to determine the endocrine status of the individual woman, using reliable, accurate and sensitive assessments. Radioimmunoassay of the steroids of interest is a prerequisite to appropriate research on the menstrual cycle.

2.1.3. Moods, Hormones and the Menstrual Cycle

Given the methodological inadequacies and difficulties in research in this area, it is hardly surprising that there is little data on the influence of specific sex hormones on women's emotional changes. Only two studies to date have been specifically concerned with this issue and have used appropriate methodological techniques.

Persky (1974 and Persky et al, 1976) studied 29 women screened for psychological or physical problems. They were tested on 3 occasions during one menstrual cycle, corresponding to the early

follicular, ovulatory and late luteal phases as assessed by both basal body temperature and plasma levels of oestradiol, progesterone and testosterone. Psychological tests included a mood check list assessing anxiety, depression and hostility, Beck's depression inventory and the M.D.Q.

Interestingly there was little change across the 3 testing occasions for the psychological measures. They also attempted to relate psychological changes to various hormones. There appeared to be some relationships between the ratio of progesterone to oestradiol in the late luteal phase and measures of depression and between plasma testosterone and assessments of "hostility" and "aggression".

Negative findings regarding cyclical changes are also reported in another study of moods, hormones and the menstrual cycle (Abplanalp et al, 1979a,b). 33 women completed daily ratings of their moods over one menstrual cycle. 14 of these women had regular blood samples taken for assessments of LH, oestradiol and progesterone enabling accurate division of their cycles into hormonally-defined phases. These women showed no significant changes across 3 cycle phases defined as "menstrual", "intermenstrual" and "premenstrual" in almost all aspects of their moods although some of the women did report that they usually noticed cyclical changes as assessed by ratings on the M.D.Q. completed prior to the study (Abplanalp et al, 1979a).

Considering the cycles which were accurately divided into hormonally-defined phases again there were no significant differences during the cycle in the women's ratings of their moods. Correlations between psychological measures and absolute levels of hormones failed to reveal any significant relationships (Abplanalp et al, 1979b).

To date, these are the first attempts to consider a broad range of moods in groups of healthy women and relate mood variations to both

hormonally-defined phases of the cycle and specific measures of hormones. Whereas some other studies have found that womens moods vary during the cycle, Abplanalp et al and Persky report that no such changes occurred in their subjects. The discrepant findings might relate to the inaccuracies inherent in other studies which have failed to assess cycle phases. Alternatively it is possible that the lack of cyclicity was due to the fact that in both studies the women were carefully screened for any psychological disturbances whereas other workers include a wider range of individuals and if such screening tests included items such as "emotional instability" or "variability" this would systematically exclude women experiencing cyclical variability.

2.1.4 Conclusions

The menstrual cycle is a rich source of information as to how natural fluctuations in the sex steroid hormones might influence womens emotional wellbeing but there is insufficient information with which to evaluate this area. Two approaches can be adopted: firstly, to consider whether women experience cyclical emotional variations and secondly, whether such variations relate to specific hormones involved in the menstrual cycle. But having reviewed the literature in this area it is clear that neither issue has been appropriately tackled. Instead we find a confused and conflicting picture of womens mood changes and their relationship to hormones. Much of this is related more to inadequate methodologies than faulty hypotheses. Careful attention must be paid to the measurement of both moods and hormones and also to the groups of women studied before we can expect to make progress in this area. The research described in this thesis is an attempt to move forward in these directions.

Pablo Picasso

LA FEMME QUI PLEURE

2.2 PREMENSTRUAL TENSION AND THE ROLE OF HORMONES

It is not clear whether the phenomenon of Premenstrual Tension represents a distinct entity or a more extreme version of less problematical mood changes experienced by a proportion of women during the cycle (Wendestam, 1980). PMT has attracted interest both as a problem of clinical significance and as an example of complex interactions between hormones and behaviour and several reviews of the research literature have appeared (Abplanalp et al, 1980; Dennerstein and Burrows, 1979; Janowsky et al, 1966, 1971; Haskett et al, 1980; Parlee, 1973; Smith, 1975, 1976; Sommer, 1978; Steiner and Carroll, 1977; Tonks, 1975). Studies have attempted to describe and define PMT, evaluate how many women experience it and relate such cyclical variations to hormonal changes during the menstrual cycle.

2.2.1 The Definition of PMT

The term PMT has been used widely and it is of interest to consider some of the descriptions and definitions in the literature. Minor premenstrual changes were described by Greek physicians at the time of Hippocrates. An early view is quoted by Ricci (1943):-

> "The menses are about to occur when a woman feels somewhat uneasy on walking, when a feeling of heaviness appears in the loins. Some develop a torpor, yawning and pandiculation whilst others develop nausea and a loss of appetite."

Frank (1931) introduced the term "Premenstrual Tension" to describe a specific and severe change in mood and wellbeing in the 7 to 10 premenstrual days:-

> "...a feeling of indescribable tension ... unrest, irritability," "... like jumping out of the skin." "... a desire to find relief by foolish and illconsidered actions."

Figure 1

PREMENSTRUAL TENSION

I	One or a combination of the following feelings:-	
	PSYCHOLOGICAL	PHYSICAL
	Depression or feeling down	Breast Tenderness
	Anxiety	Swelling or Bloated feelings
	Tension	Headaches
	Irritability	Aches or Pain
	Tiredness	Rashes
	Impaired Concentration	Changes in appetite
	Sleep Disturbances	
	Changes in Sexual Interest	
II	The feelings occur regularly every or almost every month.	
III	The feelings start 1-14 days before menstruation and disappear when menstruation starts.	
IV	The woman feels emotionally and physically well at other times.	
V	The feelings cause distress or problems.	

Israel (1938) claimed that PMT was "a cyclic alteration of personality". He described tension, unreasonable emotional outbursts, ceaseless crying spells, insomnia, vertigo, headaches and "nymphomania". Sutherland and Stewart (1965) describe PMT as "any combination of emotional or physical features which occur cyclically before menstruation". Dalton (1977) uses a more practical definition aimed at deciding whether to treat women attending a PMT clinic. A combination of depression, irritability, anxiety, lethargy, headaches, backaches, breast tenderness, aches and pains, acne, hayfever, asthma or epilepsy, occurring in four or more consecutive cycles, around the four premenstrual and four menstrual days and being incapacitating enough to the woman concerned to warrant medication merit her label of the "Premenstrual Syndrome".

Although there has been a fair amount of research in this area there is no generally agreed definition of PMT. There has been repetition of certain features but there is no consensus as to which are essential and which are more variable. Figure 1 gives a general description of some of the more frequently quoted aspects. The major problem in this area mentioned above is that such changes can be experienced to some degree by many women during the menstrual cycle but it is uncertain whether the severity of such changes alone accounts for their experience as the distressing phenomenon of PMT or whether it is qualitatively different from less pronounced variability.

A further issue concerns whether PMT is a unitary phenomenon, describable as a "syndrome" or whether different women experience different types or categories of changes (Moos and Leiderman, 1978). For example, Abraham (1978) distinguishes 4 subgroups of PMT: women with fluid retention, experiencing oedema, bloating, sore breasts and weight gain; experiences related to impaired carbohydrate

metabolism, with changes in appetite, sugar cravings, headaches and dizziness; feelings of anxiety, tension and irritability; and a 4th group of women experiencing primarily depression before menstruation. Backstrom et al distinguish between feelings of premenstrual tension and anxiety and those of depression.

One important and often overlooked distinction is between "Clinical" and "Non-Clinical" groups. Studies of PMT have been concerned both with women seeking medical treatment and those who report cyclical changes, often of a distressing nature, when asked in the context of research but have not labelled themselves as requiring treatment. There may be important differences between these groups, either in the nature of their variability or the characteristics of the women. We are unsure as to whether the experiences of "Clinical" groups are qualitatively distinct from those of women who find PMT less problematical or whether the difference is one of severity. Alternatively it may reside in the women's lifestyle or ability to cope with cyclical mood changes. Such questions have not been evaluated.

The relationship between sexuality and PMT has received little attention. Although a premenstrual decline or increase in sexual interest is remarked upon there has been insufficient systematic study of such changes or the relationship between libido and emotional and physical aspects of PMT.

Wendestam and Ohman (1980) studied 40 women with marked PMT. Half these women experienced a loss of sexual interest in the premenstrual phase but a quarter reported increased libido. The decline in sexual interest was related to depressive mood changes.

The relationship between PMT and sexuality is discussed further below (section 2.3.1.3).

2.2.2 The Prevalence and Effects of PMT

There are varying estimates as to how many women experience PMT ranging from 25-100% of women (e.g. Coppen and Kessel, 1963; Rees, 1953; Sutherland and Stewart, 1965; Wendestam, 1980; Wood et al, 1979). The wide variation in the exact figures for its prevalence most probably reflect differences in definitions and degrees of severity, the population sampled and methods of data collection.

The general impression from both common knowledge and the literature is that although mild changes are common severe PMT may only be experienced by a small minority of women (Rose and Sachar, 1980). This was borne out in a large survey of 1,083 Swedish women randomly selected from a general population (Andersch et al, 1980). 70% of this group reported that they experienced mild or moderate emotional and physical changes before menstruation, principally irritability, sadness, anxiety, breast tenderness and swelling of the abdomen, fingers, face and legs. 92% reported at least one change premenstrually, emotional and physical changes tending to occur together. However, the average prevalence of severe PMT was 2-3%. Only a small minority reported that they had been absent from work due to PMT but 14% wanted medication and 10% intended to seek medical advice for premenstrual distress.

The wide prevalence of mild changes is found in 2 other studies. Wood et al (1979) found that 75% of a randomly selected group of over 2,000 women attending a GP surgery in Australia reported some degree of tension or nervousness before menstruation; and Clare (1977) found a similar incidence of at least one premenstrual change in a GP sample of 521 women.

The presence of cyclical changes in wellbeing should not obscure the fact that for the majority of women these changes are slight and

rarely distressing. Evidence for cyclical changes has been used to excuse women from certain responsibilities as well as to discriminate against them in the allocation of positions of social status (Harrison, 1978; Tavris and Offir, 1977). However, the experimental evidence for an effect of the menstrual cycle on women's work or abilities indicates that large changes in performance do not occur in most women (Hutt et al, 1980; Person and Lockhart, 1963; Slade and Jenner, 1980b; Sommer, 1973) and that any changes in ability in the premenstrual phase can be offset by increased effort (Bernstein, 1977; Redgrove, 1971; Slade and Jenner, 1980b). The effects of severe PMT on women's daily work has not been systematically evaluated although it is possible that these women may find their concentration or efficiency temporarily impaired by distressing emotional and physical changes. There is an extensive literature documenting the occurrence of various actions and events in the premenstrual phase: women who commit crimes, have accidents or attempt suicide, for example, are likely to be premenstrual at the time (Dalton, 1977). It is possible that the stress of severe PMT might contribute to these actions although this data has been debated on methodological grounds (Parlee, 1973, 1980).

2.2.3 Characteristics of Women Experiencing PMT

Several studies have examined relationships between PMT and aspects of women's attitudes or personality (Berry and McGuire, 1972; Brooks et al, 1977; Deutsch, 1944; Paige, 1971; Shainess, 1961; Slade and Jenner, 1980a). Studies of personality and PMT include questionnaires linking severity of cyclical changes with "neuroticism" as assessed by the M.M.P.I. or Eysenck Personality Inventory (E.P.I.) (Coppen, 1965; Coppen and Kessel, 1963; Levitt and Lubin, 1967;

Rees, 1953; Slade and Jenner, 1980a; Taylor, 1979b; Wendestam, 1980). Some of these report an association although it is unclear whether PMT may itself be labelled as evidence of neuroticism which might account for a relationship (Clare, 1977, 1979a). Wendestam (1980) reports that he found no relationship between degree of severity of PMT and neuroticism as assessed by the E.P.I. and no higher ratings of neuroticism in women with PMT. Interestingly the neuroticism scores of women who had never experienced PMT were below the normal range.

There are discrepant findings regarding the relationships between PMT and age, parity and marital status. Wendestam and Ohman (1980) studied 40 women with marked PMT and a contrast group of 20 women who did not experience premenstrual changes. In comparison to the contrast group, the PMT group were older (mean age 35 cf 26), more were parous (73% cf 50%) with more children (up to 5 cf up to 2) and more were married (70% cf 40%). There is some indication that PMT is more severe in women over 30 years (Rouse, 1978). In the Swedish study (Andersch et al, 1980) the prevalence and intensity of premenstrual anxiety and swelling of the fingers and legs increased with age although the most common changes, irritability and abdominal swelling, were not age-related. Wood et al (1979b) found a slight increase in the incidence of premenstrual distress in the 30-39 age group. In several studies the average age of women with PMT is in the 30s.

In Wendestam and Ohman's group, there was no link between parity and severity of premenstrual changes which is also reported by Coppen and Kessel (1963) and Wood et al (1979b).

Coppen and Kessel (1963) found that premenstrual irritability was more common in married women although this was not confirmed by Wendestam and Ohman (1980) or Andersch et al (1980).

There is evidence that women with emotional difficulties or those under stressful social circumstances experience greater premenstrual distress (Wood et al, 1979b). Also there is a high incidence of premenstrual problems in women under psychiatric treatment (Coppen, 1965; Rees, 1953; Zola et al, 1979). The characteristics of women with severe PMT were examined by Clare (1977, 1979a) and a significant relationship was found between PMT and scores on a "General Health Questionaire". Women with life difficulties were highly likely to also experience problematical cyclical changes and marital disturbances accounted for much of the relationship. However not all women with PMT have particular problems in other areas of their lives.

There may be a relationship between PMT and a woman's satisfaction with her social role, career and marriage and Wood et al (1979b) found a relationship between PMT and dissatisfaction with work.

2.2.4 Hormones and Premenstrual Tension

A wide variety of physiological and psychological factors have been proposed to account for PMT. These include hormones, fluid retention, pyridoxine deficiency, disturbed prostaglandin metabolism, hypoglycaemia and more esotoric suggestions such as "rejection of the female role" or expectancies arising from the mother's menstrual experiences or religious beliefs (Paige, 1973). Depending on the aetiological hypothesis, an equal variety of treatments are available. There are many reviews of the aetiology and treatment of PMT (Abplanalp et al, 1980; Carroll and Steiner, 1978; Claire, 1979b; Smith, 1975, 1976; Steiner and Carroll, 1977). The discussion here will be restricted to the relationships between PMT and the sex steroid hormones.

Many maintain that PMT is due to hormonal factors although the evidence available is fragmentary. There are various approaches that have been adopted in investigating a hormonal aetiology.

2.2.4.1 The timing of PMT in relation to the menstrual cycle

One approach is to consider the timing of the emotional and physical distress. It is often claimed that PMT starts sometime during the luteal phase and stops at or around the onset of menstruation. However there is little data with which to substantiate this view. Although the improvement with menstrual onset is well established, few have made accurate hormone assessments and related these to measures of behaviour in order to determine whether the deterioration in wellbeing does correspond to the endocrinology of the luteal phase.

However one study mentioned in section 2.1.2.2, suggestive of a correlation reports that cyclical mood changes persist in women after hysterectomy (Backstrom et al, 1981). It was found that the timing of the distressing changes experienced by 7 women after hysterectomy related to the luteal phase of the cycle of ovarian hormones, as assessed by urinary hormone measurements and relief was experienced at the time corresponding to menstruation. In the absence of menstruation the women were unaware of their cycle and this would suggest that the anticipation of menstruation is not a sufficient or necessary cause of PMT but the hormonal events of the luteal phase may be implicated.

2.2.4.2 The involvement of the luteal phase hormones in PMT: is there a "hormone imbalance"?

Another approach is to consider whether the endocrinology of the luteal phase is in some way unusual or unbalanced. Thus one looks

for differences between women who do or do not experience PMT in the levels, ratios or changes of various hormones.

Theories as to the hormonal aetiology of PMT go back many years. Frank (1931) suggested that PMT might be related to excessive amounts of oestrogen and subsequent reports also maintain this view (Israel, 1938; Morton, 1950; Timonen and Procope, 1973; Widholm et al, 1967). The role of Progesterone was first suggested by Gillman (1942) and Dalton (1977) claims that PMT is caused by low progesterone and high oestrogen levels causing an imbalance in the ratio of oestrogen to progesterone.

Unfortunately those earlier reports lacked accurate measurements of the hormones of interest. More recently several studies have attempted to measure hormone levels and make comparisons between women who do experience cyclical variations and those who do not, the latter acting as "controls". Backstrom and Carstensen (1974) measured oestradiol and progesterone on the last 6 premenstrual days in 10 women experiencing anxiety prior to menstruation and a control group of 8 women. The PMT group had lower progesterone and higher oestrogen levels 3-6 days before menstruation and hence a higher ratio of oestradiol to progesterone. No differences were found in the 2 groups' levels of hormones on the last 3 days. These findings were replicated in a later study of 15 women, demonstrating elevated oestradiol levels in the luteal phase (Backstrom, Wide, Sodergard and Cartensen, 1976). In this group of women FSH was also found to be raised at this time, which might be responsible for follicular development and the increased levels of oestradiol.

Backstrom and Matteson (1975) have distinguished different types of PMT and related these to luteal-phase hormones. Measures of oestradiol and progesterone on 3-4 days before menstruation were

compared in 4 groups of women whose usual cycle-related changes were feelings of either anxiety-tension or depression or irritability or swelling. They found correlations between oestrogen levels and anxiety and irritability and between the oestradiol:progesterone ratio and anxiety. No correlation was found between progesterone and any of the emotional changes, and swelling did not appear to be related to hormone levels. However a limitation to the interpretation of this study is that the assessment of PMT was made retrospectively and it is unknown whether such premenstrual changes were actually experienced during the cycle when hormone levels were measured.

Two other reports have indicated links between hormone levels and PMT. 39 women were divided into "high" and "low" PMT groups on the basis of daily records of their emotional and physical wellbeing (Taylor, 1979a). Concommitant hormone measures indicated small hormonal differences between the 2 groups. The women in the "high" PMT group had higher oestradiol and lower progesterone levels than the "low" PMT group. Munday (1977) reports on the extensive work on PMT being conducted at St. Thomas's Hospital, London, where there is a special clinic devoted to both research and treatment. Hormone measurements from 8 women attending the clinic were compared with those from 8 "controls". The group from the clinic reported a variety of physical and emotional changes including depression, irritability and lethargy. Also 58 women who reported PMT were recruited through the press. The 8 "clinic" women had slightly lower progesterone levels and shorter luteal phases than the control group; of the larger group, 29% had low progesterone levels. These results are suggestive of a hormone imbalance at least in some individuals, although only cautiously so since hormone assessments were based on small numbers of blood samples from each individual.

In a later study (Munday et al, 1981) 20 women with PMT were compared with 10 controls. The PMT group had significantly lower progesterone levels 9-5 days before menstruation and oestradiol was higher in the last 4 days of the cycle. This is in agreement with Backstrom et al (1976).

In contrast other controlled studies have been unable to demonstrate consistently unusual hormone levels. A study of 40 women with PMT and 20 without (Andersch et al, 1979) found no significant differences between the two groups in mean levels of progesterone and oestradiol and no correlation between hormone levels and ratings of emotional and physical changes. Although Smith (1975) found a small decrease in mean plasma progesterone levels during the 7 premenstrual days in 18 women experiencing premenstrual depression in comparison with 11 controls, there was considerable overlap in hormones between the 2 groups and the presence and degree of depression was unrelated to the particular hormone levels during that cycle. There were no differences in oestrogen levels or the oestradiol to progesterone ratio between the 2 groups. Similar negative findings have been reported by Doane, Longley and Cox (1975). O'Brien et al (1980) compared 18 women experiencing PMT with 10 controls and measured plasma hormone levels on days 4, 12, 18 and 24 of the cycle. There was no evidence for low progesterone in the luteal phase. Contrary to other reports, the women with PMT appeared to have slightly higher progesterone levels after ovulation than the controls.

Studies of androgens are conspicious by their absence in the literature and to date no workers have attempted to relate levels of testosterone or androstenedione to premenstrual tension.

It is of interest to mention some hormone treatments used to alleviate PMT as this indicates further possible hormonal factors (Giles, 1979).

Dalton (1977) claims that a number of woman respond favourably to natural progesterone taken during the luteal phase although it is questionable whether this indicates an underlying hormone-imbalance. Controlled trials of progesterone indicate that there may be a strong placebo effect in such responses (Sampson, 1979; Sampson and Jenner, 1977; Smith, 1975). In a controlled clinical trial of dydrogesterone, a synthetic progestagen similar to progesterone, 73% reported relief from premenstrual irritability and depression whereas 43% improved whilst on placebo (Day, 1979).

There are anecdotal reports of androgens being successfully taken to alleviate PMT but controlled trials have not been conducted (Foss, 1951; Carter et al, 1947; Greenblatt et al, 1942).

Other hormones and non-hormonal substances apart from the steroids may play a role in PMT. Some physical aspects could be related to either retention of fluid in the tissues or redistribution of water and there are aetiological theories relating to water and sodium imbalance (Bickers, 1952; Greenhill and Freed, 1941; Janowsky et al, 1973). Some studies have demonstrated cyclical changes in weight (Janowsky et al, 1973) although other workers have failed to demonstrate any association between mood changes and fluid retention (Applby, 1960; Bruce and Russell, 1962; Reeves et al, 1971).

Aldosterone has a role in fluid balance and has been implicated in PMT (O'Brien, Craven, Selby and Symonds, 1979) although there are varying reports as to whether aldosterone levels are higher in women with PMT than control groups (Janowsky et al, 1973; Munday, 1977; Munday et al, 1981; O'Brien et al, 1979). Prolactin, also important in water and sodium retention, may be involved

(Carroll and Steiner, 1978). Some women with PMT may have raised prolactin (Halbreich et al, 1976) although this has been disputed (Andersen et al, 1977). Other suggestions for aetiological factors in PMT include prostaglandins (Craig, 1980) and a pyridoxine deficiency (Brush, 1979).

2.2.4.3 Individual sensitivities to hormones

An alternative method of considering relationships between hormones and PMT is to evaluate whether women vary in their sensitivities to hormones. If this were so, then one would not necessarily expect endocrinological differences between women. Rather, hormone-sensitivity may be manifest as a reaction to times of hormonal changes.

One line of evidence is the reponses to oral contraceptives. In the last chapter I mentioned that the pill is taken by some women to alleviate PMT but for others these steroids can exacerbate the problem causing similar feelings to PMT to be experienced throughout the pill cycle (Smith, 1975). This was investigated by Cullberg (1972) in his study of three types of oral contraceptive agents. He identified a small subgroup of women who had experienced PMT before the trial and who were "clearly hormone-dependent" in that they reacted adversely to more oestrogenic pills, in contrast to women with no such prior history of PMT. One interpretation is that PMT is due to sensitivity to endogenous oestrogens and hence exogenous oestrogens produce similar responses. Dalton (1977) claims, from her clinical experience, that the pill has an adverse effect on women with PMT, increasing their premenstrual distress.

Further analysis of individual differences in sensitivities to hormones comes from consideration of other "hormonally mediated" mood changes. Some authors have found relationships between puerperal depression and PMT (Dalton, 1971, 1980; Green and Dalton, 1953; Nott et al, 1976; Yalom et al, 1968). Nott et al, for example, note that a group of women who became depressed after childbirth included a large number who had previously experienced PMT. Dalton claims that postnatal depression frequently leads to cyclical PMT after resumption of menstruation. So although such evidence is fragmentary there are indications that PMT may preceed or follow emotional distress after birth.

2.2.5 Conclusions

A proportion of women experience marked and distressing changes in their emotional and physical wellbeing prior to menstruation. The nature, extent and cause of such changes are areas of speculation and incomplete data. A major factor is the lack of definition of PMT and confusion as to whether it is a distinct entity or quantitatively different from more common or less problematical mood changes. There is also confusion between "clinical" and "non-clinical" groups. A number of important omissions in the literature reveal our incomplete understanding of this phenomenon. Studies have frequently concentrated only on the premenstrual phase and little is known about women's experiences during the rest of the cycle. Relationships between PMT and sexuality have received insufficient attention. In the absence of detailed consideration of these points, it is hard to progress in this important area of women's wellbeing.

As to a hormonal aetiology of PMT, no study has attempted a detailed analysis of variations in the sex steroids, oestrogens, progestagens and androgens, throughout the entire cycle and related these to a variety of emotional and physical changes. Without such there is a lack of clarity as to the relationship between the endocrinology of the menstrual cycle and PMT and whether these distressing experiences relate to a hormone imbalance or the individual's sensitivity to steroids. Such knowledge is vital to the search for appropriate treatments.

The research described in this thesis was designed to further our understanding of the complexities of PMT.

2.3 HORMONES AND SEXUAL BEHAVIOUR DURING THE MENSTRUAL CYCLE

2.3.1 Sexual Changes during the Menstrual Cycle

Many species of animals including non-human primates show cyclical variations in their sexual behaviour. Although many factors modify the extent to which such cyclicity is determined by the hormonal cycle and there are species-differences (Rowell, 1974; Hanby, 1977), generally sexual activities or "oestrus" behaviour increases around midcycle and declines in the luteal phase. This was discussed in section 1.2.1.

Such cyclicity in animals' sexual behaviour has no doubt influenced investigations of humans and many workers have started with the hypothesis that women may also experience "oestrus" or increased sexuality around ovulation. Studies attempting to relate sexual interest and activities to the menstrual cycle are summarised in Table 3 and several reviews of this literature are available (Cavanagh, 1969; Kane et al, 1969; McCauley and Ehrhardt, 1976; McCulloch, 1973; O'Connor, Shelley and Stern, 1974; Schreiner-Engel, 1980; Singer and Singer, 1972).

Legend to Table 3

a) Methodology: "Subjective Opinion" refers to authors' own opinion."Retrospective" refers to womens' retrospective reports, collected using a questionnaire or interview. "Daily reports" refers to records collected on a daily basis using questionnaires or interviews.

b) X indicates peak of sexuality

S indicates second peak of lesser intensity

Ⓧ peak disappeared when data was reanalysed

c) Studies using endocrine assessments of cycle phases

Table 3

PEAKS OF WOMENS SEXUALITY IN RELATION TO MENSTRUAL CYCLE

Author	Methodology[a] + Aspect Measured	Presumed Menstrual Cycle Phase[b]			
		Pre-menstrual	Men-struation	Post-menstrual	Ovulatory
Ellis,1923	Subjective Opinion: Sexual Desire	x		x	
Davis,1929	Retrospective: Sexual Desire				
	Married Women	x			
	Single Women	x		x	
Hamilton, 1929	Retrospective: Sexual Desire			x	
Tinklepough, 1933	Retrospective: Sexual Desire	x		x	
Stopes, 1929	Subjective Opinion: Sexual Desire	x			x
McCance et al , 1937	Retrospective: Sexual Desire			x	
Terman, 1929	Retrospective: Sexual Desire			x	
Benedek & Rubenstein, 1939a & b	Psychoanalytic interpretation: Daily Reports of Dreams	S			x
Corner, 1952	Daily reports: Sexual Arousal	x		x	
Kinsey et al ,1953	Retrospective Reports: Sexual Arousal & Vaginal Lubrication	x			
Hart, 1960	Retrospective: Libido	x		x	
Udry & Morris, 1968,1970	Daily reports: Intercourse & Orgasm				(x)
Cavanagh, 1969	Retrospective and Daily Reports : Sexual Desire	S		S	x

Contd. over

Table 3 (contd..)

Author	Methodology[a] + Aspect Measured	Presumed Menstrual Cycle Phase[b]			
		Pre-menstrual	Men-struation	Post-menstrual	Ovulatory
James, 1971	Daily Reports: Intercourse			x	
McCulloch, 1973	Daily Reports: Different Aspects of Sexuality	x		x	
Spitz et al, 1975	Daily Reports: Different Aspects of Sexuality			x	
Adams et al, 1978	Daily Reports: Different Aspects of Sexuality	S		S	⊗
Genazzani et al, 1978	Retrospective: Different Aspects of Sexuality	x		x	x
Abplanalp et al, 1979a,b (c)	Daily Reports: Sexual Activities and Enjoyment	--------	NO ---	CHANGE	----------
Schreiner-Engel et al, 1981 (c)	Pschophysiological Recordings: Sexual Arousal	x		x	
Persky et al, 1978 a, b (c)	Daily Reports: Sexual Activities and Enjoyment	---------	NO ----	CHANGE	----------

The general impression is that a proportion of women do notice sexual "peaks" occurring in a cyclical manner but there is little evidence for a periovulatory or midcycle peak. In a recent review of 32 of these studies (Schreiner-Engel, 1980), 17 found increases premenstrually, 18 post-menstrually, 4 during menstruation and 8 around the time of ovulation/ (some studies reporting more than one peak). There are no doubt individual differences in the women studied, but a number of methodological issues could contribute to these conflicting results.

2.3.1.1 The method of identifying hormonal phases of the cycle.

This is likely to be crucial in research relating behavioural changes to such phases. Udry and Morris (1977) have demonstrated, by using different methods, a variety of behavioural patterns can be produced. Although direct assessment of hormones is necessary for adequate cycle phase identification, few studies have used such techniques and so those reports of a "midcycle" peak in sexuality are open to question in the absence of appropriate measures of ovulation.

2.3.1.2 The assessment of behaviour.

A variety of measures of behaviour have been used in these studies (Table 3). Two issues are of concern here: firstly the method of data collection and secondly the aspect of sexuality assessed.

(a) Methods of data collection

Some reports are based on the author's subjective impressions rather than any systematic collection of information (Ellis, 1923; Stopes, 1929)(1). Others rely on retrospective data (Davis, 1929;

Footnote (1). Marie Stopes eloquently states her opinions as to the nature of womens sexuality:- "Most women have never realised intellectually, but many have been dimly half-conscious, that women's

nature is set to rhythms over which man has no more control that he has over the tides of the sea. While the ocean can subdue and dominate man and laugh at his attempted restrictions, woman has bowed to man's desire over her body, and, regardless of its pulses, he approaches her or not as is his will. Some of her rhythms defy him - the moon - month tide of menstruation, the cycle of ten moon-months of bearing the growing child and its birth at the end of the tenth wave - these are essentials too strong to be mastered by man. But the subtler ebb and flow of woman's sex has escaped man's observation or his care."

Married Love (18th Edition, London: G.J. Putnam, 1929, Page 25).

Genazzani et al, 1978; Hamilton, 1929; Hart, 1960; Kinsey et al, 1953; Terman, 1929; Tinklepaugh, 1933) which is questionable on the grounds of being open to both inaccuracies and expectations (section 2.1.2.2).

Several workers have used daily diaries which are more accurate and reliable (Abplanalp et al, 1979b; Adams et al, 1978; James, 1971; McCance et al, 1937; McCulloch, 1973; Udry and Morris, 1968, 1970).(1) However, in such studies many different definitions of sexuality have been used: terms such as "libido", "sexual desire" and "arousal" can be interpreted in many ways.

(b) The definition of sexuality

In research relating women's sexuality to the menstrual cycle it is vital to be clear as to what is actually being measured. Many studies have concentrated on sexual activities with a partner (James, 1971; Udry and Morris, 1968, 1970) but this confuses both partners' sexuality and it is uncertain whether sexual activities depend on the womans sexual desires or the whims or availability of her partner.

It is useful at this stage to return to the primate literature described in Chapter 1. Beach (1976) introduced the distinction between three components of sexuality.

Footnote (1). Appendix III gives details about psychophysiological techniques for the assessment of human sexuality

"Attractiveness" is some feature of the female which influences males' behaviour. The more attractive the female, the more the male will approach and try to mount; "Receptivity" is the extent to which she will accept such sexual approaches; and "Proceptivity" is the extent to which the female will take the initiative by making behavioural invitations and so is a measure of her own interest in and desire for sex.

Such components of sexual behaviour may vary independently during the menstrual cycle and are under differential control by the sex steroids (Baum et al, 1977; Herbert, 1977; Johnson and Phoenix, 1976; Keverne, 1976). Although proceptive behaviour in the rhesus macaque shows a consistent correlation with the cycle, increasing in the periovulatory period, Baum et al (1977) claim that most cyclical changes in sexual interactions result from variation in non-behavioural attributes of the female's attractiveness such as the midcycle "sexual swelling" of the vulva and vaginal odours. Receptivity is not related to the cycle and instances of unreceptive behaviour are usually due to incompatability between the female and male.

In other primates, in contrast, cyclical changes in sexual interactions may be clearly a result of cyclical variations in female proceptive behaviour. For example, in the Gorilla, sexual activity depends primarily on the female taking the initiative which she does only at the time of ovulation. Although the male lives with a small group of females, he is a distinctly sexless creature and has to be coaxed and coerced to mate at this time (Nadler, 1980b; Short, 1980) and cyclical changes in the females attractiveness are largely irrelevant. In the Orangutang, males and females live separately. In contrast to the Gorilla a male will attempt to mate with, or "rape", any female encountered on his travels, whether the female is

sexually interested or not. Generally females sensibly avoid males except at midcycle when she will actively seek out a male and be receptive to his inevitable advances (Nadler, 1980a).

It would clearly be an oversimplification to extrapolate such data from primates to understand humans. However the point to emerge is that it is possible that different aspects or components of sexuality may also vary independently during the cycle. Is there any evidence for a midcycle peak in any aspect of women's sexuality?

2.3.1.3 Cyclical changes in aspects of women's sexuality. Is there any relationship to hormones?

Only two studies have addressed this issue. Adams et al (1978) distinguished partner-initiated sexual activities and those either initiated by the woman or independent of a partner. The group of 23 women reported more self-initiated activities, sexual fantasies, arousal and masturbation on the days corresponding to the estimate of ovulation. However, only dates of menstruation were used to time ovulation and subsequent recalculation of their data to reflect cycle phases more accurately have shown no differences in sexual activities between the ovulatory and other days of the cycle (Kolodny and Bauman, 1979). The women in this study also showed peaks in female-initiated activities before and after menstruation and masturbated more during menstruation.

Another study has used psychophysiological measures to assess sexual variations in relation to the menstrual cycle (Schreiner-Engel et al, 1981). Vaginal blood flow responses to erotic stimuli were measured in 30 women at three stages of the cycle. Levels of hormones were assessed at these stages. Changes in vaginal blood flow after sexual stimulation are both independent of a partner

and sexually relevant physiological changes of an objective nature (Masters and Johnson, 1966). Vaginal responses were significantly lower in the periovulatory phase than the postmenstrual and mid-luteal phase.

It would appear from the literature that there is little evidence for a midcycle peak in aspects of women's sexuality. Instead the most convincing data indicates that a pre- and post-menstrual pattern is more common.

If this is the case then it is tempting to conclude that women's sexual behaviour is relatively independent of hormonal control and there are a number of non-hormonal theories to account for the pattern.

It is not unlikely that a period of sexual abstinence during menstruation will influence both the woman's interest and the liklihood of sexual activities before and after menstruation. Avoidance of sexual activities during menstruation may be quite common (Ford and Beach, 1951; Martin and Long, 1969) and it has been demonstrated that a period of abstinence can influence the pattern of sexuality during the cycle, increasing the likelihood of pre- and post-menstrual peaks (Dobbins, 1980; Gold, 1979; Gold and Adams, 1978; McCulloch, 1973; Spitz et al, 1975).

The method of contraception may influence the timing of heterosexual activities. If a woman feels her method to be unsafe then she may avoid sexual intercourse around midcycle. Adams et al (1978) distinguished "intrusive" contraceptive methods (diaphragms, foam or sheaths) and "non-intrusive" methods (I.U.C.D. or male vasectomy). In the former group this midcycle peak in heterosexual activity was slightly lower than the post-menstrual peak.

Some women experience a degree of pelvic vasocongestion before and during menstruation (Masters and Johnson, 1966) which may enhance

sexual activities and enjoyment at these times.

A further important consideration is the influence of moods on sexual feelings and activities although this has received little attention in the literature. None of the studies described above have mentioned whether the women experience mood changes or PMT and how this effects their sexuality. Adverse emotional changes before menstruation could either increase or decrease a woman's sexual feelings or desire for sexual activities; and relief after menstruation may have a positive sexual effect contributing to a post-menstrual peak.

Shader et al (1968) found that significantly more women with high premenstrual anxiety showed premenstrual changes in libido compared to a low anxiety group. Of the 30 women who experienced premenstrual anxiety, 11 reported sexual changes:- 9 were more and 2 less sexually interested before menstruation. In contrast Mbos et al (1969) found that women with high ratings of PMT had low ratings of sexual arousal during the premenstrual phase. In the study by Wendestam and Ohman described in section 2.2.1, half the women with PMT experienced a sexual decline in the premenstrual phase whereas a quarter felt more sexual at this time.

PMT may effect the pattern of sexual interest although the direction of the influence may vary.

*

With the evidence to date we are left with more questions and speculations than firm conclusions. It is possible that menstruation is a more important determinant of any cyclical pattern in women's sexuality than ovulation and if this is the case then non-hormonal factors can certainly contribute. There is little doubt that more data is needed to evaluate this important question concerning the

relationship between the cycle and sexual behaviour in women, using appropriate measures of cycle phases and aspects of sexuality.

On the basis of the available data the contribution of hormones to women's sexuality is uncertain. In the next section I consider what role the sex steroids may play in sexual behaviour.

2.3.2 Hormones and Sexual Behaviour

2.3.2.1 The relationship between components of sexuality and hormones in primates.

In primates there is evidence that the components of sexual behaviour, "receptivity", "proceptivity" and "attractiveness", are influenced in different ways by the sex hormones (Baum et al, 1977). It is generally agreed that attractiveness in the female rhesus is mediated via the sexual swelling and vaginal odours, which depend on oestrogens. The role of progestagens is less clear but small amounts introduced into the vagina, without altering plasma or central nervous system levels, will block the local oestrogen effect so that the female's attractiveness is reduced. This leads to a compensatory increase in proceptivity. If however attractiveness is reduced by decreasing central and peripheral oestrogen levels, there will be no such increase in proceptivity. According to Herbert (1977) proceptivity is dependent on androgens. This behaviour declines following surgical removal of the adrenals and can be restored with testosterone or androstenedione. This suggests that oestrogens are necessary but not sufficient for normal proceptive behaviour. Receptivity is affected to a lesser extent by removing androgens and may be more dependent on non-hormonal factors.

in oophorectomised oestrogen-replaced animals

The differential control of aspects of sexuality may contribute to cyclical behavioural changes in the female rhesus (Baum et al, 1977). At midcycle, oestrogen levels are high and the female is

maximally attractive. During the luteal phase, when sexual interactions decline, the ovaries are secreting less oestrogen but the highest amounts of progesterone. Further hormonal change causes a reduction in attractivity. At midcycle proceptive behaviour is stimulated possibly by the increased secretion of androgens prior to ovulation. Whether the oestrogen peak at this time contributes to this behavioural effect is less certain. Increased sexual interaction has been reported just before menstruation in rhesus monkeys (e.g. Loy, 1970; Michael and Zumpe, 1970) which may be the result of falling progesterone and the increased testosterone levels which occur at this time (Hess and Resko, 1973).

2.3.2.2 Hormone-behaviour relationships in women.

There is simply not the data available to evaluate whether the system described for primates is in any way involved in women's sexuality, given that no study has convincingly demonstrated the existence of cyclical changes in women and most are methodologically imcomparable with the primate data. However 2 studies relating hormones to aspects of sexuality during the menstrual cycle (Persky et al, 1978a,b; Schreiner-Engel et al, 1981) have indicated some complex links. Persky et al studied hormone-behaviour relationships in 11 couples, assessing various measures of sexuality including degree of initiation, sexual responsiveness or avoidance, and enjoyment. There was no evidence of any correlations between oestradiol and measures of sexual interest or activities, which is in agreement with the findings of Schreiner-Engel et al (1981). In both studies, there were some interesting relationships between testosterone and sexuality. Schreiner-Engel divided women into "high" and "low" testosterone groups on the basis of their average levels. The "high" group showed

significantly greater levels of sexual response to erotic stimuli than the "low" group. Similarly Persky et al found a significant correlation between women's midcycle testosterone levels and frequency of sexual activities throughout the cycle.

Can these relationships contribute to the pattern of cyclical changes in women's sexuality? If there is no relationship between oestradiol and sexuality then absence of a midcycle peak might be expected. The role of androgens however may be complex. The fact that testosterone is at its highest in the middle third of the cycle when sexual interest and activities may even be at their lowest, indicates that there is no simple association. But the behavioural effects of a rise in testosterone may not necessarily be rapid and may occur later on in the cycle, before or after menstruation.

The role of progesterone remains speculative and one might suggest that it has some inhibitory influence on women's sexuality. Escape from this could account for either the premenstrual or post-menstrual increase in sexual interest.

In order to evaluate these issues, it is necessary to relate measures of the steroids to specific aspects of behaviour: the evidence available is insufficient to do so.

2.3.3 Conclusions

There are many fascinating and important speculations raised by the research literature relating women's sexuality to the menstrual cycle and sex steroids. The area is incomplete and inconclusive, lacking in methodologically sound studies which accurately define cycle phases and distinguish the many aspects of sexuality. Without such data it is unclear whether and when women experience times of increased sexuality in relation to the menstrual cycle and it is hard to unravel the complexities of relationships

between hormones and sexual behaviour.

The research described in this thesis is an attempt to further the understanding of these issues.

2.4 BEHAVIOURAL CHANGES DURING THE MENSTRUAL CYCLE: AIMS AND DESIGN OF THE STUDY.

The study described in this thesis was planned with the following aims:-

(1) To describe variations in moods and sexuality in relation to hormonally-defined phases of the cycle and compare and contrast such changes in groups of women.

(2) To examine the relationship between moods, PMT and sexuality in these women.

(3) To determine whether PMT is related to any hormone-imbalance or hormone sensitivity, or whether it is related to other characteristics of the women.

(4) To evaluate correlations between aspects of moods and sexuality and the sex steroid hormones.

*

Although there has been a fair amount of research investigating behavioural changes during the menstrual cycle, our understanding of this area is both contradictory and limited, much of which is due to conceptual and methodological problems. From an extensive and critical review of the literature, I established criteria for the design of a study to evaluate these issues.

(a) Changes in womens moods, physical state and wellbeing throughout the menstrual cycle.

It is clear that womens emotional and physical state and sexuality interact and cannot be realistically considered as isolated

aspects of wellbeing. In addition, it is of limited value to select a few days of the menstrual cycle as a topic of investigation, rather than considering variability across the entire cycle. This study was designed to evaluate the relationship and interrelations between aspects of our emotional, physical and sexual wellbeing during the course of the menstrual cycle.

(b) The definition and measurement of emotions and sexuality.

Research on behavioural changes during the menstrual cycle requires the development and use of valid, reliable and meaningful questionnaires to assess a variety of different moods, physical states and aspects of women's sexuality. These should be completed on a daily basis in order to overcome problems of expectancies and inaccuracies inherent in retrospective quenstionnaires.

(c) The assessment of hormonal changes during the cycle.

With the development of radioimmunoassay techniques for the sex steroids, menstrual markers have become outdated as a means of defining the endocrinological changes during the cycle. The measurement of hormones enables us, firstly, to distinguish normal ovulatory cycles from those which are anovulatory or abnormal; secondly, to divide the cycle into hormonally-defined phases and relate these to behavioural changes; and thirdly, to correlate specific aspects of behaviour to the steroids of interest.

(d) The women studied.

There is obviously a great deal of variability in both the type and degree of behavioural changes women experience during the cycle. It is important to distinguish, firstly, women who do notice marked cyclical changes in their wellbeing from those who do not; and

secondly women who find such changes problematical and seek medical advice, from those whose cyclical variability is less distressing or troublesome.

CHAPTER 3

METHODS AND PROCEDURE

3. METHODS AND PROCEDURE

3.1 THE DESIGN OF THE DAILY DIARY TO ASSESS MOODS, PHYSICAL STATE AND SEXUALITY.

A diary was designed for daily self-ratings of aspects of moods, physical state and sexuality. The rationale behind using daily self-rating techniques has been described in section 2.1.2.2.

3.1.1 The Measurement of Moods.

In designing a questionnaire suitable for the daily assessment of moods, several issues were considered.

1. What criteria should be met by rating scales for the assessment of subjective states?
2. What are moods?
3. How can moods be quantified?
4. What kinds of questionnaires may be used to assess moods?
5. Which of these might be applicable to this study?

3.1.1.1 Criteria for the design of rating scales.

There is an extensive literature describing criteria for the design of rating scales and psychometric instruments (e.g. Anastasi, 1976; Cronbach, 1970; Hall, 1980; Hamilton, 1979; Lorr, 1960; Mackay, 1980; Mittler, 1970; Oppenheim, 1966; Sainsbury and Kreitman 1975; Thorndyke and Hagen, 1977; Whittenborn, 1972) and three of these are particularly important for psychometric tests.

Firstly, the criterion of validity, or measurement of what the test claims to assess; secondly, reliability or consistency of measurement; and thirdly, objectivity, or avoidance of subjective biases or distortions.

A number of other factors are important when using a test repeatedly, as in a longitudinal study of the menstrual cycle. Response sets may occur, where the user tends to give the same answer

or agrees or disagrees regardless of the question. These can generally be avoided by careful design and question sequence. Tests must be sensitive to change, standardised for use by a large group, simple, concise and easy to score. The scales should also be meaningful to the user. For example, a scale devised to measure "hostility" cannot be meaningfully used unless the individual uses such a term to describe her feelings.

3.1.1.2 The concept of moods.

The term "mood" has a common meaning as a subjective state of mind, often transient and known only to the individual, and described or communicated in a variety of ways. Moods may be inferred from behaviour such as expressive movements, gestures, posture, from facial expressions, and from the person's verbalisation. The latter is the most feasible way to assess moods, using the individual's self report or tendency to say "I feel ....." where the mood is described by appropriate adjectives (Mackay, 1980; Wessman and Ricks, 1966).

There are limitations to the use of such self-reports (Larzarus, 1966), one problem being that different individuals may use different verbal labels for describing the same mood, or a particular mood may be described differently on separate occasions. Also one can maintain that language is too insensitive a medium for communicating private experiences (Mandler, 1962).

However for most purposes it is necessary to accept language as sufficiently rich to allow the variety and complexity of moods to be expressed, so long as appropriate descriptive terms are selected.

Much work has been done to attempt to describe mood, principally using techniques of factor analysis to arrive at dimensions or

aspects of emotional state (Aitken and Zealley, 1970; Borgatta, 1961; Clyde, 1963; Cattell, 1960; Green and Nowlis, 1957; Lorr, Daston and Smith, 1967; McNair and Lorr, 1964; Mackay, 1980; Nowlis, 1959, 1966; Nowlis and Nowlis, 1956; Wessman and Ricks, 1966). Such dimensions of mood are described as follows:-

1. Cheerful - Happy - Elation.
2. Depression - Unhappy - Sadness.
3. Vigor - Activity - General Activation.
4. Tiredness - Fatigue - General Deactivation.
5. Tension - Anxiety.
6. Relaxation - Composure.
7. Irritability.
8. Anger - Aggression.
9. Sociable - Friendliness.
10. Thoughtful - Introspection.

There is some speculation as to whether each dimension above is separate or whether some represent extremes of a bipolar dimension of mood, for example Cheerful to Depression, or Relaxation to Tension. In this study it was decided to treat each dimension as separate aspects of experience.

3.1.1.3 The quantification of moods.

As stated by Folstein and Luria (1973):- "Mood is a subjective feature of mental life which seems to vary in a smoothly graded continuous fashion. Tests attempting to measure it should neither force results into a discontinuous grading scale nor limit responses by suggesting particular qualities of mood to the subject." But, for the purpose of measurement, moods have to be graded in some way, generally into artificial categories. Such categories can either be described using suitable quantitative terms or using more

flexible numerical or self-defined categories.

3.1.1.4 Tests and ratings used to assess moods.

Many ratings have been developed as standard psychological or psychiatric measuring devices and as such are designed for more extreme moods such as "clinical" depression or anxiety. These are limited in their general applications.

A number of "non-clinical" psychometric tests are shown in Table 4. They are generally rated by the individual although some are used by an interviewer.

These tests cover various aspects or dimensions of moods described above. They tackle the issue of quantification of moods in various different ways:-

(a) Scales composed of Statements describing different quantities of moods (e.g. Wessman and Ricks, 1966).

(b) Mood Adjective Check Lists (e.g. Nowlis, 1966; McNair and Lorr, 1964; Lorr, Daston and Smith, 1967). Each mood dimension is described with a few adjectives. The user rates how much she feels of each adjective along a scale of quantitative terms, for example, "not at all", "a little", "quite a bit" or "extremely" (McNair and Lorr, 1964).

(c) Visual Analogue Scales (V.A.S.) (Aitken, 1969; Aitken and Zealley, 1970; Zealley and Aitken, 1969). Each dimension of mood is represented by a line 10 cm long, representing the range of that mood, from nothing to the greatest experience of that mood. V.A.S. have also been used to quantify bipolar dimensions of moods. The extremes of the scales are defined in the users own terms and she assesses the quantity of her moods

Table 4

EXAMPLES OF SCALES FOR THE MEASUREMENT OF MOODS

Authors	Method of Measuring moods	Principal moods
Aitken (1969) Aitken & Zealley (1970) Zealley & Aitken (1969)	Analogue Scales	Any
Arfwidsson et al (1971)	List of feelings rated on 4 point scale	Anxiety
Beck et al (1961)	Inventory of 21 categories of feelings and attitudes rated on 5 point scales	Depression
Clyde (1963)	Self Ratings by picking adjectives to describe mood	6 mood factors
Buss & Durkee (1957)	Self Ratings of adjectives	Anxiety
Green & Nowlis (1957) Nowlis (1966)	Mood Adjective Check List	Many mood factors
Gottschalk et al (1962) Gottschalk & Gleser (1969) Gottschalk (1978)	Content Analysis of Speech	Any theme chosen by rater
Lorr, Daston & Smith (1967) Lorr (1960) McNair & Lorr (1964)	Mood Adjective Check List	Many mood factors
McNair, Lorr & Droppelman (1971)	Profile of Mood States: Adjective Check List of 65 items rated on a 5 point scale	Many mood factors
Hamilton (1967)	Observer Ratings	Depression & Anxiety
Jacobson et al (1978)	Mood and Symptom Check Lists, combined by factor analysis	Many mood factors

Contd. over

Table 4 (contd..)

Authors	Methods of Measuring moods	Principal moods
Rickels et al (1976)	Hopkins Symptom Check List for assessment of emotional changes in Obstetrics & Gynaecology	Check list of descriptions of feelings
Osgood, Suci & Tannenbaum (1957) Snider & Osgood (1969) Whitehead & Matthews (1977) Marks (1965, 1966) Marks & Sartorius (1968)	Semantic Differential	Concepts such as Self Esteem, General Evaluation and Sexual Evaluation
Shapiro (1961) Phillips (1964)	Personal Questionnaire	Any feelings important to the individual
Slater (1965)	Personal Construct Theory: Repertory Grid	Any constructs important to the individual
Wessman & Ricks (1966) Wessman, Ricks & Tyl (1960)	Mood Scales using Statements of Moods	Many mood Factors
Zuckerman (1960)	Mood Adjective Check List	Anxiety
Zung (1965)	Self Ratings of Categories of Feelings	Depression

according to these pre-defined limits. The quantity is represented either as the distance along the line or as a number between 0 and 10.

3.1.1.5 Applicability of such scales to the assessment of moods during the menstrual cycle.

In deciding which scales might be appropriate for the daily assessment of moods during the menstrual cycle a number of different ratings were completed over 2 months by a group of 14 women in a small pilot trial. Their comments and criticisms were useful in deciding upon the final form of ratings used. Particular attention was paid to the issues discussed above, namely the criteria for psychometric instruments, the definition and quantification of moods, and practical considerations in using such tests on a daily basis.

Scales composed of statements (Wessman and Ricks, 1966) were found to be too long and complex for repeated mood measurement. The user is forced to choose quantitative statements which may not correspond to her own description, and require a high degree of articulacy and concentration to complete. There is little data on the reliability or validity of these scales.

Mood Adjective Check Lists have been tested for reliability and validity (Christenfeld et al, 1978; Herron, Bernstein and Rosen, 1968). However, each mood is quantified into artificial categories which may not suit each user and several adjectives are used to describe each mood dimension and so the scales are long and repetitive. Another drawback for daily use is that "response sets" have been found to influence answers on frequent and repeated use (Herron et al, 1968; Herron, 1969; Johnson, 1970; Johnston and Hackmann, 1977).

Visual Analogue Scales overcome many of the problems in attempting to quantify moods since the individual is free to use

her own descriptions of the quantity represented by the extreme points of the scales. These scales have been tested and found to be reliable and valid indicators of emotional state (Maxwell, 1978; Hall, 1980). For example, a comparative study of 4 depression scales (Beck, Hamilton, Zung and Taylor, see Table 4) with a Visual Analogue Scale (Davies et al, 1975) showed highly significant correlations between all the ratings. Zealley and Aitken (1969) also found significant correlations between the Visual Analogue depression scale and the Hamilton depression rating. Lader and Marks (1971) and Hornblow and Kidson (1976) have tested the Visual Analogue Scale for assessment of anxiety and provide evidence of their validity and reliability.

Visual Analogue scales are simple, quick to fill out, not influenced by response sets or artificial distributions of extreme scores and are sensitive to small changes in moods since the user can make as fine a discrimination as is desired. They are also adequate for a variety of techniques of statistical analysis (Maxwell, 1978).

On the basis of careful consideration of the variety of techniques used to assess moods and feedback from women trying out such techniques it was decided that Visual Analogue Scales were the most appropriate for daily use in the assessment of moods during the menstrual cycle.(1)

3.1.2 The Daily Diary.

(i) Mood Scales. 10 visual analogue scales were used, to cover the 10 dimensions of moods described by factor analytic studies of mood states. These were:-

Footnote (1). Appendix II gives details about the validation of the Daily Mood Diary.

1. Cheerful and Happy.
2. Energetic and Active.
3. Relaxed.
4. Sociable and Friendly.
5. Changable.
6. Depressed and Unhappy.
7. Fatigued and Tired.
8. Irritable.
9. Aggressive.
10. Tense and Anxious.

The order of these moods was randomised to avoid response sets which might occur if similar moods were grouped. The points 0 and 10 were defined and written down prior to use, using the individuals own terms:- 0 = "How you feel when not in this mood at all" and 10 = "How you feel when this mood is strong and prevalent". The scales and definition sheet are shown in the appendix (Figures A6 and A7).

(ii) Physical State. The 3 most widely reported physical aspects which vary in relation to the menstrual cycle are Breast Tenderness, Swelling or Bloated feelings and Headaches (e.g. Dalton, 1977). These were rated each day on a 4 point scale:-

0 = No experience
1 = Slight
2 = Moderate
3 = Severe.

The scales are shown in the appendix (Figure A6).

(iii) Sexual feelings and activities. Ratings were modified from those used by Carney et al (1978). A number of different aspects of sexuality were measured using self-defined 0-10 visual analogue scales and 4-point scales.

(a) Sexual feelings. A V.A.S. was used to measure how sexual the woman had been feeling that day.

(b) Sexual thoughts. Ratings from 0-3 of how pleasant or unpleasant the woman finds thoughts about sex at the time of completing the diary.

(c) Sexual activities were rated on V.A.S.. Categories were Masturbation, Sexual activities with partner and Orgasm. A number of women also indicated who initiated sexual activities - i.e. "self", "partner" or "both" self and partner.

These scales are shown in the appendix (Figure A6)

(iv) General Questions. A space was provided for notes about significant events, physical health and stress, or additional information the woman wished to record as influential to her moods, physical health or sexuality that day.

The diaries were completed each evening to cover moods, physical state and sexuality for the past 24 hours. No reference was made to previous days' diaries or ratings so that original definitions of the extreme points were always used.

3.2 SUBJECTS AND RECRUITMENT METHODS

3.2.1 Introduction and Aims

This study was designed to include women experiencing a range of cyclical mood and sexual changes, from no noticable variability, to "non problematical" cyclical variability, to more pronounced, distressing and problematical changes. The subjects were recruited in two different ways.

Firstly, "the Volunteers", comprising women who volunteered for this research project on the menstrual cycle. There was no

specification that they should or should not experience cyclical changes in order to participate.

Secondly, "the Clinic Group". This comprised a group of women who experienced marked and distressing changes, had complained to their General Practitioners about PMT and been referred to a gynaecologist. These women were recruited from the Gynaecology Outpatients Department in the Royal Infirmary, Edinburgh.

3.2.2 Criteria for Selecting Subjects

The women in the "Volunteers" and "Clinic" groups were recruited on the basis of the following criteria.

1. Regular menstrual cycles.
2. Not having used oral contraceptives within 3 months.
3. Not breastfeeding.
4. Usual cycle length of between 21-35 days.
5. No medical or gynaecological problems.
6. No psychological difficulties or upsetting life events.
7. No medication to be used during the study.
8. Toleration of repeated blood samples.

3.2.3 Recruitment Methods

3.2.3.1 The "Volunteers"

These women were recruited by a number of different methods.

1. Local Advertising

The project was advertised at various local functions, organisations and institutions. Women who were interested in taking part returned a handout (shown in the appendix, figure A8).

38 women returned handouts, 25 completed the project. The reasons for not participating are shown in Table 5.

Table 5

THE SUBJECTS: REASONS FOR NOT TAKING PART IN THE PROJECT AFTER EXPRESSING INTEREST OR RETURNING HANDOUTS

Group	Total No. of Volunteers	Reasons for Refusal	No.	Total taking part
Local Advertising	38	Too time consuming	10	
		Used oral contraceptives within 3 months	2	
		On medication	1	25
Nurses	10	Too time consuming	1	
		Stress in life	1	
		Dropped out after fail to menstruate	1	7
N.C.T.	8	Too time consuming	1	
		On medication	1	6
G.P.'s or F.P.A.	15	Too time consuming	6	
		Stress in life	1	
		Disliked personal questions	2	6
G.O.P.D.	27	Did not attend initial appointment	2	
		On medication	2	
		Stress in life	1	22

2. Nurses

A group of nurses was recruited from the Royal Infirmary, Edinburgh. Notices and handouts advertising the project were placed in the changing rooms and nurses' home.

10 handouts were returned and 7 women completed the project. The reasons for not participating are shown in Table 5.

3. National Childbirth Trust (N.C.T.) Newsletter

The study was advertised in the Spring (1978) Newsletter of Lothians N.C.T. A total of 8 women replied to the advert. and 6 completed the project. The reasons for not participating are shown in Table 5.

4. Women contacted through General Practitioners

This was the least successful recruitment method. 3 local GPs offered to help by asking suitable women attending their surgeries if they were interested in this project. Only one woman was recruited, since the doctors found themselves too busy to look for volunteers.

5. Women recruited through the Family Planning Services.

A number of parous women over 30 years of age were recruited at the centre in Stockbridge, Edinburgh. It was necessary to select these women on the basis of their age and parity since women in group 1 (local advertising) had tended to be younger nulliparous women. Handouts were given to suitable women attending clinics in the centre. 15 women expressed interest and 5 completed the project. The reasons for not participating are shown in Table 5.

3.2.3.2 The "Clinic" Group

A group of women was recruited from the Gynaecology Outpatients Department in the Royal Infirmary, Edinburgh, between November 1978 and March 1979, in collaboration with a co-worker interested specifically

in "Premenstrual Tension" (T. Bäckstrom). Women presenting at the clinic with PMT were asked by T. Backstrom if they would be interested in taking part in a study of hormones and PMT. If interested, I later contacted them to discuss the project in more detail and finalise arrangements for participation.

This procedure was adopted for 2 reasons. Firstly, in the context of attending a medical specialist, the women may have felt pressurised to take part in the project if it had been necessary to commit themselves at the initial visit to the clinic, possibly feeling that treatment might be contingent with the research. It was thus important to keep the project independent of medical consultation and give the women time to decide whether or not to participate.

Secondly, later interviewing was conducted away from the clinic. This achieved a separation of the clinical analysis of "Premenstrual Tension" from the research project. It is possible that discussions with a female researcher in a less formal setting may differ from those with a clinician in the context of medical treatment. For example, in a medical setting, emphasis would be more on the problematical aspects of the premenstrual phase whereas in this project it was of interest to examine changes during the entire menstrual cycle, not just PMT.

A total of 27 women were asked to take part. 2 did not attend further appointments and 4 were not suitable for this project as shown in Table 5.

3.3 PROCEDURE

3.3.1 The Interview and Division of the Volunteers into "Report PMT" and "No PMT" Groups.

All women in both "Clinic" and "Volunteers" groups who had expressed interest in the project were contacted and those wishing to

continue were interviewed, using the schedule shown in the appendix (Figure A-9). This included questions about menstrual cycles, medical and contraceptive history and social characteristics. The women also completed an Eysenck Personality Inventory (Figure A-10) and a modified version of the Moos Menstrual Distress Questionaire (Moos, 1968b, 1969) (figure A-11) covering the following aspects of cyclical change: "Arousal", "Positive affect", "Negative affect", "Concentration", "Fluid Retention", "Pain", "Insomnia", "Changed Appetite" and "Recurrent Illnesses" (Figure A-11). At this time the extreme points, 0 and 10, for the visual analogue scales, were defined and written down on the definition sheet for future reference (Figure A-7).

At the interview the women gave a detailed statement about their general experiences of mood, physical and sexual changes during the cycle. This led to a further division of the "Volunteers" into two groups. Approximately half of the women reported that they did notice cyclical changes in aspects of their emotional or physical wellbeing: these formed a group called "Report PMT", distinct from the "No PMT" group, comprising women who noticed no cyclical changes. There was no pre-selection according to their experiences during the cycle, in contrast to the selection of the "Clinic" group, and by chance it was found that the volunteers could be divided in this way into 2 equal-sized groups.

So, the total sample was divided into 3 groups, arbitrarily called the "Clinic", "Report PMT" and "No PMT" groups. Their characteristics are detailed in Table 6.

3.3.2 The Procedure

Each woman completed diaries for one week prior to starting the full procedure of blood (or in 4 cases, urine) samples so that

Table 6

CHARACTERISTICS OF THE THREE GROUPS OF SUBJECTS

	"Clinic" Group (N=19)	"Report PMT" Group (N=18)	"No PMT" Group (N=18)	X^2 or F ratio: significance of the difference between the 3 groups
Age Mean (SD)	34.3 (5.3)	32.9 (3.9)	31.2 (5.8)	F = 1.7 P = .18
Employment or Occupation				
full-time) employ-) ment part-time) outside the home	26% 37%	56% 33%	44% 28%	X^2 = 7.8 P = .45
% of Group Mother	32%	11%	22%	
Marital Status Married or Cohabiting % of Group	84%	61%	33%	X^2 = 20.6 P = .002
Parity Parous % of Group	90%	50%	67%	X^2 = 11.5 P = .17
No of Pregnancies Mean (SD)	1.8 (0.8)	1.2 (1.4)	1.3 (1.0)	F = 1.5 P = .22
Method of Contraception Barrier % of Group I.U.C.D. Steril-ised	28% 17% 28%	33% 28% 17%	35% 24% 18%	X^2 = 1.4 P = .96
Eysenck Personality Inventory Scores Extra-version Neuro-ticism mean (SD)	13.4 (4.2) 13.6 (4.3)	10.6 (4.2) 12.1 (3.3)	11.1 (3.0) 11.3 (4.9)	F = 2.7 P = .07 F = 1.39 P = .26

Menstrual/

Contd. over

Table 6 (contd)

		"Clinic" Group (N=19)	"Report PMT" Group (N=18)	"No PMT" Group (N=18)	X^2 or F ratio: significance of the difference between the 3 groups
Menstrual Cycle Questionnaire Scores for Premenstrual Phase mean (SD)	Arousal	17.4 (7.4)	13.0 (6.2)	3.1 (4.3)	F = 26.6 P < .00001
	Negative Feelings	8.9 (4.0)	6.7 (3.7)	3.2 (3.5)	F = 11.3 P = .0001
	Impaired Concentration	4.3 (3.5)	2.9 (2.6)	1.2 (2.0)	F = 5.9 P = .005
	Pain	2.7 (2.8)	3.5 (2.7)	0.8 (1.5)	F = 5.8 P = .005
	Insomnia	1.2 (1.9)	0.5 (1.1)	0.4 (0.9)	F = 1.7 P = .18
	Appetite Changes	1.6 (1.8)	1.5 (1.7)	0.3 (0.8)	F = 4.4 P = .02
	Fluid Retention	6.8 (3.9)	5.4 (3.2)	3.2 (3.4)	F = 4.9 P = .01

(N.B. N refers to numbers of women in each group with normal menstrual cycles - see Section 3.5.)

she became accustomed to recording her moods. After this she completed one cycle of ratings and blood samples beginning and ending on the same day of the cycle (counting the 1st day of menstruation as Day 1). Diaries were returned weekly by post.

The time at which the procedure was started in relation to the cycle was randomised across the women: this was to randomise effects such as response sets which might influence the ratings when making repeated behavioural assessments over time.

Blood was taken either in the Royal Infirmary with the assistance of nursing or medical staff or else at the woman's home. Blood samples were collected twice weekly in the follicular phase and 3 times weekly in the luteal phase, as approximately calculated from menstrual dates. The women in the "Clinic" group gave daily blood samples throughout the luteal phase and 1st 4 days of menstruation, used in a more detailed later study of hormones and PMT, in collaboration with T. Backstrom. 4 individuals who could not tolerate repeated venepuncture made urine collections between 10 p.m. and 8 a.m. each night.(1) The volume was recorded and a 20 ml sample retained.

Blood was collected into lithium-heparin plastic tubes, and plasma was separated by centrifuge at 3,000 rpm for 10 minutes at 4°C. Aliquots of plasma were stored at -20°C prior to assay. 20 ml urine samples were also stored at -20°C.

All women in the "Clinic" group were offered treatment after participating in the research. Details are given in the Appendix, Table A-2.

(1) It has been established (Metcalfe and Sanders, 1981) that 10 hour urine samples give a good approximation to 24 hour samples for measurement of oestrogens and pregnanediol. Overnight samples are more convenient and acceptable than 24 hour collections.

3.4 HORMONE ASSAY METHODS

Details of the radioimmunoassays for pituitary hormones are described by McNeilly and Hagen (1974).

Gonadotrophins

LH and FSH were measured in duplicate by the specific double-antibody radioimmunoassay described by Hunter and Bennie (1979). The standards used were the LH preparation MRC 68/40 (assuming 77 iu per ampoule) and the FSH preparation MRC 69/104 (assuming 10 iu per ampoule). Both were obtained from the National Institute of Biological Standards and Control (NIBSC), Holly Hill, London. Antisera to human LH (F87) and FSH (M93) were raised in rabbits and kindly supplied by Professor W.R. Butt, Birmingham. The antisera used are of very high titre and hormonal monospecificity (Butt and Lynch, 1976). ^{125}I-labelled LH was prepared from h-LH IRC-2 (Dr. A. Stockell Hartree, University of Cambridge) and ^{125}I-labelled FSH from highly purified h-FSH (Professor Butt) by the method of Hunter and Bennie (1975). Cross-reactivity with other hormones is described by McNeilly and Hagen (1974). At the end of the assay incubation period, tubes were centrifuged for 30 minutes at 4°C and 600 x g, the supernatant poured off and the precipitates containing antibody-bound hormone counted in an LKB-Wallac gamma counter. Three quality control plasmas were included in each assay (B/B_o approximately 80, 55 and 30%) and gave intra-assay coefficients of variation of 8% and 7%, and inter-assay coefficients of variation of 12% and 11% for LH and FSH respectively. Results are expressed in this thesis as u/l of the appropriate standard (1 mu LH = 11.6 ng LER 907; 1 mu FSH = 44.6 ng LER 907).

17β-Oestradiol

Concentrations of 17β-oestradiol in plasma were measured using a highly specific radioimmunoassay described by van Look et al (1972). Antiserum was raised in rabbits against 17β-oestradiol-6-(O-carboxy methyl)-ovine-bovine serum albumin (provided by Dr. P. Dean). Only 17α oestradiol (2%) and oestradiol (1.7%) showed cross reactivity with the antiserum, cross reactivity of other steroids being less than 0.3%. 17β-oestradiol (Sigma Chemical Co.) was used as standard, in solutions of 1 and 10 ng/ml ethanol. Radioactive labelled 17β-oestradiol (6,7-^{3}H-17β oestradiol : New England Nuclear) with a specific activity of 45-50 Ci/mM was used as tracer. The sensitivity of the method, defined as the amount of unlabelled 17β-oestradiol required to displace 10% of the tracer found in buffer control tubes, was 5.0 ± 1.0 (SD) pg. Inter-assay coefficients of variation of six different plasma pools with concentrations varying from 38-405 pg/ml, ranged from 6.1 - 13.3%, and the intra-assay coefficient of variation was 9.3%. Results are expressed in pg/ml.

Progesterone

The radioimmunoassay described by Scaramuzzi, Corker, Young and Baird (1975) was used to measure concentrations of progesterone in plasma. The antiserum (91920/9) was raised in sheep against progesterone-11α-hemisuccinate coupled to bovine serum albumin, and pure progesterone (Sigma, London) was used as standard. 1.2.6.7-^{3}H progesterone (Radiochemical Centre, Amersham) was used as tracer. The sensitivity of the method, defined as the amount of unlabelled hormone required to displace 10% tracer bound in B_o, was 0.14 ± 0.03 ng/ml (mean ± SEM). The inter-assay coefficient of variation was 14.8 - 15.7% and the intra-assay coefficient of

variation 8%. Results are expressed in ng/ml.

Testosterone

Concentrations of testosterone were measured using the radioimmunoassay described by Corker and Davidson (1978).

0.1 ml aliquots of plasma were extracted, after addition of 1,000 cpm 1:2 ^{3}H -testosterone, with 1 ml hexane-ether 4:1. The aqueous phase was frozen and the organic layer transferred to alumina columns prepared as described by Furuyama, Mayes and Nugent (1970). The column was washed through after the sample with 1.6 ml hexane-ether 4:1 followed four times with 1.6 ml of 0.4% ethanol in hexane. The testosterone fraction was evaporated to dryness under nitrogen and re-dissolved in 200 ul PBS. A 50 ul aliquot was taken for estimation of procedural loss.

0.1 ml aliquots of the remainder were assayed in duplicate as described by Corker and Davidson (1978). The antiserum (E01) was a gift from Dr. S. Tillson and had been raised in the goat against testosterone-3-carboxymethyl-amine BSA. The antiserum only showed significant cross reaction with 5α-dihydrotestosterone (23.9%), 11β-hydroxy-testosterone (0.4%), oestradiol-17β (0.2%) and androstenedione (0.1%). 1:2 ^{3}H Testosterone was used as a tracer. The sensitivity of the assay was 8 pg (i.e. precision of measurement of zero). The between assay variation, calculated from the results of a quality control run in each assay, was 11.5%. Results are expressed as pg/ml.

Androstenedione

Concentrations of androstenedione were measured using the radioimmunoassay described by Baird, Burger, Heavon-Jones and Scaramuzzi (1974) with modifications of the methods of extraction and chromatography.

0.1 ml aliquots of plasma were extracted, after addition of 2,000 dpm (approx. 5 pg) of 1,2,-^{3}H androstenedione (S.A. 40 Ci/mM, NEN), with 20 volumes of hexane and ether (4:1, v/v). After quick freezing of the lower aqueous layer in dry ice, the organic layer was transferred to a 28 x 8 mm aluminia column, previously washed sequentially with 3.2 ml ethanol, 6.4 ml methanol, 4.8 ml dichloromethane and methanol (1:1, v/v) and 4.8 ml dichloromethane. The column was washed through, after the sample, with a further 4.0 ml hexane and ether (4:1, v/v) and 6.4 ml 0.1% (v/v) ethanol in hexane, followed by 3.2 ml 1% ethanol in hexane. The androstenedione fraction was evaporated to dryness under nitrogen and re-dissolved in 6.5 ml PBSG. A 0.1 ml aliquot was taken for estimation of procedural loss.

Aliquots of the remainder were assayed in duplicate by the radioimmunoassay method of Baird et al (1974). The antiserum, raised in rabbits, against 11-α-hydroxy-4-androstene-3-17-dione-11-hemisuccinate coupled to bovine serum albumin was supplied by Dr. W. Schopman, Rotterdam, Holland. The antiserum showed negligible cross-reaction with other steroids except 11β hydroxy-androstenedione (36%), androstenedione (43%) and testosterone (0.3%). 1-2-^{3}H androstenedione was used as tracer.

The inter-assay coefficient of variation was 14.1% and the intra-assay coefficient of variation 8.3%. Results are expressed in pg/ml.

Urinary total oestrogens

Urinary total oestrogen excretion over periods of 10 hours were measured by fluorimetry, using the method described by Brown, MacLeod, MacNaughton, Smith and Smyth (1968) with minor modifications.

Aliquots of 1/1000th of the total 10 h volume were diluted to 6 ml with distilled water, hydrolysed by boiling with concentrated hydrochloric acid for 30 minutes, and then extracted with ether, after adding sodium chloride to improve the extraction of oestriol, in a semi-automatic Paton-Brown partitioning extractor (Paton-Brown Industries, Stepney, S. Australia). The aqueous layer was discarded and the ether extracted from the organic layer with sodium carbonate solution (pH 10.5) and also discarded. Petroleum ether was added to improve the extraction of oestrone, and phenolic steroids were extracted with N sodium chloride. The upper organic phase, containing neutral fractions was discarded, and sodium bicarbonate was added to the alkaline fraction. Oestrogens were extracted with ether, and the extract evaporated. The remaining oestrogens were measured fluorimetrically by the Kober-Ittich procedure, using an Aminco-Bowman spectrofluorimeter (American Instrument Co. Inc., Maryland, USA). Correction was made for non-specific fluorescence and the total oestrogen concentrations calculated by comparison with the corrected reading of an oestradiol standard. Results are expressed in ug/10 hours. No correction was made for procedural loss.

Urinary Pregnanediol

A gas-liquid chromatographic method, based on that described by Chamerlain and Contractor (1968) was used to measure the 10 hour urinary excretion of pregnanediol. 10 ml aliquots of the 10 hour urine sample were hydrolysed by boiling with concentrated hydrochloric acid in the presence of toluene and the cooled product was extracted in the Paton-Brown partitioning extractor, the lower aqueous layer being discarded. The acidic and phenolic fractions were extracted with 25% sodium chloride in N sodium hydroxide and discarded.

After washing with water, the toluene phase was evaporated to dryness and acetylated with acetyl chloride and benzene. Volatile components were evaporated by heating under nitrogen and cholesterol (20 ug in 0.2 ml ethanol) was added as internal standard. 10 ug of the solution was used for chromatography using a Pye 104 gas chromatograph (Pye & Co. Ltd., Cambridge). A calibrated curve was run with each assay and used to read the pregnanediol concentrations. These were corrected for the total volume of the 10 hour sample and results expressed in mg/ 10 hours.

3.5 SELECTION OF NORMAL OVULATORY CYCLES FROM ANOVULATORY, UNUSUAL OR INCOMPLETE CYCLES

For each cycle serial measurements of plasma, oestradiol, progesterone[1] and in some cases LH, were examined and all normal ovulatory cycles were selected for analysis. The generally accepted criteria for defining normal ovulatory cycles are as follows (Landgren et al, 1980; Speroff, Glass and Kase, 1978):-

(1) A preovulatory rise in oestradiol, followed by a midcycle rise in progesterone above 2 ng/ml. Where data was available, the LH surge indicated ovulation.

(2) A post-ovulatory luteal phase rise in progesterone above 4 ng/ml indicating the development of a normal corpus luteum.

(3) A second rise in oestradiol during the luteal phase.

(4) A fall in progesterone from peak luteal phase levels at least one day prior to the onset of menstruation.

(1) Urinary total oestrogens and pregnanediol were used for the 4 cycles based on urine collections.

Anovulatory cycles were defined by the absence of a rise in Progesterone above 4 ng/ml in the second half of the cycle and no midcycle oestradiol peak and concommitant rise in progesterone (Speroff, Glass and Kase, 1978).

Unusual Cycles included luteal phase abnormalities such as low progesterone levels indicating corpus luteum insufficiency (Sherman and Korenman, 1974); a short luteal phase of less than 9-10 days between ovulation and menstruation (Sherman and Korenman, 1974; Speroff et al, 1978); or cycles where menstruation starts prior to the decline in plasma progesterone (Landgren et al, 1980; Speroff et al, 1978).

Incomplete cycles were defined as those in which insufficient hormone assessments were made to reliably or accurately divide the cycle into phases according to the criteria below.
Anovulatory, unusual and incomplete cycles were excluded from the main analysis. Total number of normal, anovulatory, unusual and incomplete cycles are shown in Table 7.

3.6 DIVISION OF THE MENSTRUAL CYCLES INTO PHASES

3.6.1 Aim

Each normal ovulatory cycle was divided into phases corresponding to the main hormone changes during the menstrual cycle, so that each phase in individual cycles were endocrinologically comparable across different women.

The principal hormones used to divide the cycle were oestradiol and progesterone although phases were selected to include the main changes in all 3 sex steroids, Oestrogens, Progesterone and Androgens, which may have relevance to behavioural changes. The absolute levels of hormones, the ratio between hormones and the change in absolute levels or ratios were of particular importance.

Table 7

NUMBERS OF NORMAL, ANOVULATORY, UNUSUAL OR INCOMPLETE CYCLES

	Volunteers (N=44)	"Clinic" (N=22)	Total (N=66)	% of Total
Normal Cycles	36	19	55	83%
Anovulatory	6	-	6	9%
Unusual	1	2	3	5%
Incomplete	1	1	2	3%

3.6.2 The Phases Identified.

6 phases were chosen to maximise the differences in levels, ratios or changes in oestradiol and progesterone during the menstrual cycle.

1. Early follicular (E.F.) or Menstrual phase, when levels of both oestradiol and progesterone are low.
2. Mid follicular (M.F.) or Postmenstrual phase when levels of oestradiol are rising but progesterone remains low.
3. Late follicular (L.F.) or Midcycle phase, when oestradiol reaches a preovulatory peak, followed by the LH peak. Progesterone levels start to rise during this phase.
4. Early Luteal phase (E.L.). Oestradiol levels fall following the peak. Progesterone levels rise.
5. Mid Luteal phase (M.L.). Both oestradiol and progesterone levels are high.
6. Late Luteal (L.L.) or Premenstrual phase. Oestradiol and progesterone levels fall prior to menstruation.

3.6.3 Criteria for Identifying these Cycle Phases.

3 markers were used to identify the 6 phases in individual cycles.

1. The day of onset of menstrual bleeding.
2. The day of the pre-ovulatory oestradiol peak. When sufficient data was available, the day of the LH peak was used. This is generally accepted to occur 1 day after the oestradiol peak.
3. The day when progesterone levels fall following peak values in the luteal phase.

Using these markers the cycles were divided by the criteria detailed in Table 8. A schematic representation of the cycle phase division for a 28 day cycle is shown in figure 2.

Mean levels of hormones in each phase for all normal ovulatory cycles is given in Table 9. The mean length of each phase and the cycle is given in Table 10.

3.7 ANALYSIS

The main analysis was performed on the 55 cycles found to satisfy the criteria for Normal Ovulatory Cycles as described in Section 5 above. These cycles represented only 83% of the total number (Table 7) indicating the importance of accurate hormone assessments to distinguish normal from abnormal cycles.

3.7.1 General Methods of Analysis.

Ratings from the daily diaries and hormone levels, listed in Table 11, were coded and analysed using the computing facilities at Edinburgh University (Edinburgh Regional Computing Centre). For each of the 55 normal ovulatory cycles, average scores within the six hormonally defined phases were calculated.

3.7.2 Statistical Analysis.

Statistical tests were performed using S.P.S.S. packages (Nie et al, 1975). These included descriptive statistics (frequencies and cross tabulations), t tests, χ^2 tests, One-way Analysis of Variance with repeated measures, Principal Components Analyses, and Parametric (Pearson) and Non-Parametric (Spearman) correlations. These statistical techniques are as described in Snedecor and Cochran (1967) and Siegal (1956).

S.P.S.S. packages are not available for factoral designs with repeated measures and so only one-way analysis of variance was

Table 8

CRITERIA FOR DIVIDING CYCLES INTO PHASES

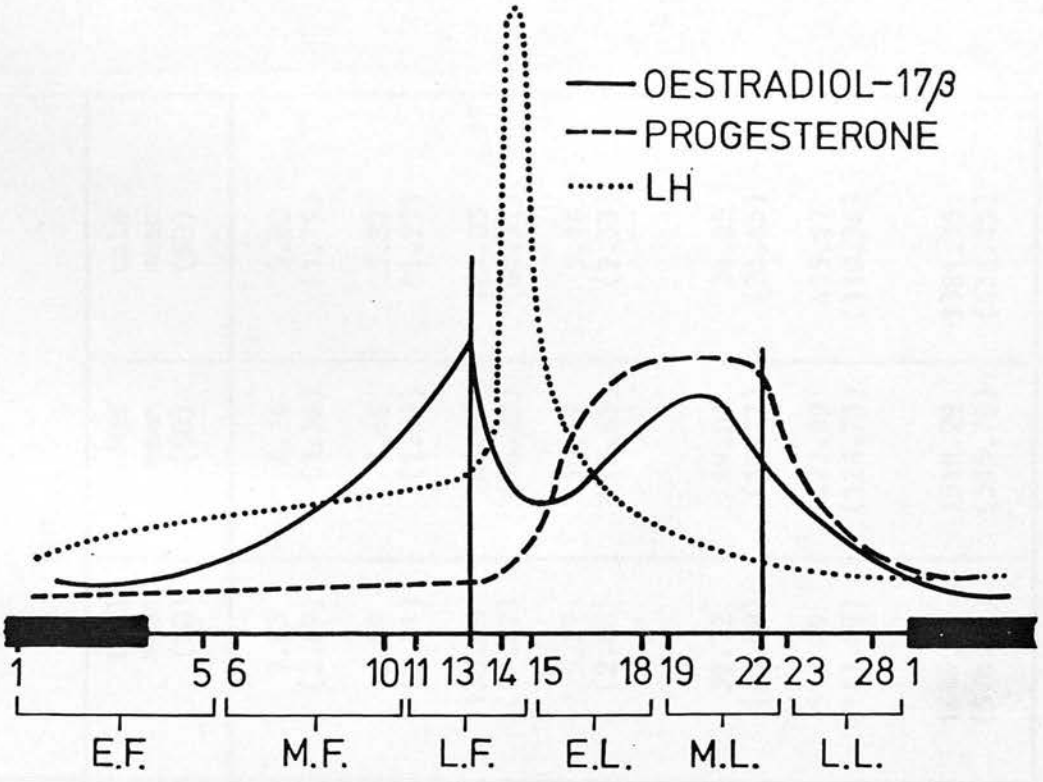
Phase	Hormonal & Physiological changes	Criteria to Identify the Phase	No. of days for "standard"* 28-day cycle
Early Follicular	Menstruation E_2 & P low	Early and mid follicular phases equally divide the time from Day 1 (onset of menstruation) to the late follicular phase, with mid follicular phase longer for unequal number of days	1-5
Mid Follicular	E_2 rising P low		6-10
Late Follicular	E_2 peak followed by LH peak & rise in P above 1 ng/ml	(i) Using the day of the E_2 peak:- from 2 days before & 1 day after the E2 peak (ii) Using the LH peak or the day P rises above 1ng/ml:- this day and preceeding 3 days	11-14
Early Luteal	Rise in P & fall in E_2 following its peak	4 days following the Late follicular Phase	15-18
Mid Luteal	Peak P followed by fall. Luteal phase E_2 peak	From the end of the early luteal phase up to and including the day of P fall	19-24
Late Luteal	E_2 & P falling prior to the next menstruation	From the end of the mid luteal phase up to and including the day before next menstruation	25-28

* "Standard"cycle, with LH peak on Day 14, fall in P on day 24 + menstruation commencing on day 29.

see Figure 2.

Figure 2.

CYCLE PHASE DIVISION



KEY

E.F.	Early	Follicular	Phase
M.F.	Mid	"	"
L.F.	Late	"	"
E.L.	Early	Luteal	"
M.L.	Mid	"	"
L.L.	Late	"	"

Table 9

MEAN (± SD) VALUES FOR HORMONES FOR ALL SUBJECTS.
(N = NUMBER OF CYCLES FOR WHICH VALUES WERE AVAILABLE FOR SIX PHASES)

Phase / Hormone	FOLLICULAR			LUTEAL		
	Early mean (SD)	Mid mean (SD)	Late mean (SD)	Early mean (SD)	Mid mean (SD)	Late mean (SD)
LH mU/ml (N = 14)	6.94 (1.43)	6.63 (2.27)	21.44 (8.85)	9.83 (2.89)	6.24 (2.36)	5.80 (1.79)
FSH mU/ml (N = 13)	9.29 (4.15)	6.38 (3.62)	8.09 (4.33)	5.89 (2.51)	3.49 (1.92)	3.87 (1.27)
Oestradiol pg/ml (N = 47)	63.81 (26.74)	109.40 (38.33)	259.53 (96.52)	136.26 (61.82)	166.84 (56.25)	123.05 (44.31)
Progesterone ng/ml (N = 47)	0.88 (0.52)	0.71 (0.39)	1.12 (0.87)	5.27 (2.68)	10.37 (3.69)	5.16 (2.33)
Oestradiol: Progesterone pg:ng (N = 48)	106.66 (115.95)	210.42 (180.25)	342.98 (248.37)	39.72 (38.08)	19.06 (11.23)	34.25 (24.65)
Testosterone pg/ml (N = 36)	392.52 (133.56)	453.68 (139.15)	526.06 (168.86)	517.49 (163.79)	477.89 (126.73)	415.17 (110.36)
Androstenedione pg/ml (N = 34)	1295.86 (446.32)	1661.25 (658.61)	1795.60 (639.68)	1694.68 (574.64)	1519.29 (535.78)	1381.33 (436.45)

Table 10

MEAN ($\pm$ SD) AND RANGE OF DAYS IN THE MENSTRUAL CYCLE AND PHASES FOR ALL SUBJECTS (N = 55)

	Cycle Length	Early Follicular	Mid Follicular	Mid Luteal	Late Luteal
Mean (SD)	27.9 (2.8)	4.9 (1.3)	5.7 (1.9)	4.7 (1.9)	4.3 (1.8)
Range	24-40	2-8	2-12	2-9	1-8

Table 11

THE VARIABLES ANALYSED IN THIS STUDY

I MOODS	Cheerful & Happy	Depressed & Unhappy
	Energetic & Active	Fatigued & Tired
	Relaxed	Tense & Anxious
	Sociable & Friendly	Irritable
	Aggressive	Changeable
II PHYSICAL	Breast Tenderness	
	Swelling or Bloated feelings	
	Headaches	
III SEXUAL INTEREST	Sexual feelings	
	Pleasant thoughts about sex	
	Unpleasant thoughts about sex	
IV SEXUAL ACTIVITIES	Frequency of Masturbation	
	Frequency and Rating of Sexual Activity with Partner	
	Frequency of Orgasm	
	Frequency of Self or Mutually Initiated Activities	
	Frequency of Partner Initiated Activities	
V HORMONES	Oestradiol 17β	
	Progesterone	
	Oestradiol : Progesterone Ratio	
	Testosterone	
	Androstenedione	

used although in some cases, a design incorporating more than one factor would have been more appropriate (Winer, 1971). Alternative methods of statistical analysis are indicated in the text of the results (Chapter 4).

3.7.3 Aims and Methods of Analysis.

The results are described in two main sections. In the first I consider how women's general emotional and physical wellbeing and sexual interest relates to the menstrual cycle and hormones. In the second, I consider how women's sexual activities vary during the cycle and the relationship with the sex steroid hormones.

3.7.3.1 Moods, PMT and the menstrual cycle.

Results are presented in Chapter 4, Section I. The data was analysed to consider four main issues:-

1. How does women's emotional and physical wellbeing and sexual interest vary in relation to hormonally defined phases of the cycle? Is PMT a qualitatively distinct phenomenon or is it related to less extreme variations in wellbeing?

One-way analysis of variance with repeated measures was performed to analyse cycle-related changes in moods (ratings on the 10 analogue mood scales), physical signs of breast tenderness, swelling or headaches, and sexual interest (ratings of sexual feelings and thoughts about sex).

This was performed both in the whole group and in the 3 groups of women formed on the basis of their experiences with cyclical changes:- the "Clinic", "Report PMT" and "No PMT" groups. Similarities and differences in the pattern of cyclical changes between these groups of women were examined.

2. How do women's moods, physical health and sexual interest interrelate, especially in the phenomenon of PMT?

Two points were of particular interest: firstly, the relationship between different aspects of moods and secondly, the links between moods and sexuality. These were examined using a principal components analysis. Variation in the "components" during the cycle was analysed in the 3 groups, using analysis of variance.

3. Do women who experience PMT differ endocrinologically from those with less marked or no cyclical variations in wellbeing?

Analysis of variance was performed on hormone levels and ratios in each phase of the cycle and changes during the luteal phase in the 3 groups ("Clinic", "Report PMT" and "No PMT").

The women were then redivided into 2 groups on the basis of changes in wellbeing during the cycle studied and hormonal differences between these groups were analysed.

Further relationships between hormones and PMT were examined by considering the women's responses in the past to times when their hormonal status was altered, such as during and after pregnancy and use of oral contraceptive agents.

4. What other aspects of these women's lives are related to PMT?

The groups of women with different experiences of cyclical changes were compared on other variables including age, parity, marital status and occupation. The relationship between these factors and hormone levels was also considered.

5. How does behaviour relate to the sex steroid hormones, Oestradiol, Progesterone, Testosterone and Androstenedione?

Links between hormones and aspects of wellbeing were analysed by correlating levels, ratios and changes in hormones with behavioural ratings in each phase of the cycle. Correlations were performed in the whole group and separately in the clinic group, with particular emphasis on how ratings in the premenstrual phase correlate with hormones.

3.7.3.2 Sexuality and the menstrual cycle.

In Chapter 4, Section II, the data was analysed to consider 2 main questions.

1. How does women's sexual interest and activities vary in relation to hormonally-defined phases of the menstrual cycle? Is the pattern related to PMT?

One way analysis of variance with repeated measures was performed to analyse cycle-related changes in sexual interest and activities, including sexual feelings and thoughts, frequency of masturbation, sexual activities with partner and orgasm and ratings of sexual activities. This was performed in the whole group and in the 3 groups, "Clinic", "Report PMT" and "No PMT" to examine similarities and differences in the pattern of cyclic sexual changes.

2. How does sexual interest and activities relate to the sex steroid hormones?

Links between hormones and sexuality were analysed by correlating levels and ratios of hormones with sexual ratings in each phase of the cycle. In addition, mean and midcycle levels of Testosterone were correlated with overall ratings of sexual interest and activities, in the whole group and in the 3 PMT groups.

CHAPTER 4

RESULTS

I. MOODS AND PREMENSTRUAL TENSION.

II. SEXUAL VARIATIONS DURING THE MENSTRUAL CYCLE.

4. RESULTS

I. MOODS AND PREMENSTRUAL TENSION

4.1 ANALYSIS OF VARIANCE OF MOODS, PHYSICAL STATE AND SEXUAL INTEREST ACROSS SIX HORMONALLY-DEFINED CYCLE PHASES.

4.1.1. In the Whole Group of 55 Normal Cycles.

Figure 3 and Table 12 show the changes in ratings of moods, physical state and sexual interest across the six hormonally-defined cycle phases, including in this analysis all 55 normal cycles.

There were significant variations during the cycle in all these aspects, the probability of obtaining an F ratio as high as the one observed being less than .0001 in most cases. Thus this group of 55 women experienced significant variations in their moods, physical state and sexual interest during the menstrual cycle.

The pattern of change is shown in figure 3. Ratings for positive moods, "Cheerful and Happy", "Energetic and Active", "Sociable and Friendly" and "Relaxed" were high in the mid follicular phase and at midcycle but declined in the mid luteal, premenstrual and menstrual phases.(1)

Negative moods, "Depressed and Unhappy", "Fatigued and Tired", "Irritable", "Tense and Anxious" and "Changable" showed the opposite pattern, increasing in the mid luteal, premenstrual and menstrual phases.

Ratings of Breast Tenderness, Swelling and Headaches also increased in the midluteal, premenstrual and menstrual phases, peaking before menstruation, but were low during the rest of the cycle.

Note (1): In order to emphasise ovulation and menstruation, the early follicular phase will also be called the menstrual phase; the mid follicular and late follicular phases, the postmenstrual phase and mid cycle phases respectively and the late luteal phase will be called the premenstrual phase.

Figure 3.

MEAN SCORES IN CYCLE PHASES ACROSS ALL WOMEN (n=55)

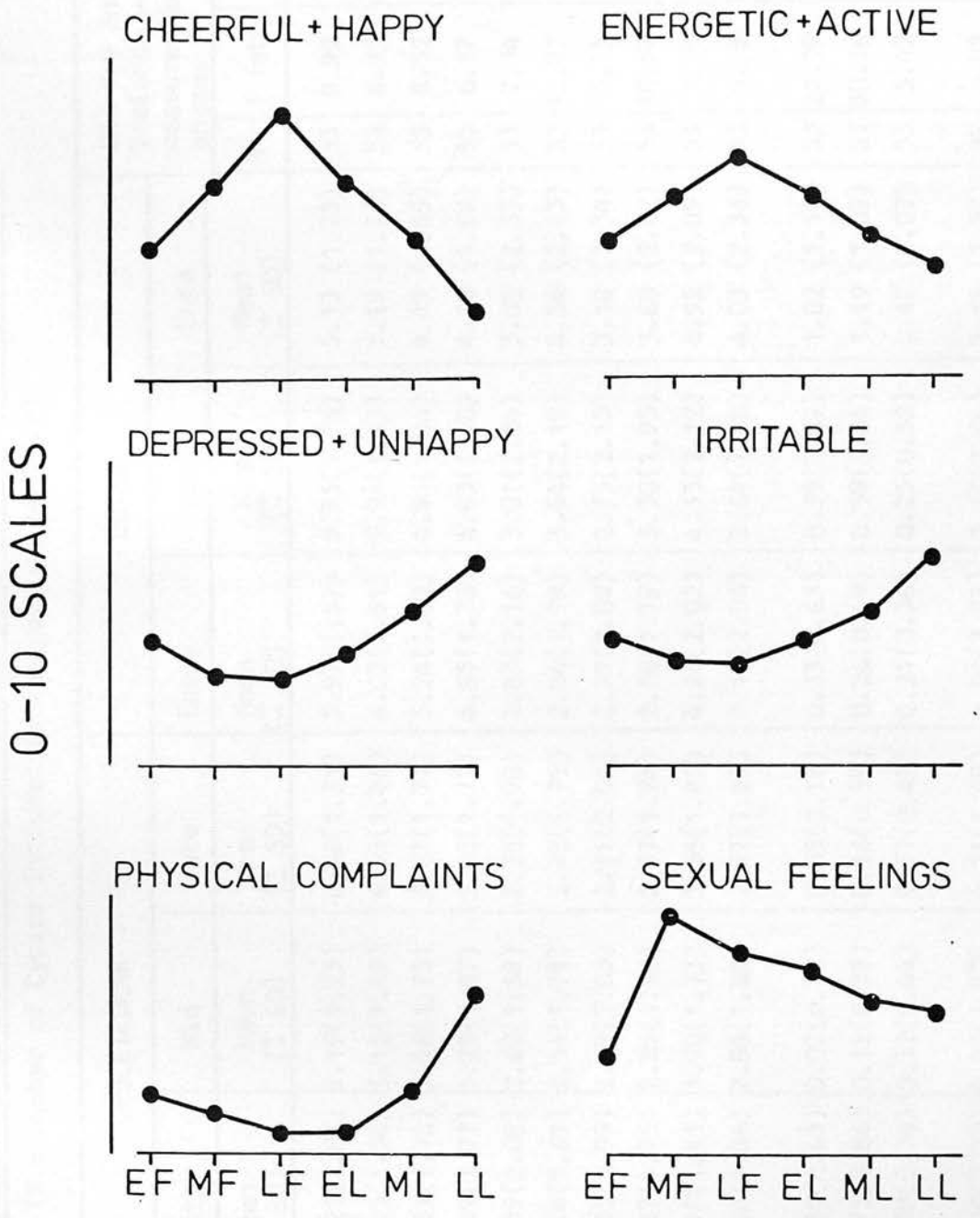


Table 12 MOODS, PHYSICAL HEALTH & SEXUAL INTEREST AS A FUNCTION OF CYCLE PHASE FOR ALL SUBJECTS

(N = Number of Cycles Included in Analysis of Variance)

Variable \ Cycle Phase	FOLLICULAR			LUTEAL			One Way Analysis of Variance - repeated measures across cycle phases		
	Early	Mid	Late	Early	Mid	Late			
	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	N	F Ratio	Probability
Cheerful & Happy	5.21(1.64)	6.19(1.73)	6.48(1.35)	5.97(1.57)	5.75(1.76)	5.17 (1.75)	53	8.99	<.00001
Sociable & Friendly	5.45(1.50)	6.15(1.49)	6.39(1.46)	6.03(1.61)	5.94(1.63)	5.19 (1.76)	53	6.95	<.00001
Energetic & Active	4.39(1.78)	5.56(1.75)	5.67(1.71)	5.24(1.60)	4.91(1.84)	4.49 (1.69)	53	8.52	<.00001
Relaxed	4.49(1.77)	5.29(1.87)	5.55(1.72)	4.85(1.70)	4.83(1.58)	4.28 (1.69)	53	6.17	<.00002
Depressed & Unhappy	3.59(2.08)	2.60(1.88)	2.36(1.98)	2.83(2.16)	3.01(2.24)	3.80 (2.55)	53	7.34	<.00001
Irritable	3.74(1.69)	2.54(1.71)	2.42(1.75)	2.84(1.99)	3.54(2.19)	4.34 (2.43)	53	13.77	<.00001
Aggressive	2.85(1.99)	2.19(2.03)	2.11(2.04)	2.39(2.09)	2.75(2.15)	3.18 (2.34)	53	5.75	.00005
Changeable	3.37(1.75)	2.29(1.68)	2.37(1.74)	2.58(1.79)	3.30(1.95)	3.68 (2.42)	53	10.57	<.00001
Fatigued & Tired	5.10(1.91)	3.90(1.73)	3.58(1.88)	4.26(2.02)	4.35(2.12)	4.92 (2.09)	53	7.79	<.00001
Tense & Anxious	3.68(1.86)	2.83(1.84)	2.81(1.83)	3.19(2.06)	3.64(1.98)	4.03 (2.36)	53	6.38	.00001
Breast Tenderness	0.39(0.63)	0.07(0.37)	0.05(0.16)	0.33(0.63)	0.59(0.87)	1.02 (1.12)	53	24.39	<.00001
Swelling	0.75(0.86)	0.12(0.39)	0.16(0.39)	0.26(0.49)	0.59(0.84)	1.19 (1.07)	53	30.16	<.00001
Headaches	0.59(0.74)	0.32(0.44)	0.31(0.48)	0.21(0.36)	0.25(0.52)	0.47 (0.07)	53	5.42	.00009
Sexual Feelings	3.66(2.30)	4.80(1.87)	4.21(1.99)	4.04(2.07)	3.76(2.06)	3.65 (2.37)	47	4.02	.002
Pleasant Thoughts	1.07(0.83)	1.38(0.76)	1.30(0.73)	1.16(0.84)	1.04(0.74)	1.07 (0.81)	48	3.54	.004
Unpleasant Thoughts	0.13(0.28)	0.05(0.14)	0.08(0.18)	0.11(0.32)	0.14(0.36)	0.13 (0.26)	48	0.92	.47

Ratings of sexual feelings and pleasant thoughts about sex reached maximum values in the postmenstrual phase but decreased during the mid and late luteal phases prior to menstruation. Ratings of "unpleasant thoughts about sex" increased during these latter phases.

4.1.2 In the 3 Groups: "Clinic", "Report PMT" and "No PMT".

The results of Analysis of Variance are shown in Table 13 (a, b and c) the pattern of change during the cycle, in figures 4, 5 and 6.

4.1.2.1 The "Clinic" Group

In this group of 19 women there were highly significant variations during the cycle in moods, physical state and sexual feelings. The pattern of change (fig. 4) was similar to that described for the whole group (section 4.1.1). Thus positive moods increased in the postmenstrual and midcycle phases but declined during the luteal phase to reach lowest ratings premenstrually. Negative moods increased during the luteal phase in contrast to low ratings in the mid and late follicular phase, reaching peak values prior to menstruation. Ratings of Breast Tenderness, Swelling and Headaches also increased during the luteal phase, peaking premenstrually and remaining high during menstruation.

Sexual feelings and pleasant thoughts about sex increased after menstruation, peaking in the mid and late follicular phases. Lowest ratings occurred before and during menstruation and at this time unpleasant thoughts about sex increased.

The most noticable pattern shown in figure 4 is the contrast between the postmenstrual and mid cycle phases and the mid luteal and premenstrual phases. Thus women in the "Clinic" Group rated

Table 13a MOODS, PHYSICAL HEALTH & SEXUAL INTEREST AS A FUNCTION OF CYCLE PHASES IN THE "CLINIC" GROUP

(N = Number of Cycles Included in Analysis of Variance)

Variable \ Cycle Phase	FOLLICULAR			LUTEAL			One Way Analysis of Variance - repeated measures across cycle phases		
	Early	Mid	Late	Early	Mid	Late			
	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	N	F Ratio	Probability
Cheerful & Happy	5.12(1.87)	6.29(1.97)	6.71(1.52)	5.49(1.39)	5.19(2.03)	4.21(1.88)	19	9.9	<.00001
Sociable & Friendly	5.25(1.69)	6.25(1.61)	6.53(1.75)	5.57(1.69)	5.54(1.96)	4.17(1.84)	19	9.4	<.00001
Energetic & Active	4.47(2.01)	6.09(1.92)	5.81(1.95)	5.30(1.67)	4.69(2.22)	3.85(1.58)	19	6.7	<.00001
Relaxed	4.29(2.00)	5.34(2.01)	5.91(1.85)	4.34(1.53)	4.12(1.72)	3.41(1.67)	19	6.9	<.00001
Depressed & Unhappy	3.62(1.76)	2.36(1.59)	1.81(1.73)	2.91(1.97)	3.41(2.35)	4.70(2.84)	19	7.1	<.00001
Irritable	4.29(1.48)	2.61(1.91)	2.39(1.84)	3.58(2.07)	4.20(2.45)	5.43(2.65)	19	8.8	<.00001
Aggressive	2.72(1.87)	1.39(1.68)	1.36(1.97)	2.21(2.22)	2.55(2.33)	3.35(2.55)	19	5.4	.0002
Changeable	3.58(1.70)	2.09(1.95)	2.28(1.86)	2.89(2.01)	3.47(1.97)	4.36(2.71)	19	6.9	<.00001
Fatigued & Tired	5.39(1.86)	3.69(1.92)	3.36(1.72)	4.51(1.75)	4.96(2.39)	6.13(1.95)	19	8.5	<.00001
Tense & Anxious	4.43(1.47)	3.19(2.04)	2.72(1.94)	3.78(1.92)	4.21(1.78)	5.28(2.34)	19	7.0	<.00001
Breast Tenderness	0.44(0.77)	0.18(0.61)	0.06(0.23)	0.49(0.73)	0.84(0.98)	1.43(1.24)	19	14.5	<.00001
Swelling	1.07(1.03)	0.25(0.62)	0.14(0.44)	0.45(0.69)	0.97(0.92)	1.72(1.03)	19	20.9	<.00001
Headaches	0.63(0.83)	0.32(0.39)	0.29(0.56)	0.23(0.29)	0.37(0.68)	0.62(0.76)	19	1.9	.09
Sexual Feelings	3.81(2.51)	5.25(2.08)	5.18(1.56)	3.97(1.89)	4.17(2.00)	3.21(2.28)	15	3.4	.008
Pleasant Thoughts	0.92(0.79)	1.32(0.88)	1.34(0.73)	0.97(0.83)	0.97(0.59)	0.89(0.81)	15	1.7	.14
Unpleasant Thoughts	0.05(0.11)	0 (0)	0 (0)	0.10(0.39)	0.15(0.47)	0.20(0.37)	15	1.6	.17

Table 13b: MOODS, PHYSICAL HEALTH & SEXUAL INTEREST AS A FUNCTION OF CYCLE PHASE IN THE "REPORT PMT" GROUP

(N = Number of Cycles Included in Analysis of Variance)

Variable \ Cycle Phase	FOLLICULAR			LUTEAL			One Way Analysis of Variance - repeated measures across cycle phases		
	Early	Mid	Late	Early	Mid	Late			
	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	N	F Ratio	Probability
Cheerful & Happy	4.99(1.61)	6.12(1.60)	6.36(1.51)	6.42(1.24)	5.93(1.63)	5.38(1.66)	18	3.5	.006
Sociable & Friendly	5.22(1.54)	6.01(1.66)	6.33(1.54)	6.31(1.46)	5.96(1.54)	5.24(1.62)	18	2.9	.02
Energetic & Active	4.18(1.68)	4.97(1.77)	5.52(1.79)	5.26(1.25)	4.81(1.69)	4.53(1.86)	18	2.4	.04
Relaxed	4.29(1.71)	5.00(2.06)	5.01(1.89)	5.04(1.72)	4.84(1.40)	4.34(1.47)	18	1.3	.27
Depressed & Unhappy	3.65(2.66)	2.33(2.06)	2.56(2.41)	2.70(2.15)	2.78(2.08)	3.63(2.48)	18	2.6	0.03
Irritable	3.68(1.98)	2.24(1.81)	2.48(2.03)	2.52(1.99)	3.43(2.31)	4.42(2.27)	18	5.6	.0001
Aggressive	2.92(2.47)	2.66(2.38)	2.64(2.32)	2.72(2.20)	3.25(2.12)	3.25(2.56)	18	0.8	.55
Changeable	3.09(1.93)	2.28(1.71)	2.29(1.91)	2.36(1.95)	3.22(2.08)	3.51(2.49)	18	3.1	.01
Fatigued & Tired	4.75(1.83)	3.53(1.69)	3.60(2.11)	3.77(2.01)	3.91(1.94)	4.12(2.13)	18	1.4	0.22
Tense & Anxious	3.47(2.15)	2.40(1.78)	2.73(2.00)	2.74(1.96)	3.56(2.28)	3.72(2.28)	18	2.6	.03
Breast Tenderness	0.52(0.66)	0.02(0.05)	0.03(0.08)	0.26(0.49)	0.47(0.89)	0.78(0.97)	18	5.8	.0001
Swelling	0.79(0.83)	0.03(0.08)	0.16(0.36)	0.16(0.31)	0.50(0.86)	1.36(0.99)	18	14.3	< .00001
Headaches	0.70(0.69)	0.41(0.53)	0.43(0.54)	0.33(0.51)	0.31(0.50)	0.62(0.75)	18	1.9	.09
Sexual Feelings	3.57(2.14)	4.30(1.89)	3.61(2.09)	4.24(2.21)	3.49(2.24)	3.69(2.32)	16	1.01	.42
Pleasant Thoughts	0.97(0.82)	1.19(0.63)	1.14(0.69)	1.15(0.78)	0.91(0.74)	1.09(0.71)	17	0.8	.58
Unpleasant Thoughts	0.16(0.27)	0.03(0.08)	0.10(0.19)	0.03(0.12)	0.14(0.37)	0.06(0.14)	17	1.3	.26

Table 13c: MOODS, PHYSICAL HEALTH & SEXUAL INTEREST AS A FUNCTION OF CYCLE PHASES IN THE "NO PMT" GROUP

(N = Number of Cycles Included in Analysis of Variance)

Variable \ Cycle Phase	FOLLICULAR			LUTEAL			One Way Analysis of Variance - repeated measures across cycle phases		
	Early	Mid	Late	Early	Mid	Late			
	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	Mean (± SD)	N	F Ratio	Probability
Cheerful & Happy	5.57(1.42)	6.04(1.65)	6.35(0.94)	6.01(1.99)	6.23(1.44)	6.07(1.09)	16	0.8	.57
Sociable & Friendly	5.97(1.15)	6.17(1.24)	6.29(0.97)	6.24(1.66)	6.41(1.22)	6.34(1.00)	16	0.3	.92
Energetic & Active	4.52(1.69)	5.48(1.36)	5.67(1.35)	5.14(1.94)	5.27(1.52)	5.20(1.37)	16	1.7	.14
Relaxed	4.97(1.55)	5.44(1.47)	5.73(1.22)	5.26(1.82)	5.64(1.23)	5.26(1.48)	16	0.8	.57
Depressed & Unhappy	3.49(1.79)	3.11(2.09)	2.80(1.66)	2.88(2.49)	2.78(2.34)	2.93(1.98)	16	0.7	.63
Irritable	3.14(1.41)	2.96(1.67)	2.38(1.36)	2.34(1.75)	2.86(1.56)	3.06(1.69)	16	1.4	.23
Aggressive	2.93(1.63)	2.47(1.82)	2.41(1.59)	2.24(1.90)	2.44(1.99)	2.89(1.91)	16	1.7	.15
Changeable	3.46(1.65)	2.61(1.37)	2.57(1.45)	2.46(1.37)	3.19(1.87)	3.07(1.85)	16	1.9	.10
Fatigued & Tired	5.14(2.12)	4.50(1.53)	3.83(1.89)	4.52(2.32)	4.13(1.94)	4.37(1.60)	16	1.8	.13
Tense & Anxious	3.01(1.70)	3.02(1.69)	3.01(1.59)	3.01(2.27)	3.08(1.77)	2.89(1.83)	16	0.04	.99
Breast Tenderness	0.19(0.33)	0.06(0.25)	0.04(0.13)	0.23(0.63)	0.44(0.68)	0.83(1.06)	16	5.7	.0002
Swelling	0.34(0.47)	0.04(0.09)	0.17(0.38)	0.14(0.29)	0.24(0.53)	0.38(0.69)	16	1.6	.16
Headaches	0.44(0.68)	0.21(0.38)	0.19(0.25)	0.05(0.09)	0.03(0.09)	0.14(0.22)	16	2.9	.02
Sexual Feelings	3.59(2.41)	4.56(1.89)	3.89(2.02)	3.90(2.22)	3.64(2.00)	4.03(2.57)	16	1.02	.41
Pleasant Thoughts	1.32(0.86)	1.53(0.79)	1.44(0.78)	1.34(0.89)	1.24(0.86)	1.20(0.93)	16	1.2	.33
Unpleasant Thoughts	0.16(0.39)	0.22(0.41)	0.13(0.22)	0.20(0.39)	0.11(0.23)	0.13(0.22)	16	0.4	.86

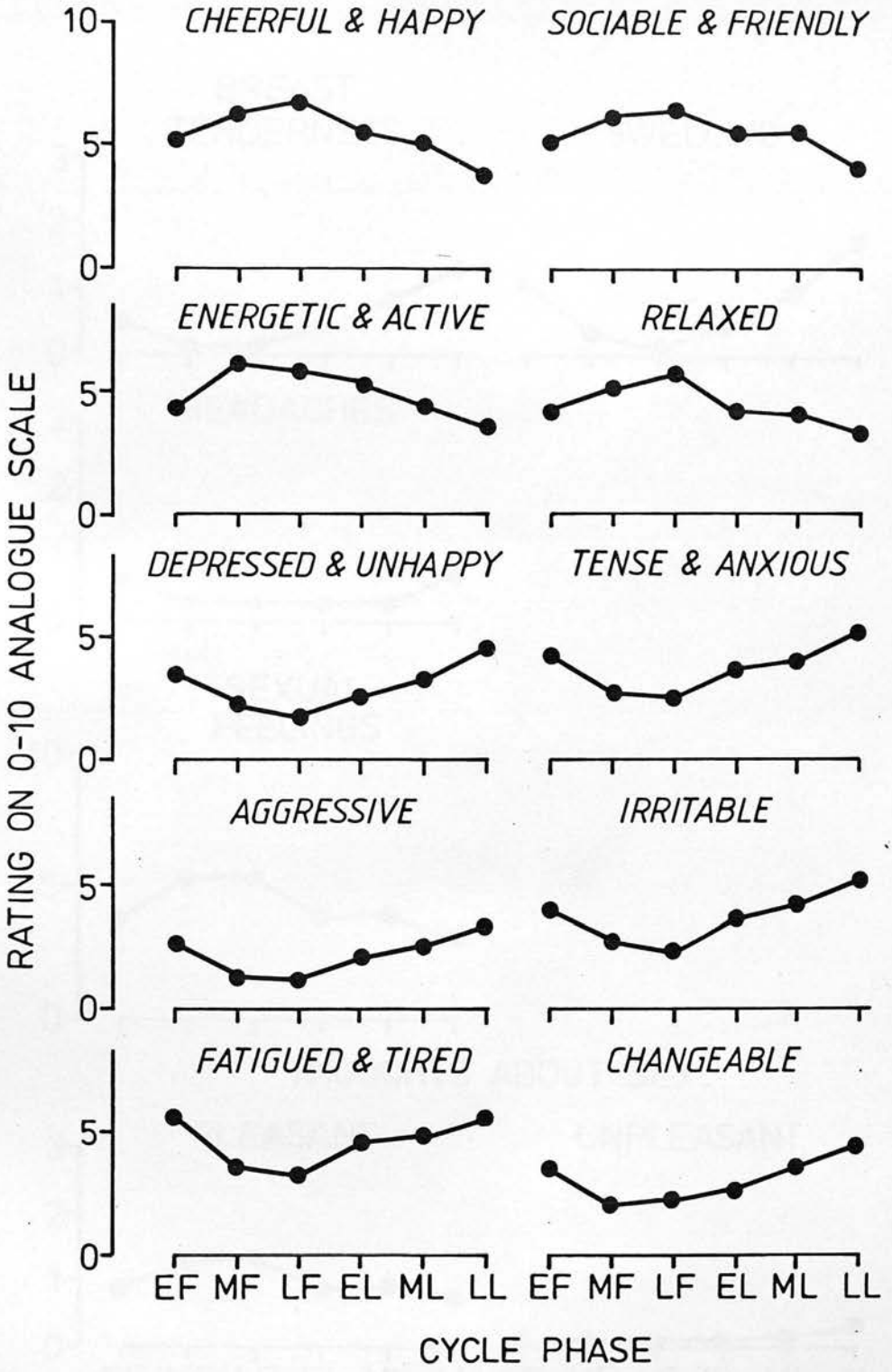


Figure 4a. MOODS AS A FUNCTION OF CYCLE PHASE IN THE "CLINIC" GROUP

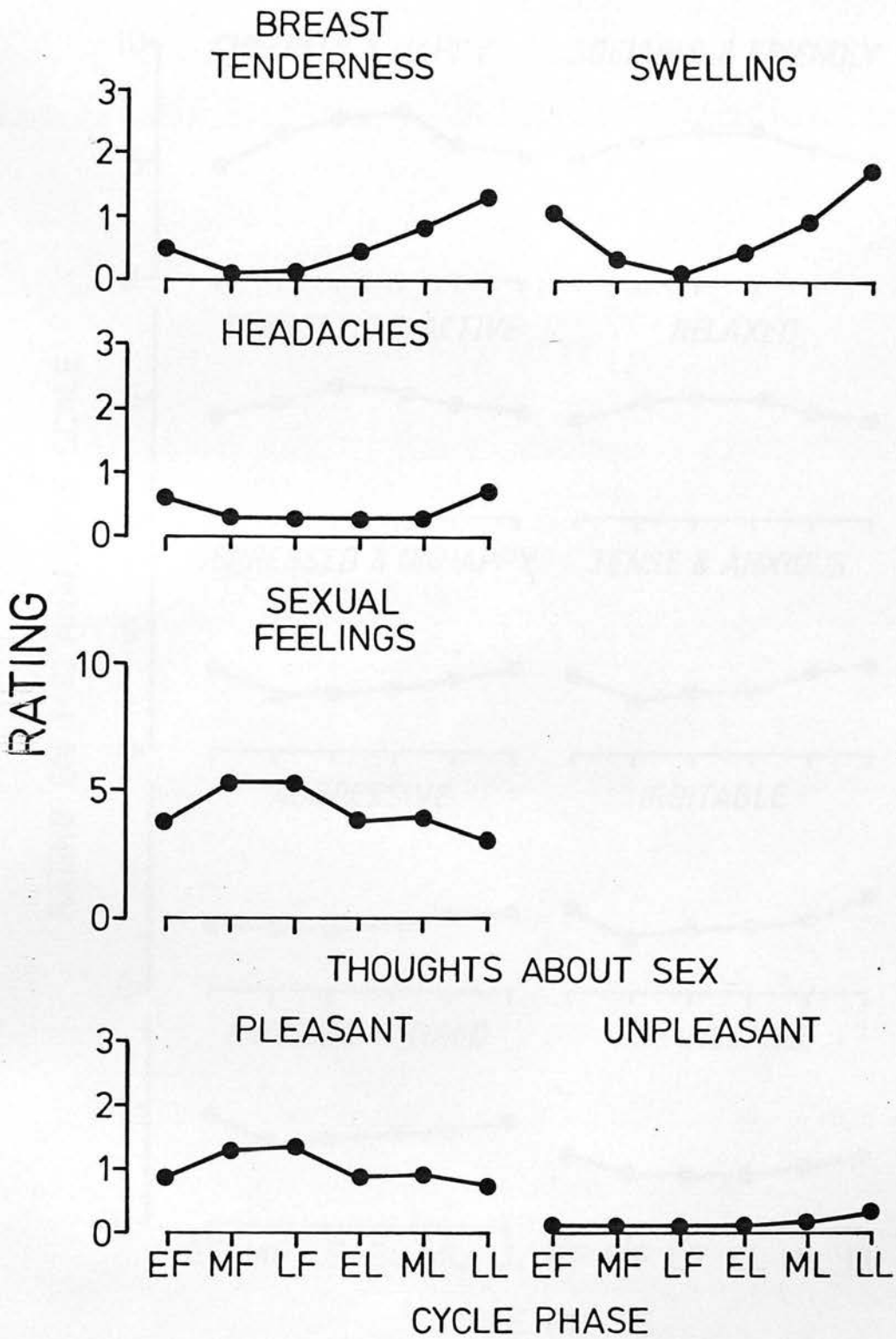


Figure 4b. PHYSICAL HEALTH AND SEXUAL INTEREST AS A FUNCTION OF CYCLE PHASE IN THE "CLINIC" GROUP

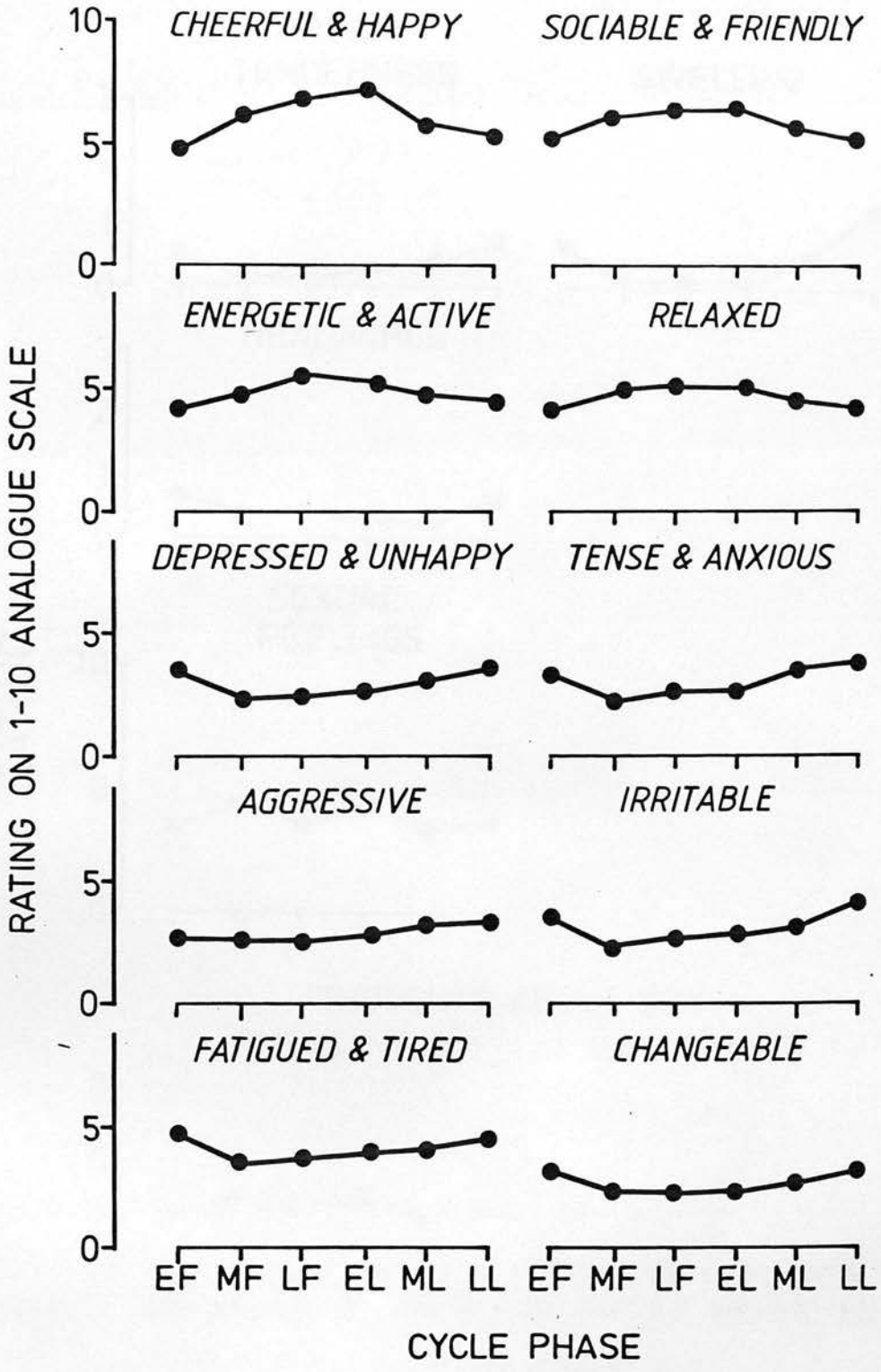


Figure 5a. MOODS AS A FUNCTION OF CYCLE PHASE IN THE "REPORT PMT" GROUP

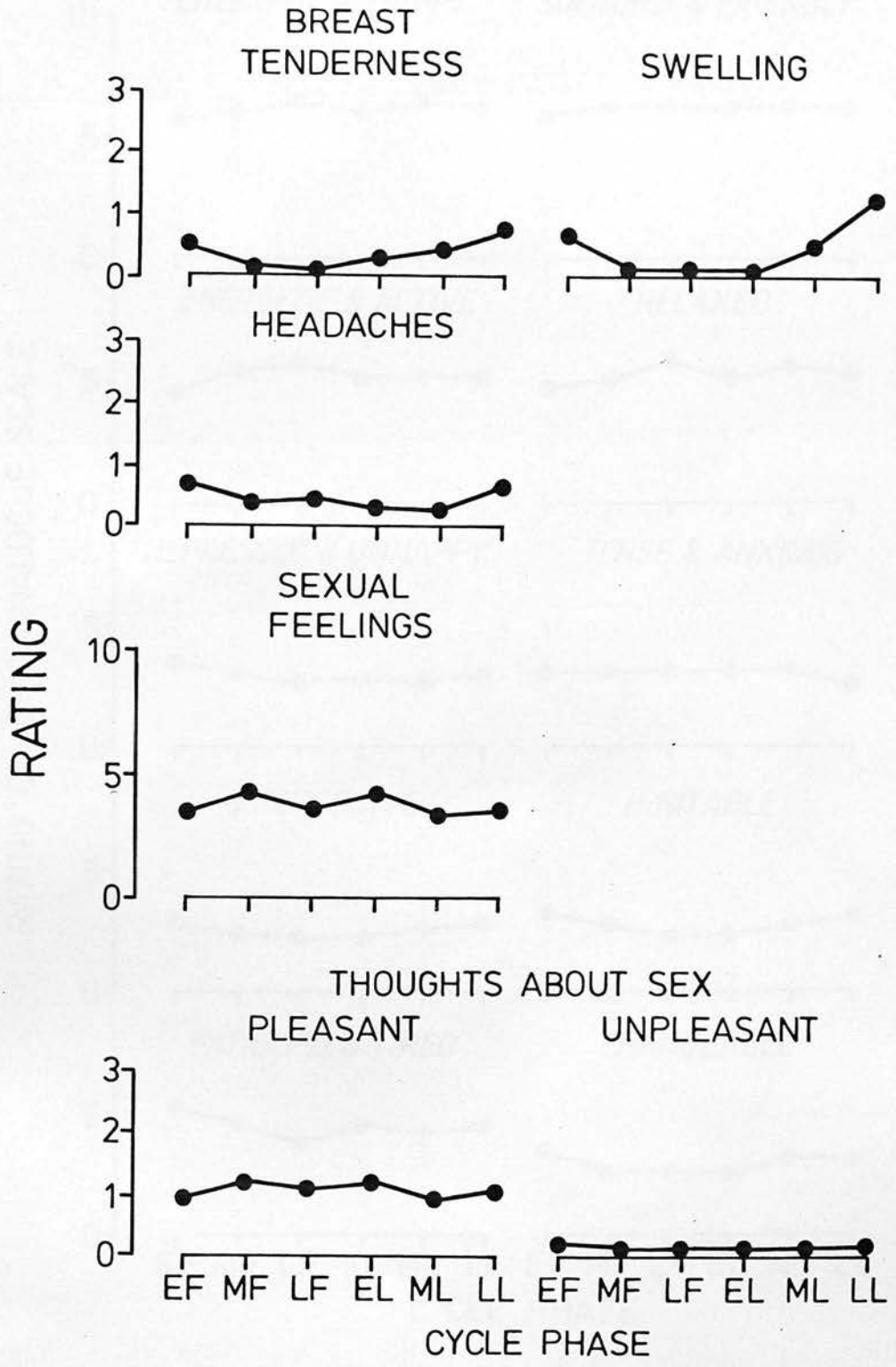


Figure 5b. PHYSICAL HEALTH AND SEXUAL INTEREST AS A FUNCTION OF CYCLE PHASE IN THE "REPORT PMT" GROUP

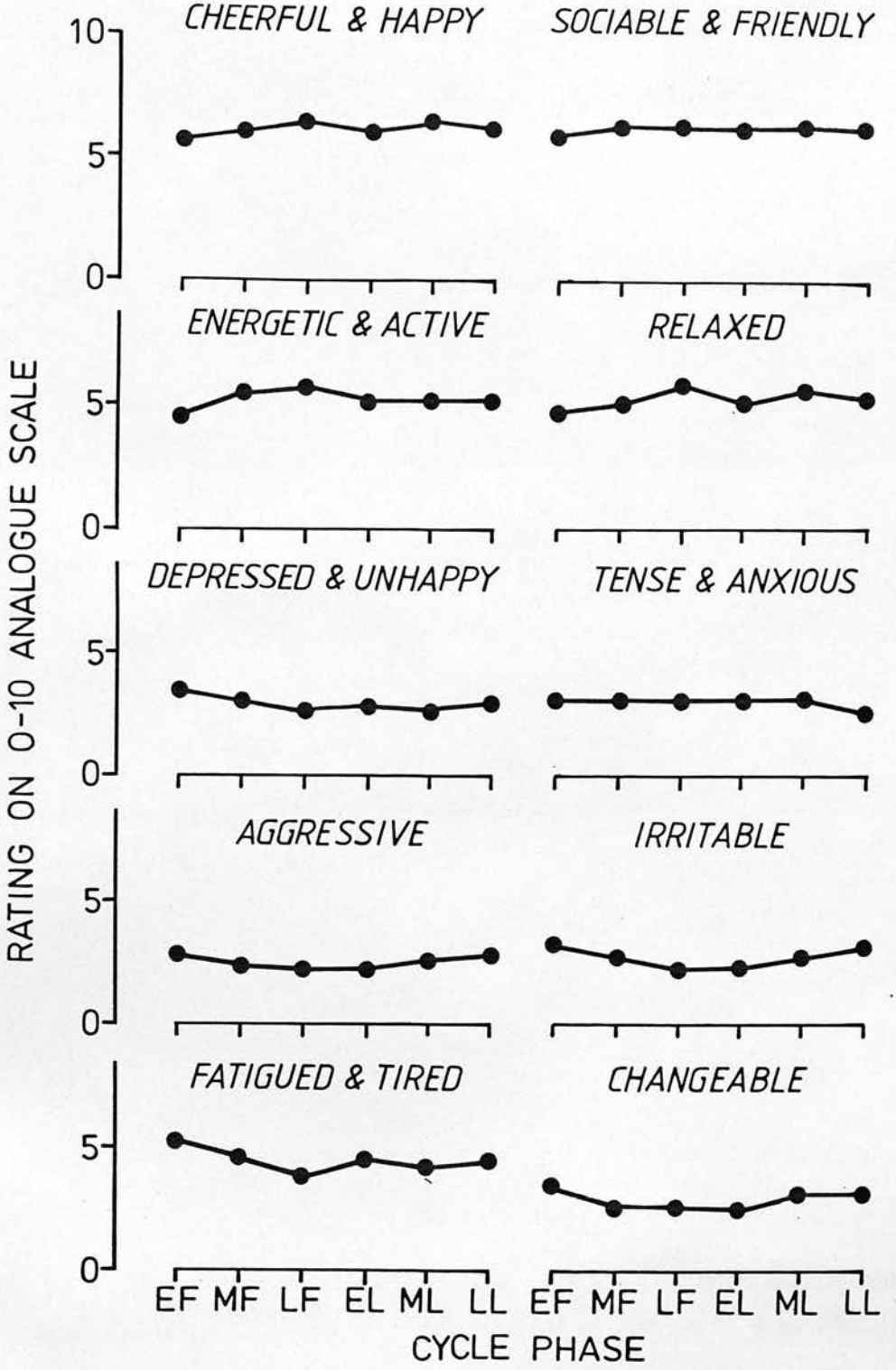


Figure 6a. MOODS AS A FUNCTION OF CYCLE PHASE IN THE "NO PMT" GROUP

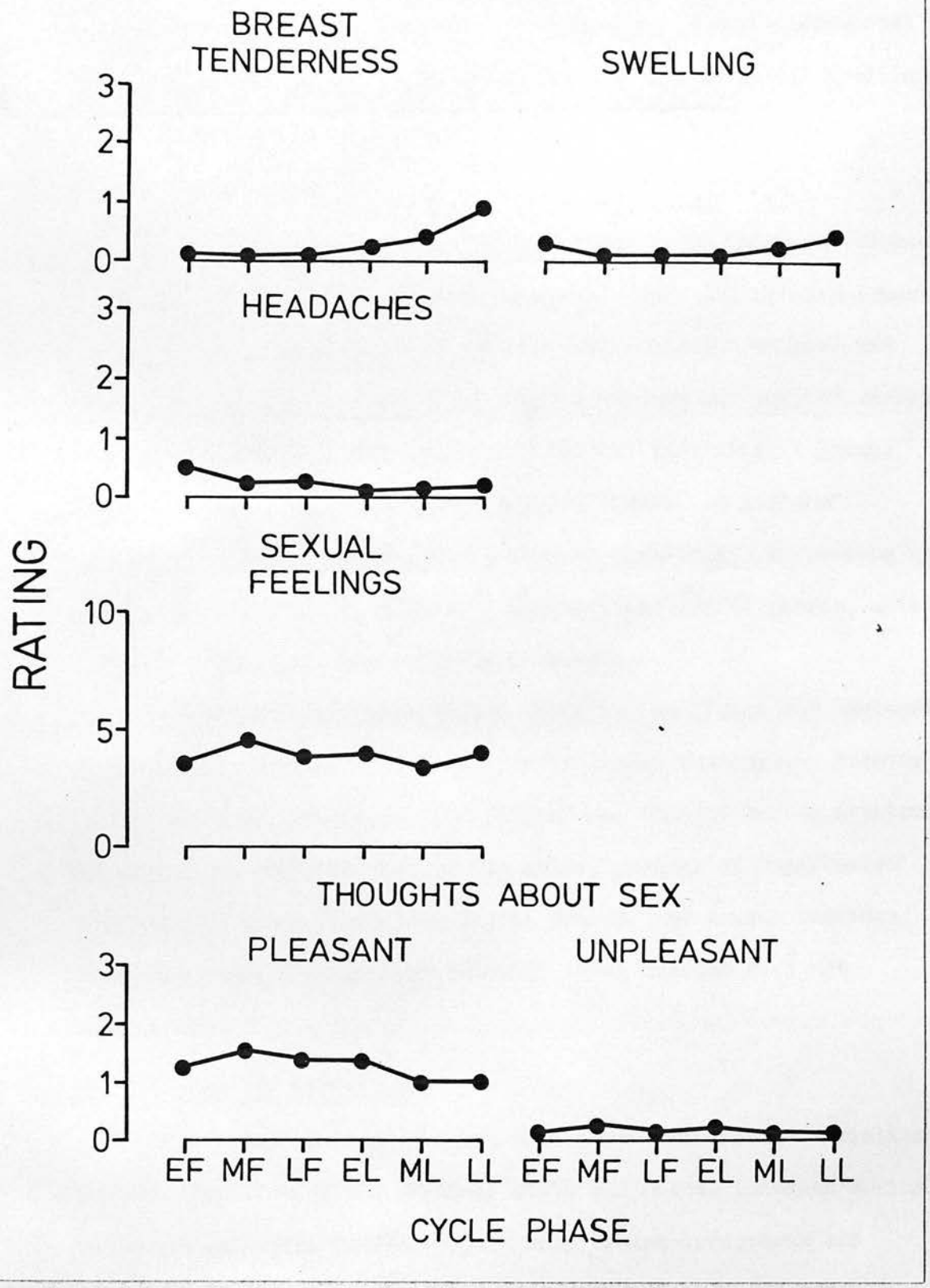


Figure 6b. PHYSICAL HEALTH AND SEXUAL INTEREST AS A FUNCTION OF CYCLE PHASE IN THE "NO PMT" GROUP

themselves as feeling very positive and well after menstruation and at ovulation. After ovulation positive moods declined and ratings of negative moods increased, along with greater breast tenderness, swelling and headaches. The pattern of ratings of sexual feelings paralleled that of positive moods.

4.1.2.2 The "Report PMT" Group

As can be seen in Table 13b this group of 18 women experienced significant variations during the cycle in some, but not all aspects of moods and physical state. Thus positive moods "cheerful and happy", "sociable and friendly" and "energetic and active" varied with a similar pattern to that described for the "Clinic" group. Negative moods, "Depressed and Unhappy", "Tense and Anxious", "Irritable" and "Changable" also varied significantly, increasing in the mid and late luteal phases. During those latter phases, ratings of breast tenderness and swelling increased.

No statistically significant variation was found for "Relaxed", "Aggressive", "Headaches" or ratings of sexual feelings. However as fig. 5 shows, "fatigued and tired" was highest during menstruation in comparison with the rest of the cycle, ratings of "aggressive" increased in the mid and late luteal phases, and sexual feelings increased after menstruation although these changes were not significant.

4.1.2.3 The "No PMT" Group

This group of women did not experience significant variations in many aspects of moods, physical state and sexual interest during the menstrual cycle (Table 13c). Only breast tenderness and headaches were found to vary, increasing prior to and during menstruation in comparison to the rest of the cycle.

However it can be seen from fig. 6 that there is a slight pattern. These women rated themselves as more tired and less energetic and relaxed during menstruation. Ratings of changable and aggressive increased before and during menstruation. Ratings of sexual feelings increased after and before menstruation although this pattern was not significant.

4.1.3 Comparison of the 3 Groups.

4.1.3.1 Comparison of "No PMT" group and women experiencing PMT ("Report PMT" and "Clinic")

The contrast between the "No PMT" group and the others reflects both the magnitude and timing of cyclical changes. As expected women in the "No PMT" group did not experience significant variations during the cycle in many aspects of moods although some cyclical changes found in the 2 PMT groups were echoed in the "No PMT" group, indicating some degree of change related to the cycle. However in the "No PMT" group the main change occurred in the menstrual phase when, in comparison with other times, these women felt more tired and less energetic and relaxed. Although a similar decline in wellbeing occurred in the PMT groups the timing was different, occurring in the mid and late luteal phases.

There are 2 similarities to note. Women in all 3 groups noticed breast tenderness prior to menstruation, although this was of lesser severity in the "Not PMT" group. Also all 3 groups of women reported a peak of sexual feelings after menstruation.

4.1.3.2 Comparison of the "Report PMT" and "Clinic" Groups

Both groups experienced changes in moods and physical state and many of these aspects were significantly related to cycle phase. As can be seen in figures 4 and 5 the pattern of change was similar

in the 2 groups. However the change was much more pronounced in the "Clinic" group, with a greater contrast between the post menstrual and mid cycle phases in comparison with ratings in the second half of the cycle.

There were other differences to note. One is that the decline in wellbeing occurred earlier in the "Clinic" group, immediately after ovulation, whereas a similar decline did not start until the mid luteal phase in the "Report PMT" group.

Also the women in the "Clinic" group experienced significant changes in aspects of their wellbeing which did not vary in such a pronounced manner in the "Report PMT" group. The "Clinic" group rated themselves as less relaxed and more fatigued and tired and aggressive in the premenstrual phase and at this time ratings of sexual feelings also declined, a pattern not seen in the "Report PMT" group.

4.2 THE INTERRELATIONSHIPS BETWEEN MOODS, PHYSICAL STATE AND SEXUAL INTEREST.

4.2.1 Introduction

The results described in section 1 establish that at least some women and approximately half a group of "volunteers" do experience changes in moods, physical state and sexuality related to hormonally-defined phases of the menstrual cycle. So far a large number of variables have been analysed, reflecting various different aspects of emotions, physical state and sexual interest. These variables were summarised and interrelated by means of a Principal Components Analysis.

Principal Components (P.C.) analysis is a mathematical technique used to summarise most of the variation in a number of variables in a smaller number of "Principal Components". The

variables are intercorrelated and those which are highly correlated are combined as Principal Components (Maxwell, 1977; Child, 1970). The first P.C. accounts for most of the variance; the rest are uncorrelated with each other or the first and account for the largest proportion of the total variance unaccounted for by the previous components. Components are selected until approximately 75% of the variance is accounted for.

4.2.2 Principal Components Analysis.

4.2.2.1 Across the whole group.

A P.C. analysis was performed on mean scores within phases for the Analogue Mood Scales, ratings of Physical State (Breast Tenderness and Swelling), Sexual Feelings and Pleasant Thoughts about Sex (converting 4 point ratings to equivalent 10 point ratings). In the initial correlation matrix it was found that ratings of Headaches and Unpleasant Thoughts about Sex were not correlated with any other variable and so were excluded in the subsequent formation of P.C.s. 4 components were formed, selecting a minimum eigenvalue of 1.1 to account for 75% of the variance (Maxwell, 1977). The loadings for the variables in each component are shown in Table 14.

The first component was a general one and so most of the variables were found to load significantly. It can be summarised as "Lack of Wellbeing"(1) and contrasts negative feelings (Irritable, Depressed, Tense, Fatigued, Changable, Aggressive, Breast Tenderness and Swelling) with positive moods (Cheerful, Sociable, Relaxed, Energetic and Sexual Interest). The component can be reversed and labelled as

Footnote (1): These names "Lack of Wellbeing", "Outward Directed Emotions", "Physical Distress" and "Sexuality" were invented to describe the components in comprehensible terms and have no other statistical or conceptual meaning (Child, 1970).

Table 14

PRINCIPAL COMPONENTS ANALYSIS OF MEAN SCORES ACROSS ALL SUBJECTS: LOADINGS OF MOOD, PHYSICAL AND SEXUAL VARIABLES ON THE FOUR PRINCIPAL COMPONENTS

PC1 "Lack of Wellbeing"		PC2 "Outward Directed Emotions"		PC3 "Physical Distress"		PC4 "Sexuality"	
Irritable	.84	Changeable	.60	Breast Tenderness	.82	Pleasant Sexual Thoughts	.74
Depressed	.80	Aggressive	.60	Swelling	.69	Sexual Feelings	.69
Tense	.79	Energetic	.52	Depressed	−.21	Energetic	−.31
Fatigued	.70	Sociable	.49				
Changeable	.61	Relaxed	.37				
Aggressive	.54	Cheerful	.36				
Swelling	.51	Irritable	.34				
Breast Tenderness	.30	Tense	.32				
Cheerful	−.83	Depressed	.27				
Sociable	−.73	Fatigued	.17				
Relaxed	−.72						
Energetic	−.59						
Pleasant Sexual Thoughts	−.46						
Sexual Feelings	−.44						
Eigenvalue	5.97		2.03		1.32		1.26
Percentage of variance	42.7%		14.5%		9.4%		9.0%

(Total % of variance accounted for by 4 PCs = 75.5%)

"Wellbeing" for ease of conceptualisation and said to contrast positive feelings with negative.

The second component, accounting for 14.5% of the variance may be described as "Outward Directed Emotions". "Changable", "Aggressive", "Energetic" and "Sociable" have the highest loadings. The third component accounts for 9.4% of the variance and consists of the "Physical Distress" variables, Breast Tenderness and Swelling or Bloated feelings. The fourth component contrasts sexual feelings and thoughts with Energetic and Active and may be described as "Sexuality".

These components both summarise different aspects of moods, physical state and sexuality and indicate which aspects relate to each other.

It might be expected that at different phases of the cycle the variables could be interrelated in different ways. For example in the premenstrual phase an overall negative mood state might prevail with high scores on all negative variables and low on positive moods. In contrast at midcycle moods may be more discriminating in that one might feel cheerful but not necessarily relaxed or sociable, or tense but not necessarily depressed. This phase effect can reduce the validity of performing the P.C. analysis across all phases. To check this, six separate analyses were performed, one for each phase. It was found that the components were very similar to those formed across all phases. The main difference was in the order: thus the "Physical" and "Sexual" components were either third or fourth depending on the phase. Since the proportion of variance accounted for by these later components is small anyway the order is not crucial to the main analysis. Hence the main P.C. analysis performed using all 6 phases was valid.

4.2.2.2 In the 3 groups

In addition 3 P.C. analyses were performed separately for the "Clinic", "Report PMT" and "No PMT" groups (Table 15). The components formed were very similar to the overall analysis (section 2.2.1), comprising lack of "Wellbeing", "Outward Directed Emotions", "Physical Distress" and "Sexuality", although the loadings and order of the variables in each component differed differed slightly in the 3 groups. In the "Clinic" and "Report PMT" groups, sexual feelings was significantly loaded on Component 2 in contrast to the "No PMT" group, indicating a close relationship between sexual feelings and outward directed emotions in the women with PMT.

4.2.3 Analysis of Variance of the Principal Components.

The components formed in the first P.C. analysis across all women (Table 14) were used to evaluate variations across the 6 phases in the 3 groups. Scores for the P.C.s were calculated for each phase for each individual. One way analysis of variance with repeated measures across cycle phases was performed for each component, firstly across all women and secondly in the 3 groups.

4.2.3.1 Across the whole group

As can be seen in Table 16 significant variations were observed in "Wellbeing", "Physical Distress" and "Sexuality". "Wellbeing" declined in the mid and late luteal phases, remained low during menstruation and increased in the mid and late follicular phases, declining again after ovulation. The pattern of change on the third component, "Physical Distress", reflected the increased ratings of Breast Tenderness and Swelling during the mid and late luteal phases. Thus the changes in these 2 components during the cycle were similar to those on the individual ratings.

Table 15 LOADINGS OF MOOD, PHYSICAL & SEXUAL VARIABLES ON THE FOUR PRINCIPAL COMPONENTS:-

P.C. Analysis of the 3 groups

PC / Variable	CLINIC GROUP				REPORT PMT GROUP				NO PMT GROUP			
	1	2	3	4	1	2	3	4	1	2	3	4
Cheerful	-.84	.41	.02	-.20	-.89	.10	.12	-.01	-.64	.63	.09	.08
Fatigued	.78	.24	.03	.08	.77	.14	-.24	.04	.59	.01	-.10	.23
Sociable	-.76	.50	.08	-.17	-.81	.25	.22	-.17	-.42	.69	.06	.11
Energetic	-.71	.51	.09	-.27	-.57	.20	.33	-.53	-.37	.78	-.04	.02
Tense	.77	.42	-.19	.12	.85	.18	-.01	-.10	.77	.30	-.18	.09
Irritable	.83	.36	-.14	.13	.87	.17	.23	-.02	.77	.35	.20	.11
Changeable	.54	.68	-.01	-.11	.62	.55	.24	-.04	.69	.31	.20	.30
Aggressive	.04	.49	-.01	-.17	.43	.66	.31	-.25	.68	.49	.10	.02
Depressed	.78	.34	-.29	-.01	.83	.22	.01	.03	.85	-.01	-.12	.22
Relaxed	-.74	.47	-.02	-.08	-.77	.05	.22	-.06	-.49	.51	-.12	-.10
Breast Tenderness	.34	.12	.85	.07	.28	-.55	.58	.35	.08	.03	.78	-.11
Swelling	.66	.07	.52	-.01	.40	-.42	.69	.02	.10	-.08	.76	-.35
Sexual Feelings	-.55	.55	-.002	.43	-.45	.60	.08	.44	-.41	-.17	.24	.69
Sexual thoughts	-.57	.21	.02	.71	.37	.48	.13	.62	-.45	-.25	.20	.70
Eigen value	6.82	2.49	1.16	0.94	6.3	2.1	1.3	1.1	4.6	2.4	1.5	1.4
% of Variance	48.7%	17.8%	6.4%	6.8%	45.3%	14.9%	9.7%	8.0%	32.9%	17.5%	10.7%	9.9%
Total % of Variance	81.7%				77.9%				71.0%			

Table 16

PRINCIPAL COMPONENT SCORES AS A FUNCTION OF CYCLE PHASE IN THE WHOLE GROUP AND IN THE THREE GROUPS: "CLINIC", "REPORT PMT" AND "NO PMT" (N = NUMBER OF CYCLES INCLUDED IN ANALYSIS OF VARIANCE)

Principal Component \ Cycle Phase	FOLLICULAR						LUTEAL						One Way Analysis of Variance - repeated measures across cycle pha	
	Early		Mid		Late		Early		Mid		Late			
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	F ratio	Probabi
I - WHOLE GROUP (N = 47)														
1. "Lack of Wellbeing"	.37	(0.89)	-.37	(0.87)	-.49	(0.83)	-.13	(0.89)	.13	(0.97)	.58	(1.05)	13.38	<.0000
2. "Outward Emotions"	-.11	(1.04)	.06	(0.91)	.07	(0.87)	-.04	(1.01)	.03	(0.96)	-.03	(1.05)	0.88	.49
3. "Physical Distress"	.005	(0.91)	-.34	(0.74)	-.22	(0.54)	-.16	(0.79)	.23	(1.17)	.85	(1.51)	15.93	<.0000
4. "Sexuality"	.12	(0.98)	.18	(0.91)	-.14	(1.07)	-.04	(0.99)	-.07	(1.00)	.21	(1.11)	2.51	.03
II - "CLINIC GROUP" (N = 15)														
1.	.57	(0.97)	-.41	(1.09)	-.77	(0.84)	.20	(0.89)	.57	(0.85)	1.28	(0.99)	10.72	<.0000
2.	-.09	(1.24)	.12	(1.09)	.23	(1.06)	-.01	(1.19)	-.06	(1.35)	-.11	(1.26)	0.88	.49
3.	.23	(1.11)	-.002	(1.07)	-.003	(0.51)	.09	(0.82)	.58	(1.32)	1.26	(1.71)	5.85	.0001
4.	.09	(0.64)	.17	(0.86)	-.05	(1.03)	-.06	(0.99)	.26	(0.68)	.38	(0.96)	1.13	.35
III - "REPORT PMT" GROUP (N = 16)														
1.	.51	(0.99)	-.35	(0.94)	-.27	(0.99)	-.25	(0.83)	.12	(1.09)	.64	(0.95)	4.68	.0009
2.	-.24	(0.97)	.04	(0.85)	.64	(0.79)	.04	(0.80)	.07	(0.81)	.02	(1.03)	0.77	.57
3.	.09	(0.97)	-.48	(0.54)	-.36	(0.59)	-.30	(0.47)	.05	(1.13)	.82	(1.46)	6.43	.0000
4.	.16	(0.92)	.14	(0.86)	-.26	(1.07)	-.06	(0.86)	-.27	(0.95)	.24	(1.04)	1.83	.12
IV - "NO PMT" GROUP (N = 16)														
1.	.05	(0.66)	-.36	(0.59)	-.44	(0.55)	-.30	(0.92)	-.26	(0.79)	-.14	(0.69)	1.48	.21
	-.009	(0.93)	.11	(0.83)	.06	(0.76)	-.14	(1.08)	.07	(0.69)	.05	(0.90)	0.49	.78
3.	-.29	(0.54)	-.50	(0.38)	-.28	(0.49)	-.26	(0.99)	.09	(1.06)	.50	(1.34)	3.92	.003
4.	.09	(1.32)	.24	(1.07)	-.11	(1.17)	.001	(1.16)	-.17	(1.26)	.004	(1.33)	0.97	.44

The pattern of change in the second component, "Outward Directed Emotions" was not statistically significant. However ratings increased in the mid and late follicular phases and decreased before and during menstruation.

The fourth component, "Sexuality", was of interest in that the pattern during the cycle was different from that predicted from variations in "Sexual feelings" (figure 3). 2 peaks were observed, one post menstrual and one premenstrual. This component reflected sexual interest controlling for the effects of mood, especially energy.

4.2.3.2 In the 3 Groups: "Clinic", "Report PMT" and "No PMT"

Results of the separate analyses of variance are shown in Table 16 and the pattern of change during the cycle in figure 7.

4.2.3.2.1 Comparison between the "No PMT" group and the Others

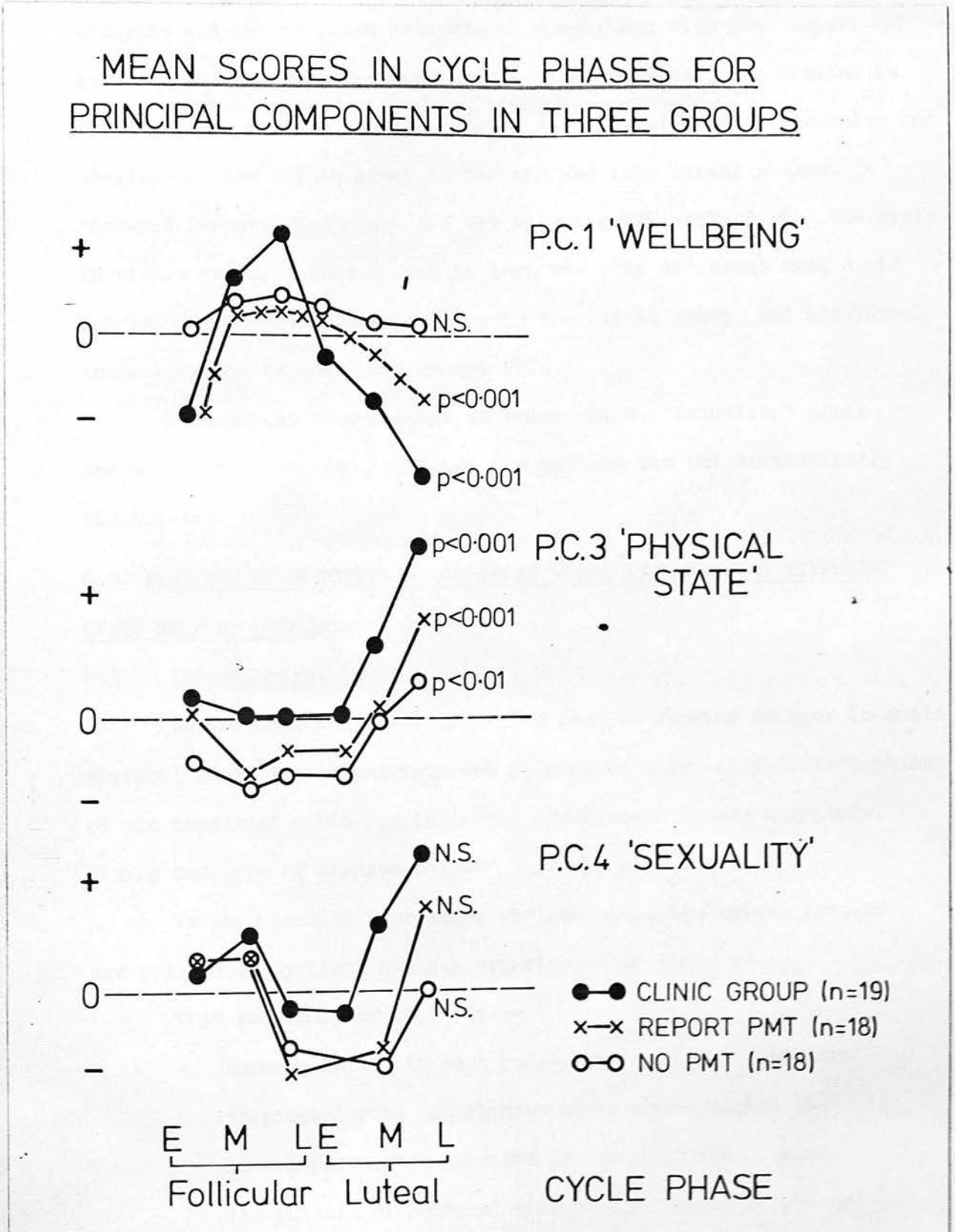
Women in the "No PMT" group only showed significant variations in "Physical Distress". This component increased in the mid luteal phase and peaked premenstrually. This is a similar but less marked pattern to that seen in the other 2 groups. (Fig. 7) The pattern of change in "Wellbeing" was also similar but comparatively less marked and non-significant in the "No PMT" group, with a peak in the mid follicular phase and decline in the luteal phase.

No significant changes were seen in components 2,"Outward Directed Emotions" and 4, "Sexuality" in any of the groups. However, although a postmenstrual sexual peak occurred in all 3 groups, only the 2 PMT groups also showed the premenstrual peak described in the whole group (2.3.1 above).

4.2.3.2.2 Comparison between the "Clinic" Group and "Report PMT" Group

As can be seen in figure 7, there were some interesting similarities and differences between the 2 groups. "Wellbeing" declined

Figure 7.


MEAN SCORES IN CYCLE PHASES FOR PRINCIPAL COMPONENTS IN THREE GROUPS
P.C.1 'WELLBEING'
+
0
−
N.S.
p<0·001
p<0·001
P.C.3 'PHYSICAL STATE'
p<0·001
p<0·001
p<0·01
P.C.4 'SEXUALITY'
N.S.
N.S.
N.S.
CLINIC GROUP (n=19)
REPORT PMT (n=18)
NO PMT (n=18)
E M L E M L
Follicular Luteal
CYCLE PHASE

during the luteal phase in both groups:- however this decline started earlier in the "Clinic" group, with a more marked contrast between midcycle and luteal phase ratings, in comparison with the "Report PMT" group. The pattern of change in "Physical Distress" was similar in the 2 groups, but indicated a greater severity of Breast Tenderness and Swelling in the "clinic" group in the mid and late luteal phases. "Outward Directed Emotions" did not vary significantly during the cycle in either group. However the pattern was very different with a mid and late follicular phase increase in the "clinic" group, and mid-luteal phase increase in women who report PMT.

Both groups showed peaks in component 4, "Sexuality" after and before menstruation, although the pattern was not statistically significant.

4.3 ANALYSIS OF HORMONES IN GROUPS OF WOMEN EXPERIENCING DIFFERENT CYCLE-RELATED CHANGES.

4.3.1 Introduction.

In the last section I presented results showing changes in moods, physical state and sexual interest related to hormonally-defined phases of the menstrual cycle and indicated differences in the magnitude, timing and type of changes between 3 groups of women.

In this section I consider whether endocrinological factors are related to cyclical changes experienced by these women.

This was analysed in 3 ways:-

1. Hormone levels in each phase, the ratio of oestradiol to progesterone and changes in hormones during the luteal phase were examined in the 3 groups. Also the pattern of hormonal changes and length of phases was analysed. (Section 4.3.2)

2. The women were redivided into new groups based on the changes during the cycle and endocrinological differences between these new groups were examined. (Section 4.3.3)

3. An analysis was made of whether there were differences in these womens experiences at times of hormone changes, such as pregnancy, after birth and whilst using oral contraceptive agents. (Section 4.3.4)

4.3.2 Analysis of Variance of Hormone Levels, Ratios and Changes in the 3 Groups: "Clinic", "Report PMT" and "No PMT".

Mean levels of hormones in each phase in the 3 groups are shown in Table 17 and Figure 8. It can be seen that there was a wide within-group variation which reduces the significance of observed differences between the groups.

One way Analysis of Variance was performed to test the significance of the differences in hormone levels and ratios in each phase and mean levels across the cycle (Table 17).

4.3.2.1 Levels in each phase and changes in the luteal phase Oestradiol levels in the follicular phase were not significantly different in the 3 groups. In the luteal phase levels were lowest in "Clinic" group, which was a significant difference ($P < 5\%$) in the early luteal phase. The change in oestradiol from mid to late luteal phases was not significantly different in the 3 groups. Progesterone levels in the luteal phase were not significantly different, although were highest in the early and mid luteal phases in the clinic group. These women also showed the biggest drop in Progesterone before menstruation ($P = .26$).

Table 17 MEAN (± SD) LEVELS OF HORMONES DURING THE MENSTRUAL CYCLE IN THE 3 GROUPS

HORMONE & PHASE	GROUP			ANALYSIS OF VARIANCE	
	"CLINIC" N=19	"REPORT PMT" N=18	"NO PMT" N=18	F Ratio	Probability
OESTRADIOL					
pg/ml EF	62.0 (33.2)	64.7 (19.0)	65.9 (24.1)	0.10	.90
MF	114.5 (41.4)	103.8 (31.4)	110.0 (39.1)	0.37	.69
LF	262.4 (109.2)	257.8 (95.6)	240.6 (90.7)	0.23	.79
EL	112.7 (49.5)	141.3 (59.6)	173.6 (88.8)	3.65	.03
ML	153.2 (55.9)	162.8 (56.2)	189.4 (69.4)	1.68	.19
LL	108.1 (40.2)	123.1 (35.5)	139.5 (50.9)	2.38	.10
Difference between ML & LL	45.1 (37.1)	39.7 (41.7)	43.1 (50.8)	.07	.93
Mean across Cycle	135.5 (43.4)	146.7 (31.7)	149.7 (38.2)	0.64	.53
PROGESTERONE					
ng/ml EL	5.8 (2.9)	4.6 (1.6)	4.9 (2.9)	1.07	.35
ML	10.8 (3.2)	10.2 (3.7)	9.8 (4.1)	0.37	.69
LL	5.0 (2.4)	5.8 (2.6)	5.1 (2.2)	0.57	.60
Difference between ML & LL	5.8 (2.0)	4.4 (3.2)	4.7 (2.7)	1.38	.26
Mean across Cycle	4.0 (1.2)	3.9 (1.2)	3.8 (1.3)	0.16	.85
OESTRADIOL & PROGESTERONE					
pg/ng EL	34.5 (43.5)	37.5 (18.4)	57.7 (60.8)	1.39	.26
ML	15.4 (6.0)	18.1 (9.4)	22.9 (15.2)	2.25	.12
LL	33.2 (18.2)	26.2 (12.7)	39.9 (36.1)	1.37	.26
Difference between ML & LL	17.8 (14.2)	8.1 (9.3)	17.1 (22.8)	1.94	.16
Mean across Cycle	146.1 (114.8)	98.7 (53.7)	124.4 (54.4)	1.29	.28

Contd. over

Table 17 (contd ....)

HORMONE & PHASE		GROUP			ANALYSIS OF VARIANCE	
		"CLINIC" N=19	"REPORT PMT" N=18	"NO PMT" N=18	F Ratio	Probability
TESTOSTERONE						
pg/ml	EF	414.5 (208.9)	401.6 (128.4)	398.7(111.8)	0.05	.96
	MF	443.3 (192.3)	455.8 (140.2)	481.8(129.6)	0.26	.77
	LF	486.2 (154.8)	510.3 (171.8)	571.5(146.8)	1.11	.34
	EL	431.1 (107.1)	549.3 (147.2)	556.5(174.9)	3.11	.05
	ML	460.7 (133.8)	482.3 (135.5)	524.8(124.4)	0.96	.39
	LL	414.6 (125.6)	392.7 (103.9)	473.7(107.9)	2.12	.13
Difference between ML & LL		46.2 (56.3)	89.6 (95.4)	54.5(86.3)	1.25	.29
Mean across Cycle		418.7 (128.9)	464.1 (123.2)	501.7(100.6)	1.48	.24
ANDROSTENEDIONE						
pg/ml	EF	1142.7 (507)	1531.0 (459)	1429.6 (536)	2.27	.12
	MF	1509.3 (729)	1835.4 (779)	1627.6 (842)	0.66	.52
	LF	1608.5 (508)	2084.5 (765)	1677.0 (426)	2.92	.06
	EL	1361.5 (515)	1928.6 (453.5)	1795.1 (547)	5.13	.01
	ML	1342.7 (402)	1729.8 (510)	1660.8 (957)	1.42	.25
	LL	1248.2 (434)	1547.9 (450)	1430.6 (494)	1.73	.19
Difference between ML & LL		97.9 (237)	181.9 (356)	191.7 (626)	0.21	.81
Mean across Cycle		1257.9 (360)	1849.2 (459)	1540.4 (377)	6.35	.005

(NB. The N values for each group are approximate: due to missing values, numbers in each analysis of variance are less than in the whole group)

Figure 8.

PLASMA OESTRADIOL AND PROGESTERONE DURING THE SIX PHASES OF THE CYCLE IN THREE GROUPS OF WOMEN

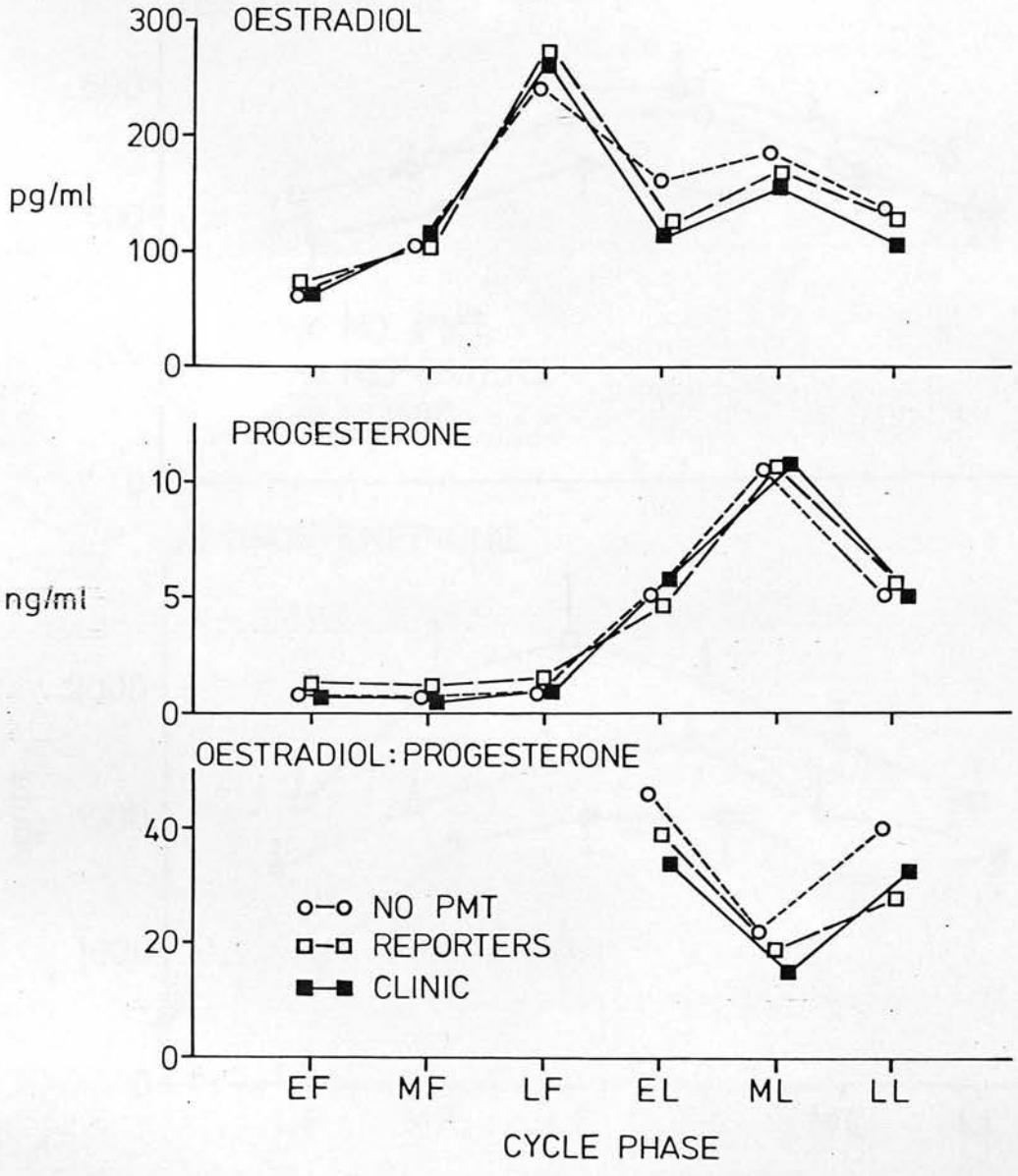


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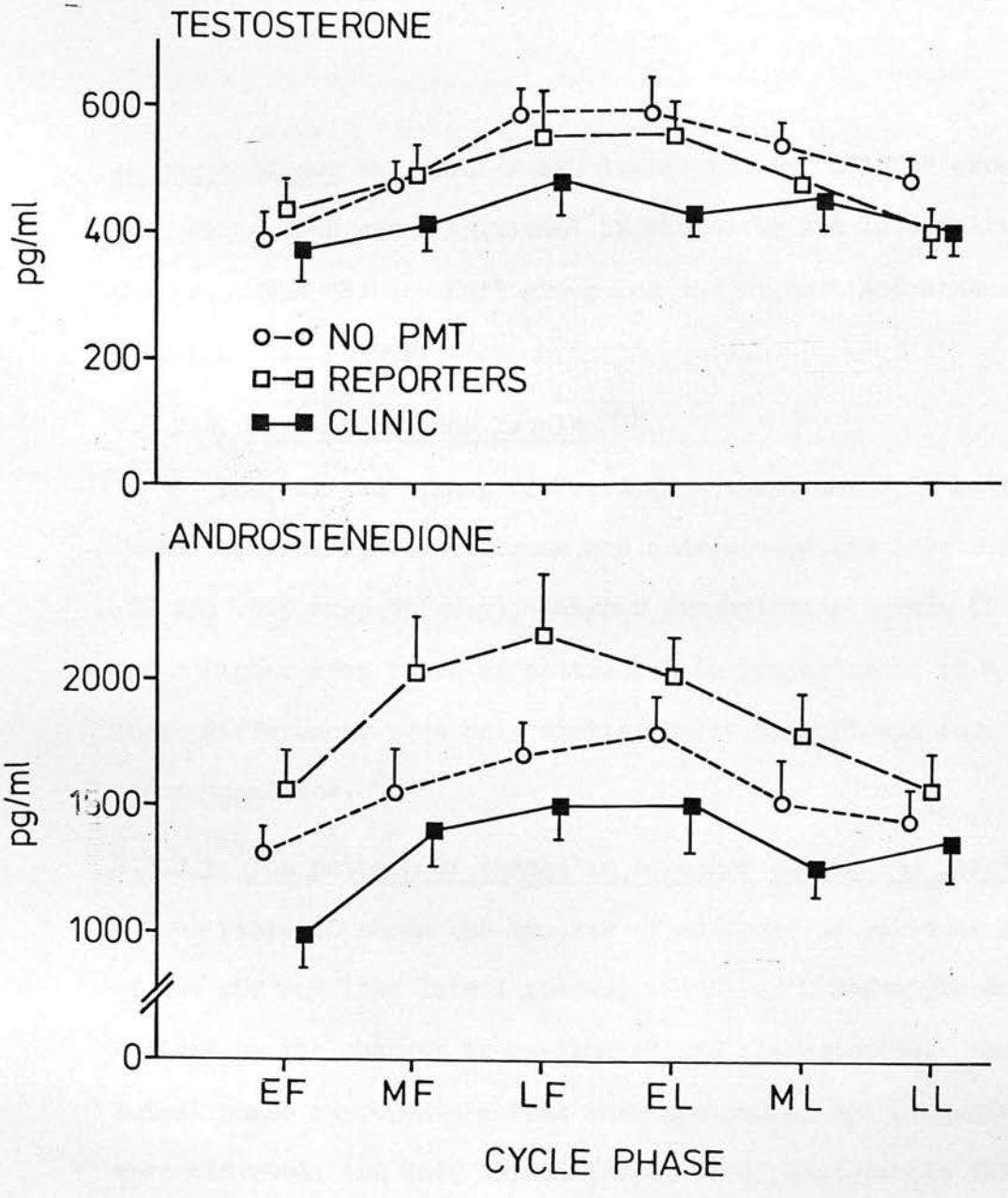
Figure 8 (continued).



The ratio of Oestradiol to Progesterone in the luteal phase was not significantly different in the 3 groups.

Testosterone was lowest in the "Clinic" group in the mid and late follicular and early and mid luteal phases. After ovulation the difference between the "Clinic" and other 2 groups was significant ($P = .05$).

Androstenedione was, similarly, lowest in the "Clinic" group and this difference was significant in the early and late follicular phases. The "Report PMT" group had the highest Androstenedione levels in all phases.

4.3.2.2 Overall hormone levels

The "Clinic" group differed from the other 2 in having lower average oestradiol, testosterone and androstenedione levels ($P = .53$, .28 and .009 respectively), higher progesterone levels ($P = .85$) and a higher mean ratio of oestradiol to progesterone ($P = .28$). These differences were only statistically significant for androstenedione.

4.3.2.3 The pattern of change in hormones during the luteal phase

Table 18 shows the results of analysis of variance of lengths of the mid and late luteal phases. These phases were defined by the changes in oestradiol and progesterone: thus the mid luteal phase represents a time when oestradiol and progesterone levels were elevated, the late luteal phase, when progesterone falls prior to menstruation.

Although there were no statistically significant differences in the lengths of these phases there was some indication that the

Table 18

THE LENGTH OF THE MID AND LATE LUTEAL PHASES AND THE MENSTRUAL CYCLE IN THE 3 GROUPS (MEAN ± SD)

	"Clinic" Group (N = 19)	"Report PMT" Group (N = 18)	"No PMT" Group (N = 18)	Analysis of Variance	
				F Ratio	Probability
Mid Luteal Phase	4.00 (1.73)	4.78 (2.07)	4.72 (1.74)	1.02	.37
Late Luteal Phase	5.05 (1.43)	4.39 (1.88)	4.05 (1.89)	1.57	.22
Cycle Length	27.47 (3.45)	28.33 (2.72)	28.00 (2.59)	0.39	.67

late luteal phase was longer in the "Clinic" group, i.e. these women experienced a longer time of falling progesterone levels prior to menstruation.

4.3.3 Formation of New Groups based on the Changes Observed during the Cycle and Differences in Hormones between the New Groups.

4.3.3.1 Introduction

The analysis so far has considered 3 groups of women categorised according to their usual experiences of PMT. The women were redivided into new groups based on the changes in wellbeing observed during the cycle studied, independent of their original reports. Hormonal differences between these new groups were then analysed.

In other studies of the menstrual cycle 2 ways of grouping individuals have been used:-

(a) The method of Sampson and Jenner (1977). This involves fitting sine curves to the data and analysing the timing and magnitude of the highest point of the curve (Acrophase) in relation to menstruation. The women who show a premenstrual peak in aspects of emotional and physical distress can be grouped and compared and contrasted to women who do not "peak" at this time.
The method is useful in that it takes account of data collected every day and therefore avoids loss of information by using statistical summaries. However it is a complex technique and methods of assessing statistical significance of the timing and magnitude of the peaks are not fully established in relation to the analysis of longitudinal menstrual cycle data (Sollberger, 1965; Ferin et al, 1974).

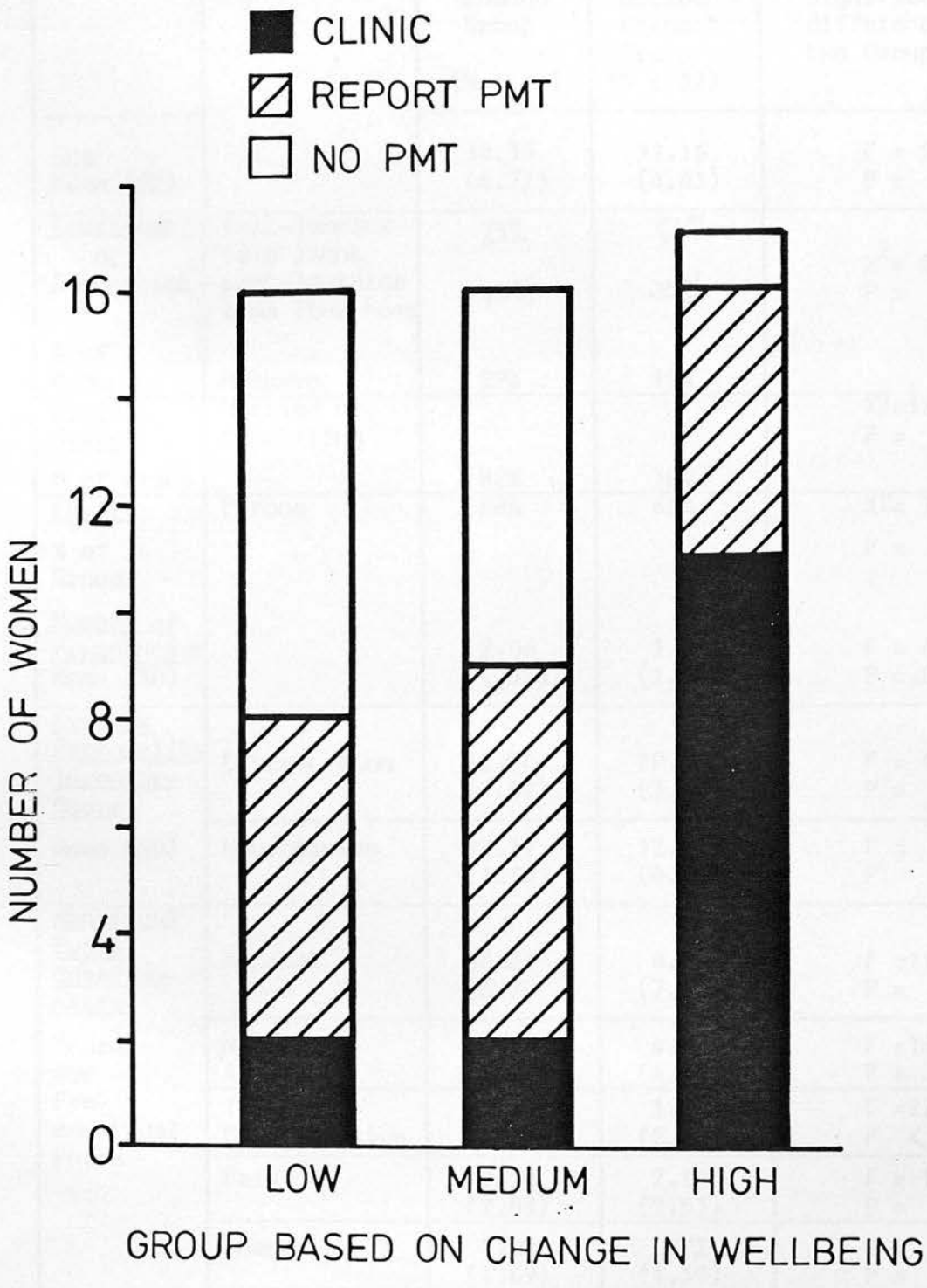


Figure 9. NUMBER OF WOMEN FROM THE ORIGINAL THREE GROUPS IN THE NEW GROUPS

Table 19

CHARACTERISTICS OF THE TWO GROUPS BASED ON CHANGES IN "WELLBEING" DURING THE MENSTRUAL CYCLE

		"High Change" Group (N = 17)	"Low & Medium Change" Group (N = 32)	X^2 or F ratio: Significance of the difference between the two Groups
Age Mean (SD)		34.35 (4.72)	32.16 (4.83)	F = 2.33 P = .13
Employment or Occupation	full-)employ- time)ment part-)outside time)the home	29% 42%	46% 35%	X^2 = 2.63 P = .62
% of Group	Mothers	29%	19%	
Marital Status	Married or Cohabiting			X^2=12.6 P = .005
% of Group		82%	38%	
Parity	Parous	88%	63%	X^2= 7.6
% of Group				P = .11
Number of Pregnancies Mean (SD)		2.06 (.97)	1.25 (1.08)	F = 6.7 P = .01
Eysenck Personality Inventory Score	Extraversion	12.94 (4.52)	10.43 (3.27)	F = 4.82 P = .03
Mean (SD)	Neuroticism	12.17 (3.66)	12.30 (4.32)	F = .01 P = .92
Menstrual Cycle Questionnaire	Arousal	16.23 (6.78)	8.59 (7.89)	F =11.4 P = .001
Scores for Pre-menstrual Phase	Negative Affect	9.35 (3.29)	4.84 (4.17)	F =14.9 P = .0004
	Impaired Concentration	5.47 (2.76)	1.87 (2.42)	F =22.2 P < .00001
	Pain	3.18 (2.83)	2.19 (2.53)	F = 1.56 P = .22
	Insomnia	1.00 (1.69)	0.72 (1.39)	F = .38 P = .54
	Appetite Changes	2.17 (1.74)	0.78 (1.34)	F = 9.70 P = .003
	Fluid Retention	6.94 (3.01)	3.87 (3.49)	F = 9.39 P = .004

(b) A simpler more practical method is that of O'Brien et al (1979). This is to compare scores in the premenstrual phases with midcycle scores and form groups according to whether a large change in aspects of wellbeing occurred.

The latter method is both simple and practical and so was used to redivide this group of women.

4.3.3.2 Formation of the new groups

For each individual the difference in scores on component 1 "Lack of Wellbeing" between the midcycle (late follicular) and premenstrual (late luteal) phases was calculated. The distribution of these change scores across the whole group was divided into three groups containing equal numbers of women. Women in the "High Change" group were compared and contrasted with the "Medium Change" and "Low Change" groups.

It can be seen from figure 9 that this division largely preserved the original groupings of "Clinic", "Report PMT" and "No PMT". Thus the "High Change" group compared 11 women from the Clinic group, 5 from the "Report PMT" group, 1 from the "No PMT" group (65%, 29% and 6% of this group respectively). The "Medium" and "Low" change groups were composed mainly of women in the "Report PMT" and "No PMT" groups, (81% and 94% respectively).

Characteristics of the new groups are shown in Table 19. Women in the High Change group scored significantly higher on the Menstrual Cycle Questionnaire, indicating correspondence between their usual cycle-related changes and those observed during the cycle studied.

4.3.3.3 Hormonal differences between the groups

One way analysis of variance was used to analyse the differences between the 2 groups in hormone levels in the 6 cycle phases, changes in

the luteal phase and overall hormone levels. Results are presented in Table 20.

Oestradiol was not significantly different in the 2 groups. In the premenstrual phase levels were slightly lower in the "High Change" group ($P = .30$). The drop in oestradiol before menstruation was also greater in these women ($P = .20$).

Progesterone levels were lower in the premenstrual phase in the "High Change" group ($P = .10$) with a greater decline from mid to late luteal phases although this was not statistically significant.

The Ratio of Oestradiol to Progesterone, although not significantly different in the 2 groups, was higher in the "High Change" group in the luteal phases.

Testosterone and Androstenedione levels were, surprisingly, higher in most phases except for the early and late luteal phases in the "High Change" group. Differences in testosterone were only significant in the early follicular phase ($P = .08$) and the late follicular phase for androstenedione ($P = .09$). The "High Change" group showed a greater drop in testosterone ($P = .17$) and androstenedione ($P = .009$) before menstruation and a significantly greater change in androstenedione between the midcycle and premenstrual phases ($P = .007$).

These results are in contrast to the lower levels of androgens found in the "Clinic" group.

Overall Hormone Levels

Mean Oestradiol and Progesterone levels across the cycle were not significantly different in the 2 groups although there was some indication that the ratio of Oestradiol to Progesterone was slightly higher in the "High Change" group. Mean levels of androgens were slightly but not significantly higher in the "High Change" group.

Table 20 MEAN (± SD) LEVELS OF HORMONES DURING THE MENSTRUAL CYCLE IN THE 2 GROUPS

HORMONE & PHASE	GROUP				ANALYSIS OF VARIANCE	
	"High Change" N=17		"Low & Medium Change" N=32		F Ratio	Probability
OESTRADIOL						
pg/ml EF	68.8	(29.6)	63.4	(26.2)	0.40	.53
MF	112.6	(29.8)	105.1	(40.9)	0.43	.51
LF	245.7	(122.1)	254.4	(88.4)	0.08	.77
EL	143.1	(84.0)	143.3	(68.6)	0.009	.93
ML	173.2	(103.3)	166.2	(64.1)	0.13	.72
LL	115.7	(38.4)	133.0	(43.6)	1.79	.18
Difference between ML & LL	49.7	(32.9)	33.2	(43.0)	1.79	.18
Mean across Cycle	142.3	(47.1)	145.0	(35.9)	0.04	.83
PROGESTERONE						
ng/ml EL	5.3	(2.7)	5.0	(2.5)	.09	.77
ML	10.0	(3.7)	10.4	(3.5)	.09	.75
LL	4.6	(2.0)	5.8	(2.3)	2.94	.09
Difference between ML & LL	5.5	(3.4)	4.6	(2.4)	1.09	.30
Mean across Cycle	3.8	(1.1)	3.9	(1.2)	0.23	.63
OESTRADIOL : PROGESTERONE						
pg/ng EL	49.9	(62.7)	40.2	(35.5)	0.45	.50
ML	19.1	(8.3)	18.6	(12.8)	0.02	.89
LL	35.1	(18.4)	32.6	(28.1)	0.10	.75
Difference between ML & LL	16.4	(14.8)	13.9	(17.9)	.21	.65
Mean across Cycle	141.7	(132.4)	119.2	(53.6)	.61	.44
TESTOSTERONE/						

Table 20 (contd .....)

HORMONE & PHASE		GROUP				ANALYSIS OF VARIANCE	
		"High Change" N=17		"Low & Medium Change" N=32		F Ratio	Probability
TESTOSTERONE							
pg/ml	EF	431.1	(119.1)	360.2	(115.4)	3.25	.08
	MF	481.3	(121.6)	424.3	(132.7)	1.74	.19
	LF	531.5	(168.9)	499.6	(152.9)	0.34	.56
	EL	529.6	(135.1)	510.6	(171.7)	0.12	.74
	ML	510.4	(100.2)	462.3	(130.9)	1.38	.25
	LL	423.0	(100.4)	411.1	(113.5)	0.09	.75
Difference between ML & LL		90.4	(102.1)	51.2	(74.8)	1.87	.17
Mean across Cycle		488.9	(114.1)	448.1	(117.4)	0.87	.36
ANDROSTENEDIONE							
pg/ml	EF	1439.1	(607)	1233.0	(371)	1.69	.20
	MF	1771.2	(725)	1435.4	(584)	2.63	.11
	LF	1997.8	(814)	1649.9	(466)	3.03	.09
	EL	1647.5	(549)	1996.6	(562)	.07	.78
	ML	1636.3	(539)	1442.2	(546)	1.16	.29
	LL	1308.6	(367)	1379.6	(467)	.23	.63
Difference between ML & LL		250.0	(335)	66.6	(297)	.30	.09
Mean across Cycle		1632.2	(542)	1528.9	(407)	.32	.57

(NB. The N values for each group are approximate: due to missing values, numbers in each analysis of variance are less than in the whole group)

4.3.3.4 The pattern of change in hormones during the luteal phase

The lengths of the mid and late luteal phases of the cycle were not significantly different in the 2 groups (Table 21).

4.3.4 Comparison of the Groups in their Experiences at times of Hormonal Changes.

Information collected at the interview included questions concerning the womens pregnancies, use of and reactions to oral contraceptives, usual length of cycle and menstruation, experience of dysmenorrhoea and age at menarche. The original 3 groups and 2 new groups were compared and contrasted on these aspects (Table 22).

4.3.4.1 Comparison of "Clinic", "Report PMT" and "No PMT" Groups

(i) Pregnancies. The women in the Clinic group had been pregnant more often, including miscarriages, terminations and live births. They also experienced significantly more problems during pregnancy, including morning sickness or nausea and high blood pressure, mood disturbances, tension and insomnia and more short term and long term depression after birth.

(ii) Use of and Reactions to Oral Contraceptive Agents. A large number of women with PMT, including "Clinic" and "Report PMT" groups, had taken oral contraceptive agents at some time. A larger proportion of these women in the "Clinic" group reported adverse reactions to the pill, including depression, fluid retention, or weight gain, nausea and headaches, breast tenderness and mood disturbances, in comparison with the proportion of women experiencing such reactions in the other 2 groups ($P < 20\%$).

(iii) Dysmenorrhoea.All the women in the "Clinic" group reported

TABLE 21

THE LENGTH OF THE MID AND LATE LUTEAL PHASES AND THE MENSTRUAL CYCLE IN THE 2 GROUPS (MEAN $\pm$ SD)

	"High Change" Group (N = 17)	"Low & Medium Change" Group (N = 32)	Analysis of Variance	
			F Ratio	Probability
Mid Luteal Phase	4.35 (1.97)	4.50 (1.90)	.06	.80
Late Luteal Phase	4.47 (1.97)	4.59 (1.60)	.06	.81
Cycle Length	27.29 (1.89)	27.96 (2.73)	.82	.37

dysmenorrhoea, experienced occasionally or every cycle. 73% of the women in the "Report PMT" group experienced dysmenorrhoea in comparison to approximately half of the women in the "No PMT" group. These differences between the groups were significant ($P < 5\%$).

(iv) Age at menarche, Length of the Cycle and Menstruation. There were no differences in age at menarche or cycle length between the groups. The "Clinic" group had longer menses than the other 2 groups ($P < 10\%$).

4.3.4.2 Comparison of Groups of women based on changes in "Wellbeing" during the cycle

(i) Pregnancies. The women in the "High Change" group had been pregnant more often, including live births and miscarriages ($P < 10\%$). In contrast to the findings for the "Clinic" group (section 3.4 above) there were no significant differences between these 2 groups on their experiences during pregnancy, although more women in the "High Change" group reported short or long term postpartum depression (not significant).

(ii) Use of and Reactions to Oral Contraceptive Agents. In both groups a large proportion of women had taken oral contraceptive agents at some time. Adverse reactions were reported by about half the women in each group.

(iii) Dysmenorrhoea. More women in the "High Change" group experienced dysmenorrhoea but this was not significantly different from the "Medium and Low Change" group.

(iv) Age at Menarche, Cycle Length and Menstruation. Age at menarche and cycle length were not significantly different in the 2 groups. Women in the "High Change" group had longer menses ($P < 20\%$) than women in the other group.

Table 22a COMPARISON OF THE DIFFERENT GROUPS IN THEIR EXPERIENCES AT TIMES OF HORMONAL CHANGES

	"CLINIC" GROUP (N=19)	"REPORT PMT" GROUP (N=18)	"NO PMT" GROUP (N=18)	X^2 or F Ratio Significance of Difference between groups
PREGNANCIES Mean (SD)				
Parity	1.78 (0.86)	1.22 (1.35)	1.28 (1.02)	F = 1.53 P = .22
Number of Miscarriages	0.42 (0.61)	0.05 (0.24)	0.11 (0.32)	F = 4.02 P = .02
Total Number of Pregnancies	2.42 (1.17)	1.39 (1.38)	1.78 (1.39)	F = 2.91 P = .06
PROBLEMS DURING PREGNANCY				
Problems % of Group	41%	0%	33%	X^2 = 5.01 P = .08
PROBLEMS AFTER PREGNANCY				
Short Term Depression	18%	11.1%	0%	X^2 = 11.5 P = .02
Longer Depression % of Group	41%	0%	8%	
USE OF AND REACTIONS TO THE ORAL CONTRACEPTIVE PILL				X^2 = 2.2
Taken sometime	95%	83%	78%	P = .33
Adverse Reactions % of Group	77%	47%	43%	X^2 = 6.3 P = .18

Contd. over

Table 22a (contd .....)

	"CLINIC" GROUP (N=19)	"REPORT PMT" GROUP (N=18)	"NO PMT" GROUP (N=18)	X^2 or F Ratio Significance of Difference between groups
AGE AT MENARCHE Mean (SD)	12.57 (1.54)	12.40 (1.38)	13.06 (1.43)	F = 0.85 P = .43
USUAL CYCLE LENGTH Mean (SD)	28.47 (3.56)	28.05 (2.28)	28.61 (1.60)	F = 0.22 P = .80
USUAL LENGTH OF MENSTRUATION Mean (SD)	6.00 (2.03)	4.83 (0.86)	5.27 (1.32)	F = 2.88 P = .06
DYSMENORRHOEA Occasional or every cycle % of group	100%	73%	55%	F = 5.82 P = .05

Table 22b COMPARISON OF THE DIFFERENT GROUPS IN THEIR EXPERIENCES AT TIMES OF HORMONAL CHANGES

	HIGH CHANGE GROUP (N=17)	"LOW & MEDIUM CHANGE" GROUP (N=32)	X^2 or F Ratio Significance of Difference between groups
PREGNANCIES Mean $\pm$ SD			
Parity	2.06 (0.97)	1.25 (1.08)	F = 6.7 P = .01
Number of Miscarriages	0.35 (0.61)	0.16 (0.37)	F = 1.99 P = .16
Total Number of Pregnancies	2.47 (1.28)	1.75 (1.37)	F = 3.22 P = .08
PROBLEMS DURING PREGNANCY			
Problems	13%	30%	X^2 = .57 P = .45
% of Group			
PROBLEMS AFTER PREGNANCY			
Short Term Depression	7%	10%	X^2 =1.65
Longer Depression	33%	15%	P = .44
% of Group			
USE OF AND REACTIONS TO THE ORAL CONTRACEPTIVE PILL			
Taken sometime	77%	91%	X^2 = .34 P = .36
Adverse Reactions	50%	55%	X^2 = .59 P = .74
% of Group			

Contd. over

Table 22b (contd.....)

	HIGH CHANGE GROUP (N=17)	"LOW & MEDIUM CHANGE" GROUP (N=32)	X^2 or F Ratio Significance of Difference between groups
AGE AT MENARCHE Mean (SD)	12.64 (1.32)	12.67 (1.59)	F = .004 P = .95
USUAL CYCLE LENGTH Mean (SD)	28.12 (2.99)	28.37 (1.60)	F = .16 P = .69
USUAL LENGTH OF MENSTRUATION Mean (SD)	5.88 (1.76)	5.31 (1.31)	F = 1.65 P = .21
DYSMENORRHOEA Occasional or every cycle	88%	65%	X^2 = .53 P = .47

4.4. SOCIAL AND OTHER NON-ENDOCRINOLOGICAL FACTORS INVOLVED IN PMT AND THE INTERACTION WITH HORMONES.

4.4.1 Introduction.

In the last section I presented the analysis of endocrinological differences between women with various experiences of cycle-related changes, considering firstly, differences in hormones during the cycle and secondly, differences in women's reactions to times of hormonal changes.

There was little evidence for significant differences in mean levels of oestradiol, progesterone or the oestradiol to progesterone ratio in the 6 cycle phases or across the cycle in the original 3 groups although women who experienced a greater change in wellbeing before menstruation had lower levels of oestradiol and progesterone, a higher ratio of oestradiol to progesterone and a large change in these hormones before menstruation, in comparison with women who experienced less emotional changes.

In this section various other factors which might contribute to PMT are analysed. The groups of women formed, firstly, on the basis of usual cyclical variations and secondly on the basis of the changes observed during the cycle studied, were compared on a number of variables, including age, parity, marital status and occupation (section 4.2).

The results for androgens appear complex and although there was some indication that the "Clinic" group had low androgens in comparison with women reporting less severe or no cyclical changes, the difference was not found between the new groups. This would suggest that androgen levels are not necessarily related to PMT but more to other differences between the groups of women. Hence I

examined the relationship between testosterone and other factors distinguishing the women in the different groups, namely age, marital status and occupation (Section 4.3).

4.4.2 Comparison of women with different experiences of PMT : age, parity, marital status and occupation.

4.4.2.1 The 3 Groups: "Clinic", "Report PMT" and "No PMT".

In Table 6 these 3 groups are compared. It can be seen that women in the "Clinic" group tended to be married women with children and occupied in childcare. Some were also employed part-time outside the home, but more women in the other 2 groups were in full-time employment outside the home. Fewer women in these 2 groups were married.

4.4.2.2 The 2 Groups formed on the basis of changes in "Wellbeing" during the Cycle

The "Low and Medium Change" groups were compared with the "High Change" group (Table 19). The latter group comprised more married parous women, whose main occupation was childcare although some were working part-time outside the home. This group was also slightly older.

4.4.3 Interactions between Testosterone and Age, Marital Status and Occupation.

Testosterone levels were not significantly different in women of different ages although were lowest in the 40-44 group (Table 23).

There were significant ($P < 10\%$) differences in testosterone levels in women who were married or cohabiting rather than single, and women who are employed outside the home in comparison with those involved in childcare or not working outside the home. Thus women who were married or cohabiting had lower Testosterone levels than

Table 23

THE RELATIONSHIP BETWEEN TESTOSTERONE AND AGE, MARITAL STATUS AND OCCUPATION

Age Group	Mean Testosterone	(SD)	N	Analysis of Variance F or t Probability
20-24	475.8	(89.8)	3	
25-29	489.5	(146.0)	6	F = .24 NS
30-34	457.3	(143.3)	17	
35-39	492.8	(128.5)	7	
40-44	416.0	(47.6)	3	
Marital Status				
Married	433.3	(124.8)	17	
Single, Divorced or Separated	494.6	(139.7)	19	t = 1.34 P < .10
Occupation				
Part-time Employment or Mother	430.2	(128.6)	18	
Full-time Employment	502.1	(134.1)	17	t = 1.57 P < .10

single women. Women involved primarily with childcare and either in part-time or no employment outside the home had lower Testosterone levels than those who were employed and not necessarily supported by a partner.

4.5 CORRELATIONS BETWEEN HORMONES AND BEHAVIOUR.

4.5.1 Introduction.

Relationships between hormone levels and behavioural ratings were examined using non-parametric correlations (Spearman Rank). Levels of Oestradiol, Progesterone, Oestradiol: Progesterone Ratio, Testosterone and Androstenedione were correlated with behavioural ratings in each phase and in subsequent phases/ and the mid to late luteal change in these hormones were correlated with behavioural ratings in the late luteal and follicular phases. These correlations were performed for the whole group and separately in the "Clinic" group.

A large number of correlations increases the likelihood of some being statistically significant by chance (Siegal, 1956) which limits the interpretation of significant correlations. Much of this data has not been included in this thesis. Instead the matrices were used to examine specific aspects of hormone-behaviour relationships:-

A. The relationship between hormones and behaviour in each phase.

(i) The relationship between hormone levels and behaviour within each phase.

(ii) The "delayed effects" of hormones, expressed as correlations between hormones in one phase and behavioural ratings in subsequent 3 phases.

(iii) The effect of changing hormone levels, expressed as correlations between late luteal and follicular phase ratings and the change in hormone levels from mid to late luteal phases.

Correlations for ratings of 2 aspects considered most relevant to cyclical mood changes, "Lack of Wellbeing" and "Energetic and Active" across all women in this study, are shown in Tables A3-A7 in the appendix and summarised in Table 24.

B. The relationship between ratings in the late luteal phase and hormones in the "Clinic" Group.

Correlations between hormones and specific aspects of PMT, "Lack of Wellbeing", "Physical Distress" and "Energetic and Active" in the "Clinic" group are shown in Table 25.

4.5.2 Relationships between Hormones and Behaviour in each phase Across all Women.

Significant correlations are summarised in Table 24 and described below.

4.5.2.1 Correlations with Oestradiol (Table A3)

"Lack of Wellbeing" was not strongly related to oestradiol levels. In the mid follicular phase there was a weak negative correlation ($P < 0.1$). There was a weak negative correlation between "Energetic and Active" in the late luteal and early follicular phases and the premenstrual change in oestradiol ($P < 0.1$). Luteal phase ratings were negatively correlated with midcycle oestradiol levels.

4.5.2.2 Correlations with Progesterone (Table A4)

"Lack of Wellbeing" and low energy in the premenstrual phase were related to a large drop in progesterone before menstruation ($P < 0.05$, 0.01). Energy in the luteal phases was positively correlated with early luteal progesterone levels ($P < 0.01$).

4.5.2.3 Correlations with the Oestradiol: Progesterone Ratio (Table A4)

Correlations were low and non-significant.

Table 24

SUMMARY OF SIGNIFICANT* CORRELATIONS BETWEEN HORMONES & BEHAVIOUR ACROSS ALL WOMEN (N = 55)

(*significant at or below 10% level)

	"LACK OF WELLBEING"	"ENERGETIC & ACTIVE"
OESTRADIOL (E) I Hormone & Ratings in same phase	Negative correlation in mid follicular phase	-
II Hormone & Ratings in subsequent phases	-	Negative correlation between mid cycle E and luteal phase ratings
III Change in Hormone from mid to late luteal phases & ratings in pre-menstrual & follicular phases	-	Negative correlation with premenstrual & follicular phase ratings
PROGESTERONE (P) I	-	Positive correlation in early luteal phase
II	-	Positive correlation between early luteal phase P & luteal phase ratings
III	Positive correlation in premenstrual phase	Negative correlation in premenstrual phase
OESTRADIOL: PROGESTERONE RATIO (E:P) I	-	-
II	-	-
III	-	-
TESTOSTERONE (T) I	Positive correlation during menstruation	-

Contd. over

Table 24 (contd)

	"LACK OF WELLBEING"	"ENERGETIC & ACTIVE"
TESTOSTERONE (T)(contd)		
II	-	Positive correlation between T & ratings in subsequent phases
III	-	-
ANDROSTENEDIONE (A)		
I	Positive correlation in early follicular phase. Negative correlation in early luteal phase	-
II	-	-
III	Negative correlations with follicular phase ratings	-

4.5.2.4 Correlations with Testosterone (Table A5)

"Lack of Wellbeing" was positively correlated with testosterone during menstruation.

The correlations indicated that the relationship between testosterone and energy may be "delayed" : follicular phase testosterone levels were positively correlated with ratings of "Energetic and Active" in subsequent phases.

4.5.2.5 Correlations with Androstenedione (Table A6)

The correlation coefficients also indicated "delayed" relationships with "lack of wellbeing": the change in androstenedione before menstruation was negatively correlated with ratings in the follicular phases. In the early follicular phase, there was a weak positive correlation whereas a negative correlation ($P < .05$) was found in the early luteal phase.

4.5.3 Correlations between Premenstrual Ratings and Hormones in the "Clinic" Group.

"Lack of Wellbeing" was related to high levels of oestradiol and testosterone, low Progesterone and a high ratio of Oestradiol to Progesterone. The change in oestradiol and the oestradiol: progesterone ratio before menstruation was also correlated with "Lack of Wellbeing", indicating that not only absolute levels but also changes in these hormones may be involved in premenstrual emotional distress.

"Physical Distress" before menstruation was related to low oestradiol and progesterone levels, a large ratio of oestradiol to progesterone and a large premenstrual change in oestradiol and the oestradiol: progesterone ratio.

Low testosterone and a large change in androstenedione before menstruation was related to premenstrual physical distress.

Table 25 SPEARMAN RANK CORRELATION COEFFICIENTS BETWEEN RATINGS IN THE PREMENSTRUAL PHASE AND HORMONE LEVELS IN THE EARLY, MID AND LATE LUTEAL PHASES AND THE CHANGE IN HORMONES FROM MID TO LATE LUTEAL PHASES IN THE "CLINIC GROUP"

	"LACK OF WELLBEING" IN LATE LUTEAL PHASE				
Luteal Phase Hormone Levels	Oestradiol	Progesterone	E:P	Testosterone	Androstenedione
Early	.32	-.19	.42**	.42	-.06
Mid	.28	-.16	.52**	.71***	.15
Late	.39*	-.38*	.58***	.58**	.05
Change from mid to late luteal phases	-.12	.15	.56***	0	.16
	"PHYSICAL DISTRESS" in LATE LUTEAL PHASE				
Early	-.23	-.40*	.32	-.05	-.06
Mid	.04	-.27	.37*	-.16	.31
Late	-.27	-.43**	.22	-.11	.09
Change from mid to late luteal phases	.29	-.09	.15	.05	.31
	"ENERGETIC & ACTIVE" IN LATE LUTEAL PHASE				
Early	-.12	.33*	-.13	.05	-.16
Mid	-.17	-.24	-.08	-.28	.02
Late	-.32*	.01	-.05	-.25	.25
Change from mid to late luteal phases	-.13	-.29	-.12	-.09	-.24

*P < .10 **P < .05 ***P < .01

II. SEXUAL VARIATIONS DURING THE MENSTRUAL CYCLE.

4.6 ANALYSIS OF VARIANCE OF SEXUAL INTEREST AND SEXUAL ACTIVITIES ACROSS SIX HORMONALLY-DEFINED CYCLE PHASES.

One way analysis of variance with repeated measures across the six cycle phases was performed for various measures of "sexual interest" and sexual activities. Aspects of "sexual interest" comprised Sexual Feelings, Pleasant and Unpleasant Thoughts about Sex and the "Sexuality" component. Sexual activities comprised frequency of masturbation (for those women who masturbated) and for those women with a sexual partner, frequency and ratings of sexual activities with partner and frequency of orgasm. Frequency of initiation of sexual activities by the woman or her partner was also analysed.

Results of these analyses across the whole group and in the 3 groups, "Clinic", "Report PMT" and "No PMT" are presented in Tables 26-29 and Figures 10-15.

4.6.1 Sexual Interest.

Variations in sexual interest during the cycle were described in Section I (4.1.1 & 4.1.2). Across the whole group and in the 3 groups, there was postmenstrual peak in sexual feelings and pleasant thoughts about sex. In the "Clinic" group these aspects of sexual interest declined prior to menstruation. However when the effects of moods were statistically controlled, as in the "sexuality" component, sexual interest increased before menstruation. This premenstrual peak was also seen in the "Report PMT" group and to a lesser extent in those women who did not experience cyclical mood changes. These cyclical changes were not statistically significant.

4.6.2 Sexual Activities.

4.6.2.1 Across the whole Group

Frequency of Masturbation peaked in the prementrual phase and also after menstruation, although this pattern was not statistically significant (P = 0.34).

Frequency of Sexual Activities with Partner was significantly related to the cycle (P = .009). This peaked after menstruation and remained stable throughout the rest of the cycle.

Orgasm frequency also peaked after menstruation.

Ratings of Sexual Activities were slightly, but not significantly higher in the follicular phase in comparison to the luteal phase.

Initiation of Sexual Activities.

18 women in the "Volunteers" group recorded who initiated sexual activities, i.e. Self, mutual or partner. Frequency of "Self or mutually" initiated activities showed a different pattern during the cycle to those initiated by partner. Women initiated more activities after menstruation whereas frequency of partner-initiated activities were higher in the second half of the cycle (Figure 10). The pattern for woman or both initiated activities was statistically significant (Table 26). // The distribution of sexual behaviour during the cycle was analysed in the three groups. No statistically significant patterns were found. However various trends emerged:

4.6.2.2 The "Clinic" Group (Figure 11)

Frequency of Masturbation peaked at midcycle in this group.

Frequency of Sexual Activities with Partner was low during menstruation but peaked in the mid follicular and mid luteal phases (P = .19).

Frequency of Orgasm showed a similar but less marked pattern.

Ratings of Sexual Activities were higher in the follicular phases than the early and mid luteal phases.

4.6.2.3 The Report PMT Group (Figure 12)

Frequency of masturbation peaked before menstruation but was low during menstruation.

Frequency of Sexual activities with partner and frequency of orgasm peaked after menstruation and was lowest before and during menstruation.

Ratings of Sexual Activities were slightly higher in the follicular phase in comparison to luteal phase ratings.

4.6.2.4 The "No PMT" Group (Figure 13)

Frequency of Masturbation was highest before and after menstruation, but was low during menstruation.

Frequency of Sexual activities with partner peaked in the mid follicular phase.

Frequency of orgasm showed no obvious pattern.

Ratings of sexual activities were highest in the early luteal phase.

4.6.2.5 Comparison of the 3 groups

Masturbation frequency showed a different pattern in the 3 groups. A slight increase at midcycle was seen in the "Clinic" group whereas in the other 2 groups the frequency of masturbation was highest in the premenstrual phase. The "Report PMT" and "No PMT" groups also showed a postmenstrual peak of masturbation and lowest frequency during menstruation.

Sexual activities with partner peaked in the mid follicular phase, after menstruation, for all 3 groups. But the pattern of sexual activities in the luteal phase in the "Clinic" and "Report PMT" groups contrasts with the "No PMT" groups in that women with PMT showed a peak in the mid luteal phase followed by a premenstrual

Table 26

SEXUAL ACTIVITIES AS A FUNCTION OF CYCLE PHASES ACROSS ALL SUBJECTS

Cycle Phase / Variable	FOLLICULAR			LUTEAL			One Way Analysis of Variance -repeated measures across cycle phases		
	early	mid	late	early	mid	late			
	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	N	F Ratio	Probability
Frequency of Masturbation (per week)	0.62 (0.17)	1.11 (0.22)	0.87 (0.16)	1.01 (0.27)	1.00 (0.22)	1.46 (0.23)	26	1.16	.33
Frequency of Sexual Activities with Partner (per week)	1.43 (0.29)	2.65 (0.29)	1.93 (0.29)	1.97 (0.30)	1.98 (0.27)	1.85 (0.28)	40	3.12	.009
Rating of Sexual Activities with Partner	6.14 (2.07)	6.17 (1.82)	6.39 (2.17)	5.10 (2.38)	5.09 (2.16)	5.47 (1.68)	7	1.13	.37
Frequency of Orgasm (per week)	0.69 (0.18)	1.39 (0.22)	0.89 (0.16)	0.89 (0.21)	0.89 (0.19)	0.92 (0.20)	39	1.61	.16
Frequency of Self- or Both Initiated Activities (per week)	0.76 (0.17)	2.56 (.25)	1.13 (0.23)	1.03 (0.18)	0.97 (0.17)	0.85 (0.15)	17	4.29	.002
Frequency of Partner-Initiated Activities (per week)	0.27 (0.09)	0.41 (0.08)	0.51 (0.12)	0.82 (0.18)	0.67 (0.16)	0.65 (0.15)	17	1.27	.28

Table 27

SEXUAL ACTIVITIES AS A FUNCTION OF CYCLE PHASES IN THE "CLINIC" GROUP

Variable \ Cycle Phase	FOLLICULAR			LUTEAL			One Way Analysis of Variance -repeated measures across cycle phases		
	early	mid	late	early	mid	late			
	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	N	F Ratio	Probability
Frequency of Masturbation (per week)	0.68 (0.15)	0.66 (0.16)	0.87 (0.14)	0.0 0	0.76 (0.17)	0.58 (0.20)	6	0.48	.78
Frequencies of Sexual Activities with Partner (per week)	1.28 (0.22)	2.42 (0.30)	2.24 (0.30)	2.13 (0.33)	2.61 (0.28)	1.94 (0.28)	14	1.51	.19
Rating of Sexual Activities with Partner	6.23 (3.22)	5.93 (1.29)	6.33 (1.89)	4.83 (2.84)	3.43 (1.25)	5.60 (2.08)	3	1.85	.19
Frequency of Orgasm (per week)	0.32 (0.09)	1.04 (0.18)	0.88 (0.16)	0.49 (0.12)	1.08 (0.20)	0.84 (0.15)	14	1.41	.23

Table 28

SEXUAL ACTIVITIES AS A FUNCTION OF CYCLE PHASES IN THE "REPORT PMT" GROUP

Variable \ Cycle Phase	FOLLICULAR			LUTEAL			One Way Analysis of Variance -repeated measures across cycle phases		
	early	mid	late	early	mid	late			
	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	N	F Ratio	Probability
Frequency of Masturbation (per week)	0.52 (0.18)	1.11 (0.20)	0.79 (0.17)	1.27 (0.32)	0.80 (0.21)	1.78 (0.19)	11	1.21	.32
Frequency of Sexual Activities with Partner (per week)	1.08 (0.27)	2.36 (0.25)	1.48 (0.22)	1.48 (0.17)	1.48 (0.23)	1.14 (0.19)	13	1.50	.20
Rating of Sexual Activities with Partner	7.05 (0.49)	8.10 (0.14)	8.00 (0)	4.50 (3.54)	7.50 (2.12)	6.50 (1.41)	2	1.91	.25
Frequency of Orgasm (per week)	0.81 (0.21)	1.67 (0.23)	0.81 (0.17)	0.81 (0.17)	0.93 (0.22)	0.62 (0.14)	13	1.52	.19

Table 29

SEXUAL ACTIVITIES AS A FUNCTION OF CYCLE PHASES IN THE "NO PMT" GROUP

Variable \ Cycle Phase	FOLLICULAR			LUTEAL			One Way Analysis of Variance -repeated measures across cycle phases		
	early	mid	late	early	mid	late			
	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	N	F Ratio	Probability
Frequency of Masturbation (per week)	0.71 (0.18)	1.43 (0.28)	0.97 (0.18)	1.36 (0.27)	1.41 (0.28)	1.65 (0.27)	9	0.50	.77
Frequency of Sexual Activities with Partner (per week)	1.92 (0.37)	3.22 (0.32)	2.02 (0.35)	2.29 (0.37)	1.80 (0.28)	2.46 (0.35)	13	1.49	.21
Rating of Sexual Activities with Partner	5.10 (0.98)	4.60 (1.98)	4.85 (3.32)	6.10 (1.56)	5.15 (0.64)	4.25 (1.06)	2	0.84	.57
Frequency of orgasm (per week)	0.98 (0.22)	1.48 (0.25)	1.02 (0.17)	1.46 (0.29)	0.57 (0.15)	1.35 (0.29)	12	0.75	.58

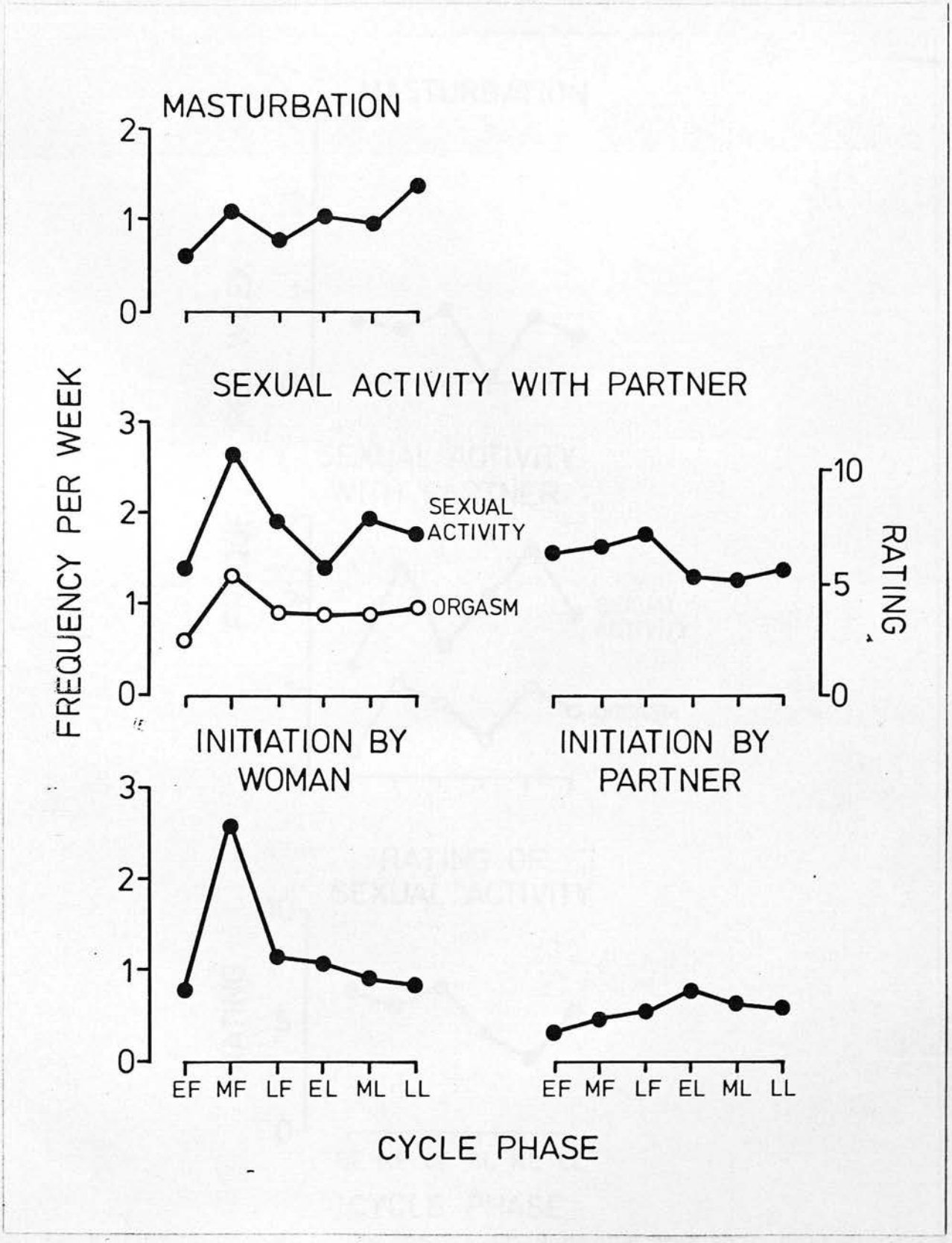


Figure 10. SEXUAL ACTIVITIES AS A FUNCTION OF CYCLE PHASE IN THE WHOLE GROUP

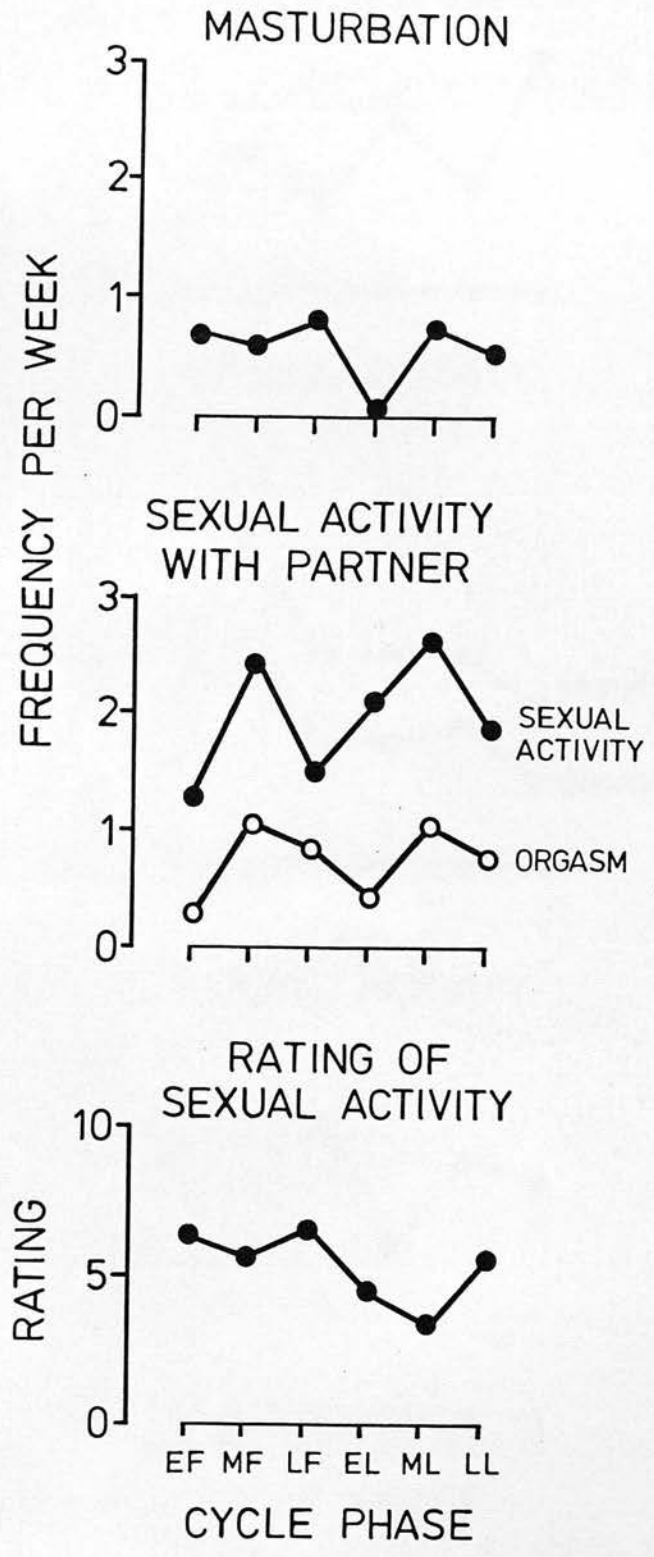


Figure 11. SEXUAL ACTIVITIES AS A FUNCTION OF CYCLE PHASE IN THE "CLINIC" GROUP

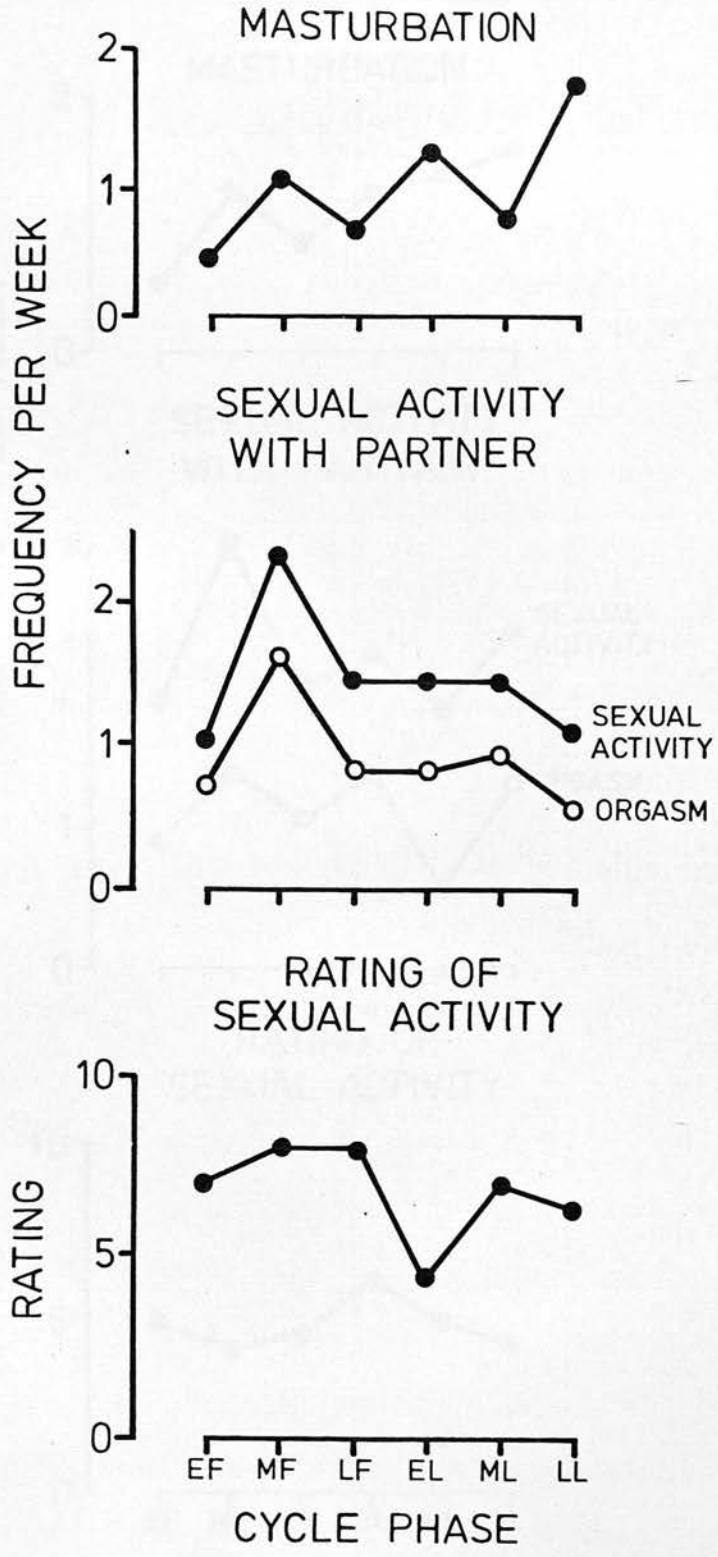


Figure 12. SEXUAL ACTIVITIES AS A FUNCTION OF CYCLE PHASE IN THE "REPORT PMT" GROUP

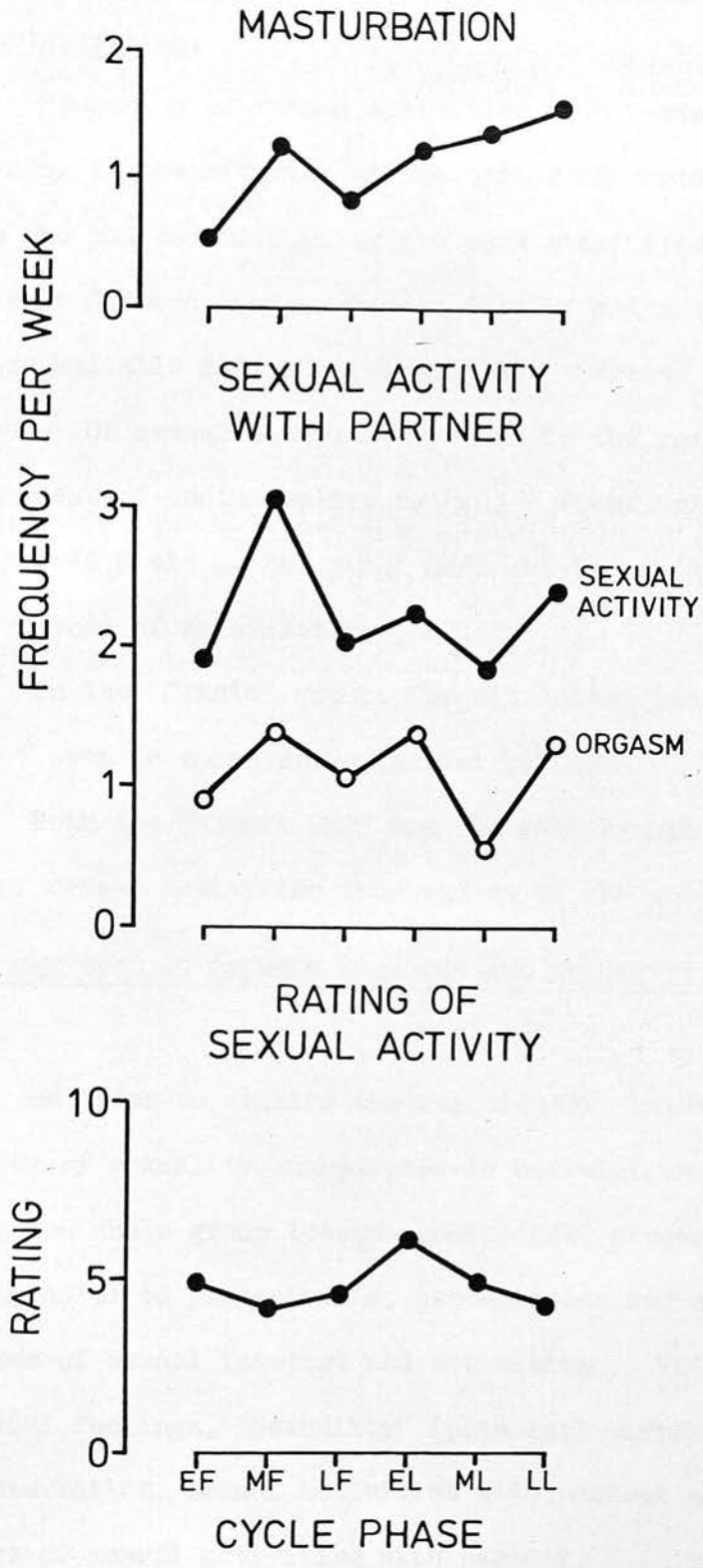


Figure 13. SEXUAL ACTIVITIES AS A FUNCTION OF CYCLE PHASE IN THE "NO PMT" GROUP

decline. Such a pattern was not seen in the "No PMT" group whose sexual activities increased throughout the luteal phase.

4.6.3 Analysis of Variance of Sexual Activities according to Method of Contraception.

Frequency of sexual activities with partner were analysed according to the efficacy of the method of contraception used. Women who had an I.U.C.D. or who were sterilised comprised the "Reliable Method" group, whereas barrier methods were categorised as a "Less Reliable Method" (Figure 14). Across the whole group frequency of sexual activities peaked in the postmenstrual phase independent of contraceptive method. Women using reliable methods also showed a mid luteal phase peak but in neither group was there any evidence of an ovulatory peak.

In the "Clinic" group, the mid luteal peak in sexual activities was not seen in women using barrier methods.

Both the "Report PMT" and "No PMT" groups showed a postmenstrual peak of sexual activities independent of the method of contraception.

4.7 CORRELATIONS BETWEEN HORMONES AND SEXUALITY DURING THE MENSTRUAL CYCLE.

In order to examine the relationship between hormones and measures of sexuality, nonparametric correlations were performed across the whole group between oestradiol, progesterone, the ratio of oestradiol to progesterone, testosterone and androstenedione and measures of sexual interest and activities. These included ratings of sexual feelings, "Sexuality" (principal component 4), frequency of masturbation, sexual activities with partner and orgasm, and ratings of sexual activities with partner.

The matrices are presented in the appendix, Tables A7-A10 and their interpretation is as described for the previous hormone-

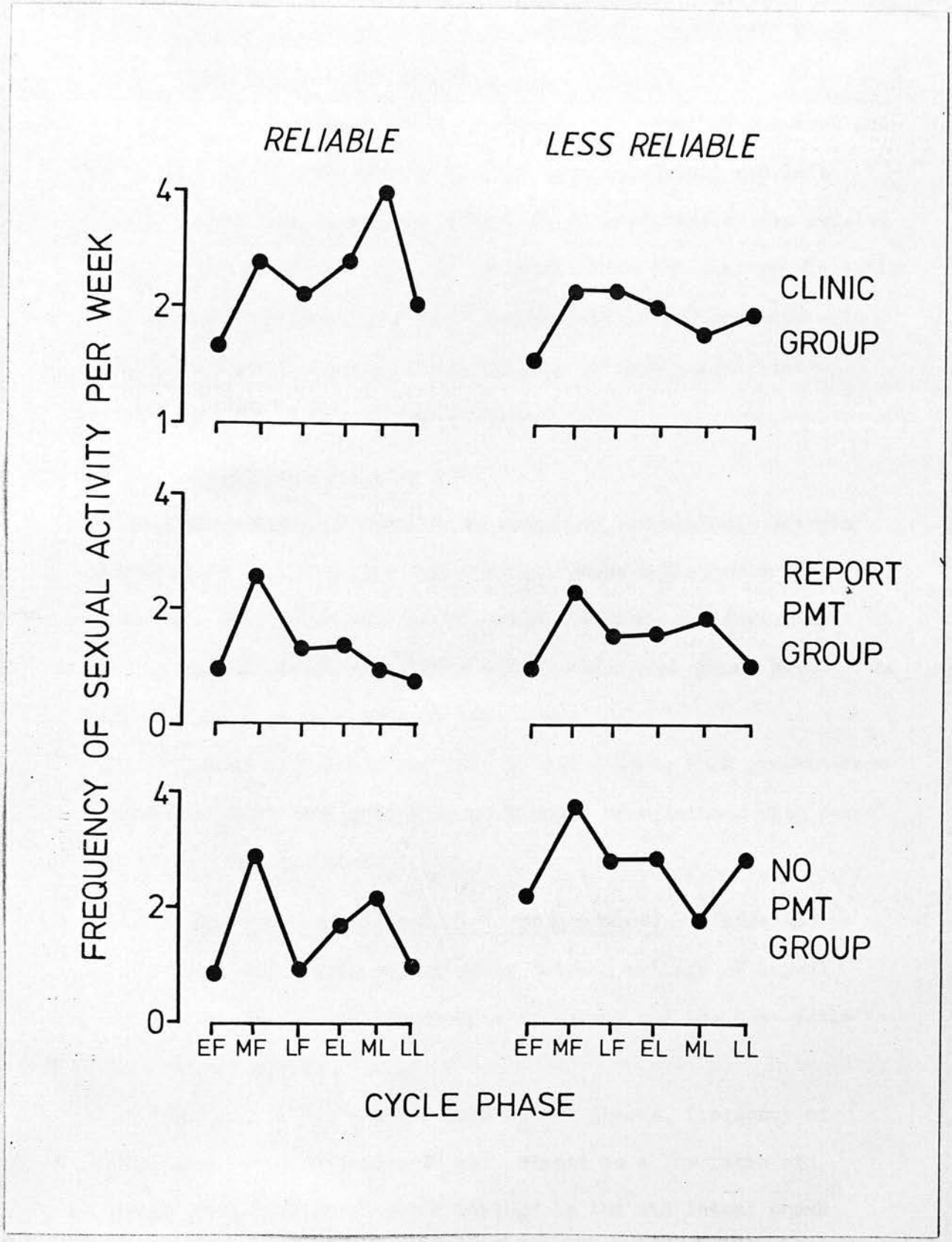


Figure 14. FREQUENCY OF SEXUAL ACTIVITIES WITH PARTNER AS A FUNCTION OF CYCLE PHASE IN WOMEN USING "RELIABLE" (STERILISATION OR I.U.C.D.) AND "LESS RELIABLE" (BARRIER) METHODS OF CONTRACEPTION

behaviour correlations, in section I, 4.5.1 above. These correlations are described in sections 4.7.1 and 4.7.2 below.

4.7.1 Correlations between Hormones and Sexuality in each Phase.

4.7.1.1 Oestradiol (Table A7)

Correlations with sexual feelings were negative but weak and non-significant. In the mid follicular (postmenstrual) and late luteal (premenstrual) phases, frequency of masturbation was related to high oestradiol levels. In contrast there was some relationship between low oestradiol and high frequency of sexual activity with partner in these phases although ratings of sexual activities related to high levels of oestradiol.

4.7.1.2 Progesterone (Table A8)

There were some significant negative correlations between progesterone levels in the early luteal phase and aspects of sexuality: thus high ratings of sexual feelings and frequency and ratings of sexual activities with partner and orgasm were related to low progesterone at this time.

However in the mid and late luteal phases, when progesterone levels were high and falling respectively, correlations with sexual activities were positive.

4.7.1.3 The ratio of oestradiol to progesterone (Table A8)

There was little relationship between ratings of sexual feelings, sexuality or masturbation frequency and the E:P ratio in the luteal phases.

However in the mid and late luteal phases, frequency of sexual activities with partner was related to a low ratio of oestradiol to progesterone but ratings in the mid luteal phase were positively correlated with the ratio.

Table 30 SIGNIFICANT CORRELATIONS BETWEEN HORMONES & PEAKS OF SEXUAL INTEREST AND ACTIVITIES IN THE PRE- AND POST-MENSTRUAL PHASES

		POST-MENSTRUAL PEAK		
	Oestradiol	Progesterone	E:P	Testosterone & Androstenedione
Ratings of Sexual Feelings	Weak negative correlation with follicular & luteal phase E		Weak positive correlation with luteal phase ratio	Negative correlation with follicular phase T & A
"Sexuality" (principal component 4)	Weak negative correlation with follicular & luteal phase E			
Frequency of Masturbation	Weak positive correlation with follicular & luteal phase E			Positive correlation with follicular phase T & A & Luteal Phase A
Frequency of Sexual Activity with Partner	Negative correlation with follicular phase E	Positive correlation with luteal phase P	Negative correlation with luteal phase ratio	Negative correlation with follicular & luteal phase T & A
Frequency of Orgasm		Positive correlation with luteal phase P	Negative correlation with luteal phase ratio	Negative correlation with follicular & luteal phase T & A

Contd. over

Table 30(contd.....)

		PREMENSTRUAL PEAK		
	Oestradiol	Progesterone	E:P	Testosterone & Androstenedione
Ratings of Sexual Feelings				
"Sexuality" (principal component 4)	Weak negative correlation with luteal phase E	Negative correlation with early luteal phase P		Negative correlation with luteal phase T
Frequency of Masturbation	Positive correlation with luteal phase E	Positive correlation with pre-menstrual P	Positive correlation with early luteal phase ratio	
Frequency of Sexual Activity with Partner				
Frequency of Orgasm				

4.7.1.4 Testosterone and Androstenedione (Tables A9 and A10)

Levels of androgens were negatively correlated with all aspects of sexuality except for frequency of masturbation. This was related to high testosterone and androstenedione levels in the same and previous phases: for example the frequency of masturbation after ovulation was positively correlated with androgens in the follicular and early luteal phases.

4.7.2 Correlations between Hormones and Sexuality in the Mid Follicular (Postmenstrual) and Late Luteal (Premenstrual) Phases.

As described in Section 4.6 above, different aspects of sexuality peaked in the postmenstrual or premenstrual phases. Correlations between hormone levels and ratings of sexual feelings, sexuality, frequency of masturbation, sexual activity with partner and orgasm and ratings of sexual activities in these phases are summarised in Table 30.

Sexual feelings peaked after menstruation. There was a weak relationship between ratings in this phase and low levels of oestradiol and a high ratio of oestradiol to progesterone. Correlations with androgens were negative.

"Sexuality" peaked before and after menstruation. The mid follicular phase peak was weakly related to low oestradiol levels, the premenstrual peak to low levels of oestradiol, progesterone and testosterone.

Frequency of Masturbation increased before and after menstruation. In the mid follicular phase this was related to high levels of oestradiol and androgens in the follicular and luteal phases. In the luteal phase, masturbation frequency was related to high levels of oestradiol, progesterone and the ratio of oestradiol to progesterone, but there was no significant correlation with androgens.

Frequency of sexual activities with partner peaked after menstruation. This peak was related to low levels of oestradiol and androgens in the follicular phase, and was also related to hormone levels in the luteal phase, namely low luteal phase androgens, a low ratio of oestradiol to progesterone but high levels of progesterone.

Frequency of orgasm similarly peaked after menstruation and was correlated with low levels of androgens but high levels of progesterone in the luteal phases. This peak was also negatively correlated with androgens in the follicular phase.

4.8 CORRELATIONS BETWEEN RATINGS OF SEXUAL INTEREST & ACTIVITIES AND AVERAGE AND MIDCYCLE TESTOSTERONE LEVELS.

From the correlations described in section 7 above, it would appear that testosterone is negatively correlated with all aspects of sexuality except for masturbation frequency. These relationships were examined in greater detail. Average levels of testosterone across the whole cycle (mean for 6 phases weighted according to the number of blood samples) and average midcycle levels (mean for the late follicular and early luteal phases) were calculated for each woman and correlated with mean ratings for different aspects of sexuality using parametric correlation coefficients (Pearson).

Correlations were performed firstly across the whole group and secondly in the 3 smaller groups of women, "Clinic", "Report PMT" and "No PMT". Ratings of "Sexual Feelings" were analysed for all women. Frequency of masturbation was analysed only for these women who masturbated at some time during the cycle studied and sexual activities with partner, only for women with partner. The women were subdivided into those who did masturbate (during the cycle studied) and those that did not. Frequency and ratings of sexual activities and orgasm were correlated with mean and midcycle testosterone levels in these

different groups.

Correlations are presented in Table 31.

4.8.1 Across the whole group

Ratings of "Sexual Feelings", frequency and ratings of sexual activities with partner and orgasm frequency were all negatively correlated with mean and mid cycle testosterone levels across all women. However when those women who masturbate were considered, positive correlations were found between frequency of masturbation and frequency of all sexual activities, including with partner.

Thus, considering women with partners, for those who masturbate, frequency and enjoyment of sexual activities appeared to relate to high levels of testosterone, whereas for women who do not masturbate, sexual activities were related to low testosterone levels.

4.8.2. In the "Clinic", "Report PMT" and "No PMT" Groups

A similar pattern of correlations to that described above is found in the 3 groups. Thus when women who masturbate were distinguished from those who do not, positive correlations between all sexual activities and testosterone levels were found, whereas there were negative correlations for women who do not masturbate. However interpretation of the correlations presented in Table 31 is limited in that the number of women in each group is small (e.g. women from the "Clinic" group with partners, who do not masturbate, N = 4).

Table 31 PEARSON RANK CORRELATION COEFFICIENTS, (N) & PROBABILITY FOR CORRELATIONS BETWEEN MEAN & MIDCYCLE TESTOSTERONE LEVELS AND SEXUALITY FOR ALL SUBJECTS AND THE 3 GROUPS

	ALL SUBJECTS		CLINIC GROUP		REPORT PMT GROUP		NO PMT GROUP	
	mean T	midcycle T	mean T	midcycle T	mean T	midcycle T	mean T	midcycle T
I ALL WOMEN								
Sexual Feelings	-.24 (33) P = .08	-.20 (37) P = .11	-.63 (9) P = .04	-.65 (11) P = .02	-.11 (12) P = .36	.10 (13) P = .37	-.42 (12) P = .09	-.26 (13) P = .19
II ALL WOMEN WHO MASTURBATE								
Frequency of Masturbation	.76 (18) P < .001	.79 (21) P < .001	-.54 (3) P = .32	.26 (4) P = .37	.91 (9) P < .001	.81 (10) P = .002	.70 (6) P = .06	.85 (7) P = .008
III WOMEN WITH PARTNERS								
1. All								
Frequency of Sexual Activity with partner	-.13 (28) P = .26	-.09 (33) P = .31	.03 (9) P = .47	.10 (11) P = .38	-.39 (9) P = .15	-.18 (11) P = .30	-.15 (10) P = .34	-.25 (11) P = .23
Rating	-.35 (27) P = .03	-.19 (32) P = .14	-.57 (10) P = .04	-.51 (13) P = .04	-.54 (8) P = .08	-.26 (10) P = .23	-.15 (9) P = .35	.29 (9) P = .22

Contd. over

Table 31 (Contd....)

	ALL SUBJECTS		CLINIC GROUP		REPORT PMT GROUP		NO PMT GROUP	
	mean T	midcycle T	mean T	midcycle T	mean T	midcycle T	mean T	midcycle T
III contd.....								
Orgasm Frequency	-.11	-.06	-.14	.02	-.48	-.24	-.22	-.22
	(28)	(33)	(9)	(11)	(9)	(11)	(10)	(11)
	P= .28	P = .38	P=.36	P=.48	P= .09	P=.23	P=.27	P= .26
2. Women Who Masturbate								
Frequency of all Sexual Activities	.41	.45	.95	.51	.66	.68	-.23	.14
	(14)	(17)	(3)	(4)	(6)	(7)	(5)	(6)
	P =.07	P = .04	P=.09	P=.24	P= .08	P= .04	P = .35	P=.39
Frequency of Orgasm	.57	.57	-.90	-.33	.78	.69	.11	.57
	(14)	(17)	(3)	(4)	(6)	(7)	(5)	(6)
	P=.02	P = .009	P=.14	P=.33	P= .03	P= .04	P= .43	P= .12
3. Women who do not Masturbate	-.31	-.26	-.16	-.03	-.94	- .78	.43	.12
Frequency of Sexual Activities	(14)	(16)	(6)	(7)	(3)	(4)	(5)	(5)
	P=.14	P = .16	P= .38	P=.47	P= .12	P= .11	P= .23	P = .42
Frequency of Orgasm	-.36	-.27	-.05	.13	-.97	-.69	.27	-.05
	(14)	(16)	(6)	(7)	(3)	(4)	(5)	(5)
	P=.11	P = .15	P= .46	P=.39	P= .08	P =.15	P= .33	P =.47

CHAPTER 5

DISCUSSION

5. DISCUSSION

The research described in this thesis aimed to investigate emotional and sexual changes during the menstrual cycle and their relationship to the reproductive steroid hormones.

In previous research in this area there have been many discrepant findings as to the nature of cyclical changes, Premenstrual Tension and hormone-behaviour relationships in women. Much of the confusion is due to methodological issues and in attempting to avoid shortcomings inherent in research in the area, several features were included in the design of this study:-

A distinction was made between different groups of women:- those who notice no cyclical changes; women who report a degree of cyclical variability in their moods and physical wellbeing; and women who experience marked and distressing Premenstrual Tension.

Rather than relying on retrospective accounts, daily assessments of behaviour were used throughout the cycle, investigating both positive and negative emotions and various aspects of women's sexuality.

Frequent blood samples were taken for measurement of hormones in order to ensure that all cycles were endocrinologically normal and to relate behaviour to hormonally defined phases of the cycle and to levels of the sex steroids, Oestradiol, Progesterone, Testosterone and Androstendione.

The importance of adequate hormone assessments was demonstrated by the finding that not all the cycles were normal and ovulatory according to generally accepted criteria (Landgren et al, 1980; Speroff et al, 1978). 9% were anovulatory and 5% were endocrinologically unusual and in 3% it was not possible to accurately identify the cycle phases, leaving only 83% for analysis.

Four out of the six women with anovulatory cycles were under 24 years old, one was 51 and one was in a stressful situation at work. Other evidence suggests that anovulatory cycles are more common in younger women, those approaching the menopause and in women under stress (Döring, 1969; Matsumoto et al, 1979; Metcalfe, 1979; Metcalfe and MacKenzie, 1980).

The exclusion of anovulatory cycles and analysis only of normal cycles limits direct comparisons between this and other studies, which have often failed to determine whether all cycles were endocrinologically normal (Table 2). Much research on the menstrual cycle has involved students or younger women and there may therefore have been a number of anovulatory or unusual cycles included. The precise effect of this is uncertain and there is debate as to whether cyclical mood changes or PMT occurs in anovulatory cycles (Adamopolos et al, 1972; Smith, 1975) so inclusion of such cycles may influence the results.

5.1 EMOTIONAL AND PHYSICAL CHANGES AND THE RELATIONSHIP TO HORMONALLY DEFINED CYCLE PHASES.

Cyclical patterns were consistent with the women's original reports in that the "Clinic" group experienced pronounced changes in their emotional and physical wellbeing, in the "Report PMT" group, less marked changes were seen and in the "No PMT" group, only breast tenderness was significantly related to cycle phases.

The changes observed were related to hormonally defined cycle phases, demonstrating that there is at least a temporal link between the hormonal variations during the menstrual cycle and emotional and physical wellbeing in some women.

Emotional changes related to two aspects of moods, "lack of

wellbeing" and "outward directed emotions". These dimensions of moods resulting from the principal components analysis are in agreement with factor analytic studies (Mackay, 1980) which suggest that moods can be thought of as essentially two dimensions: "Unpleasantness - Pleasantness" and "Activation" or "Vigor" (Bush, 1973; Meddis, 1969; Sjoberg and Svensson, 1976). Physical changes were mainly those of breast tenderness and feelings of swelling and the principal components analysis indicated that physical wellbeing may be separate from emotional wellbeing although the two aspects vary together.

5.1.1 The "No PMT" Group: the Normal Menstrual Cycle.

The lack of significant relationship between cycle phases and moods in the "No PMT" group is not surprising given that these women generally experience no cyclical changes or PMT. Only a very slight pattern was observed in some moods and the principal component "Lack of Wellbeing" (Figures 6 and 15) with an increase in positive feelings after menstruation, and higher ratings of irritability, aggression and fatigue before and during menstruation. This pattern was not, however, significant.

These results are in agreement with the few studies that have attempted to screen for women with pronounced cyclical changes. Abplanalp et al (1979b) similarly used repeated hormone assessments to divide the cycle into phases and found no significant mood changes in their "no problem" group. Careful analysis of their results indicates that the overall pattern was of lower energy and higher tension during menstruation in comparison with the intermenstrual phase although this pattern was not significant.

Breast tenderness, however, was significantly related to the cycle in the women in the present study, increasing before menstruation. Physical changes are reported in almost every study of the menstrual cycle

(Table 1) although the severity varies greatly between individuals. Epidemiological studies of the prevalence of "symptoms" in the premenstrual phase (section 2.2.2) indicate that mild physical changes are a common herald to the onset of menstruation and as such can be regarded as a normal physiological aspect of the menstrual cycle (Wendestam, 1980).

5.1.2 Premenstrual Tension: the "Report PMT" and "Clinic" Groups.

In contrast to the "No PMT" group, the "Report PMT" and "Clinic" groups showed significant changes in their emotional and physical well-being during the cycle (Figures 4, 5 and 7; Tables 13 and 15). The types of mood changes agree with those in previous studies (Figure 1). Irritability, tension and aggression figure in the literature as cardinal distressing aspects of PMT and in these women, ratings increased in the premenstrual phase. Loss of energy and increased fatigue and depression are also commonly reported and/these significantly increased before menstruation in the "Report PMT" and "Clinic" groups.

Two issues are of particular concern in interpreting the results. Firstly, is PMT on a continuum from less problematical cyclical changes or is it distinct or qualitatively different? The second issue to be discussed is the differences between women who report cyclical changes in the context of a research interview and those who find PMT a problem and seek medical advice.

The emotional and physical changes experienced by the women with problematical PMT were more severe than those of the "Report PMT" group, with a greater contrast between feelings of wellbeing in the follicular phase and the marked distress in the premenstrual phase, indicating that mood and physical changes described as PMT may be a severe and pronounced version of milder and more common cyclicity.

This is in agreement with Wendestam and Ohman (1980) who conclude that PMT can be seen as lying within a normal distribution curve of the range of cyclicity experienced by women, the clinical and distressing PMT being the upper extreme.

There has been much speculation as to the definition of PMT (Section 2.2.1) and it has been broadly categorised, including very mild changes such as premenstrual breast discomfort, swelling or irritable mood. Since minor premenstrual changes appear to be common, this might lead to the conclusion that almost all women with normal menstrual cycles experience PMT. However a more feasible definition must take into account the severity of the changes in relation to a "normal distribution" of cyclicity.

Other important differences between the "Report PMT" and "Clinic" groups indicate some distinctions between problematical PMT and cyclical changes which are not so troublesome to the individual. The start of the decline in wellbeing was earlier in the "Clinic" group and shortly after ovulation these women began to feel less well. In contrast the "Report PMT" group felt well until the mid luteal phase. Ratings of irritable, tense, fatigued and changable remained high during menstruation in the "Clinic" group. This indicates that these women not only felt worse but the loss of wellbeing extended over a longer time, for approximately half the cycle.

There was a difference in the type of changes experienced by the "Clinic" and "Report PMT" groups. The women in the "Clinic" group showed a pronounced loss of energy and sexual interest and more feelings of aggression in the premenstrual phase. These may be important aspects of PMT which are found to be particularly troublesome and contribute to the distress which leads these women to seek medical advice.

This study is consistent with the view that PMT is a more pronounced version of normal and less distressing variability of mood and physical wellbeing, as a continuum from the normal range of cyclicity rather than a distinct phenomenon. The magnitude and timing of the loss of well-being distinguishes women who experience cyclical changes which are problematical from those with less troublesome premenstrual changes. Lack of energy and sexual interest before menstruation were more pronounced in the "Clinic" group, indicating that these aspects may be features of PMT which are particularly distressing.

*

A point to note is the increase in positive moods in the middle phases of the cycle. Most research has focussed on the premenstrual and menstrual phases and negative moods rather than explore the variation in overall menstrual cycle pattern and only a few studies have commented on this (Abplanalp et al, 1979a; Benedek and Rubenstein, 1939a and b; Dan, 1976; Ivey and Bardwick, 1968). The positive times are obviously an important aspect of women's cyclicity, compensating for times of decreased wellbeing, and cyclical changes can be viewed as contrasting states within the individual. If this viewpoint were adopted there might be a substantial body of literature examining the phenomenon of women's positive moods, energy, efficiency and creativity during at least half her cycle. I suggest further examination of this "postmenstrual peak" (PMP) as a necessary addition to our interest in Premenstrual Tension.

5.1.3 The Incidence, Significance and Effects of Cyclical Mood Changes.

From this study it is not possible to comment on the incidence of severe PMT in the population since it is invalid to attempt

generalisations from a small select group of women. It is likely that the premenstrual distress experienced by the "Clinic" group is not common, epidemiological studies indicating that 2-3% of women with normal menstrual cycles have severe and problematical PMT (Andersch et al, 1980; Section 2.2.2). Other research indicates that milder cyclical changes are commonly reported, and the high incidence of physical changes in this study supports other data. It is possible, however, that women who notice some degree of cyclicity, including minor premenstrual breast tenderness, are more likely to volunteer for research on the menstrual cycle, leading to an over-representation of "cyclical women". The incidence of women who notice no premenstrual changes cannot, therefore, be commented on. Other data, however, suggests these individuals may be a minority (Section 2.2.2).

In the first chapter I discussed how evidence of changes in wellbeing related to menstruation have been viewed as one of women's biological disadvantages and, as McCance et al (1937) states, a "disability inherent in her sex". As such, the fact that women have menstrual cycles has been used to discriminate against them with a fear that any loss of efficiency may effect performance in responsible roles. I would suggest that this is an extreme view with little rational or factual basis. Severe PMT may well influence a woman's efficiency and concentration for a time each month although this was not specifically investigated in this study. However, these women frequently noted that the postmenstrual phase often compensated for this and "PMP" could be put to good use. Women with severe PMT may represent only a small proportion of the population of women. Although milder emotional and physical changes may be more common, the presence of phase differences should not obscure the fact that these changes are small and unlikely to influence concentration

or efficiency in any marked way. Evidence indicates that the majority of women's performance of daily work on a variety of tasks and tests is not altered significantly or detrimentally by the cycle, and that any premenstrual changes can be offset by increased concentration or effort (Redgrove, 1971; Sommer, 1973).

In this context it is not often admitted that men go through periods of tension, anxiety or depression and there is evidence suggesting that their moods may undergo some rhythmic changes perhaps related to more elusive biological or environmental rhythms (Doering et al, 1974; Ferin et al, 1974; Hersey, 1931; Sollberger, 1965). In the absence of external physiological markers these rhythms are less predictable than premenstrual changes. Women's cyclicity may therefore be considered an advantage rather than a disability, a certain degree of prediction of moods being useful in scheduling activities which may be influenced by one's ups or downs.

5.1.4 The Consistency between the Original Groups and New Groups formed on the basis of Changes in Wellbeing during the Cycle.

As described in Section 2.1.2.2 many studies report discrepancies between retrospective reports of cyclical mood changes and PMT and actual changes assessed using daily ratings. In the present study there was good agreement between the original groups formed on the basis of the women's accounts of cyclical changes and later regroupings according to observed variations in wellbeing during the cycle, although four women in the "Clinic" group were not categorised as expected, into the "high change" group.

This has various implications:

(a) The women's original reports and answers on the menstrual cycle questionnaire were adequate reflections of their cyclical changes. It has been suggested that discrepancies between retrospective

and daily self-report data are due to the individuals responding to questionnaires in a biased way according to their expectancies (e.g. Parlee, 1974; Ruble et al, 1980). It seems more likely that discrepancies may relate to the variable nature of cyclical changes: women with PMT comment that it can vary according to circumstances, two women in the "Clinic" group who were inconsistently regrouped noting that the cycle studied had been better than usual.

(b) The method used to redivide the group and assess cyclical changes only took into account "Lack of Wellbeing". Two other women in the "Clinic" group whose regrouping was inconsistent reported that they were more distressed by physical than by emotional changes. It is possible that if a different method were used to determine cyclical changes, taking into account both physical and emotional aspects (e.g. Sampson and Jenner, 1977), there might be better agreement.

(c) The method of daily ratings using analogue mood scales is appropriate to assess cyclical changes during the menstrual cycle and distinguish between women with no mood variability and those with pronounced premenstrual changes.

5.1.5 Characteristics of the Women: the Relationship between PMT and Personality, Age, Marital Status, Parity and Occupation.

Association between measures of personality and PMT have been reported in the literature and cited as evidence that PMT is conditioned by "neurotic tendencies" (Section 2.2.3). However this study suggests no relationship between personality and PMT. No significant differences in ratings of neuroticism were found between the women with different degrees of cyclical mood changes (Tables 6 and 19).

Although absolute scores were highest in the more distressed women, there was considerable overlap between the groups and comparison with normative data (Eysenck and Eysenck, 1964) reveals no higher degree of neuroticism. This is in agreement with Wendestam (1980) and Golub (1976). Although Wendestam found that women with no complaints of premenstrual distress had unusually low neuroticism scores this was not supported in this study.

The comparison between PMT groups and women who do not experience PMT provides evidence that neuroticism is not a necessary characteristic of premenstrually distressed women.

There are some indications that PMT is more common in women over 30 years (Section 2.2.3). This was supported in this study: the "Clinic" group were slightly older than the others, in their 30s. Since parity and marital status are age-related, there is debate whether these factors influence PMT (Wood et al, 1979b). The design of this study does not permit conclusions as to whether PMT is generally more common in older, married, parous women, although the findings are consistent with that view.

In the literature there has been little attention to the particular social circumstances and pressures experienced by women with PMT and in so far as they are mentioned it tends to be assumed that they are a consequence of rather than a contributory factor to PMT (e.g. Dalton, 1977, 1978). However there is evidence that women with emotional difficulties or these under stressful social circumstances are more likely to complain of premenstrual distress (section 2.2.3).

This raises the question of whether the women with PMT in the present study also had more pressures and stresses in their situation or circumstances.

The traditional role of women as married with children and

involved in home-work rather than outside employment, is recognised to be one of disadvantaged social status for some women and one in which they are legally and socially discriminated against.

This situation may be particularly stressful, resulting in loss of esteem and confidence and there are reports of higher rates of depression amongst married women compared to unmarried women and men (Weissman and Klerman, 1977; Gove, 1972).

The results of the present study can be interpreted in the light of research by Brown and Harris (1978) who collected data on rates of depression in women, in a large community survey in London. Various factors served to protect women from becoming depressed, one being employment outside the home. It was suggested that this provided a protective effect by alleviating boredom and increasing self esteem, economic circumstances and social contacts.

The women in the "Clinic" group were mainly those in a traditional female role and few were fully or principally employed outside the home. It is possible that this situation contributes to a degree of emotional problems expressed as exaccerbation of cyclical mood changes. For example the stress of circumstances may sensitise a women to changes in her premenstruum which might otherwise not be noticed. Events in the premenstrual phase might be seen as the 'last straw' whereas at other times similar events are put up with (Shuttle and Redgrove, 1978).

In addition a woman's situation may make cyclical emotional changes more problematical because of her interactions with others. Two books have recently appeared in the popular press documenting the deleterious effects of PMT on a woman's husband and children (Dalton, 1978; Lever, 1979). Attitudes such as these may influence the woman's distress and many PMT sufferers express concern about their influence on the family, especially on young children. Moods, such

as irritability, can often be best coped with by a period of seclusion, and fatigue, by reducing the demands on one's energy. However married women with children may find their families make no concessions to moods and small children are unlikely to understand their mother's decreased tolerance of their misdemeanors at certain times.

Two dimensions of moods, 'aggression' and 'tiredness' were significantly related to cycle phase in the "Clinic" group but not in the other women with PMT. It is likely that these changes interact with these women's lifestyle such that PMT becomes distressing and a problem requiring "clinical" attention.

Psychologists interested in the menstrual cycle have previously invested little time in understanding the social context of behaviour. Clearly we need to take into account many factors, social and situational as well as individual, which influence cyclical mood changes and PMT.

5.2 HORMONES AND PREMENSTRUAL TENSION

The role of hormones in the aetiology of PMT is an area of conflicting findings. In this study four areas were considered:-

1. The timing of PMT in relation to hormonal variations during the cycle.
2. The role of oestradiol, progesterone and the oestradiol:progesterone ratio, whether levels of these hormones are abnormal or unusual in women with PMT and the relationship between behavioural ratings and the sex steroids.
3. Whether some women are "hormone-sensitive".
4. The role of androgens in PMT.

5.2.1 The Timing of PMT in Relation to Hormonal Changes.

The cyclical nature is a predominant characteristic of PMT and yet from previous research there is uncertainty as to the exact

relationship between the emotional and physical distress and hormonal variations of the cycle.

In this study the women felt at their lowest in the late luteal phase and improved during and after menstruation and were free from emotional and physical distress in the follicular phase. The on-off nature of PMT is in agreement with other reports (Abplanalp et al, 1980; Haskett et al, 1980; Sampson and Jenner, 1977; Steiner and Carroll, 1977).

However in the "Clinic" group the distressing changes started quite early in the cycle with the post-ovulatory development of the corpus luteum. It is widely accepted that PMT is restricted to the luteal phase although only one study to date has previously used appropriate endocrinological measurements to time ovulation and the luteal phase (Backstrom et al, 1981). In the present study it was confirmed that severe PMT starts in the early luteal phase shortly after ovulation whereas others have assumed that PMT only occurs when oestradiol and progesterone levels fall before menstruation (Dalton, 1977). This time coincides with the maximal distress but the symptoms of PMT start much earlier in the cycle.

5.2.2 The evidence for a "Hormone Imbalance" in PMT.

(a) Levels of Oestradiol and Progesterone.

There was no evidence for marked endocrine abnormalities in the PMT groups, the levels of hormones, length of phases and pattern of hormonal change being within the normal range (given in the appendix), and the length of cycles was in agreement with other data (Wood et al, 1979a). PMT can occur in the absence of severe endocrine abnormalities.

Low levels of progesterone, high oestradiol levels and a high oestradiol:progesterone ratio in the luteal phase are most frequently implicated in premenstrual distress (section 2.2.4) and there has been

some experimental support for these claims.

The theory that low progesterone is involved in PMT was not conclusively supported in this study. Luteal phase progesterone levels were not significantly different in the 3 groups (Table 17). These findings are in agreement with Andersch et al (1979) and O'Brien et al (1980).

In other studies claiming to find an association between low progesterone and PMT, not all the women had unusually low levels: Brush (1977) for example reports that only 30% of women attending a PMT clinic had levels of progesterone below average. The wide range of levels in PMT and control groups has been remarked upon (Smith, 1975; Andersch et al, 1979). It remains possible that some women experiencing PMT may have low progesterone in the luteal phase although it is not a necessary feature. This is supported by studies of treatment with progesterone (section 2.2.4.2) which report that whilst some womens' distressing PMT is relieved by natural or synthetic progestagens, controlled trials have found a strong placebo effect. Treatment with progesterone may be illogical in the absence of a progesterone deficiency.

Levels of oestradiol and the ratio of oestradiol to progesterone were not significantly different in the 3 groups (Tables 17 and 20), which is in agreement with Andersch et al (1979) (cf Backstrom and Carstensen, 1974; Munday et al, 1981).

These results give reason to doubt the importance of absolute levels of oestradiol and progesterone in PMT but the data must be regarded as preliminary. Only a crude method was used to analyse hormonal differences between the groups, using average within-phase hormone levels. Comparison of daily measurements in women with PMT and a comparable control group is necessary for full evaluation of

the significance of luteal phase hormone levels.

(b) The patterns of hormonal variations in the luteal phase.

The pattern of changing hormones in the luteal phase differed between women with different degrees of cyclical mood changes: the progesterone peak occurred earlier in the "Clinic" group, with a larger drop in oestradiol and progesterone between the mid-luteal and premenstrual phases (Tables 17-21). This earlier timing of the luteal phase progesterone peak was also found by O'Brien et al (1980).

The significance of a large change in hormones and progesterone withdrawal has been discussed in relation to puerperal depression (Dalton, 1980; Green and Dalton, 1953; Nott et al, 1976) and it can be speculated that a longer time of exposure to falling hormone levels before menstruation may contribute to the severity of premenstrual distress in the "Clinic" group. This was not fully evaluated in the study and requires further consideration.

(c) Correlations between hormones and behaviour in the premenstrual phase.

Although absolute levels of hormones did not differ significantly between women with different degrees of cyclical mood changes, hormone-behaviour correlations indicated some tentative links. In the "Clinic" group there were significant correlations between ratings of "lack of wellbeing" and "physical distress" and low levels of progesterone and high oestradiol and oestradiol:progesterone ratio.

Other research on hormones and PMT (Section 2.2.4) has indicated that low progesterone and/or high oestradiol levels are related to premenstrual distress. The observed correlations indicate that there may be some relationship between the severity of PMT and hormone levels within a group of women with severe PMT.

The precise relationship remains uncertain. The hormonal changes may be a reflection of other physiological mechanisms, perhaps centrally mediated, which are more causative of PMT than absolute hormone levels. An alternative explanation suggested by this research is that although those women's hormone levels are within a normal range and not significantly different from those of women without PMT, it is possible that some women are sensitive to physiological factors, manifest as changes in wellbeing related in time to fluctuating hormone levels. Individual sensitivities to hormones may be a more fruitful basis for aetiological discussion.

5.2.3 Individual Sensitivity to Hormones.

In the "Clinic" group a high proportion of women had a history of adverse reactions to oral contraceptives (Table 22) which is in agreement with other reports on the effects of the pill. For example, Cullberg's (1972) study indicated that certain women are "hormone-sensitive" in that individuals with a history of cyclical mood changes reacted badly to more oestrogenic pills.

This is an important finding with implications for the aetiology of PMT and clearly further systematic investigation is required to establish whether adverse reactions to the pill are common in women with PMT and whether this relates to the synthetic steroids.

There are reports in the literature of links between PMT and emotional problems after birth, PMT either preceding puerperal disturbances or a period of postnatal depression is followed by cyclical mood changes (Section 2.2.4.3). In this study, more women with PMT had histories of problems during and after pregnancy but this was not investigated in detail and further information would be relevant in evaluating links between PMT and times of endocrinological change.

In conclusion, it is clear from this research that the model of low progesterone and/or high oestradiol levels is only one part of the complex story of the involvement of hormones in PMT.

5.2.4 The Role of Androgens in PMT.

This was the first study to date to relate PMT and androgen levels.* Women in the "Clinic" group had significantly lower levels of androstenedione and testosterone: however the difference between the groups disappeared when the women were regrouped according to changes in wellbeing during the cycle.

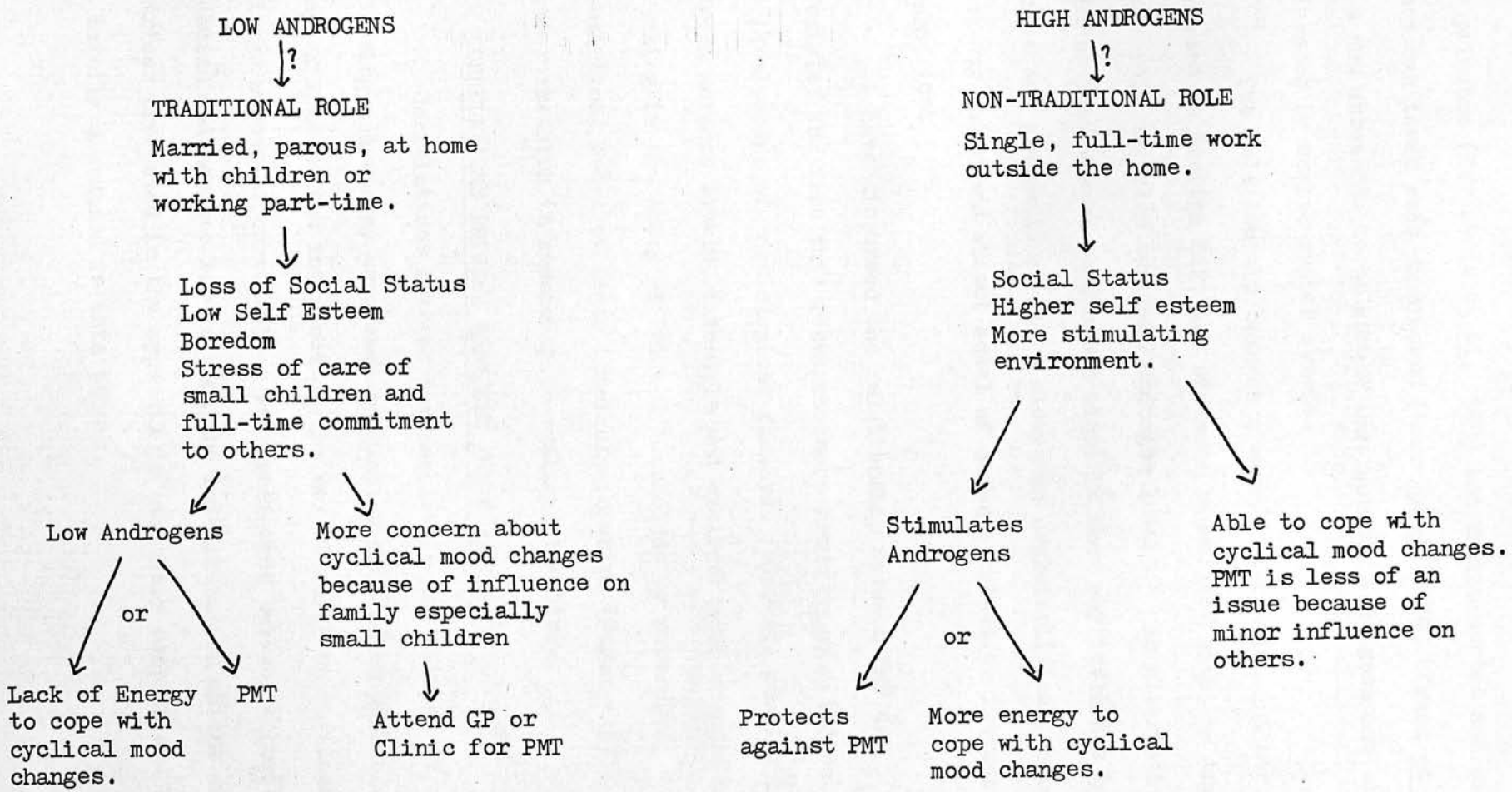
Androgen levels in the "Clinic" group were related to aspects other than PMT, namely these womens' lifestyle and occupation. Married or cohabiting women had lower testosterone levels than single women; those working outside the home had higher testosterone than women involved primarily in home-work and child care (Table 23).

This is in agreement with Purifoy and Koopmans (1980) who correlated androgens with occupational status in 55 women, and found that mean testosterone and androstenedione levels were higher in students and professional, managerial and technical workers compared to clerical workers and housewives. The "clinic" group were mainly married, parous women involved in childcare and their androgen levels may relate more to their situation than their cyclical mood changes.

It is possible that positive or negative stress associated with occupation or lifestyle could be related to androgen secretion. Research has shown that behavioural states and situations, especially stress-related ones, can lead to physiological changes (Section 2.1.2.3) and the effects of stress on the menstrual cycle are well documented (Matsumoto et al, 1979; Osofsky and Fisher, 1967; Russell, 1972; McClintock, 1971; Graham and McGrew, 1980). There is much evidence of

*Backstrom and Aakvaag (1981) recently found no significant differences in testosterone levels between 15 women with PMT and 17 without.

FIGURE 15 THE RELATIONSHIP BETWEEN ANDROGENS, LIFESTYLE AND PMT.



the effects of environmental and social stress on androgen levels in male primates (Bernstein et al, 1974) and environmental and surgical stress can lower men's androgens (Rose et al, 1969; Kreuz et al, 1972): it is not unreasonable to assume that women's androgens are similarly influenced by environmental events.

The relationship between a woman's situation and stress was discussed in Section 6.2, and stresses associated with the traditional female role may also suppress androgen levels. An alternative viewpoint might be that women's androgens might in some way influence her choice of role and occupation: it is always an oversimplification to assume a one-way cause and effect model of hormone behaviour interactions (Beach, 1974).

I have discussed the relationship between PMT and lifestyle, and from this research there are intriguing indications for the involvement of physiological factors. Certain complex interactions between hormone levels, lifestyle and cyclical mood changes may be operating in the story of PMT and I conclude by presenting a hypothetical model of these interrelationships (Figure 15). Clearly further research is necessary to evaluate the links.

5.3 CORRELATIONS BETWEEN HORMONES AND BEHAVIOUR.

Correlations between hormone levels and ratings of emotional wellbeing and energy were used to examine hypotheses discussed in Chapter 1 as to the influence of the sex steroids on emotional wellbeing. A large number of correlations were performed between behavioural measures and hormone levels, and the interpretation of the correlation matrices presented in the appendix is obviously complex and will only be briefly discussed in this thesis.

(a) Oestradiol and Progesterone

The most striking finding was a lack of significant correlation between levels of oestradiol and progesterone and behavioural ratings. This is in agreement with Abplanalp et al (1979b) who found no obvious relationship between women's moods and hormone levels; Persky (1974) similarly reports on inconsistent hormone-behaviour correlations.

The effects of exogenous steroids have been cited as evidence that hormones influence behaviour: progestagens in pharmacological doses have a sedatory or tranquillising effect (reviewed by Herrmann and Beach, 1978) whereas oestrogens have excitatory properties (Backstrom, 1978). The lack of correlation between circulating hormone levels and behaviour suggests 2 possibilities:-

(i) Absolute levels of circulating hormones are not related to wellbeing because endogenous levels are above threshold necessary for adequate functioning. This theory agrees with studies of hormone-behaviour relationships in menopausal and ovariectomised women, discussed in Section 1.2.3: whereas there is little relationship between levels of circulating steroids and moods in menopausal women (Campbell, 1976), after ovariectomy, when there is a substantial fall in endogenous hormones, exogenous oestrogens and progestagens correlate with emotional wellbeing (Dennerstein et al, 1978, 1980; Utian, 1972).

(ii) Hormones may influence wellbeing only in some individuals who are sensitive to hormones: the concept of hormone-sensitivity has been discussed above. In the "Clinic" group there were several significant correlations between premenstrual distress and luteal phase hormones

suggesting that levels of hormones may be relevant to these women who are particularly hormone-sensitive.

(b) Androgens

There were some significant correlations between androgens and energy, indicating some influence of testosterone and androstenedione, although this effect may be delayed: thus a rise in androgens may be manifest as a behavioural response later on. There is no reason to suppose that the influence of a hormone on behaviour is necessarily rapid and there is insufficient information to evaluate the mechanisms whereby a change in circulating hormone level might influence behaviour, so a temporal delay is not impossible.

5.4 THE DISTRIBUTION OF SEXUAL BEHAVIOUR DURING THE MENSTRUAL CYCLE.

5.4.1 The Relationship between Cycle Phase and Sexuality.

There was little evidence for any increase in sexual interest or activities around ovulation in this group of women: the most obvious peak occurred in the mid-follicular phase, after menstruation (Figures 10-13).

This is consistent with other studies relating women's sexuality to cycle phase (Section 2.3). Although a small proportion of these report that some women show a midcycle peak of sexuality, by far the most common pattern is peri-menstrual with pre- and post-menstrual peaks in sexual interest and activities (Table 3). This is the conclusion drawn by several reviewers of the literature on cyclical changes in women's sexuality (Cavanagh, 1969; McCauley and Ehrhardt, 1976; Schreiner-Engel, 1980; Singer and Singer, 1972).

This study differed from other research in the area in that cycle phases were defined using appropriate and frequent measures of hormone levels. Studies cited as evidence for a midcycle peak in

sexuality have lacked accurate assessments of ovulation. James (1971) reanalysed the data of McCance et al (1937) and Udry and Morris (1968) who claimed to find ovulatory peaks and demonstrated that they in fact occurred in the follicular phase; although Adams et al (1978) recently reported that woman-initiated heterosexual and autosexual behaviours increased during the ovulatory phase, subsequent recalculation of their data to reflect menstrual cycle phases more accurately showed no differences in the women's sexual behaviour between the ovulatory phase and other days of the cycle (Kolodny and Bauman, 1979).

Two studies which have used appropriate hormone measures have not demonstrated any midcycle peak. Schreiner-Engel et al (1981) found objectively-assessed sexual arousal to be higher in the mid-follicular and mid-luteal phases than at ovulation; and Abplanalp et al (1979b) found no significant differences in women's sexual behaviour across cycle phases.

Although a post-menstrual peak was the most striking finding, there was some evidence of an increase in sexual interest before menstruation, although this was confounded by the influence of general wellbeing, especially energy. The Principal Components Analysis showed that a fair proportion of the variance in the sexual ratings was taken up by the first component: how sexual a woman feels is influenced by her general wellbeing and energy. The fourth component was a measure of sexuality independent of the effects of mood and energy. This "sexuality" component of subjective ratings, when freed from the effects of cyclical mood change, showed a definite peak not only in the mid-follicular phase but also before menstruation. This is consistent with other data. Thus the difference in the distribution of measures of subjectively assessed sexuality, "sexual feelings" and the fourth "sexuality" component, may reflect the effects of cyclical mood change.

5.4.2 Theories to Account for the Pattern of Sexual Changes.

As discussed in Section 1.2.1 many non-human mammalian species including primates have an oestrus pattern of sexual behaviour, although this is often obscured by factors such as the level of sexual drive, the social organisation and effects of partner-preference and novelty. The lack of a comparable oestrus pattern in women makes it likely that the determinants of cyclical sexual behaviour in women are fundamentally different from those of other animals. Is it possible that non-hormonal factors are the overriding determinants of women's sexuality, hormonal mechanisms being insignificant? If this is the case, what factors might account for a perimenstrual pattern of sexuality?

(a) Menstrual Abstinence might contribute to the pattern. In many societies women are not sexually active during menstruation regardless of their sexual desire (Ford and Beach, 1951; Martin and Long, 1969): Paige (1973) found that over half of 960 couples were never sexually active during menstruation. As described in Section 2.3.1.3, menstrual abstinence has been demonstrated to influence the distribution of sexual activities during the cycle: women who are sexually inactive during menstruation are more likely to report post- and pre-menstrual peaks in sexual interest and activities than non-abstainers. The same pattern is observed before and after a partners' absence (Gold and Adams, 1978; McCulloch, 1973). Thus anticipation of abstinence might contribute to a pre-menstrual peak and the emergence from a time of deprivation may increase the likelihood of sexual activities after menstruation.

Although this may be a contributory factor for some women, it is unlikely to be sufficient to totally account for the observed pattern. Sexual feelings, independent of sexual activities, showed a definite

post-menstrual peak even in women who were not sexually active with partners. It is not unusual to find women who say that the only time they feel sexual and initiate or enjoy sexual activities is just before or after menstruation (Personal Communications); occasionally women say they are more interested during their period. Schreiner-Engel's findings of a definite increase in physiologically assessed sexual arousal in the mid-follicular and mid-luteal phases is hard to explain on the grounds of abstinence: it could be that after a period of abstinance a woman may show more arousal to erotic stimuli but it is hard to see why increased arousal would occur before this (Schreiner-Engel et al, 1981).

I would conclude that whereas abstinence during menstruation may contribute to a postmenstrual peak it is not sufficient to account for the cyclical pattern of sexual behaviour observed.

(b) Contraceptive Method

It is possible that desire to avoid conception might influence the pattern of sexual activities, according to the method of contraception used:- women using less reliable methods might avoid heterosexual activities at midcycle and a post-menstrual peak may reflect increased sexual activities at a time felt to be "safe". Thus women using more reliable methods might be expected to show less evidence of peri-menstrual pattern.

In fact, the postmenstrual peak was in evidence in women using both reliable and less reliable methods: distinction between sterilisation and I.U.C.D.s and barrier methods revealed no significantly different patterns (Figure 14). So although the desire for or avoidance of conception might explain some womens' pattern of sexual activities this was not supported in this study.

(c) Effects of General Wellbeing and Energy

As discussed in Section 5.4.1 above, the Principal Components Analysis indicated interactions between sexuality and emotional wellbeing, particularly energy. An effect of general wellbeing on sexuality would hardly be surprising: but the extent to which this may influence the pattern of sexual feelings and activities is more speculative. For women with cyclical mood changes, an improvement in moods after menstruation might contribute to the postmenstrual increase in sexuality: but a midcycle peak might then be expected given that this was the time when these women felt at their best. This was not observed.

Moods appeared to have more influence on the distribution of sexuality during the luteal phase. The women with a pronounced deterioration in their moods and energy before menstruation had lower ratings of sexual feelings in the premenstrual phase and sexual activities declined at this time: this pattern was not seen in women who did not experience PMT and, as the Principal Components Analysis indicated, the premenstrual decline was related to moods and energy.

Only a few studies have investigated the relationship between sexuality and PMT (Section 2.2.1). These indicate that a proportion of women with PMT feel less sexually interested before menstruation (Wendestam and Ohman, 1980) although some feel more sexual at this time (Moos et al, 1969).

*

Non-hormonal factors such as menstrual abstinance and non-specific effects of general wellbeing may contribute to the cyclical pattern of sexual interest and activities: but they are not sufficient explanations. What other mechanisms might account for this pattern and in particular, to what extent might it be hormonally determined?

5.4.3 Hormones and Sexual Behaviour during the Menstrual Cycle.

It is difficult to see how Oestradiol, which is believed to be crucial for oestrus behaviour in most mammals, could account for the pattern in women. The post-menstrual peak is not temporally related to the time of highest oestradiol levels around ovulation; and in agreement with others (Abplanalp et al, 1979b; Persky et al, 1978a; Schreiner-Engel et al, 1981) there was little correlation between oestradiol levels in the different cycle phases and sexual behaviour (Tables 30, A-7).

It is more likely on the basis of this and other evidence that although a certain amount of oestradiol is necessary to maintain normal sexual behaviour, varying the levels above this baseline will not be reflected in any aspect of women's sexuality except for possible non-specific temporal relationships with mood changes.

The concept of a threshold necessary for adequate functioning was discussed in Chapter 1. Oestrogens appear to have little marked sexual effect in women with distressing menopausal changes, apart from those associated with alleviating vaginal dryness or changes secondary to improved wellbeing. However exogenous oestrogens have a more sexually enhancing effect after ovariectomy, when the women's endogenous levels are presumably below threshold (Dennerstein et al, 1980). Thus levels during the normal menstrual cycle are sufficient for women's sexuality and so one would expect little correlation between fluctuating levels and sexual behaviour.

*

There were some negative correlations between Progesterone and sexual interest and activities (Tables 30 and A-8) which have been reported by others (Abplanalp et al, 1979b; Schreiner-Engel et al, 1981). An inhibitory role of progesterone on women's sexuality has

been suggested by other research discussed in Chapter 1. In primates progesterone has a clear dampening effect on female's proceptive behaviour; and in women exogenous progestagens may have anti-libido effects (Bancroft, 1974, 1977). The women in Dennerstein's study found that progestagens decreased the sexually-enhancing influence of oestrogens (Dennerstein et al, 1980).

The perimenstrual pattern could reflect disinhibition from the effects of progesterone. Falling levels before menstruation may be behaviourally expressed as a relative increase in sexual interest at this time. The post-menstrual peak might fit with a delayed escape from the inhibitory effects of progesterone.

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Androgens are widely believed to activate sexual interest and activities in female primates (Herbert, 1977) and also in women. The evidence for cyclical change in androgens in women has previously indicated an increase in the middle third of the cycle (Baird et al, 1974; Frolich et al, 1976; Judd and Yen, 1973; Vermeulen and Verdonck, 1976), although most studies have involved only small numbers of women. The present work confirmed a cyclical pattern (Figure 8), levels of testosterone and androstenedione rising significantly in the late follicular and early luteal phases. Might this cyclical pattern contribute to the distribution of sexual behaviour?

The fact that levels of androgens were highest in the middle third of the cycle whereas sexual feelings and activities peaked at other times indicates little positive association. However two possibilities require consideration: firstly, the temporal relationship between hormonal change and its behavioural expression, and secondly, the effects of overall hormone levels on women's

sexuality rather than changing levels.

Behavioural effects of a hormonal change may have a long latency. There is no reason to assume that fluctuating steroid levels produce behavioural effects within a few hours, comparable to rodent oestrus cycles. Behavioural effects of androgens given to hypogonadal men occur after 1-2 weeks (Skakkebaek et al, 1981). If the same sort of temporal relationship is relevant to women, then one might expect changes in sexual interest later on in the cycle. This may compete with the negative effects of progesterone, obscuring any simple hormonal influence.

The second consideration is that, as with oestradiol, the variations in androgen levels are less important than the tonic effect which might be reflected in average levels. This has been suggested by other studies. Persky et al (1978b) found a positive correlation between women's midcycle testosterone levels and their frequency of sexual behaviour at all times of the cycle and also correlations between their average testosterone levels and average "sexual gratification" score. Bancroft et al (1980) found a significant correlation between average self-ratings of sexual appetite and overall testosterone levels in women taking oral contraceptives.

In this study average and midcycle testosterone levels were significantly correlated with measures of sexual behaviour (Table 31). The significant associations demonstrate that it is more useful to consider effects of androgens on womens sexuality in terms of overall levels rather than in terms of cyclical hormonal changes.

However the direction of the correlations indicated that the association is by no means simple. For women who masturbated, positive correlations between testosterone and masturbation were found. For women who did not masturbate, when considering sexuality involving

the partner, the correlations were negative.

It seems possible that androgens may have an effect on women's individual sexual interest or activities but this effect is obscured within the context of a sexual relationship. Schreiner-Engel divided the women in her study into three groups according to their average testosterone levels throughout the cycle. Vaginal response to erotic stimuli was significantly higher in the "high testosterone" group than the "low testosterone" group. However she also found that the "high testosterone" group reported more problems with their heterosexual relationships and women with lower testosterone levels had more and better sexual relationships and higher sexual interest overall (Schreiner-Engel, Personal Communication).

This may be explained by considering some of the known effects of testosterone in women and how these may interact with sexuality. Testosterone is thought to be a libido-enhancing hormone in both men and women (Foss, 1951; Greenblatt et al, 1942; Salmon and Geist, 1943; Shorr et al, 1938) and one controlled study, although not replicated, indicated some beneficial effects of testosterone when combined with counselling for women experiencing sexual difficulties (Carney et al, 1978). Androgens have an effect on the peripheral genitalia and probably maintain clitoral sensitivity. Kinsey et al (1953) report that women feel more active, aggressive and sexual when taking exogenous testosterone.

One might expect that raised androgen levels might increase a woman's sexual drive, desire and enjoyment. However the response may depend on the individual's attitude to her sexuality: a woman with sexual anxieties may react anxiously to increased sexual drive whereas women who are more relaxed about their sexuality may feel more positive. The effects of androgens may interact with relationships and increased sexuality could lead to further anxiety

if sexual relationships are problematical. Some influences of androgens may conflict with a traditional stereotype of femininity and could be troublesome to more conventional roles and expectations within a relationship.

It is possible that, in this study, the women who masturbate differ from non-masturbators in aspects of their attitude towards themselves and their sexuality: a degree of questioning of the traditional female role may relate to more freedom to enjoy one's sexuality and experience sexually-enhancing effects of androgens as beneficial.

Other intriguing correlations with testosterone permit further speculation about androgen-behaviour relationships in women. Women who were working full-time had higher testosterone levels than women who were not employed outside the home or employed part-time; and women who were married or cohabiting had lower testosterone levels than those who were not cohabiting (Table 23). Although these associations were not strong ($P < 10\%$) they raise the interesting possibility that high testosterone is associated with other aspects of lifestyle which may conflict with a satisfactory heterosexual partnership. Thus we should expect little simple relationship between tesoterone and women's sexuality.

5.4.4 Conclusions.

This study provided evidence of sexual cyclicity in women, with a clear postmenstrual peak in sexual feelings and initiation of sexual activities and a premenstrual pattern related to changes in general wellbeing. This is in contrast to the more typical oestrus pattern linked to ovulation, characteristic of other mammals.

The research suggests that although non-hormonal mechanisms are involved in women's sexuality, hormonal factors are not irrelevant.

We may be wrong in looking for simple associations between changing hormone levels and alterations in behaviour, and the relationship may be more in a tonic effect of hormones, with interactions between oestrogens, progesterone and androgens, and aspects of women's sexual attitudes and life-style.

Clearly animal models are an oversimplification for understanding the story for women and we require further analysis of the many and complex non-hormonal and hormonal factors influencing women's sexuality during the menstrual cycle.

CHAPTER 6

SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH

6. SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FURTHER RESEARCH.

6.1 EMOTIONAL AND PHYSICAL CHANGES DURING THE MENSTRUAL CYCLE.

Emotional and physical changes are related to hormonally-defined phases of the menstrual cycle and occur to varying degrees in different women. Those complaining of severe Premenstrual Tension showed significant changes in their moods and physical wellbeing with a pronounced deterioration in the luteal phase and improved moods and energy in the follicular phase and at midcycle. A similar but less marked pattern was observed in women reporting milder cyclical changes although the decline in wellbeing started later in the cycle, during the mid luteal phase. In contrast, only a slight and non-significant pattern of mood changes was seen in women who do not experience PMT although mild premenstrual breast tenderness was common. Premenstrual changes can be regarded as a normal physiological accompaniment of the menstrual cycle: Premenstrual Tension may represent a more prolonged, severe and distressing extreme of this normal and non-problematical cyclicity.

Differences between women who report cyclical changes and those experiencing severe Premenstrual Tension are of significance to the understanding of PMT as a clinical problem. Women in the "Clinic" group experienced a marked loss of energy and decline in sexual interest and increased aggression in the premenstrual phase. Many of these women were married and involved in looking after children at home and it is possible that these aspects of their lifestyle interact with cyclical changes such that PMT is exacerbated causing distress and problems which lead the individual to seek medical advice.

The hormonal aetiology of PMT remains obscure. There was little evidence for abnormal levels of oestradiol, progesterone or an unusual

oestradiol:progesterone ratio in the "Clinic" group. This may have implications for the treatment of PMT: the increasing therapeutic use of progesterone may be illogical in the absence of a progesterone deficiency.

Absolute levels of hormones may be less important than the rate and degree of change during the cycle. There was a different pattern of progesterone secretion in the luteal phase in women with pronounced PMT, progesterone levels starting to fall earlier, indicating a longer time of exposure to falling hormones before menstruation. The change in oestradiol levels in the luteal phase was also greater in these women. This pattern may contribute to the severity of premenstrual distress.

Women with PMT may also be more sensitive to hormones. These women had reacted adversely to the steroids of the pill and a large proportion had experienced problems during and after pregnancy. This indicates that links between hormones and PMT may reside in an individual's constitutional sensitivity.

Correlations between oestradiol and progesterone and ratings of moods failed to reveal consistent relationships. It is possible that above a threshold necessary for adequate functioning, levels of these steroids are irrelevant. However the temporal relationships between hormonal and behavioural changes during the cycle suggests that steroids, whilst not in themselves causative factors, may be related to other endocrine or neurophysiological factors which are causally related to behaviour.

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Women in the "Clinic" group had lower levels of testosterone and androstenedione in comparison with women who report less marked mood changes. Testosterone was correlated with ratings of energy,

possibly with a delayed action and hence low testosterone may relate to premenstrual loss of energy in PMT.

However there is no straightforward relationship between androgens and PMT. When the subjects were redivided according to the observed changes in wellbeing from midcycle to premenstrual phases, there was no indication of low androgen levels in the women experiencing premenstrual distress.

Levels of testosterone correlated with other factors: low androgens, characteristic of the "Clinic" group were related to these women's lifestyle and marital status. The interactions between social and situational variables, hormones and cyclical mood changes is an area which has received little attention and I discussed the implications and importance of an interactional approach to premenstrual tension.

6.2 SEXUAL CHANGES DURING THE MENSTRUAL CYCLE.

There was no evidence that women's sexuality or sexual activities peak at midcycle: the pattern was perimenstrual rather than periovulatory. Sexual interest and woman-initiated sexual activities peaked after menstruation whereas partner-initiated activities peaked after ovulation.

Women's ratings of sexual interest were affected by moods and energy. Women with PMT felt less sexual before menstruation in contrast to the middle of the cycle, a pattern which paralleled the mood changes. When the effects of moods and energy were controlled statistically, the pattern was of sexual peaks in both the premenstrual and postmenstrual phases.

The hormonal basis of this pattern remains obscure. There was little evidence that oestradiol was related to sexuality, but progesterone may have an inhibitory effect in the luteal phase.

Escape from this could account for the pre- or post-menstrual peaks. It remains possible that these peaks represent delayed effects of the increase in androgens during the middle third of the cycle.

Alternative non-hormonal explanations were considered, including the influence of premenstrual mood changes and anticipated or actual abstinance from sexual activities during menstruation.

The role of testosterone in women's sexuality appears complex. Testosterone was negatively correlated with measures of sexual interest. However for women who masturbate, testosterone was positively related to frequency of masturbation and sexual activities including a partner whereas negative correlations were found for women who do not masturbate. It is possible that although testosterone may enhance certain aspects of women's sexuality it has other effects which may be inhibitory or detrimental to sexual relationships. This was discussed in relation to the interactions between hormones and sexuality.

*

In conclusion: This study has demonstrated the importance of appropriate methodology to study cyclical changes in women's behaviour and the relationship to sex steroid hormones. Adequate description of the population of women, definition of the aspects of behaviour of interest, precise assessments of cycle phases and consideration of social and situational influences on an individual's behaviour should be features of further research into hormone-behaviour relationships during the menstrual cycle.

6.3 SUGGESTIONS FOR FURTHER RESEARCH.

There is a growing need for the development of effective and acceptable methods of treating PMT and its hormonal and physiological basis must be established to provide a rationale for treatment.

The involvement of hormones in the aetiology of PMT remains uncertain. Further research is required, combining daily ratings of wellbeing with daily hormone measures in groups of women experiencing PMT and a comparable control group to assess whether hormone levels or ratios differ between the groups and whether the pattern or degree of hormonal changes might be involved.

The role of other hormonal and non-hormonal factors in PMT also requires investigation using this research design.

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In this study several results indicated that women's individual sensitivity to hormones might be a fruitful basis for aetiological investigation. Reactions to exogenous steroids may differ in women who do or do not experience cyclical changes. Further prospective studies of oral contraceptives would be useful and relevant.

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We have little information on non-physiological factors involved in women's cyclical mood changes: in this study there was suggestive evidence that PMT is more common in women over 30 years and is influenced by marital status, parity and occupation. Only small numbers of women were involved: investigation of these factors in larger groups is required. Long-term prospective studies would be relevant.

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Intriguing relationships between women's lifestyle and androgen levels were found in this study and it was suggested that hormones and lifestyle interact with cyclical mood changes in the distressing phenomenon of PMT. Further research on androgens is called for, to investigate androgen production in women and how this interrelates with lifestyle.

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Patterns of sexual variations during the cycle were shown to be influenced by mood changes and PMT, interactions which have previously received little attention. It is suggested that further consideration of relationships between the menstrual cycle and sexuality should not ignore the influences of emotional factors.

*

The role of androgens in women's sexuality is undoubtedly complex and this study indicated subtle interactions with the individual's sexual attitudes and lifestyle. These results are by no means conclusive but are indications for expansion of research.

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APPENDIX

1. HORMONES AND THEIR VARIATIONS THROUGHOUT LIFE AND DURING THE MENSTRUAL CYCLE.

Definitions and Descriptions.

There are 3 important components of the system involved in regulating reproductive functions and the sex hormones:
The Hypothalamus, Pituitary and Ovaries (Fig. A-1). The hormones secreted by these 3 glands influence other parts of the hypothalamo-pituitary-ovarian axis by mechanisms of feedback. Negative feedback occurs when a high level of one hormone inhibits secretion of another and Positive Feedback where one hormone promotes the secretion of another. The system is also influenced by external and internal factors.

There are two different types of hormones involved in womens reproductive functions: Gonadotrophins and the Sex Steroids.
Gonadotrophins. Under the influence of releasing factors from the hypothalamus follicle stimulating hormone (FSH) and luteinising hormone (LH) are secreted by the pituitary. The release is pulsatile and hence levels in plasma may fluctuate or only be detectable for a short time.
FSH is involved in the growth and development of ovarian follicles and the secretion of ovarian oestrogens.
LH promotes oestrogen secretion and increases ovarian blood flow and hence the supply of substances necessary for steroid synthesis. It also triggers ovulation in the mature, FSH-primed follicle. After ovulation LH is involved in the formation and maintenance of the corpus luteum and progesterone secretion.
A third gonadotropin, Prolactin (PRL) is produced by the pituitary. One definite function is in stimulating the growth and activity of the milk-secreting system in the breast (McNeilly, 1977). Its

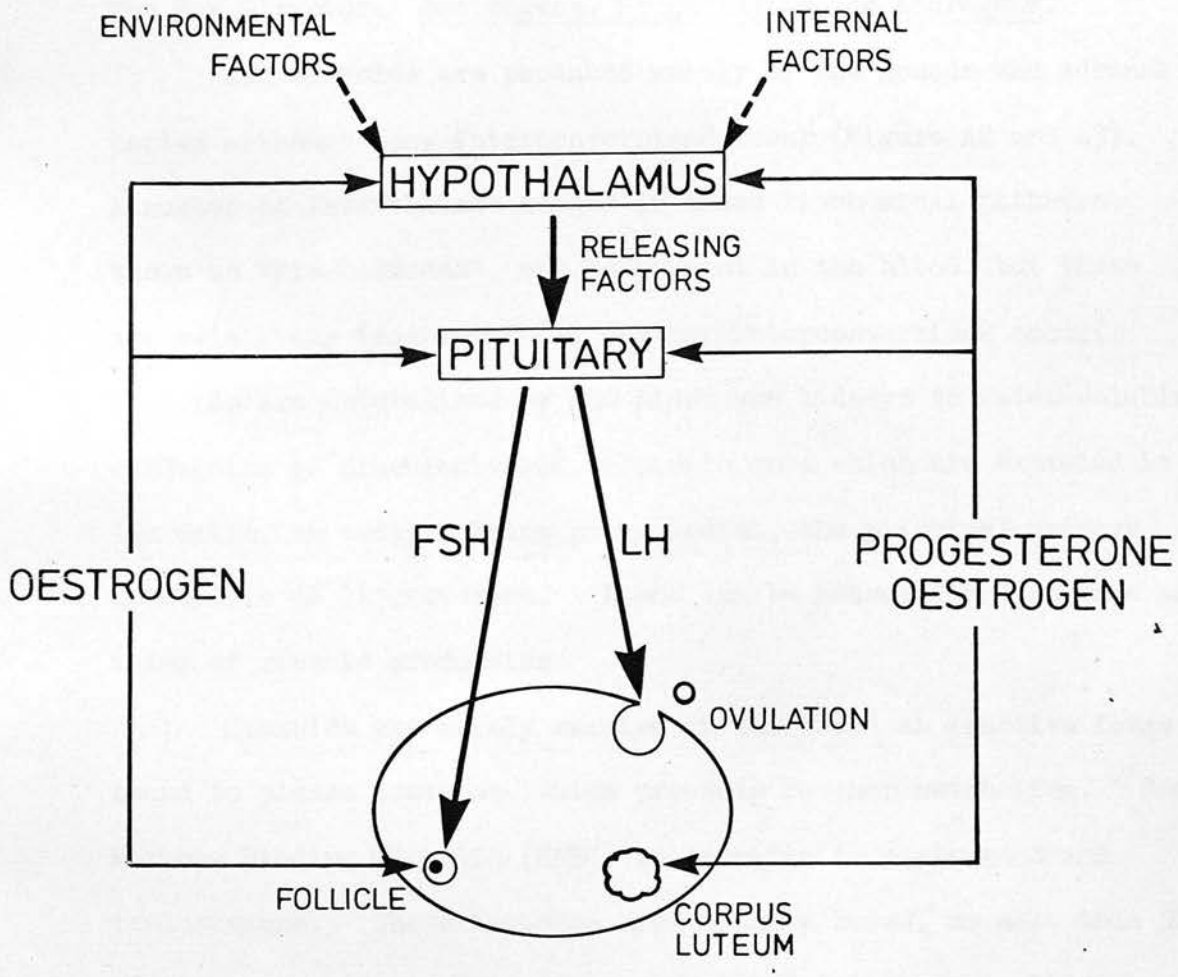


Figure A-1. THE HYPOTHALAMO-PITUITARY-OVARIAN AXIS INVOLVED IN THE MENSTRUAL CYCLE

ovarian actions are less certain, but production of ovarian steroids requires appropriate levels of PRL whereas higher levels have an inhibitory effect. PRL is also involved in the maintenance of the corpus luteum after ovulation.

The Sex Steroids: Oestrogens, Progestagens and Androgens.

Sex steroids are produced mainly by the gonads and adrenal cortex although many interconversions occur (Figure A2 and A3). A number of intermediate stages in these biochemical pathways, known as "Pre-hormones", may be present in the blood, but these are relatively inactive until further interconversions occur. Steroids are metabolised by the liver and kidneys to water-soluble conjugates of glucuronic and sulphuric acid which are excreted in the urine, an example being pregnanediol, the principal urinary metabolite of Progesterone. These can be measured and provide an index of steroid production.

Steroids are mainly carried in the blood as inactive forms bound to plasma proteins, which prevents further metabolism. Sex Hormone Binding Globulin (SHBG) is specific to oestrogens and testosterone. These hormones are strongly bound, no more than 5% of the total steroid being free or unbound in plasma. Other steroids such as androstenedione and progesterone are only weakly bound, mainly to albumin.

Steroids have a wide variety of metabolic effects and a particular role in reproduction. They are responsible for sexual differentiation, the development of secondary sex characteristics at puberty and the establishment and maintenance of pregnancy and lactation. Their effects on behaviour in adult life is the topic of this thesis.

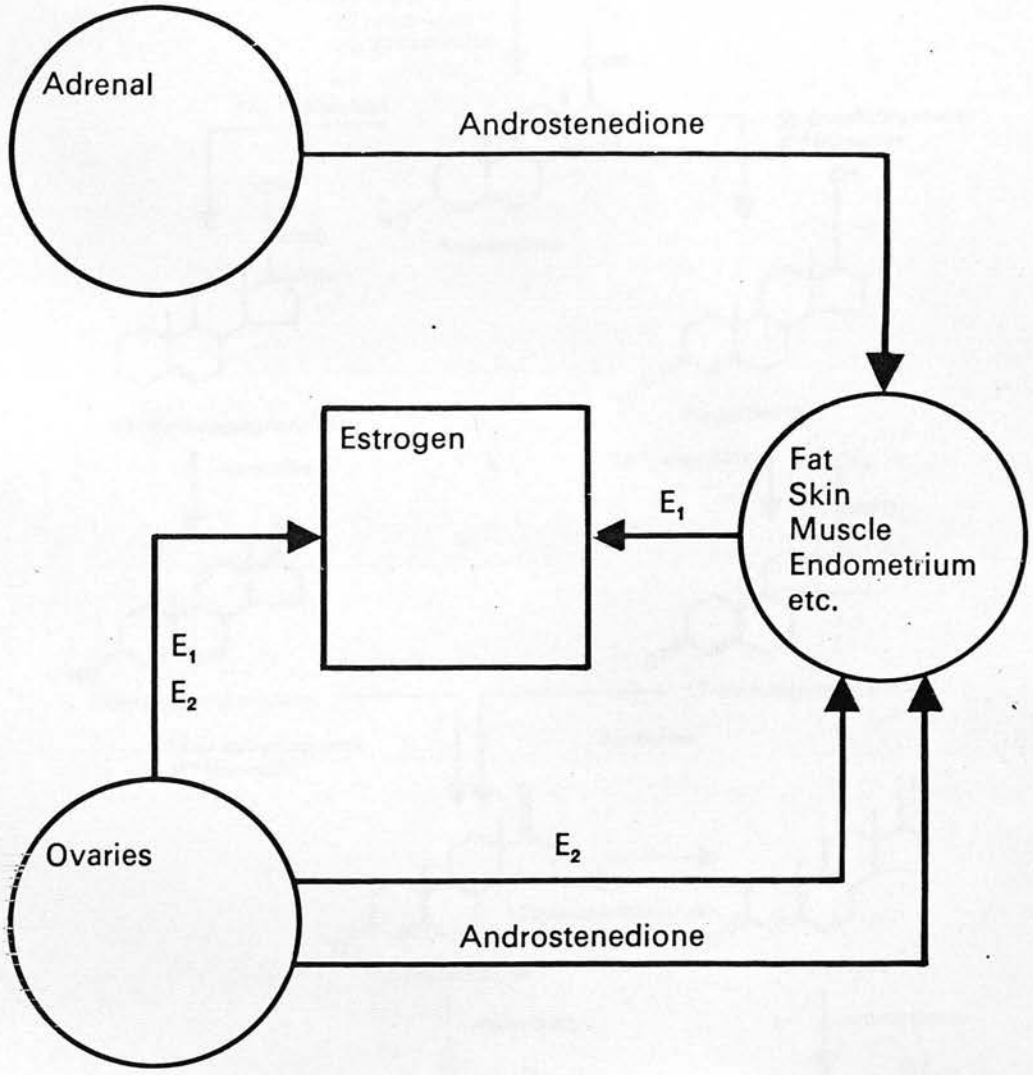


Figure A-2. THE CONVERSION OF STEROIDS IN PERIPHERAL TISSUES (from Speroff et al, 1978)

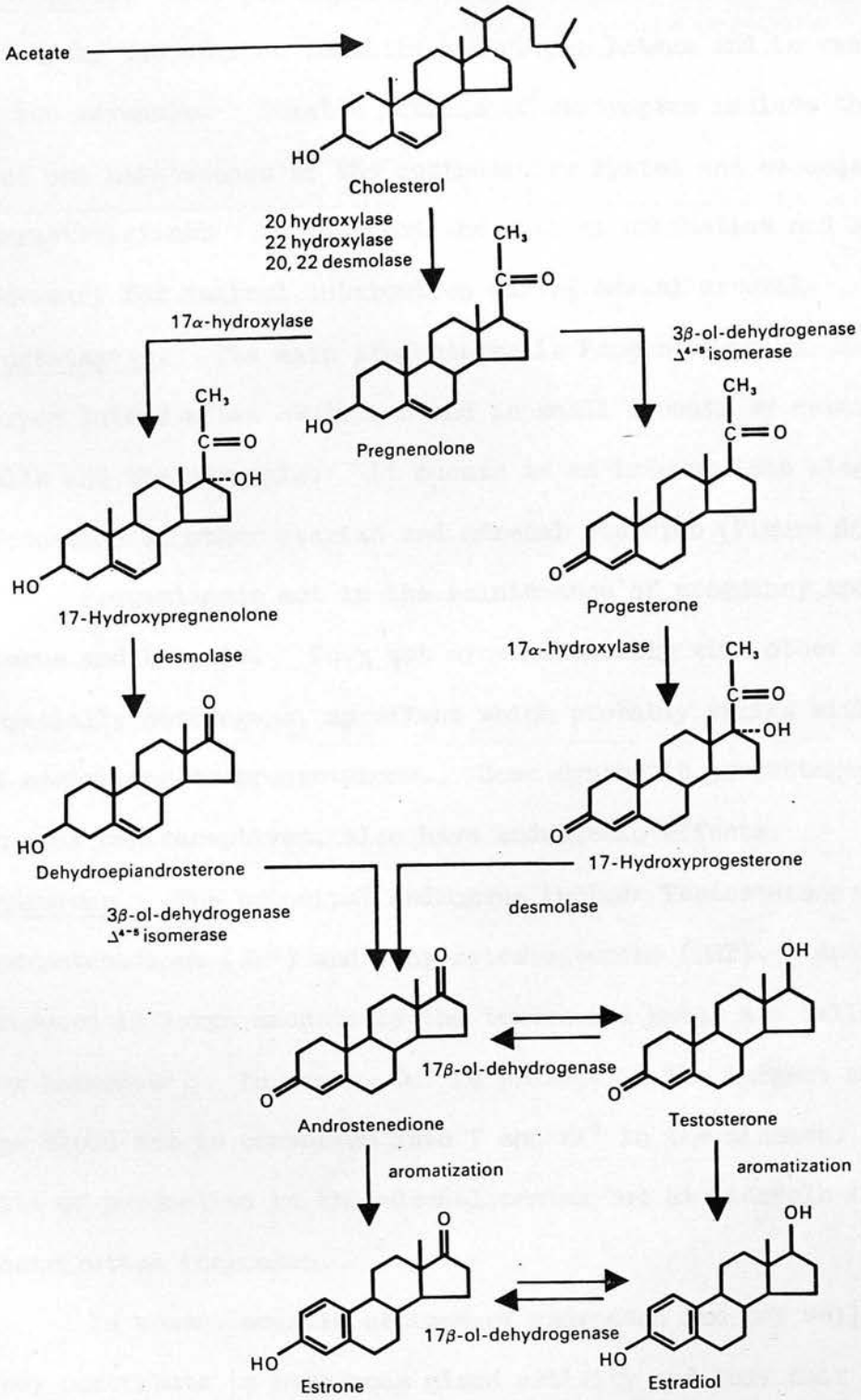


Figure A-3. BIOSYNTHETIC PATHWAYS OF THE SEX STEROID HORMONES (from Speroff et al,1978)

Oestrogens. The principal oestrogen is Oestradiol 17β, produced mainly by the ovarian follicle and corpus luteum and in smaller amounts by the adrenals. Somatic actions of oestrogens include the development and maintenance of the reproductive system and secondary sex characteristics. They affect the vaginal epithelium and are necessary for vaginal lubrication during sexual arousal.

Progestagens. The main progestagen is Progesterone, produced by the corpus luteum after ovulation and in small amounts by mature follicle cells and the adrenals. It occurs as an intermediate stage in the production of other ovarian and adrenal steroids (Figure 4-3).

Progestagens act in the maintenance of pregnancy and on the uterus and breasts. They act synergistically with other steroids, especially oestrogens, an effect which probably varies with the ratio of oestrogens to progesterone. Some synthetic progestagens, as used in oral contraceptives, also have androgenic effects.

Androgens. The principal androgens include Testosterone (T), Androstenedione (Δ^4) and Dihydrotestosterone (DHT). Androgens are produced in large amounts by the testes and hence are called "male sex hormones". In women, Δ^4 is present in the largest amounts in the blood and is converted into T and Δ^4 in the tissues. The main site of production is the adrenal cortex but at midcycle the ovarian contribution increases.

In women, somatic actions of androgens are not well understood. They contribute to sebaceous gland activity and body hair growth and may be necessary for normal pubertal development of the external geritalia. High doses of exogenous androgens may cause enlargement and increased sensitivity of the clitoris.

Principal Hormonal Changes during the Menstrual Cycle.

After birth the sex hormones remain fairly constant and at low levels until puberty when the hypothalamo-pituitary system begins to release gonadotropins in a cyclical fashion and the ovaries start producing sex hormones. This initiates a pattern of hormonal changes characterising the menstrual cycle. The first few are usually anovulatory but once normal regular cycles are established they usually continue in a predictable way, possibly interrupted only by pregnancy and lactation, until the menopause.

Definition and Description of the Menstrual Cycle.

The Menstrual Cycle is usually defined as starting at the onset of menstrual bleeding and continuing until the onset of the next menstrual bleed. This definition is used here although others use ovulation to mark the start and end of the cycle (e.g. Speroff et al, 1978). The cycle is divided into 2 phases corresponding to ovarian and endometrial changes.

The Follicular or Proliferative Phase is from the start of the cycle until ovulation when ovarian follicles develop and the endometrium proliferates. The Luteal or Secretory Phase is when the follicle turns into a progesterone-secreting corpus luteum after ovulation and the endometrium changes further to support a conceptus should fertilisation occur. Otherwise the luteal phase ends after the disintegration of the corpus luteum, at the onset of menstruation.

The length of the cycle and these phases varies although the variability within an individual is less than that across different women. The levels of hormones and timing of hormonal changes is also variable. The mean cycle length varies from 21-40 days. It

is usually maintained that the follicular phase produces the most variability in cycle length, the luteal phase usually being 14 days although this, again, can vary (Dyrenfurth et al, 1974; Landgren et al, 1980; Presser, 1974; Trelpar et al, 1967; Vollman, 1977).

The incidence of abnormal cycles is hard to assess and many internal and external factors can affect the cycle, such as stressful situations (Matsumoto et al, 1979) or the phenomenon of "menstrual synchrony" occurring when women live closely together (Graham and McGrew, 1980; McClintock, 1971). Anovulatory cycles are more common in younger women and those approaching the menopause (Döring, 1969; Metcalfe, 1979; Metcalfe and McKenzie, 1980). Unusual cycles are also found, such as short or insufficient luteal phases (Sherman and Korenman, 1974).

Hormonal Changes during the Menstrual Cycle.

The concentrations and patterns of change of gonadotrophins and sex steroids have been well described and there are several reviews reporting serial measurements of hormones throughout the cycle (Abraham et al, 1972; Dyrenfurth et al, 1974; Faiman, Winter and Reyes, 1976; Johansson et al, 1971; Moghusi, Syner and Evans, 1972; Ross et al, 1970; Speroff and Vande Wiele, 1971; Yen et al, 1970).

Also there is a growing understanding of the relationships between the hypothalamus, pituitary and ovaries which underlie regular ovulatory menstrual cycles (e.g. Austin and Short, 1972; Hafez, 1979; Hafez and Evans, 1973; Speroff, Glass and Kase, 1978).

A summary of the changes in gonadotrophins and sex steroids during the menstrual cycle is shown in Figures A4 and A5.

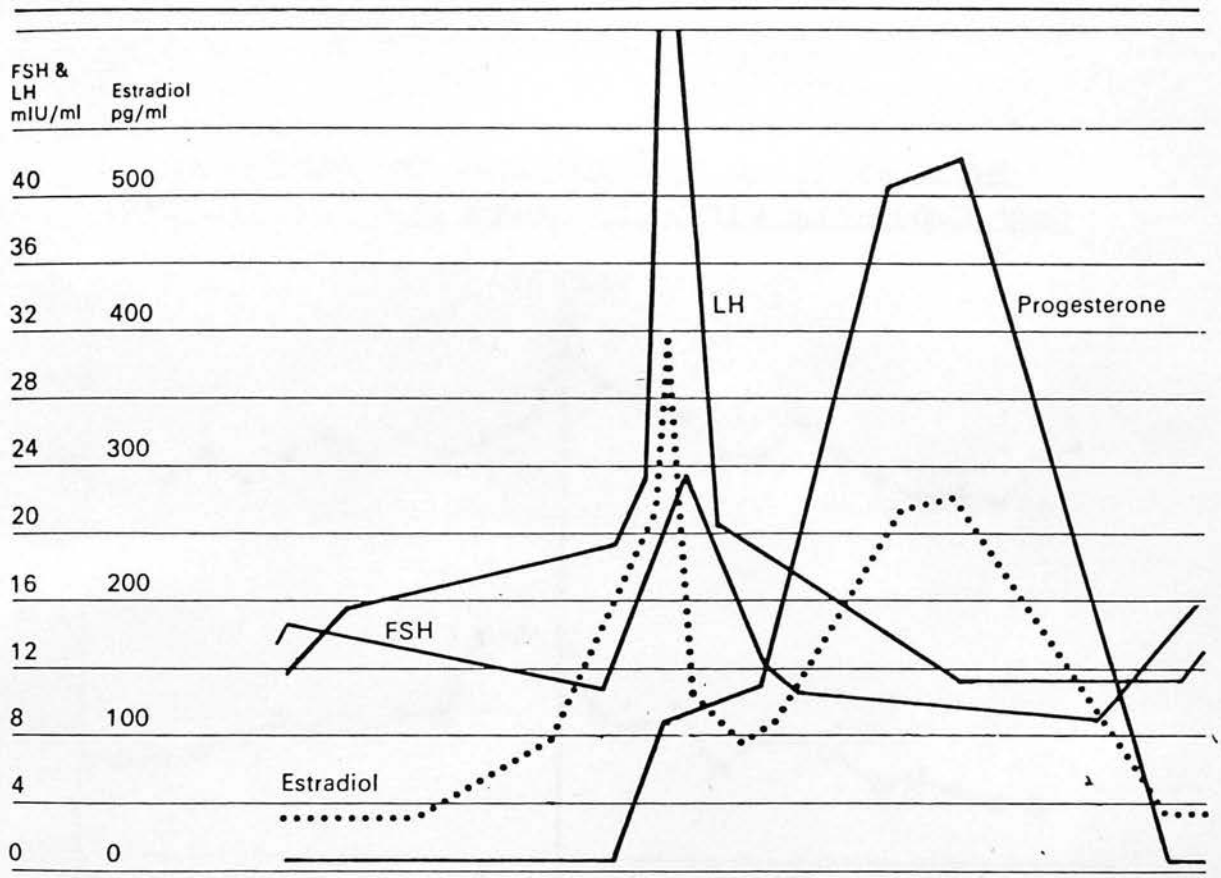
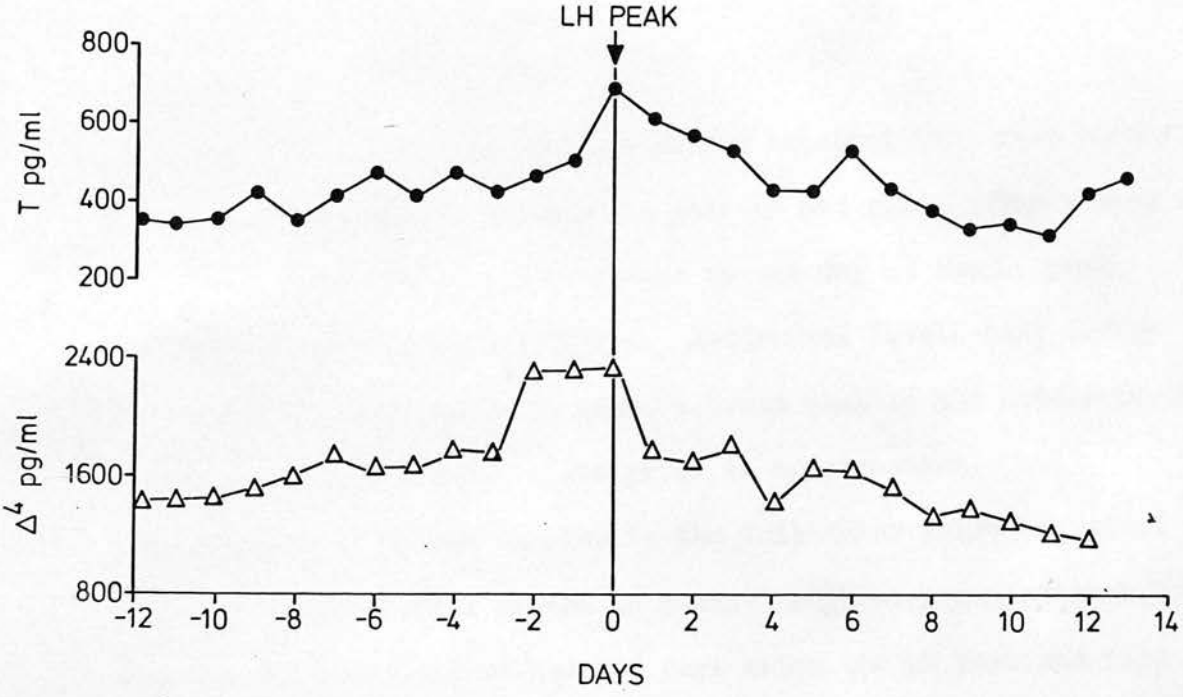


Figure A-4. PLASMA LEVELS OF GONADOTROPINS AND OVARIAN STEROIDS DURING THE NORMAL MENSTRUAL CYCLE (from Speroff et al,1978)

Figure A-5.

TESTOSTERONE AND ANDROSTENEDIONE LEVELS DURING THE MENSTRUAL CYCLE IN 15 WOMEN. (VERMEULEN and VERDONCK, 1976).



Gonadotrophins. Levels of FSH and LH gradually rise at the beginning of the cycle, leading to the development of follicles and oestrogen secretion. Rising levels of oestrogens exert a negative feedback effect causing LH and FSH to fall. However, at midcycle, prior to ovulation, oestradiol switches to positive feedback, triggering the LH peak followed by ovulation 16-24 hours later. FSH levels also rise at this time.

Sex Steroids.

Oestrodiol 17β. Levels are low during menstruation, rise slowly and then more abruptly to reach a peak at midcycle. The timing of this peak varies from 2 days before to the day of the LH peak (Diczfalusy and Landgren, 1977). Oestradiol levels fall before ovulation but rise again to reach a broad peak in the middle of the luteal phase and decline again prior to menstruation.

Progesterone. Levels are low in the follicular phase but start to rise at the initiation of the LH peak. Following ovulation levels rise to reach maximum values 6-8 days after the LH peak and fall again as the corpus luteum regresses prior to menstruation.

Androgens. The pattern of androgens is less certain than that of the other hormones. A number of studies involving serial samples from small numbers of women do find a cyclical pattern as shown in Figure 5 (e.g. Abraham, 1974; Abraham and Chakmakjai, 1973; Baird et al, 1974; Dupon et al, 1973; Frolich et al, 1976; Genazzani et al, 1977; Judd and Yen, 1973; Lloyd et al, 1971; Vermeulen and Verdonck, 1976). Testosterone and Androstenedione increase at mid-cycle from 3 days before to 3 days after ovulation, and lowest levels are found in the early follicular and late luteal phases. All these studies report wide inter- and intra- individual variations in the levels of androgens.

"Normal" ranges of hormones in the follicular and luteal phases and at midcycle are given in Table A-1. However, levels of gonadotrophins and steroids and the timing of the changes vary a great deal across individuals and may be influenced by many factors, such as age (Purifoy, Koopmans and Tatum, 1980).

Physiological Indicators of Hormone Levels.

The most accurate way of assessing hormone levels and their variations during the menstrual cycle is by radioimmunoassay of plasma samples as described below, or by assay of urinary metabolites (Brotherton, 1976; Lorraine and Bell, 1976). There are also several indirect methods of assessment. These include the rise in basal body temperature which occurs after ovulation; changes in vaginal cytology which reflect alterations in oestrogenic stimulation of the vaginal epithelium; and quantitative and qualitative changes in cervical mucus (Hafez and Evans, 1973; Moghissi et al, 1972; Speroff, Glass and Kase, 1978; Vollman, 1977). Such methods, being indirect, are less accurate but have been used in determining both cycle phase and approximate levels of hormones.

Table A1

NORMAL RANGES FOR PLASMA FSH, LH, OESTRADIOL, PROGESTERONE AND TESTOSTERONE DURING THE MENSTRUAL CYCLE (FROM SPEROFF, GLASS & KASE, 1978).

	LH mIU/ml	FSH mIU/ml	OESTRADIOL pg/ml	PROGESTERONE ng/ml	TESTOSTERONE pg/ml
Follicular Phase	5-20	5-30	25-75	<1	200-800
Midcycle	15-60 (3 times base level)	10-60 (2 times base level)	200-600	<1	200-800
Luteal Phase	5-20	5-30	100-300	5-20	200-800

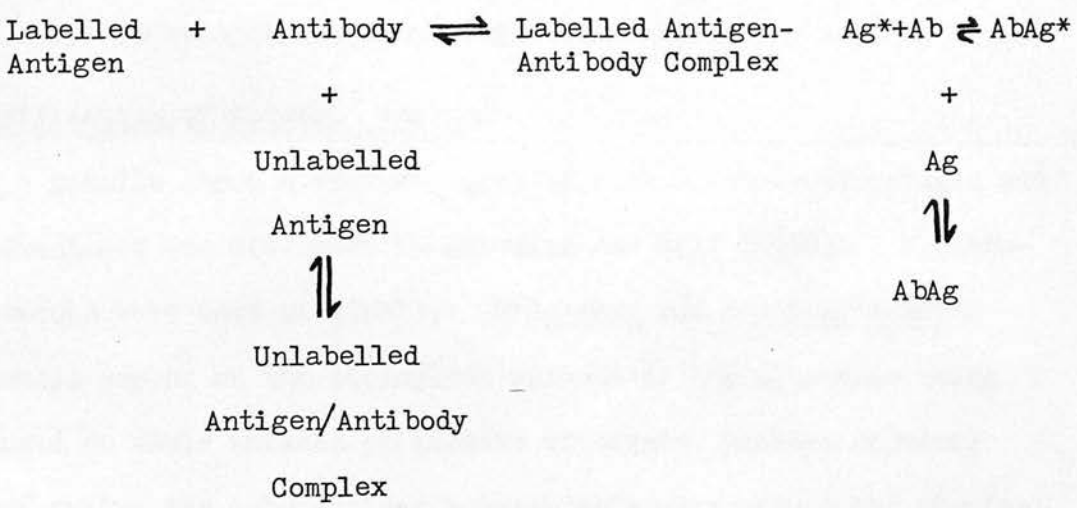
2. HORMONE ASSAYS

In the past 20 years there has been great progress in methods for the measurement of minute quantities of many biological substances including enzymes, vitamins, plasma proteins, drugs, cancer antigens and peptide and steroid hormones. The technique of radioimmunoassay has especially contributed to the routine measurement of hormones in biological fluids. Since R.I.A. was first described by Yalow and Berson (1960) the technique has improved considerably with respect to its specificity, precision, accuracy and sensitivity. It is now used on a routine basis and rapid measurement of many samples at a time is achieved via automation of various procedures. The introduction of International Reference Standards has facilitated comparability and standardization of results both within and across laboratories.

The principles of R.I.A. have been detailed elsewhere (Lorraine and Bell, 1976; Ekins, 1974; Yalow and Berson, 1960; Cameron, Hillier and Griffiths, 1974; British Medical Bulletin, 1974; Berson and Yalow, 1968; Skelley, Brown and Besch, 1973).

RIA uses the principle involved in binding of antibody to antigen, the Immune reaction, and the principle of Radiochemistry by using a radioactive labelled compound. The system is based on the competition between an unlabelled antigen and corresponding labelled antigen for a limited number of antibody binding sites. An antigen may be a drug, hormone, vitamin or any substance in blood, urine or cerebrospinal fluid which, when injected into an animal, will stimulate the immune system to produce an antibody specific to that antigen. Steroids are low molecular weight substances and so the steroid is attached to a carrier protein of high molecular weight, usually Bovine Serum Albumin and the antibody is raised to this

compound. For polypeptide hormones, antigens are raised to the pure hormone. The system can be diagramatically represented:-



The experimental conditions are chosen so that a fixed amount of antibody and a relative excess of antigen, labelled and unlabelled, react together. When equilibrium is reached, some antigen is unbound (i.e. free) and, the rest is bound to the antibody. The percentage of bound antigen will decrease as the amount of unlabelled (i.e. unknown) antigen in the sample increases. The amount of radioactivity in the bound portion is measured using radiochemical counting techniques. The evaluation of the amount of substance in an unknown sample is made by reference to a standard curve. This is prepared by plotting a value related to the measurement of radioactivity (as % binding of labelled antigen) to the known concentrations of standards.

So the principal components of radioimmunoassay are:-

1. Pure antigen used to raise antibodies.
2. Labelled Antigen.
3. Standard Antigen.
4. Unknowns in the sample.
5. Antibody specific to the antigen.

6. Techniques for the separation of Bound from Free antigen.

7. Techniques for assessing radioactivity.

Classification of Hormone Assays.

Details about different types of assays, their advantages and disadvantages are discussed in Lorraine and Bell (1976). 2 classifications were used originally: Bioassays and Chemical Assays. Bioassays depend on the biological effects of the substance being measured on whole animals or tissues or organs, whereas chemical assays employ the interactions between molecular groups and chemical reagents. Immunoassay is therefore a type of chemical assay, which exploits biological reagents such as antibodies and hormone-binding proteins.

An alternative and more appropriate classification now used is to distinguish functionally specific assays and structurally specific assays. Functionally specific assays depend on the functional activity of hormonally active substances in a biological environment. Structurally specific assays on the other hand involve reactions between molecular structures which may or may not have relevance to the biological functions of the substances. Hence the former type of assay measures the functional activity of a substance, whereas the latter gives a measure of the gravimetric amount or concentration of a substance. Functionally specific assays therefore depend on standards and unknowns being functionally identical whereas structural identity of standards and unknowns is required of structurally specific assays.

RIA is a form of structurally specific assay. The assay depends on a chemical reaction between groups on these molecules which are involved in the immunological reaction between the

antigen (such as the hormone) and the antibody. These sites may have no relevance to the hormone's biological or functional activity in vivo, only its immunological activity in this specific reaction with an antibody.

Other structurally-specific assays include Competetive Protein Binding assays; Radioreceptors assays, using tissue receptor molecules in place of antibodies; Immunoradiometric assays, using labelled antibody; and Radio-Enzymatic assays, utilizing enzymes not antibodies.

Radioimmunoassay.

There are a number of criteria which have to be assessed in interpreting the results of RIA of hormones since the extent to which the assay fulfil these criteria will affect the results. These are as follows, discussed in relation to the measurement of hormones during the human menstrual cycle.

(1) Sensitivity. The assay must be sensitive, especially when very small amounts of hormones are being measured. The human menstrual cycle encompasses a large range of levels of hormones and although sensitivity is less crucial for the higher concentrations, the lower range calls for a highly sensitive assay.

Sensitivity is technically defined as the precision of measurement of the hormone at zero concentration. It should be well below the lower limits of the normal range of levels found along the cycle. It is largely dependent on the sensitivity of the antibody used.

(2) Specificity. The assay should be specific to the hormone being measured. Biological fluids are intrinsically heterogenous and as well as the hormone of interest, contain a number of other molecules which may interfere with a non-specific assay. Examples include hormone fragments or precursors, enzymes, and hormone binding

proteins. Such substances have a similar structure but unrelated biological function and may compete for binding on the antibody, or influence the distribution of bound and free hormone during separation.

In addition to the presence of other substances, environmental factors may influence specificity, including temperature, pH and the presence of anticoagulants.

Specificity can be increased by the use of highly specific antibodies. Specificity is checked for each batch of antibody since antibodies raised to any one antigen are rarely homogenous but consist of many forms with different binding sites of variable affinities to cross-reacting substances.

In addition specificity can be increased by keeping environmental conditions constant and incorporating procedures such as extraction and purification of samples prior to assay to remove non-specific competing substances.

(3) Precision. The assay must be precise: there should be a high degree of agreement of repeated measures of a sample.

Precision depends on a number of factors, including the amount of hormone recovered after extracting it from the plasma sample and standardization of all steps of the assay. Use of Quality Control techniques is important to monitor the assay for any changes. Quality Controls involve procedures such as the use of a standard reference material, or a "pool" of plasma of low, medium and high values of the substance of interest, or including samples assayed in a previous batch in each run.

Measures such as simplifying the assay procedures, the use of duplicates and dilutions of samples and standards and ensuring that the standards used cover the range of hormones being measured

also improve precision. "Blanks" can be used such as the "antibody blank" and "non-specific binding" blank, where no antigen or hormone is present and zero concentration should be measured.

(4) Accuracy. The assay should be accurate and give true measures. Accuracy is mainly dependent on the standards used which should therefore be "true" concentrations of the hormone. If the system is not specific to the hormone of interest, this may affect the accuracy, giving biased results. This can mean either repeatable but inaccurate results or variable, non-replicable results.

(5) Standardization. Assays should be standardized to allow comparison between laboratories or assays. Since assay-techniques do vary, it is important that the range of normal values (i.e. the range of values in a large population) is established for each assay procedure rather than compared across laboratories or methods of RIA.

The Components of the R.I.A. System which may affect results and the criteria of sensitivity, specificity, precision, accuracy and standardization.

(1) The Antigen. The purification of the antigen, the pure form of the hormone to be tested, is crucial since it is used at various different stages of the assay, e.g. to raise antisera, in its labelled form for radioactivity counts, and as standards .

(2) The Antibody. This is raised to specific hormones in experimental animals and should meet up to various criteria:-

(a) It must be specific to the antigen and minimally cross-react with other substances. Antibodies are rarely homogenous since many different forms may be raised within a biological system. All antibodies are checked for the degree of cross-reaction, and substances with which cross-reaction occurs.

(b) It should be sensitive and have a high affinity for the antigen. This determines the detection limit of the assay.

(c) The titre is the dilution of antibody which binds a given amount, such as 50%, of the total labelled antigen in the system. The appropriate dilution is established for each new batch of antibody used. Specificity, sensitivity, affinity and titre are all tested between different immunizations in the same animal as well as using different animals to raise antibodies.

(3) The Standards. These should show identical behaviour to the unknown in the samples being tested. Standards should be stable, accurate and free from substances which interfere with the assay. The range of standards used should cover the range of values to be measured in the samples. Ideally the samples' range should be covered by the steepest region of the standard curve which is prepared in each assay by plotting a value related to the measurement of radioactivity, the percentage binding of labelled antigen, to the known concentration of standards.

(4) Separation Techniques. This involves the separation of antigen bound to antibody and free labelled antigen. Bound and free antigen are in an equilibrium reaction and so the separation should not interfere with this equilibrium. "Stripping" occurs when the separation process strips the antigen from the antibody giving an inaccurate high value for free labelled antigen and hence an inaccurate high value for the unknown. This can be avoided by timing the separation process so that it is completed over a time when degree of

stripping is stabilized (approx. 15') and keeping environmental conditions constant (e.g. continuous low temperature during the separation time).

(5) Measurement of Radioactivity. The use of a labelled antigen of high specific energy (i.e. the relative radioactivity of radioisotope per unit mass) increases the accuracy and precision of counting procedures especially at the low concentrations of antigen used in RIA.

(6) The use of Tests, Quality Control, Non-specific Binding measures, Recoveries and Blanks all introduce checks in the system at the various stages at which inaccuracies may arise.

The Interpretation of RIA Results.

In interpreting results from RIA of hormones in plasma taken at different stages of the menstrual cycle it is necessary to be cautious as to the meaning and validity of the results obtained. There are several possible sources of inaccuracy which have to be taken into account. Another consideration is the meaning of a hormone level in relation to its physiological or behavioural significance.

(a) Possible sources of inaccuracy.

Unless an assay is sensitive, precise, accurate, specific and reliable the results must be interpreted with caution. Biological systems are innately variable and complex and so assay results can rarely be absolute but are best used for comparative purposes to look at changes in hormones over time. Also samples are always compared to suitable reference materials but these may themselves vary either between assays or between labs. It is necessary to take this into account in making comparisons of different results. The confidence

limits i.e. the margin of error allowed for in the results of an assay should be stated.

In addition, variability or inaccuracies may arise due to factors other than the assay and the conditions under which blood samples are obtained may affect the results. Some hormones may vary according to the time of day, although this has not been found for oestradiol, progesterone or androgens (Lorraine and Bell, 1976). LH and FSH are released in a pulsatile manner and many hormonal changes in plasma are very rapid and can easily be missed.

A subjects posture, physical activity, level of arousal or stress and meal times may effect hormone levels. Ideally samples should be obtained under the same conditions at the same time of day for each individual.

Plasma levels of hormones are expressed as units of concentration and therefore depend on the volume of plasma, but total plasma volume in the body varies both between different sized people and for an individual at different times of day (Lorraine and Bell, 1976). This is rarely taken into account in comparing results across individuals or from samples taken from one individual at different times of day or under variable conditions, mainly because there is little information available as to how much plasma volume variations can influence hormone levels.

The effects of sample-handling and storage may influence results. Blood samples frequently spend some time at room temperature prior to centrifugation and separation and temperature may effect the interconversions between different hormones (Brotherton, 1976). Some hormones may be absorbed by red blood cells prior to separation, giving an inaccurately low result. The anticoagulant (Heparin) used to treat the sample following venapuncture may interfere with

the assay. Repeated thawing and re-freezing of plasma samples may also effect the hormones (Lorraine and Bell, 1976). Ideally, therefore, samples should be protected from temperature fluctuations, separated as soon as possible following venapuncture, kept frozen prior to assay and not be re-frozen after thawing.

(b) The Meaning of a Hormone Level.

There are several points that should be considered in interpreting hormone levels.

(1) The amount of a hormone may be distinct from its activity. The level of a hormone as measured by RIA does not necessarily equate exactly with its biological activity in physiological systems. The technique of RIA involves a reaction based on the hormone's immunological properties and the biologically active part of a hormone may reside in a different region of the molecule to the site of immunological activity. Hormone fragments, precursors or metabolites may have immunological activity but not biological activity or vice versa and so distort the results. Hence it cannot be assumed that a hormone level is directly proportional to its biological activity, or that all of the hormone measured is that which has relevance other than in an immunological reaction.

(2) Levels of hormones are not static but continually change in biological systems, with numerous interconversions (Figures A2 and A3) and the "residence time" of a hormone in the blood varies according to its interconversions or clearance rate. The residence time may be very short, as for steroids, or several hours, as for FSH and protein

hormones. Hormones also pass from the plasma into adjacent compartments such as interstitial fluids or body fat. They may be metabolized and returned to the plasma as different molecular forms or be excreted in the urine, faeces or sweat.

So the level in plasma at one time does not necessarily reflect the actual secretion rate by the gland or glands but its turnover rate due to metabolic factors must also be taken into account.

(3) Hormones may be carried in plasma bound to plasma proteins. albumin or globulin(e.g. Sex Hormone Binding Globulin). In addition, steroids may exist as conjugates such as glucuronates or sulphates, which are metabolically inactive forms and it is possible that only the unbound or unconjugated form is biologically active. Protein binding is important for the movement of steroids in and out of the plasma compartment. It is likely that free unbound steroids pass through the walls of blood vessels more easily than the bound fraction since it has been found that the concentration of bound hormone is higher than in interstitial fluid (Klopper et al, 1973). Bound hormones also cannot be excreted by the kidney.

So the distinction between bound and unbound is important in interpreting the results of assays in terms of biological activity. Measurements of binding substances as well as of hormone levels gives information about the degree of binding and is useful in assessing a hormone's biological activity.

3. APPENDIX. FIGURES AND TABLES

(Not included in main text.)

Figure A6 - THE DAILY DIARY

MOOD SCALES

	0 _____ 10
Cheerful and Happy	
Fatigued and Tired	
Sociable and Friendly	
Energetic and Active	
Tense and Anxious	
Irritable	
Changeable	
Aggressive	
Depressed and Unhappy	
Relaxed	

PHYSICAL HEALTH

Breast Tenderness ____	0 = no experience
Swelling/Bloated feelings ____	1 = mildly noticable
Headaches ____	2 = moderately noticable
	3 = very noticable

How have you been feeling physically?
Note any changes or symptoms
Note any drugs or medications taken.

Note any significant events which occurred.

SEXUAL DIARY

Sexual Feelings 0 _____ 10

Present Thoughts about sex: Pleasant _____

Unpleasant _____

0 = none
1 = slight
2 = moderate
3 = very

Sexual Activities

	0 _____ 10
Masturbation	
Sexual Activity with partner	
Orgasm	

Sexual Activity initiated by:

Self
Partner
Both

Figure A7 - DEFINITIONS OF THE EXTREME POINTS OF THE ANALOGUE SCALES

Write, in a few words, how you would define the points 0 and 10 for each mood, sexual feelings and ratings of sexual activities

	0 = How you feel when not in this mood at all	10 = How you feel when this mood is strong and prevalent
Cheerful/Happy		
Fatigued/Tired		
Sociable/Friendly		
Energetic		
Tense/Anxious		
Irritable		
Changeable		
Aggressive		
Depressed/Unhappy		
Relaxed		
	0 = How you feel when not feeling sexual at all	10 = How you feel when feeling your most sexual
Definition of feeling "sexual"		
	0 = The least satisfactory and/or enjoyable experience you have had	10 = The most satisfactory and/or enjoyable experience you have had
Masturbation		
With Partner		
Orgasm		

Figure A-8 THE HANDOUT USED TO RECRUIT VOLUNTEERS

A STUDY OF WOMEN'S MENSTRUAL CYCLES

I am studying various changes women may experience during the menstrual cycle, including moods and sexual feelings, to see if these are in any way linked to the different hormones of the cycle. This is of interest since little is yet known about the contribution of hormones to moods and sexuality in women and also more information is needed about "Premenstrual Tension" which can cause a number of women quite a lot of distress.

The study involves a group of non-pill using women, who fill in daily questionnaires in the form of a short diary of:-

moods
sexual feelings and activities
physical changes

Also measurements are made of hormone levels, by regular blood or urine tests. Women will be asked to fill in questionnaires and have the necessary hormone tests for one cycle and the collection of this information will, hopefully, be useful and interesting to the women involved as well as of scientific and medical value.

I would be glad to hear from anyone who may be interested in taking part. Please could you return the attached form and I will contact you for further details. Thank you.

A STUDY OF WOMEN'S MENSTRUAL CYCLES

NAME .....

ADDRESS .....

.....

TEL. NO. ..... EVENING .....

WORK ADDRESS .....

TEL. NO. .....

Figure A-9 THE INTERVIEW SCHEDULE

Name:..... Address:.....

.....

Phone No:..... Work No:.....

Date of birth:..... Age: .....

Place of birth:..... Nationality .....

Married/Divorced/Widowed/Separated? .....

Living with husband/partner? ..... If single, living with partner? .....

Date of marriage/cohabitation? ..... Age of leaving school? ....yr

Any further education or training? .....

Religion ..... Do you attend services? .....

How often? .....

Present employment status? full-time/part-time/not working/self-employed

Present occupation .....

Who is the principle breadwinner? Self/partner/parent .

Occupation of principle breadwinner .....

Number of children ..... Types of delivery (i.e. normal or caesarian?) .....

Dates of birth .....

Any other pregnancies? .....

Outcome (i.e. Miscarriage or abortion?) .....

Dates of end of other pregnancies: .....

Length of pregnancy? .....

Any problems with pregnancy or after birth? .....

.....

General Health in past year? .....

Any gynaecological problems? .....

Any particular depression or anxiety? .....

Any treatment or medication currently taken? .....

Contd/.....

Age when menstruation started ..... years

What was your reaction? (i.e. were you prepared for it?) .....

.....

Current length of cycles ..... (days)

Number of days bleeding .....

How regular? .....

Do you have period pains? Give details (time, severity, any medication taken)

.....

.....

Contraceptives used in past year .....

Contraceptives used presently .....

Oral contraceptives taken in the past - please specify type of pill, when taken, for how long, and any reactions you may have had.

.....

.....

.....

Please give details of any physical, mental or sexual changes you have noticed to be linked in any way to your menstrual cycle (when they occur in the cycle, how much you are affected etc.)

.....

.....

.....

.....

.....

Age when menstruation started ..... years

What was your reaction? (i.e. were you prepared for it?) .....

.....

Current length of cycles ..... (days)

Number of days bleeding .....

How regular? .....

Do you have period pains? Give details (time, severity, any medication taken)

.....

.....

Contraceptives used in past year .....

Contraceptives used presently .....

Oral contraceptives taken in the past - please specify type of pill when taken, for how long, and any reactions you may have had.

.....

.....

.....

Please give details of any physical, mental or sexual changes you have noticed to be linked in any way to your menstrual cycle (when they occur in the cycle, how much you are affected etc.)

.....

.....

.....

.....

.....

Figure A10 THE MENSTRUAL CYCLE QUESTIONNAIRE (ADAPTED FROM MOOS, 1968b)

This is a list of things that some people may experience at different times. Please indicate whether you experience any of the following, when you experience them in relation to your period, for how long, how frequently and give a rating for how strongly you experience each feeling.

NB For items that you do not experience leave blank.

	When Occur 1=Before menstruation 2=during 3=after 4=other times	How Long? (days)	How frequently? 1=every month 2=every other month 3=less frequently	Rating for Severity 0=No experience 1=barely noticeable 2=mild 3=moderate 4=strong 5=severe
Overactivity				
Restlessness				
Nervousness				
Irritability				
Anxiety				
Physical tension				
Excitement				
Feelings of well-being				
Bursts of energy				
Feeling down				
Fatigue, tiredness				
Difficulty in concentrating				
More accidents				
Feelings of swelling				
Weight gain				
Painful Breasts				
Headache				
General aches & pains				
Insomnia				
Appetite changes				
Palpitations				
*Recurring illnesses				
(please specify) *				

Figure A-11

SCALES ON THE MENSTRUAL CYCLE QUESTIONNAIRE

Scale	Feelings
AROUSAL	Overactivity Restlessness Nervousness Irritability Anxiety Tension Palpitations
POSITIVE AFFECT	Excitement Well-Being Bursts of Energy
NEGATIVE AFFECT	Feeling Down Fatigue Mood Swings
CONCENTRATION	Difficulty Concentrating More Accidents
FLUID RETENTION	Swelling Weight Gain Painful Breasts
PAIN	Headaches Aches & Pains
INSOMNIA	Insomnia
CHANGES IN APPETITE	Appetite Changes
RECURRENT ILLNESSES	Recurrent Illnesses

Table A2

FOLLOW UP AND TREATMENT OF THE "CUNC" GROUP

TREATMENT	NO. OF WOMEN	RESPONSE TO TREATMENT
I. Refused Medical Treatment	8	These women wished to learn to cope and live with cyclical changes rather than trying any treatments. Self-help remedies were useful.
II. Pyridoxine (Vitamin B6)	3	1 noticed no change on Pyridoxine 2 found it helped tension, breast tenderness and insomnia.
III. Synthetic Progestogens 1. Medroxy-progesterone Acetate (Provera)	8	2 found Provera helpful with no side effects. 1 found no change on Provera. 1 found Provera helped for 3 months and then stopped having benefical effects. 2 felt worse on Provera and experienced breakthrough bleeding. (1 woman also felt weight gain a problem). 2 improved on Provera but noticed breakthrough bleeding.
2. Noristerone	1	Experienced few beneficial effects and found weight gain a problem
3. Primulet (N.B. 4 women tried both Primulet & Provora).	5	1 found Primulet helpful but weight gain was a problem. 2 felt worse on Primulet. 1 improved and did not notice side effects. 2 found Primulet had no effect.
IV. Oral Contra-ceptives	1	Felt worse on the pill

Tables A-3 - A-6

MATRICES OF SPEARMAN RANK CORRELATION COEFFICIENTS FOR CORRELATIONS BETWEEN HORMONES AND RATINGS OF "LACK OF WELLBEING" (PRINCIPAL COMPONENT 1), "PHYSICAL DISTRESS" (PRINCIPAL COMPONENT 3) AND "ENERGETIC AND ACTIVE" ACROSS ALL WOMEN

KEY AND EXPLANATION OF THE MATRICES

Probability of obtaining observed correlation coefficient

* $P \leq 10\%$

** $P \leq 5\%$

*** $P \leq 1\%$

Phases

EF = Early, MF = Mid, LF = Late — Follicular

EL = Early, ML = Mid, LL = Late — Luteal

C = Change in hormone level from mid to late luteal phases

Coefficients in the unshaded boxes represent correlations between hormones and ratings in the same phase

Coefficients in the shaded boxes represent correlations between hormones and ratings in the subsequent 3 phases

Coefficients in the area marked ▭ represent correlations between ratings in the premenstrual phase and hormones in the Late follicular, Early, Mid and Late Luteal phases and change in hormones before menstruation.

TABLE A-3 CORRELATIONS WITH OESTRADIOL

BEHAVIOURAL RATING

LEVELS OF OESTRADIOL

"LACK OF WELLBEING"

	EF	MF	LF	FL	ML	LL	C
EF	-·05						
MF	-·13	-·19 *					
LF	-·07	-·21 *	·04				
EL	-·02	-·17	·13	-·14			
ML		·06	·14	-·08	-·12		
LL			-·13	-·09	-·09	-·08	·03
EF				-·06	-·07	-·12	·09
MF					-·25 **	-·09	-·16
LF						·15	-·33 ***

"ENERGETIC AND ACTIVE"

	EF	MF	LF	FL	ML	LL	C
EF	·004						
MF	·09	·10					
LF	·10	·17	-·08				
EL	-·06	·17 *	-·17	·06			
ML		·01	-·34 ***	-·02	·01		
LL			-·28 **	·09	-·03	·05	-·18 *
EF				-·07	·00	·19 *	-·18 *
MF					·20 *	·13	·14
LF						-·02	·23 **

TABLE A-3 (CONTINUED)

RATING OF "PHYSICAL DISTRESS"

LEVELS OF OESTRADIOL

	EF	MF	LF	EL	ML	LL	C
EF	−·24 **						
MF	·10	·21 *					
LF	−·02	·21 *	·04				
EL	−·16	·11	−·01	−·06			
ML		−·11	−·09	−·08	·08		
LL			−·24 **	−·17	−·05	−·20 *	·02
EF				−·32 ***	−·12	−·32 ***	−·02
MF					·31 ***	·08	·27 **
LF						−·08	·42 ***

TABLE A-4 CORRELATIONS WITH PROGESTERONE AND THE RATIO OF OESTRADIOL TO PROGESTERONE

BEHAVIOURAL RATING

LEVELS OF PROGESTERONE

	EL	ML	LL	C
EL	·02			
ML	-·06	-·06		
LL	·03	·11	-·08	·29 **
EF	·07	·10	·14	-·04
MF		-·05	-·07	-·07
LF			·19 *	-·15

RATIO OF OESTRADIOL: PROGESTERONE

	EL	ML	LL	C
EL	-·13			
ML	·05	·03		
LL	-·07	-·04	·11	·16
EF	-·14	-·11	-·19 *	-·18 *
MF		-·13	·03	·14
LF			-·08	·02

"LACK OF WELLBEING"

"ENERGETIC AND ACTIVE"

	EL	ML	LL	C
EL	·33 ***			
ML	·37 ***	-·08		
LL	·28 **	-·43 ***	-·15	-·43 ***
EF	·22 **	-·15	-·12	-·07
MF		-·11	-·04	-·01
LF			·21 *	-·05

	EL	ML	LL	C
EL	-·13			
ML	-·24 **	·05		
LL	-·14	·26 **	·15	-·01
EF	-·15	·12	·22	·14
MF		·20 *	·15	·01
LF			·18 *	-·03

TABLE A-4 (CONTINUED)

RATING OF "PHYSICAL DISTRESS"

LEVELS OF PROGESTERONE

	EL	ML	LL	C
EL	·20 *			
ML	·08	-·14		
LL	-·24 **	-·19 *	-·19 *	-·21 *
EF	-·01	-·18 *	-·35 ***	-·09
MF		-·15	-·20 *	·02
LF			-·31 ***	-·29 **

RATIO OF OESTRADIOL: PROGESTERONE

	EL	ML	LL	C
EL	-·10			
ML	-·03	·17		
LL	·07	·14	·10	·06
EF	-·11	·03	-·04	·10
MF		·34 ***	·19 *	-·01
LF			·28 ***	·22 *

TABLE A-5 CORRELATIONS WITH TESTOSTERONE

BEHAVIOURAL RATING

LEVELS OF TESTOSTERONE

"LACK OF WELLBEING"

	EF	MF	LF	EL	ML	LL	C
EF	.22 *						
MF	−.04	−.08					
LF	.06	−.14	−.05				
EL	.05	−.12	−.25 *	−.03			
ML		.04	−.07	.08	.15		
LL			−.06	.07	.16	.04	.06
EF				.30 **	.29 **	.17	.17
MF					−.28 **	−.09	−.22 *
LF						−.01	−.25 **

"ENERGETIC AND ACTIVE"

	EF	MF	LF	EL	ML	LL	C
EF	.002						
MF	.07	.04					
LF	−.001	.25 **	.20 *				
EL	.08	.29 **	.22 *	.07			
ML		.25 **	.31 **	.24 *	.16		
LL			.14	.02	−.06	.08	−.17
EF				−.07	−.04	.08	−.18
MF					.35 ***	.17	.25 **
LF						.19 *	.24 **

TABLE A-5 (CONTINUED)

LEVELS OF TESTOSTERONE

RATING OF "PHYSICAL DISTRESS"

	EF	MF	LF	EL	ML	LL	C
EF	-.23 *						
MF	.07	.09					
LF	-.23 *	.01	.07				
EL	-.49 ***	-.09	-.05	-.14			
ML		.02	.003	-.12	-.07		
LL			-.08	-.05	-.06	-.06	-.09
EF				-.22 *	-.29 **	-.24 *	-.25 **
MF					.29 **	.08	-.22 *
LF						-.07	.33 ***

TABLE A-6 CORRELATIONS WITH ANDROSTENEDIONE

BEHAVIOURAL RATING

LEVELS OF ANDROSTENEDIONE

"LACK OF WELLBEING"

	EF	MF	LF	EL	ML	LL	C
EF	.21 *						
MF	.03	.002					
LF	-.07	-.21 *	.14				
EL	-.25 *	-.18	-.22 *	-.31 **			
ML		.07	-.12	-.04	-.003		
LL			-.01	-.18	.05	.04	.07
EF				.15	.07	.29 **	-.22 *
MF					-.12	.19	-.39 ***
LF						.14	-.35 ***

"ENERGETIC AND ACTIVE"

	EF	MF	LF	EL	ML	LL	C
EF	-.12						
MF	-.08	-.20 *					
LF	-.02	.08	.03				
EL	.26 **	.16	-.19 *	.21 *			
ML		-.14	-.01	-.02	.04		
LL			-.02	.08	-.03	.09	-.17
EF				-.22 *	.02	-.05	.03
MF					-.04	-.21 *	.27 **
LF						-.05	.12

TABLE A-6 (CONTINUED)

RATING OF "PHYSICAL DISTRESS"

LEVELS OF ANDROSTENEDIONE

	EF	MF	LF	EL	ML	LL	C
EF	·09						
MF	-·06	-·07					
LF	·01	-·02	-·01				
EL	·13	·04	·11	·13			
ML		·03	·02	-·03	·04		
LL			·11	·02	·21 *	·25 **	-·05
EF				-·08	·004	-·16	·15
MF					·02	-·27 **	·38 ***
LF						-·26 **	·41 ***

Tables A-7 to A-10

MATRICES OF SPEARMAN RANK CORRELATION COEFFICIENTS FOR CORRELATIONS BETWEEN HORMONES AND "SEXUAL FEELINGS", "SEXUALITY", FREQUENCY OF OF MASTURBATION, SEXUAL ACTIVITY WITH PARTNER AND ORGASM, AND RATING OF SEXUAL ACTIVITY WITH PARTNER ACROSS ALL WOMEN

KEY AND EXPLANATION OF THE MATRICES

Probability of obtaining observed correlation coefficient

* P ≤ 10%

** P ≤ 5%

*** P ≤ 1%

Phases

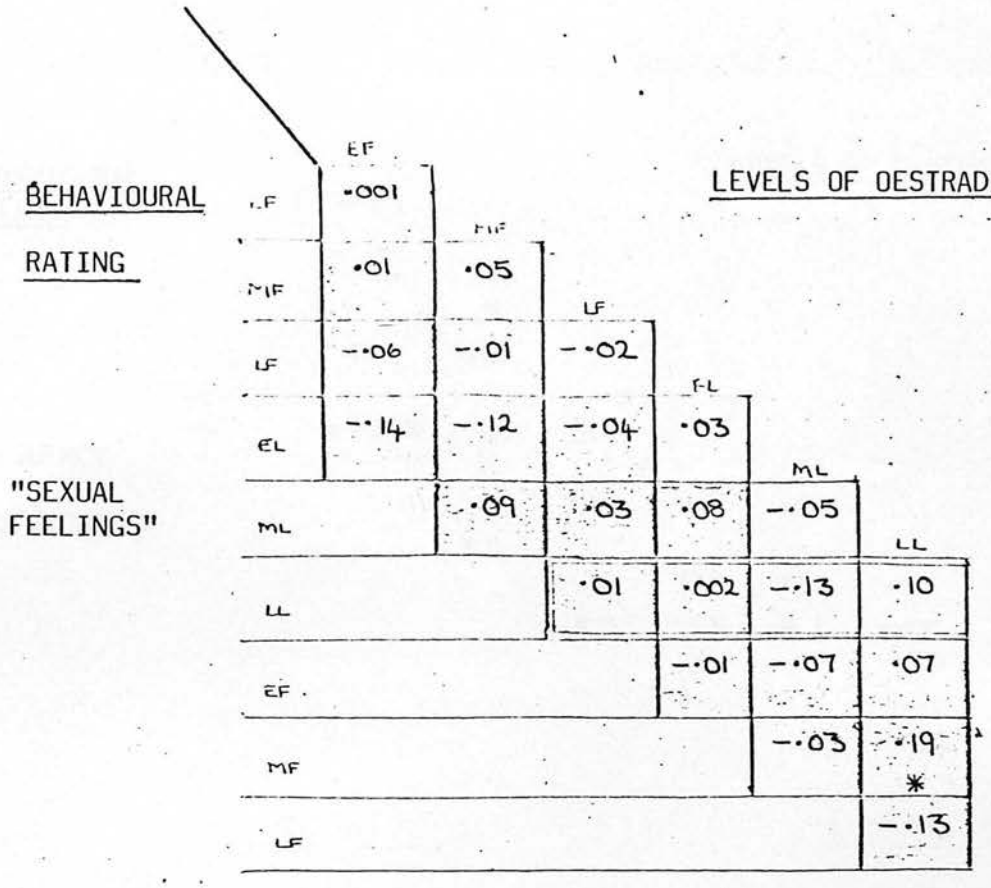
EF = Early, MF = Mid, LF = Late — Follicular

EL = Early, ML = Mid, LL = Late — Lubeal

Coefficients in the unshaded boxes represent correlations between hormones and behaviour in the same phase

Coefficients in the shaded boxes represent correlations between hormones and behaviour in the subsequent 3 phases.

TABLE A-7 CORRELATIONS WITH OESTRADIOL



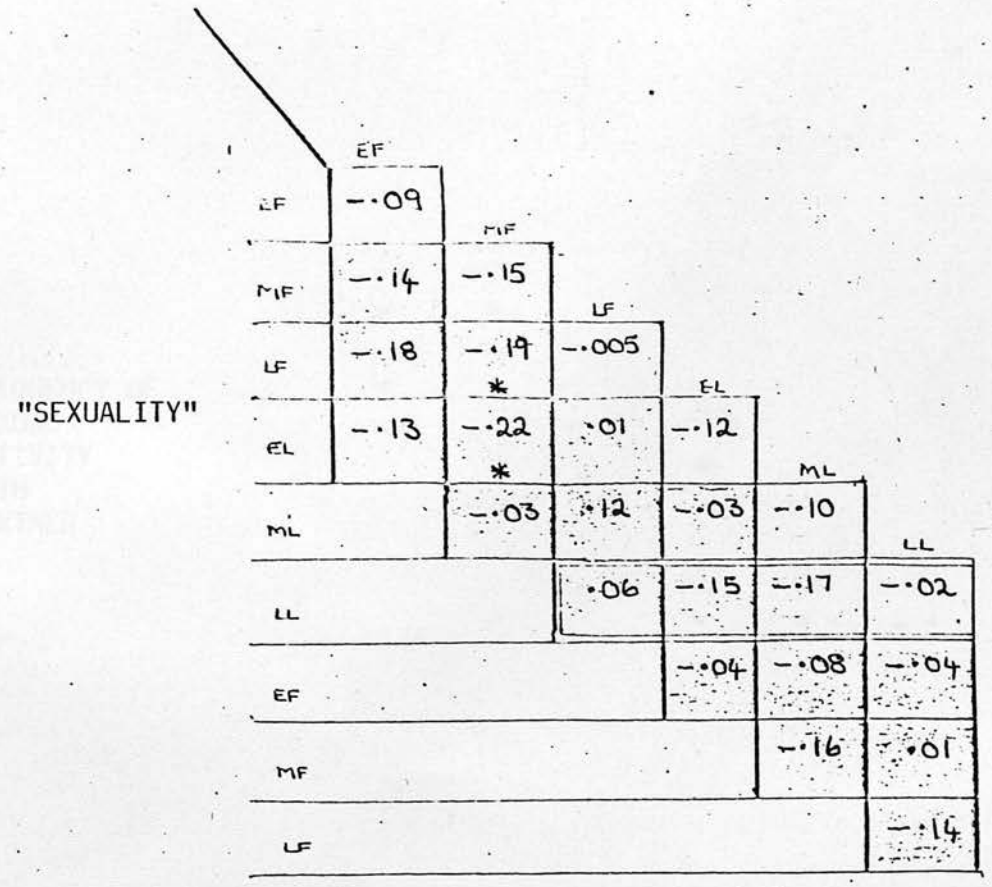


TABLE A-7 (CONTINUED)

BEHAVIOURAL RATING

LEVELS OF OESTRADIOL

FREQUENCY OF MASTURBATION

	EF	MF	LF	EL	ML	LL
LF	−·09					
MF	·16	·22 *				
LF	−·11	·10	−·05			
EL	−·002	·22 *	·006	·14		
ML		·27 **	·13	·11	·07	
LL			·29 **	·31 ***	·19 *	·38 ***
EF				·15	−·06	−·08
MF					·04	−·02
LF						−·03

FREQUENCY OF SEXUAL ACTIVITY WITH PARTNER

	EF	MF	LF	EL	ML	LL
EF	−·13					
MF	−·19 *	−·23 *				
LF	−·18 *	−·21 *	−·007			
EL	−·05	−·07	−·16	−·23 *		
ML		−·08	·01	−·05	−·11	
LL			−·11	−·21 *	−·21 *	−·26 **
EF				−·07	−·06	−·14
MF					−·06	−·07
LF						−·16

TABLE A-7 (CONTINUED)

BEHAVIOURAL RATING

LEVELS OF OESTRADIOL

RATING OF SEXUAL ACTIVITY WITH PARTNER

	EF	MF	LF	EL	ML	LL
EF	·06					
MF	·24 *	·15				
LF	·06	−·05	·13			
EL	·06	−·13	·23	−·16		
ML		−·06	·18	·24	·41 **	
LL			·33	·30 *	·40 **	·25
EF				−·11	−·16	−·38 *
MF					·002	·06
LF						−·16

FREQUENCY OF ORGASM

	EF	MF	LF	EL	ML	LL
EF	·10					
MF	−·07	−·12				
LF	−·06	−·14	−·001			
EL	·19 *	·05	−·03	−·26 **		
ML		−·03	·01	−·12	−·08	
LL			−·06	−·11	−·14	−·23 **
EF				·06	·06	−·08
MF					−·09	−·002
LF						−·08

TABLE A-8 CORRELATIONS WITH PROGESTERONE AND THE RATIO OF OESTRADIOL TO PROGESTERONE

BEHAVIOURAL RATING

"SEXUAL FEELINGS"

LEVELS OF PROGESTERONE

	EL	ML	LL
EL	-·17		
ML	·005	-·03	
LL	-·07	-·14	·03
EF	-·16	-·05	-·14
MF		-·07	-·03
LF			-·04

RATIO OF OESTRADIOL TO PROGESTERONE

	EL	ML	LL
EL	·07		
ML	-·01	·04	
LL	·02	-·01	·02
EF	·10	·02	·19 *
MF		·07	·18
LF			-·12

"SEXUALITY"

	EL	ML	LL
EL	-·45 ***		
ML	-·23 **	·006	
LL	-·33 ***	-·09	·02
EF	-·27 **	-·01	-·07
MF		·04	·08
LF			·03

	EL	ML	LL
EL	·18		
ML	-·07	-·01	
LL	·05	-·01	-·03
EF	·14	-·02	-·07
MF		-·09	-·02
LF			-·24 **

TABLE A-8 (CONTINUED)

BEHAVIOURAL RATING

LEVELS OF PROGESTERONE

	EL	ML	LL
EL	·03		
ML	−·03	·19 *	
LL	−·05	·04	·23 **
EF	·07	−·17	−·18
MF		·04	·04
LF			·01

RATIO OF OESTRADIOL: PROGESTERONE

	EL	ML	LL
EL	·03		
ML	·04	−·05	
LL	·27 **	·17	·12
EF	·05	·15	·08
MF		·05	·00
LF			·03

FREQUENCY OF MASTURBATION

FREQUENCY OF SEXUAL ACTIVITY WITH PARTNER

	EL	ML	LL
EL	−·35 ***		
ML	·08	·26 **	
LL	−·15	·02	−·02
EF	−·01	·04	−·07
MF		·28 **	·19 *
LF			·15

	EL	ML	LL
EL	·12		
ML	−·17	−·26 **	
LL	−·09	−·23 **	−·19 *
EF	−·04	−·13	−·06
MF		−·25 **	−·17
LF			−·33 ***

TABLE A-8 (CONTINUED)

BEHAVIOURAL RATING

RATING OF SEXUAL ACTIVITY WITH PARTNER

LEVELS OF PROGESTERONE

	EL	ML	LL
EL	-.16		
ML	.22	.05	
LL	-.01	-.23	.07
EF	-.41 **	-.32 *	-.49 ***
MF		-.15	-.11
LF			.13

RATIO OF OESTRADIOL: PROGESTERONE

	EL	ML	LL
EL	-.06		
ML	.18	.33 **	
LL	.22	.49 ***	.19
EF	.20	.22	.24
MF		.12	.21
LF			-.12

FREQUENCY OF ORGASM

	EL	ML	LL
EL	-.18		
ML	-.11	.16	
LL	-.18	.12	-.08
EF	.07	.08	-.09
MF		.21 *	.17
LF			.11

	EL	ML	LL
EL	-.01		
ML	-.02	-.14	
LL	-.02	-.18 *	-.01
EF	-.01	-.07	.06
MF		-.25 **	-.12
LF			-.20 *

TABLE A-9 CORRELATIONS WITH TESTOSTERONE

BEHAVIOURAL RATING

LEVELS OF TESTOSTERONE

"SEXUAL FEELINGS"

	EF	MF	LF	FL	ML	LL
EF	−.38 ***					
MF	−.21 *	−.19				
LF	−.28 **	−.23 *	−.19			
EL	−.17	−.14	−.07	−.17		
ML		−.36 ***	−.15	−.17	−.27 **	
LL			−.16	−.17	−.30 **	−.18
EF				−.32 **	−.33 ***	−.28 **
MF					−.11	−.03
LF						−.04

"SEXUALITY"

	EF	MF	LF	EL	ML	LL
EF	−.38 ***					
MF	−.13	−.01				
LF	−.14	−.19 *	−.13			
EL	−.12	−.06	−.13	−.25 **		
ML		−.26 **	−.19 *	−.27 **	−.30 **	
LL			−.22	−.19	−.21 *	−.16
EF				−.13	−.25 **	−.30 **
MF					−.15	.05
LF						−.06

TABLE A-9 (CONTINUED)

BEHAVIOURAL RATING

LEVELS OF TESTOSTERONE

FREQUENCY OF MASTURBATION

	EF	MF	LF	EL	ML	LL
LF	-.02					
MF	.23 *	.21 *				
LF	-.19	-.07	-.16			
EL	.22 *	.29 **	.32 **	.46 ***		
ML		.00	.05	.07	.08	
LL			.03	.15	.01	.10
EF				.14	.12	.10
MF					.16	.10
LF						-.09

FREQUENCY OF SEXUAL ACTIVITIES WITH PARTNER

	EF	MF	LF	EL	ML	LL
EF	-.31 **					
MF	-.31 **	-.05				
LF	+.21 *	-.13	-.12			
EL	-.03	.004	-.11	-.003		
ML		-.10	-.13	-.21 *	-.22 *	
LL			-.13	-.14	-.09	-.10
EF				-.19 *	-.16	-.19 *
MF					-.19 *	-.14
LF						.02

TABLE A-9 (CONTINUED)

BEHAVIOURAL RATING

LEVELS OF TESTOSTERONE

RATING OF SEXUAL ACTIVITIES WITH PARTNER

	EF	MF	LF	FL	ML	LL
EF	−·41 **					
MF	−·23	−·34 **				
LF	·09	·10	·02			
FL	−·25	·19	−·44 **	−·09		
ML		·09	·23	·12	·09	
LL			·04	−·04	−·03	·09
EF				−·51 **	−·43 **	−·30
MF					·02	−·03
LF						·16

FREQUENCY OF ORGASM

	EF	MF	LF	FL	ML	LL
EF	−·33 ***					
MF	−·18	−·11				
LF	−·18	−·15	−·04			
FL	−·15	−·04	·01	−·11		
ML		−·21 *	·03	−·22 *	−·14	
LL			−·14	−·19 *	−·09	−·16
EF				−·14	−·07	−·16
MF					−·01	−·01
LF						−·10

TABLE A-10 CORRELATIONS WITH ANDROSTENEDIONE

LEVELS OF ANDROSTENEDIONE

BEHAVIOURAL RATING

"SEXUAL FEELINGS"

	EF	MF	LF	EL	ML	LL
LF	−.17					
MF	−.26 *	−.15				
LF	−.38 ***	−.33 ***	−.17			
EL	−.16	−.22 *	−.11	−.07		
ML		−.28 **	−.19	−.26	−.16	
LL			−.17	.01	−.12	.04
EF				−.06	.03	−.12
MF					−.08	−.15
LF						−.13

"SEXUALITY"

	EF	MF	LF	EL	ML	LL
EF	−.02					
MF	−.12	.07				
LF	−.23 *	−.27 *	−.05			
EL	−.22 *	−.17	−.09	−.20 *		
ML		−.10	−.07	−.15	−.12	
LL			−.11	−.03	−.08	.009
EF				.08	.08	−.01
MF					.01	−.10
LF						−.08

TABLE A-10 (CONTINUED)

BEHAVIOURAL RATING

LEVELS OF ANDROSTENEDIONE

FREQUENCY OF MASTURBATION

	EF	MF	LF	FL	ML	LL
LF	.23 *					
MF	.43 ***	.38 ***				
LF	.23 *	.14	.05			
EL	.29 **	.31 **	.26 **	.26 **		
ML		−.03	−.04	.09	.05	
LL			−.06	.22 *	.06	.10
EF				.36 ***	.19 *	.16
MF					.36 ***	.29 **
LF						.37 ***

FREQUENCY OF SEXUAL ACTIVITIES WITH PARTNER

	EF	MF	LF	EL	ML	LL
EF	−.31 **					
MF	−.24 *	−.06				
LF	−.38 ***	−.24 **	−.29 **			
EL	−.19	−.04	−.19 *	−.22 *		
ML		−.12	−.29 **	−.25 *	−.29 **	
LL			−.17	−.19 *	−.31 **	−.26 *
EF				−.24 *	−.33 ***	−.49 ***
MF					−.11	−.29 **
LF						−.26 **

TABLE A-10 (CONTINUED)

BEHAVIOURAL RATING

LEVELS OF ANDROSTENEDIONE

RATING OF SEXUAL ACTIVITIES WITH PARTNER

	EF	MF	LF	EL	ML	LL
EF	−.11					
MF	−.20	−.28 *				
LF	−.04	−.30 *	−.12			
EL	.17	.14	.02	−.22		
ML		−.03	.22	.07	.13	
LL			.09	.16	.16	.29 *
EF				−.25	.17	.16
MF					−.12	−.00
LF						.12

FREQUENCY OF ORGASM

	EF	MF	LF	EL	ML	LL
EF	−.09					
MF	−.27 **	−.11				
LF	+.35 ***	−.25 **	−.32 ***			
EL	−.05	.004	.08	−.11		
ML		−.25 **	−.29 **	−.27 **	−.29 **	
LL			−.23 *	−.19 *	−.30 **	−.31 **
EF				−.07	−.22 *	−.34 ***
MF					−.18	−.23 *
LF						−.35 ***