THE MENSTRUAL CYCLE, MOTIVATION, AND PERFORMANCE

by

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Abstract

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Studies concerned with emotional changes in the week before menstruation indicate that such changes might be expected to affect performance. In addition, Broverman et al. (1968) have hypothesized that cyclical changes in estrogen would lead to cyclical changes in performance. On the other hand, psychological factors, specifically motivation, are hypothesized to influence performance and to exert a stronger effect than the menstrual cycle. The effects of the menstrual cycle and motivation on performance was studied by administering simple perceptual-motor and complex perceptual tasks to 96 Ss twice during their menstrual cycles. Two groups which differed in motivation were created through instructional sets. Data on the Ss' menstrual cycles was collected independently from performance data and related to changes in performance. Neither the menstrual

cycle nor motivation affected performance, except in interaction with other factors. There was a strong practice effect. Results are discussed in terms of an optimal level of arousal model and it is suggested that using such a model can eliminate some of the problems and biases involved in the study of the menstrual cycle and behavior.

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Finally, I would like to thank Suzanne Kessler, Over the years we have become colleagues as well as friends and I look forward to our continued collaboration.

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Menstruation and the normal cyclical changes in the female reproductive system have been, since early history, the object of myth, fear, and disgust on the part of both men and women (for a review of some of these beliefs, see Dalton, 1969). Although it is no longer believed that menstruating women will sour milk or kill plants, the menstrual cycle is still cited by some people as a reason for judging women less capable than men. A highly publicized example of this occurred in 1970, when Dr. Edgar Berman, a member of the Democratic National Committee, asserted that women are not fit to be President because of the "raging hormonal influences of the menstrual cycle" (Lydon, 1970). Dr. Berman, and others who make similar statements, support their assertions by saying that this is a well-known scientific fact.

The belief in this "fact" is widespread but, as a review of the literature will show, although much is known about the menstrual cycle and about the hormones involved, and although there is some evidence for cyclical changes in affect correlated with the menstrual cycle, there is no clear information about: 1) any causal relationship between normal, cyclical changes in hormone

levels and changes in affect or 2) whether, even if there are cyclical changes in affect (for whatever reasons), there are cyclical changes in performance correlated with changes in hormone levels during the menstrual cycle. This study is concerned with the second question.

The Physiology of the Menstrual Cycle

The menstrual cycle consists of a complex negative feedback system involving five hormones (See Figure 1). Three of these (FSH, LH and LTH) are pituitary hormones and two (estrogen and progesterone) are ovarian hormones.

The cycle begins during menstruation with the secretion of large amounts of FSH (follicle stimulating hormone) by the pituitary gland. FSH stimulates a follicle (a hollow ball of several layers of cells) in the ovary to develop futher cell layers and mature an egg cell in the center. As the level of FSH rises, it causes increasing amounts of estrogen to be secreted by some of the cells in the follicle.

As estrogen level rises, the FSH secretion is inhibited, but the secretion of two other pituitary hormones, LH and LTH, is stimulated. LH (luteinizing hormone) causes the follicle to rupture and expel the egg cell into the Fallopian tube (ovulation) and also causes the outer layers of the ruptured follicle to

develop further. The developed, ruptured follicle is known as a corpus luteum.

LTH (luteotropic hormone) is necessary for the production of progesterone by the corpus luteum. If no fertilization occurs, the rising level of progesterone inhibits LH and LTH secretion and the corpus luteum degenerates. As it degenerates, estrogen and progesterone levels decline, FSH production is stimulated, menstruation occurs and the cycle begins again. The average length of time from the first day of one menstruation to the first day of the next is 28 days.

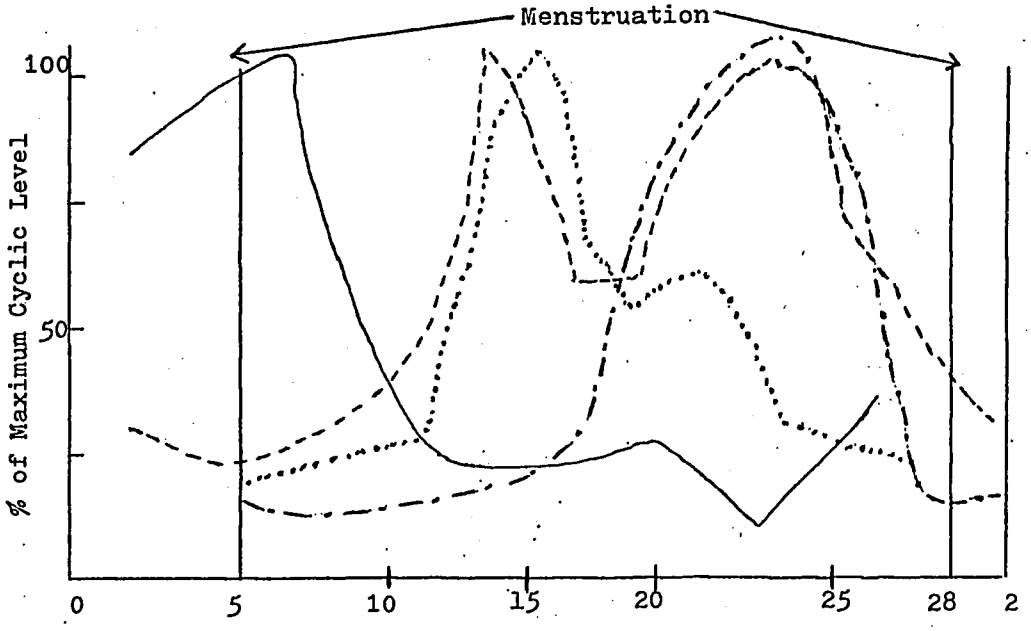
The cyclical secretions of estrogen and progesterone also cause cyclical changes in the uterine lining and cervical mucus. Menstruation is the shedding of the uterine lining as a result of the decline in estrogen and progesterone levels after ovulation, provided there is no fertilization.

The Menstrual Cycle and Affect

The ovarian hormones, estrogen and progesterone, are the hormones which are asserted to affect behavior. After ovulation, the sudden decrease in estrogen level and the increase and then decrease in progesterone level (both of which continue to decrease until menstruation) have been found to be correlated with changes in affect in a large number of studies (e.g., Benedek &

FIGURE 1

Hormones of the Menstrual Cycle



(Adapted from J. Bardwick, Psychology of Women. New York, Harper & Row, 1971, p.25)

Rubenstein, 1939; Ivey & Bardwick, 1968; Gottschalk, Kaplan, Gleser & Winget, 1962).

These studies present evidence for the psychological aspects of what Dalton (1964) has termed the "premenstrual syndrome." This syndrome occurs during the week before menstruation and sometimes continues into the first few menstrual days. It includes both psychological and physiological changes in women which are correlated with low levels of estrogen and progesterone. According to Dalton (1964), any organ of the body may be affected. Physical symptoms may range from headaches to conjunctivitis. The psychological component of the syndrome, usually referred to as "premenstrual tension," consists of such symptoms as irritability, depression, lethargy, anxiety, tension, forgetfulness, confusion, and lowered judgement. The finding that changes in some women's affect occur during the premenstruum (week before menstruation) is often used as support for such statements as that cited above by Berman.

However, there are severe methodological and conceptual problems with most of these studies. As Sutherland and Stewart (1965) point out, the only factor which these studies have in common is that whatever changes they report occur in 28 day cycles. Because over 150 different behaviors and psychological states have been associated with the menstrual cycle (Moos, 1968), it is

no surprise that, depending on how it is defined, the incidence of premenstrual tension ranges from 25% to 100% of the Ss studied (Sutherland & Stewart, 1965).

More serious than the conceptual problem of how to define premenstrual tension, however, is the fact that most of these studies can be criticized on the basis of their methodology. We will use as examples three of the most widely quoted studies, but the criticisms are applicable to most of the research in the area.

Moos (1968) and Moos, Kopell, Melges, Yalom, Lunde, Clayton and Hamburg (1969) asked a large number of women to fill out a "Menstrual Distress Questionnaire," which asked Ss about their experiences just before and during menstruation. Some of the Ss also kept a daily mood adjective check list, to determine if there were cyclical changes in affect associated with the menstrual cycle. The investigators found some evidence for cyclical changes in affect and 30% to 50% of the women reported some symptoms of premenstrual tension.

Ivey and Bardwick (1968) had 26 women talk into a tape recorder for five minutes about any life experience they wished to. Ss were measured at mid-cycle and premenstrually. Using Gottschalk et al.'s (1962) method of content analysis for anxiety and hostility, they concluded that hostility and anxiety were higher premenstrually.

Benedek and Rubenstein's (1939) pioneer study of premenstrual tension had 9 Ss. They were all patients in psychoanalysis. Benedek analyzed records of their dreams and was able to predict, on the basis of dream content, the day on which Ss ovulated. Ovulation was determined by taking daily vaginal smears from the nine women.

The most serious problem with these studies is that the Ss probably knew the purpose of the study because of the way data about their menstrual cycles was obtained. In filling out questionnaires or reporting dream content or telling stories Ss were probably aware that these data were going to be related to their menstrual cycle. Either they had to keep records of their cycle themselves (Moos) or they had to appear for the study at specific times in their cycle (Ivey & Bardwick) or daily physiological records were kept (Benedek & Rubenstein, Ivey & Bardwick).

At the very least, Ss' beliefs about the purpose of the study (Orne, 1962) and Es' expectations about the outcomes (Rosenthal, 1963) were factors. It is even possible that, (particularly in the self-report studies), knowing they were premenstrual and sharing the beliefs of many people about premenstrual tension, the women noticed more "signs" of premenstrual tension than they did when they were not premenstrual. Any retrospective

measures, such as Moos' Menstrual Distress Questionnaire are additionally suspect since Reynolds (1969) has shown that women's responses to retrospective questions about their behavior during the menstrual cycle leads to different results than when the same women keep daily logs.

Another problem with these studies is that they lack the controls which would eliminate non-biological factors and enable investigators to infer causal connections between hormone level changes and changes in affect. Few studies compare women with cyclical changes in hormone levels with women who do not experience these changes. Studies by Paige (1969) and Herzberg and Coppen (1970) showed that the degree and incidence of premenstrual tension is lower in women taking birth control pills (which maintain high levels of estrogen and progesterone throughout the cycle). These studies lend some support to causal connections between hormones and affect. However, at least one study (Silbergeld, Brast & Noble, 1971) has reported cyclical differences in affect, paralleling normal hormonal changes, in women taking birth control pills. In this study, as in most of the others, Ss were aware of the relevance of their menstrual cycles to the symptoms they were reporting.

Some studies have investigated psychological, rather than biological, factors in premenstrual tension. Paulson

(1961) found that Ss reported the same level of premenstrual tension for their mothers as for themselves. The contribution of psychological factors was studied more directly by Beck (1971). She found that women who believed that there is such a thing as premenstrual tension are more likely to exhibit symptoms of the syndrome.

From the evidence we have, it seems that a social learning explanation of premenstrual tension is as tenable as a biological one. The social learning explanation would be of the following form: Some women expect to behave and are permitted to behave "badly" premenstrually and they may even be reinforced for such behavior. (It is interesting to note here that premenstrual tension serves as a legal defense in France (Dalton, 1964).) Women not taking birth control pills may be more aware of and concerned about what phase of the menstrual cycle they are in. Awareness of being premenstrual then might serve as a discriminative stimulus for feeling depressed, anxious, etc.

To summarize, there is evidence that some women, for whatever reasons, undergo cyclical changes in affect correlated with the menstrual cycle. It would seem possible then, that these changes might affect performance.

The Menstrual Cycle and Performance

It is odd that although one often hears comments similar to Berman's that women are not good risks for positions of responsibility and power because of uncontrollable, erratic emotions, few studies have been done to actually assess the effects of these "erratic" emotions on performance.

Dalton (1964) reports that during the premenstruum more women than would be expected to by chance are (1) admitted into mental hospitals, (2) treated for accidents, (3) arrested for crimes, and (4) punished for rule infractions. However, the reasons for these phenomena are not delineated nor are the circumstances under which they take place made clear. Even if the correlations are sound, the causal relationship between the variables is unknown (e.g., perhaps being in an accident affects the menstrual cycle).

Broverman and his colleagues (Broverman, Klaiber, Kobayashi & Vogel, 1968; Klaiber, Broverman, Vogel & Kobayashi, 1972) have hypothesized about the effects of the menstrual cycle on specific types of performance. Many studies have shown that performance on certain types of tasks is related to the sex of the subject (Broverman et al., 1968). Specifically, women tend to do better than men on tasks which involve simple perceptual-motor

associations and which are evaluated in terms of speed and accuracy (e.g., Digit-Symbol subtest of the WAIS). Men tend to do better than women on tasks which involve the ability to ignore extraneous stimuli (e.g., Embedded Figures Test, Rod and Frame Test).

In their review of these studies, Broverman et al. (1968) hypothesize that a possible reason for this sex difference is that estrogen levels influence central nervous system excitation. The specific mechanism for this, proposed by Klaiber et al. (1972), is through the effects of estrogen on plasma Monoamine Oxidase (MAO), a blood enzyme.

High levels of MAO would facilitate performance on complex perceptual tasks like the Embedded Figures Test (EFT) by inhibiting excitatory (adrenergic) neurotransmitters, thus increasing the ability to inhibit responses to extraneous stimuli. However, high levels of MAO would interfere with the central nervous system excitation necessary to perform well on simple perceptual motor skills. The opposite would be true for low levels of MAO. MAO is connected to the menstrual cycle because levels of estrogen are inversely related to levels of MAO.

Therefore, one would expect women to do better on simple perceptual-motor skills postmenstrually, when level of estrogen is higher, level of MAO is lower

and CNS excitation is higher, than premenstrually. Conversely, one would expect women to do better on complex perceptual tasks premenstrually, when level of estrogen is lower, level of MAO is higher, and CNS excitation is lower, than postmenstrually.

Klaiber et al. (1972) administered the Rod and Frame Test to 6 women daily throughout one or two menstrual cycles. They found that performance was correlated with the menstrual cycle. Judgement of the vertical axis was tilted towards extraneous stimuli (body, rod and frame) when estrogen level was high and away from extraneous stimuli when estrogen level was low. There is, however, no evidence that their Ss were better at judging the true vertical when they were premenstrual than when they were postmenstrual.

In a study designed to test the Broverman, et al. (1968) hypothesis, Anderson (1972), using 48 Ss, administered a battery of simple (e.g. WAIS Digit-Symbol subtest) and complex (e.g. Embedded Figures Test) tasks to Ss three times during their menstrual cycle. Estrogen level was measured through urine specimens. Although estrogen level and phase of cycle were related to task performance, her results failed to support the Broverman hypothesis, since, overall, performance on both types of tasks tended to be better when Ss were premenstrual.

In contrast, an early study of a small number of women (Hollingworth, 1914) concluded that on measures of sensory-motor and associational processes (e.g. motor fatigue, controlled word association) there was "no periodic mental or motor inefficiency in normal women; the variability of performance is not affected by phsyiological periodicity" (p. 94). Wickham (1958) found no effect of the menstrual cycle on aptitude test performance.

More recently, Sommer (1972a; 1972b) studied the relationship between the menstrual cycle and intellectual and perceptual-motor performance by administering the Watson-Glaser Critical Thinking Appraisal and the Repetitive Psychometric Measures to Ss 4 to 7 times during their menstrual cycle. Some of the tasks she used were of the types related to the Broverman et al. (1968) hypothesis. She concludes that "there is no good evidence of menstrual cycle related cognitive change in the intellectual sphere--(or)--perceptual-motor area." (Sommer, 1972a, p. 15)

Zimmerman and Parlee (1973) tested their Ss four times during their menstrual cycles on six different types of tasks. Arm-hand steadiness was greater when Ss were postmenstrual than premenstrual. However, there was no effect of the menstrual cycle on GSR to auditory stimuli, simple and choice reaction time, time

estimation, or performance on the Digit-Symbol subtest of the WAIS.

In summary, then, although most of the evidence points to little effect of the menstrual cycle on performance, there are studies where some effect has been found. Clearly, further research is needed.

Motivation and Performance

In most of the generalized statements about the effects of the menstrual cycle on performance, the probability that additional factors besides hormone level determine how well a woman will perform is neglected. One of the most important of these factors, particularly in terms of its practical implications, is the woman's attitude towards the task she is performing. Intuititvely, it seems probable that if it is important to someone that they do well on a task they will behave differently from someone who does not care how well she does, and her performance will differ as a result.

Importance of the task is a variable which has been manipulated in many studies of the effects of motivation on performance (Young, 1961). The importance of the task has been varied in a number of ways, including offering a reward for high performance (Atkinson, 1958), saying that the tasks measure some important trait such as

intelligence (McClelland, Atkinson, Clark & Lowell, 1953), and praising the Ss for good performance (Young, 1936). In general, these techniques manipulate the importance of doing well by making good performance central to some aspect of the self (i.e., by being ego-involving). The more central that aspect of the self is, the more important it is to do well (Cofer & Appley, 1964). The manipulation of importance when women are Ss has special problems. There is some evidence (Horner, 1970) that importance instructions which stress competitiveness (e.g., saying that the task is an intelligence test) can interfere with performance for some women. To eliminate this possibility one would need instructions which would make it important to the S that she do well without arousing interfering motives. Such instructions might emphasize the reward value of good performance for a group the S was a member of and de-emphasize individual performance.

In discussing problems related to making specific predictions about the effects of this type of motivation on performance, Cofer and Appley (1964) point out that "so little is usually known about the properties of the task and the processes involved in it, that it is often moot as to whether motive arousal will facilitate, inhibit or have no effect on performance." (p. 802). Although it is probable that motivation is at least

as much a factor in determining women's performance, it is clear that we need further research in order to be able to specify how the arousal of motivation through manipulating the importance of doing well affects performance and how it might interact with any effects of the menstrual cycle.

Purpose of This Study

The question that remains, and which this research is an attempt to answer, is: does the menstrual cycle affect performance and, if it does, how does its contribution compare to that of non-biological factors like motivation? No other study of the menstrual cycle and performance has manipulated both biological and psychological factors. It is clear, however, that there is a need to know the relative contribution of each of these types of factors to performance in order to assess the importance of the menstrual cycle.

In addition, previous studies of the effects of the menstrual cycle on affect or performance have collected data on Ss' menstrual cycles in such a way that Ss were probably aware of the purposes of the study. Even when data on the menstrual cycle is physiological, Ss probably make good guesses as to what type of data is being extracted from the specimens. In order to prevent bias or confounding, menstrual cycle data must

be collected totally independently from performance data.

This research is designed to answer questions about the contribution of biological and psychological factors to performance when Ss are unaware that either is being studied. Although many types of performance could (and should) be studied (e.g. decision making), simple and complex perceptual tasks were chosen as performance measures in order to test the Broverman et al. (1968) hypothesis and because most previous studies of performance (Anderson, 1972; Sommer, 1972a, 1972b; Zimmerman and Parlee, 1973) have used these types of tasks.

Hypotheses

To summarize, the purpose of this study is to assess the effects of cyclicity and motivation on simple perceptual-motor and complex perceptual tasks when Ss are not aware that their menstrual cycles are being studied. The hypotheses concerning the effects of the two independent variables on the two dependent variables are made cautiously, considering the small number of previous studies.

Hypothesis 1: Given previous studies which indicate little effect of the menstrual cycle on performance, presence or absence of motivation to do well

will contribute more to the overall variance than whether a woman is premenstrual or postmenstrual.

Hypothesis 2: If Broverman et al.'s (1968) hypothesis is correct, then

A: Women will do better postmenstrually than premenstrually on a simple perceptual-motor task, and

B: Women will do better premenstrually than postmenstrually on a complex perceptual task.

Hypothesis 3: Since the type of instructions being used are meant to minimize motives which might interfere with performance, and since performance can be facilitated when motivation to do well is high (c.f. Young, 1936), performance will be better when motivation to do well is high than when motivation to do well is low.

Hypothesis 4: Since motivation is being asserted to have a stronger effect on performance than the menstrual cycle (Hypothesis 1), if there is an effect of the menstrual cycle on performance it will be more pronounced in the low motivation condition than in the high motivation condition. That is, the difference between pre- and postmenstrual scores in the high motivation condition will be smaller than the difference between pre- and postmenstrual scores in the low motivation condition.

METHOD

Subjects

Ss were female students in 21 introductory psychology classes at Hunter College. Although only data from women with normal menstrual cycles was analyzed, it was collected from all students in each class in order to prevent Ss from knowing that the menstrual cycle was being studied.

Most of the classes had a few male students, rarely more than three or four out of an average of twenty students. In order to further disguise the purposes of the study data was collected from the men on all occasions, including the "Biorhythms Questionnaire" (see Appendix A), which had a separate section for them to fill out. The male students' data was eliminated for the purposes of this study.

Measurement and Manipulation of the Independent Variables

The menstrual cycle: Ss were measured twice during their menstrual cycles, once when their estrogen levels were high (postmenstrual) and once when their estrogen levels were low (premenstrual). In order to maximize the likelihood that their hormone levels would be at the extremes, performance measures were taken two weeks apart.

Information about the Ss' menstrual cycles was obtained from a "Biorhythms Questionnaire" (see Appendix A). Although a large number of questions were asked in order to disguise the purpose of the questionnaire, the critical questions were the dates of the S's last and next menstruation and the length of her menstrual cycle.

Motivation: Before the data was collected, classes were assigned to one of two motivational conditions using a random numbers table. These two conditions were designated "High motivation" and "Low motivation," referring to the level of motivation to do well which the instructions were expected to instill in the Ss. Depending upon which condition the class had been assigned to, one of the following sets of instructions was given:

> High motivation condition: My name is Wendy McKenna, and before I begin I'd like to tell you something about the research I'm doing. About 20 years ago an extensive study was done on sex differences in cognitive abilities. It was discovered that there are certain tasks on which men always perform better than women. It was also found that doing well on these tasks was related to doing well in job positions which require making decisions and having authority, and these sex differences in performance on these tasks have been frequently cited as reasons why women should not be in important jobs.
>
> However, 20 years have passed since that study. It seems to me that since that time there have been many changes, for example, more education for women and somewhat more equal

expectations, and it is quite likely that these differences don't exist any more and that women, too, will do well on these tasks. If that is so, then this earlier report can't be used any longer as reason to deny women equal opportunities.

My research involves trying to show that these differences no longer exist and that women's scores are as stable as mens'. To show stability, I am going to give these tasks to you twice, once now and again in a few weeks.

Now let me distribute the tasks. Please fill out the cover sheet and wait for further instructions.

Low motivation condition: My name is Wendy McKenna and before I begin I'd like to tell you about the research I'm doing. What I'm doing is studying whether certain tasks are reliable, that is, whether each time people do them they get about the same scores. So I'll be giving these tasks to you twice, once now and again in a few weeks.

Now let me distribute the tasks. Please fill out the cover sheet and wait for further instructions.

These two sets of instructions were pretested by administering them to two different groups and asking Ss: 1) "Is it important to you that you do well on these tasks? Yes___ No___" and 2) "How important is it to you that you do well on these tasks?" The second question was answered by placing a mark on a line whose extremes were "Extremely important" and "I couldn't care less." Both a chi-square test of answers to the first question ($X^2=11.12$, $p < .01$; see Table 1) and a Mann-Whitney U of the answers to the second question ($U=260.5$, $p < .01$) were significant, indicating that it was more important to Ss who received the high motivation instructions to do well than it was to Ss who received the low motivation instructions.

TABLE 1

Chi-Square For Pretest Of Instructions

Ss' Answers*	Instructions** H	Instructions** L
Yes	23	18
No	6	31

$X^2 = 11.12$
$p < .01$

* Question: Is it important to you that you do well on these tasks?

**
H = high motivation instructions
L = low motivation instructions

Dependent Variables

Simple perceptual-motor and complex perceptual skills were measured by two different tasks. A description of each task follows and copies may be found in the appropriate appendices.

Finding A's: (See Appendix B) This test is one of 74 in the Kit of Reference Tests for Cognitive Factors published by Educational Testing Service, Inc. The purpose of the Kit is to provide researchers with easily administered tests which measure 24 different cognitive factors.

"Finding A's" is part of the factor "perceptual speed" (French, Ekstrom & Price, 1963). It tests performance on a simple perceptual-motor skill, crossing out words with the letter "A" in them. This type of perceptual-motor response is one on which women tend to do better than men (Broverman, et al., 1968). It has two equivalent forms and is scored by counting the number of words with "A" in them crossed out in two minutes.

"Finding A's" will be referred to as ST (for "simple task").

Hidden Figures: (See Appendix C) This, too, is one of the tests in the Kit of Reference Tests for Cognitive Factors and is part of the factor "flexibility

of closure" (French, et al., 1963). It is a group form of the Embedded Figures Test and measures the ability to ignore extraneous stimuli, the kind of task on which men tend to do better than women (Broverman, et al., 1968). It consists of two equivalent forms and is scored by counting the number of simple figures correctly identified as being embedded in more complex figures in ten minutes.

"Hidden Figures" will be referred to as CT (for "complex task").

Procedure

The data was collected from each class in three stages:

Part I

The experimenter, after prearrangements with the class instructor, entered the classroom and was introduced as "Wendy McKenna, who is doing some research and would like your help." The experimenter then read the appropriate instructions to the class. Her manner in the high motivation condition attempted to convey the impression that this was serious research, while in the low motivation condition she acted more casually (e.g., in terms of dress, delivery, etc.).

Tasks were then distributed to all students in the class. To check on the effectiveness of the instructions

and to make motivation more salient to the Ss, the questions "Is it important to you that you do well on these tasks?" and "How important is it to you that you do well on these tasks?" were asked on the cover sheet of the tests. In addition, the cover sheet asked for data about the Ss which could later be used to match the information collected in the three separate parts of the study. (See Appendix D for cover sheet)

After the cover sheets were filled out, E instructed Ss to turn the page and read the instructions for the first task while E read them out loud. E then timed the first task. After the first task had been completed, the second was administered in the same way.

Following administration, the tasks were collected by E, the class was thanked and told "See you again in a few weeks."

Part II

In each class, instructors distributed the "Biorhythms Questionnaire" (see Appendix A) to the students about a week after Part I took place. The questionnaire was not connected to E or to Part I in any way, since it was critical that information about Ss' menstrual cycles be collected independently from the rest of the data.

Part III

Part III, which took place two weeks after Part I, was essentially a replication of Part I. Ss were told: "Let me remind you again about the study I'm doing" and were given the same instructions they had been given in Part I. They then filled out another cover sheet and the two tasks were administered.

When the tasks had been collected Ss were debriefed by E, told about the connection between the tasks and the "Biorhythms Questionnaire" and any questions they had were answered.

Experimental Design and Selection of Subjects

In addition to the primary independent variables, motivation and menstrual cycle, four order effects had to be controlled for. The experimental design controlled for these order effects by insuring that Ss were equally represented in each condition (see Table 2).

There were two different tasks, simple perceptual-motor (ST) and complex perceptual (CT). Half of the classes took the simple task before the complex one on both administrations. For the other half of the classes the order was reversed, CT before ST on both administrations.

In addition, each dependent variable had two forms (1 and 2) and the order of the administration of the two

forms had to be controlled for. There were four combinations of the forms for the classes which received the simple task first (ST_1CT_1 on Part I then ST_2CT_2 on Part III; ST_1CT_2 then ST_2CT_1; ST_2CT_1 then ST_1CT_2; ST_2CT_2 then ST_1CT_1) and an analagous four combinations for the classes which received the complex task first (CT_1ST_1 then CT_2ST_2; CT_1ST_2 then CT_2ST_1; CT_2ST_1 then CT_1ST_2; CT_2ST_2 then CT_1ST_1). Thus, for order of task and order of form there were eight different conditions.

Finally, each order condition had to be used in both the high and low motivation condition, leading to a final total of 16 different experimental conditions, and thus the necessity of using at least 16 different classes.

The fourth effect which needed to be controlled for was the time in the menstrual cycle when Parts I and III were administered to the Ss. In order that cycle effect not be confounded with any practice effects, half of the Ss had to be premenstrual on the first administration and postmenstrual on the second administration and half had to be postmenstrual on the first administration and premenstrual on the second. This made a grand total of 32 conditions. It was not possible to know, before all the data was collected, what part of the menstrual cycle Ss were in when they took the tests. However, this information was crucial in the final

TABLE 2

Experimental Design*

Order of form ***	SC ** Order of Dependent Variables				CS			
	ST_1CT_1/ST_2CT_2	ST_1CT_2/ST_2CT_1	ST_2CT_1/ST_1CT_2	ST_2CT_2/ST_1CT_1	CT_1ST_1/CT_2ST_2	CT_1ST_2/CT_2ST_1	CT_2ST_1/CT_1ST_2	CT_2ST_2/CT_1ST_1
High Motivation								
Order of menstrual cycle:								
Premenstrual/Postmenstrual	3	3	3	3	3	3	3	3
Postmenstrual/Premenstrual	3	3	3	3	3	3	3	3
Low Motivation								
Order of menstrual cycle:								
Premenstrual/Postmenstrual	3	3	3	3	3	3	3	3
Postmenstrual/Premenstrual	3	3	3	3	3	3	3	3

*Three subjects in each cell, each subject measured twice

** SC= Simple task first CS= Complex task first

*** ST_1=Simple task, form 1 CT_1=Complex task, form 1

ST_2=Simple task, form 2 CT_2=Complex task, form 2

selection of Ss.

Because information about the menstrual cycles of the women in the classes was separated from the rest of the data until the study was completed, it was impossible to identify the Ss before the tasks were administered. Therefore, the final 96 Ss were selected out of a total of about 400 people to whom the tasks were administered.

When all the data had been collected from all the classes, the three parts were matched by date of birth for each female student. Anyone with missing data was discarded. For each potentially usable S, the dates of her last and next menstruation and the length of her menstrual cycle were coordinated with the two dates on which she had taken the tests. For each administration Ss were classified as premenstrual (day 20 or higher of her cycle, counting the first day of her last period as Day 1), menstrual (Days 1-8), or postmenstrual (Days 9-19). Ss who were taking birth control pills were eliminated from the sample. The number of women on the pill was so small (N=27), and they were so unevenly distributed among the conditions, that this subsample did not seem adequate for any sort of comparison and it was eliminated from further analysis.

The final pool from which Ss were drawn was from those women who were either premenstrual on Part I and

postmenstrual on Part III or postmenstrual on Part I and premenstrual on Part III. Given the number of Ss in each of the 16 classes who fit these specifications, it was decided to have 3 Ss in each of the 32 cells. Some cells contained more than that number. In order to have equal n's, Ss were chosen on the basis of "best fit" to the premenstrual and postmenstural categories. A few cells initially contained less than three Ss, which necessitated the running of five additional classes.

Independent Variables: Summary

The design and subsequent analysis involved the following seven independent variables as well as the interactions among them.

Motivation to do well (M) This factor had two levels, high motivation (M_1) and low motivation (M_2). These two conditions were obtained through the use of different instructional sets. This was a between Ss factor.

Menstrual cycle (Cy): This factor had two levels, premenstrual (Cy_1) and postmenstrual (Cy_2). It was measured through the "Biorhythms Questionnaire" and was both a between Ss and within Ss factor.

Practice (P): This factor had two levels, first administration (Ad_1) and second administration (Ad_2).

It was both a between Ss and within Ss factor.

Order of the dependent variables (OT): This factor had two levels, simple task before complex (SC) and complex task before simple (CS). It was a between Ss factor.

Order of form of the simple task (OS): This factor had two levels, form 1 on the first administration and form 2 on the second administration (OS_1) and form 2 on the first administration and form 1 on the second (OS_2). This factor was between Ss.

Order of form of the complex task (OC): This factor had two levels, form 1 on the first administration and form 2 on the second administration (OC_1) and form 2 on the first administration and form 1 on the second administration (OC_2). It was a between Ss factor.

Order of the menstrual cycle (OCy): This factor had two levels, premenstrual on the first administration and postmenstrual on the second administration (OCy_1) and postmenstrual on the first administration and premenstrual on the second (OCy_2). This factor was between Ss.

RESULTS

Success of Instructional Set

The success of the instructional set manipulation, aimed at producing two distinct levels of motivation to do well, was assessed by the use of two questions which were answered by Ss at each administration of the tasks. The questions were: 1) Is it important to you that you do well on these tasks? (Yes___ No___) and 2) How important is it to you that you do well on these tasks? As indicated previously, Ss answered this question by placing a mark on a line whose extremes were labeled "Extremely important" and "I couldn't care less."

Since the analysis of the data involves comparisons of pre- and postmenstrual scores and of first and second administration scores, results will be reported for both analyses of the two questions.

Analysis of answers: premenstrual and postmenstrual

Question 1: Two chi-squares (see Table 3) were calculated to compare Ss who answered "Yes" and "No" in the high motivation (M_1) condition with Ss who answered "Yes" and "No" in the low motivation (M_2) condition. The first chi-square was for testing the answers Ss gave when they were premenstrual and the second was for testing the answers they gave when they were postmenstrual.

TABLE 3

Chi-Squares for Instructional Set

Premenstrual

**Yes	* H	L
	30	19
No	15	29

$X^2=5.79$
$p < .02$

Postmenstrual

Yes	H	L
	37	17
No	11	30

$X^2=14.58$
$p < .01$

First Administration

Yes	H	L
	37	23
No	9	25

$X^2=9.39$
$p < .01$

Second Administration

	H	L
	30	13
	17	34

$X^2 =10.97$
$p < .01$

* H = high motivation instructions
L = low motivation instructions

** Ss' answers to the question: Is it important to you that you do well on these tasks?

Both the premenstrual (x^2 = 5.79, df=1, $p < .02$) and the postmenstrual (x^2 = 14.58, df=1, $p < .01$) analyses of this question reached significance. Ss in the M_1 condition answered "Yes" more often than Ss in the M_2 condition, and Ss in the M_2 condition answered "No" more often than Ss in the M_1 condition.

Question 2: Answers to the second question were scored by measuring, in centimeters, the distance of the mark Ss made from the beginning of the line. Scores ranged from 0 (extremely important) to 13 (I couldn't care less). Two t tests were calculated to compare the means of the Ss in the M_1 and M_2 conditions when they were premenstrual ($\bar{X}_{M_2} - \bar{X}_{M_1} = 1.55$, $t = 2.33$, df=80, $p < .05$) and when they were postmenstrual ($\bar{X}_{M_2} - \bar{X}_{M_1} = 2.25$, $t=3.56$, df=87, $p < .01$). Both differences were significant. Ss in the M_1 condition said that it was more important for them to do well than Ss in the M_2 condition.

It is clear from these results that the instructions affected Ss answers to the two questions both when they were premenstrual and when they were postmenstrual. The significance of all four tests lends confidence to the conclusion that the instructions induced different levels of motivation to do well between the two groups.

Analysis of answers, first and second administration

Question 1: Chi-squares (see Table 3) calculated for both the first administration ($x^2=9.39$, df=1, $p < .01$) and the second administration ($x^2=10.97$, df=1, $p < .01$) were significant. However, examination of the pattern of responses for the first administration indicates that although most Ss in the M_1 condition answered "Yes" to the question, about the same number of Ss in the M_2 condition answered "Yes" as answered "No." On the second administration Ss were more likely to answer "Yes" in the M_1 condition and "No" in the M_2 condition.

Question 2: For both the first administration ($\bar{X}_{M_2} - \bar{X}_{M_1} = 1.75$, $t=2.73$, df=81, $p < .01$) and the second administration ($\bar{X}_{M_2} - \bar{X}_{M_1} = 2.04$, $t=3.22$, df=86, $p < .01$) answers to the question were significantly different in the two motivation conditions. It was more important to Ss in the M_1 condition that they do well than it was to Ss in the M_2 condition.

Taken as a whole, these results indicate that the instructions affected Ss answers to the two questions on both the first and second administration of the tasks, and that there were differences in level of motivation to do well between the two motivation conditions.

Given the overall significance of the differences between the high motivation and low motivation conditions, it was decided to proceed with the analysis of the data using instructional condition as an experimentally induced independent variable. However, since the differences were not large, it was also decided to do a separate analysis using Ss answers to the two questions, regardless of the experimental condition to which S had been assigned. This analysis treats motivation as a subject, rather than an experimental, variable.

Correlation between the dependent variables

Because there were two dependent variables, before the analysis could proceed it was necessary to determine whether there was a relationship between scores on the simple task and scores on the complex task. Since the tasks were measuring what were supposed to be independent cognitive factors (French, et al., 1963; French, 1951), it was expected that each dependent variable could be analyzed separately in a univariate analysis of variance.

The correlations between the scores were calculated separately for the four major conditions (see Table 4). All four of the correlations were converted to z's and tested for significance. In addition, a $z_{average}$ was

TABLE 4

Correlations Between The Dependent Variables

	Premenstrual	Postmenstrual
High motivation instructions	.45	.39
Low motivation instructions	.33	.37

$Z_{average}=.407$

$r_{average}=.38$

$p < .01$

computed and tested for significance ($z_{average}$=.407; r=.38). All of the correlations were significant beyond the .01 level. It was clear that scores on the two tasks were not independent of each other and that the appropriate analysis would be a multivariate analysis of variance. A discussion of this unexpected relationship is deferred until the discussion section of this paper.

Statistical Analysis

The multivariate analyses of variance (MANOVA's) were run on an IBM 360, using the program developed by Clyde (1969). Both pre- and postmenstrual scores and first and second administration scores on the two dependent variables were treated as two sets of four dependent variables (i.e., preST, postST, preCT, postCT and Ad_1ST, Ad_2ST, Ad_1CT, Ad_2CT). Because each set was a different organization of the same scores, one MANOVA was done using pre- and postmenstrual scores and a second was done using first and second administration scores.

In order to determine the main effects of menstrual cycle and practice, analyses of variance (ANOVA's) were run on an IBM 360, using the STPAC program (Verity, et al., undated). Since the MANOVA's showed that none of the main effects of order of the form of the simple

task, order of the form of the complex task or order of the dependent variables were significant, it was decided to eliminate these as factors in further analyses, thus making them part of the error term. ANOVA's with motivation (M), order of the menstrual cycle (OCy) and menstrual cycle (Cy) as factors were run separately for the simple task scores and complex task scores. ANOVA's with M, OCy, and practice (P) were run separately for simple task scores and complex task scores.

Finally, MANOVA's using M and OCy as factors and ANOVA's as described above using M,OCy and Cy and M, OCy and P as factors were calculated for the subsample of Ss who answered either "Yes" or "No" both times to the question "Is it important to you that you do well on these tasks?", regardless of the motivational condition to which they had been assigned.

Results of Analysis

Complete summary tables of the MANOVA's will be found in Appendix E. Means will be found at the end of this section in Tables 21 and 22 and should be referred to throughout the discussion of the results. This discussion will summarize the main effects and the significant interactions, first for the simple task, then for the complex task, and finally for the two tasks using the subsample of Ss who answered "Yes" both times or

"No" both times to Question 1.

Simple Task

Main effects: The only factor which affected the Ss' scores was practice (Table 8). Ss did significantly better the second time they took the test. Neither the menstrual cycle (Table 7) nor motivation (Tables 5-8) affected the Ss' performance.

Interactions

The menstrual cycle and practice (Tables 5, 7; Figure 2); Ss who were premenstrual on the first administration did not perform differently from Ss who were premenstrual on the second administration. However, Ss who were postmenstrual on the second administration did significantly better than Ss who were postmenstrual on the first administration.

Form of complex task, practice and the menstrual cycle (Table 5; Figure 3):

For premenstrual Ss, getting form CT_1 led to higher scores on the simple task than getting form CT_2. This effect was stronger than practice, since Ss who got form CT_1 on the first administration did better than Ss who got form CT_2 on the second administration. There was no interaction on these factors for postmenstrual Ss.

Motivation, form of simple task and form of complex task (Tables 5, 6; Figure 4):

Under the low motivation instructions, Ss did better with different forms of the dependent variables (e.g. ST_1CT_2) than they did with the same forms. Under high motivation they scored highest when they got CT_2 on the first administration and CT_1 on the second, regardless of the form of ST. However, there was a tendency to do better on the same forms of CT and ST than on different forms. (They did best with CT_2CT_1, ST_1ST_2 (different forms), next best on CT_2CT_1, ST_2ST_1 (same forms), than on CT_2CT_1, ST_2ST_1 (same forms), and worst on CT_1CT_2, ST_2ST_1 (different forms).)

Motivation, form of simple task, practice and the menstrual cycle (Tables 5, 6; Figure 5)

In the high motivation condition, when Ss are measured in the order postmenstrual/premenstrual, they score higher if the order of form of ST is ST_1ST_2. When they are measured in the order premenstrual/postmenstrual they score higher if the order of form of ST is ST_2ST_1. Thus, for the high motivation condition, it is better to get ST_2 premenstrually and ST_1 postmenstrually.

In the low motivation condition, when Ss are measured in the order postmenstrual/premenstrual, they do better if the order of the form of ST is ST_2ST_1. When they are measured in the order premenstrual/postmenstrual,

they do best if the order of form of ST is ST_1ST_2. Thus, for the low motivation condition, it is better to get ST_1 premenstrually and ST_2 postmenstrually.

For premenstrual Ss, the effect of form is stronger than the effect of practice. That is, Ss taking the preferred form (e.g., ST_2 for high motivation) always do better than Ss taking the less preferred form (e.g., ST_1 for high motivation), regardless of whether it is the first or second time they are taking the task.

For postmenstrual Ss, the effect of practice is stronger than the effect of form. That is, Ss who are postmenstrual on the second administration always do better than Ss who are postmenstrual on the first administration, regardless of what form they are taking.

TABLE 5

Simple Task, Results for Factors Significant in MANOVA

Premenstrual

Source	SS	MS	F(1,64)	P less than
OCy	213.013	213.013	2.335	.131
OCy(OC)	509.748	508.748	5.578	.021*
M(OS)(OC)	822.487	822.487	0.018	.004**
M(OS)(OCy)	894.255	894.255	9.805	.003**

Postmenstrual

Source	SS	MS	F(1,64)	P less than
OCy	1464.820	1464.820	15.897	.001***
OCy(OC)	68.342	68.342	.742	.392
M(OX)(OC)	635.500	635.500	6.897	.011*
M(OS)(OCy)	499.590	499.590	5.422	.023*

Key:

OCy: Order of the menstrual cycle
OC: Order of form of complex task
OS: Order of form of simple task
M: Motivation to do well

TABLE 6

Simple Task, Results for Factors

Significant in MANOVA

First Administration

Source	SS	MS	F(1,64)	P Less Than
M(OS)(OC)	759.363	759.363	9.966	.002**
M(OS)(OCy)	782.038	782.038	10.263	.002**

Source	SS	MS	F(1,64)	P Less Than
M(OS)(OC)	709.578	709.578	6.628	.012*
M(OS)(OCy)	605.005	605.005	5.651	.020*

Key:

M: Motivation to do well
OS: Order of form of the simple task
OC: Order of form of the complex task
OCy: Order of the menstrual cycle

TABLE 7

Analysis of Variance, Simple Task

Source*	SS	MS	F(1,92)
Between Ss			
M	1.021	1.021	.006
OCy	280.333	280.333	1.575
M(OCy)	243.000	243.000	1.365
Error	16373.1	177.969	
Within Ss			
Cy	75.000	75.000	3.067
M(Cy)	33.333	33.333	1.363
OCy(Cy)	1397.520	1397.520	57.144***
M(OCy)(Cy)	9.188	9.188	.376
Error	2249.96	24.456	

***p < .001

*Key:
M: Motivation to do well
OCy: Order of the menstrual cycle
Cy: Menstrual Cycle

TABLE 8

Analysis of Variance, Simple Task

Source*	SS	MS	F(1,92)
Between Ss			
M	1.505	1.505	.008
OCy	273.130	273.130	1.535
M(OCy)	249.797	249.797	1.404
Error	16373.300	177.971	
Within Ss			
P	1413.760	1413.760	58.361***
MP	7.922	7.922	.327
(OCy)P	71.297	71.297	2.943
M(OCy)(P)	35.880	35.880	1.481
Error	2228.650	24.224	

***p < .001

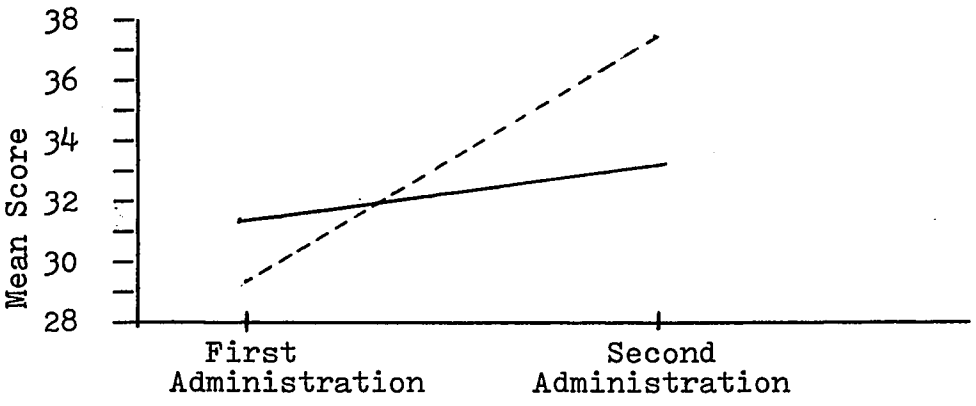
*Key:
M: Motivation to do well
OCy: Order of the menstrual cycle
P: Practice

FIGURE 2

Order of Menstrual Cycle X

Menstrual Cycle Interaction

Simple Task



——————— Premenstrual

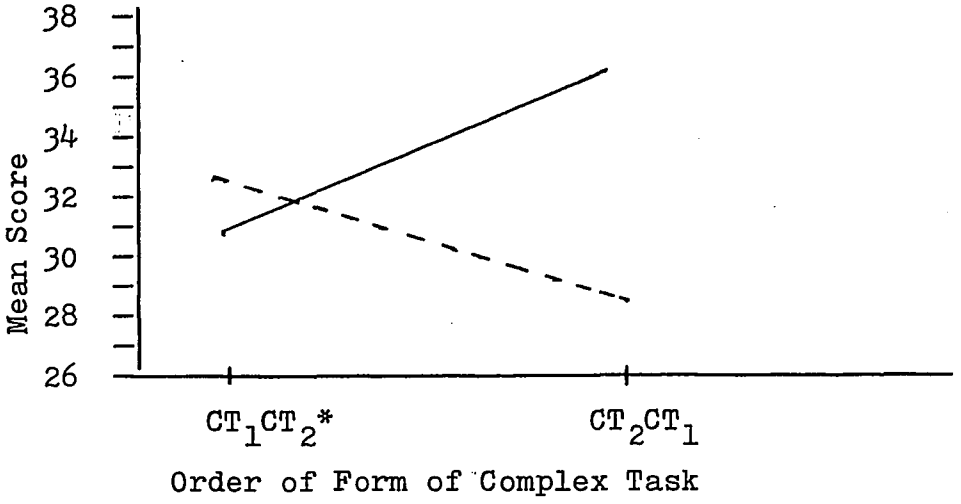
- - - - - - - - - - - - - - - - Postmenstrual

FIGURE 3

Order of Form of Complex Task X

Order of Menstrual Cycle Interaction

For Premenstrual Subjects, Simple Task



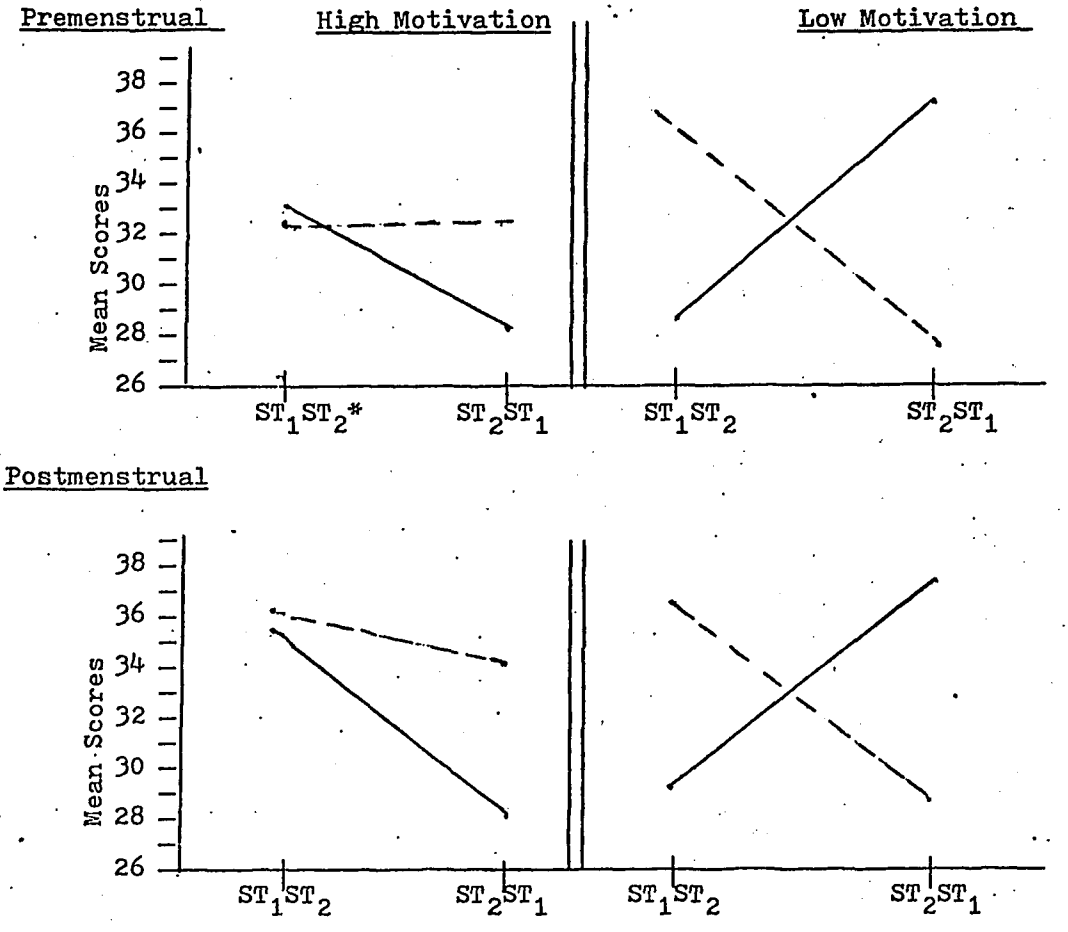
---------- First Administration

_____ Second Administration

*CT_1: Complex task, form 1
CT_2: Complex task, form 2

FIGURE 4

Motivation X Form of Simple Task X Form of Complex Task Interaction for Simple Task

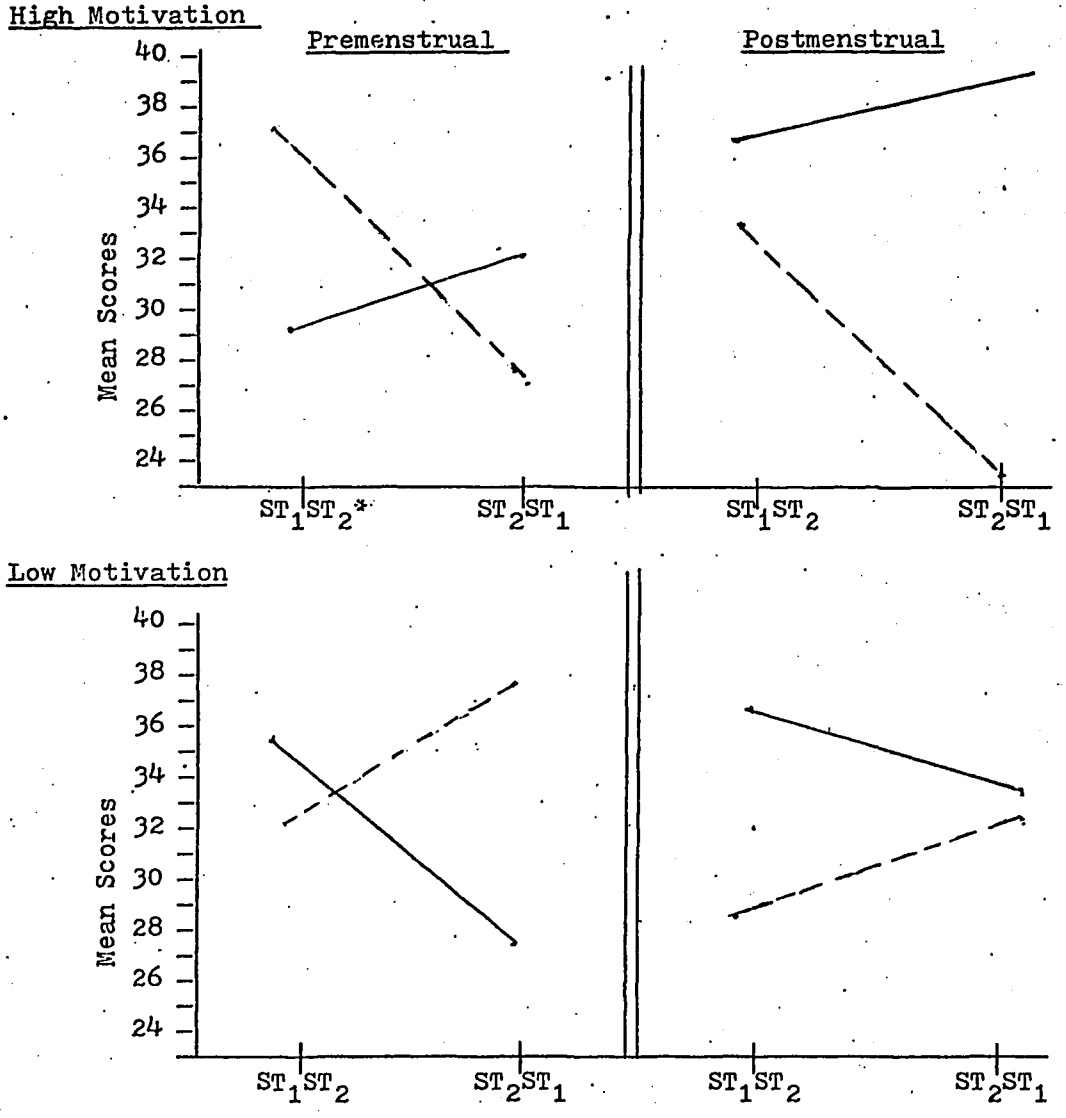


*ST_1: Simple task, form 1 ST_2: Simple task, form 2

**CT_1: Complex task, form 1 CT_2: Complex task, form 2

FIGURE 5

Motivation X Form of Simple Task X Order of Menstrual Cycle Interaction for Simple Task



Complex Task

Main effects: The only factor which affected the Ss scores was practice (Table 12). Ss performed significantly better the second time they took the tests. Neither the menstrual cycle (Table 11) nor motivation (Tables 9-12) affected the Ss' performance.

Interactions

The menstrual cycle and practice (Tables 9, 11; Figure 6): Ss who were premenstrual on the second administration did better than Ss who were premenstrual on the first administration. There was no difference between Ss who were postmenstrual on the first administration and Ss who were postmenstrual on the second administration.

Form of complex task, practice and the menstrual cycle (Table 9; Figure 7): For Ss who were premenstrual on the first administration, scores on CT_1 were equal to scores on CT_2. However, for Ss who were premenstrual on the second administration, CT_1 scores were better than CT_2 scores. There was no effect of this kind for postmenstural Ss.

TABLE 9

Complex Task, Results for Factors

Significant in MANOVA

Premenstrual

Source	SS	MS	F(1,64)	P Less Than
OCy	75.261	75.261	9.970	.003**
(OCy)(OC)	33.843	33.843	4.402	.040*
M(OS)(OC)	2.344	2.344	.305	.583
M(OS)(OCy)	7.594	7.594	.988	.324

Postmenstrual

Source	SS	MS	F(1,64)	P Less Than
OCy	26.041	26.041	3.027	.087
(OCy)(OC)	.167	.167	.019	.890
M(OS)(OC)	26.041	26.041	3.027	.087
M(OS)(OCy)	.375	.375	.044	.835

Key:

OCy: Order of the menstrual cycle
OC: Order of form of complex task
OS: Order of form of simple task
M: Motivation to do well.

TABLE 10

Complex Task, Results for Factors

Significant in MANOVA

First Administration

Source*	SS	MS	F(1,64)	P Less Than
M(OS)(OC)	20.166	20.166	2.965	.090
M(OS)(OCy)	.167	.167	.025	.876

Second Administration

Source	SS	MS	F(1,64)	P Less Than
M(OS)(OC)	4.594	4.594	.484	.489
M(OS)(OCy)	8.761	8.761	.923	.340

*Key:
M: Motivation to do well
OS: Order of form of simple task
OC: Order of form of complex task
OCy: Order of the menstrual cycle

TABLE 11

Analysis of Variance, Complex Task

Source*	SS	MS	F(192)
Between Ss			
M	9.630	9.630	.768
OCy	6.380	6.380	.509
M(OCy)	13.547	13.547	1.081
Error	1153.340	12.537	
Within Ss			
Cy	4,380	4.380	1.143
M(Cy)	1.505	1.505	.393
OCy(Cy)	94.922	94.922	24.770***
M(OCy)(Cy)	.130	.130	.034
Error	352.563	3.832	

***p < .001

*Key:
M: Motivation to do well
OCy: Order of the menstrual cycle
Cy: Menstrual cycle

TABLE 12

Analysis of Variance, Complex Task

Source*	SS	MS	F(1,92)
Between Ss			
M	9.630	9.630	.768
OCy	6.380	6.380	.509
M(OCy)	13.547	13.547	1.081
Error	1153.340	12.537	
Within Ss			
P	94.922	94.922	24.770***
MP	.130	.130	.034
OCy(P)	4.380	4.380	1.143
M(OCy)(P)	1.505	1.505	.393
Error	352.563	3.832	

*** $p < .001$

*Key:
M: Motivation to do well
OCy: Order of the menstrual cycle
P: Practice

FIGURE 6

Order of Menstrual Cycle X Menstrual Cycle Interaction, Complex Task

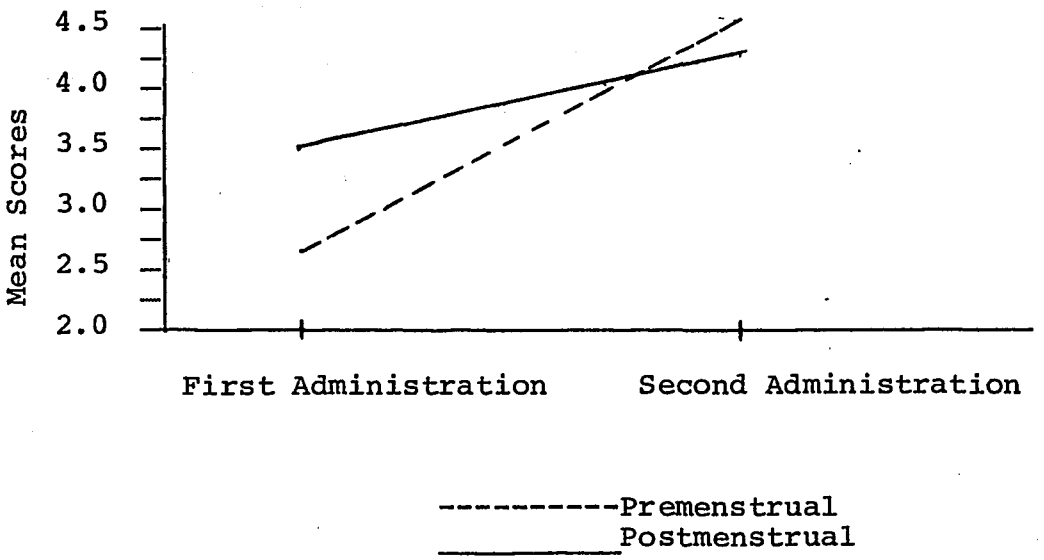
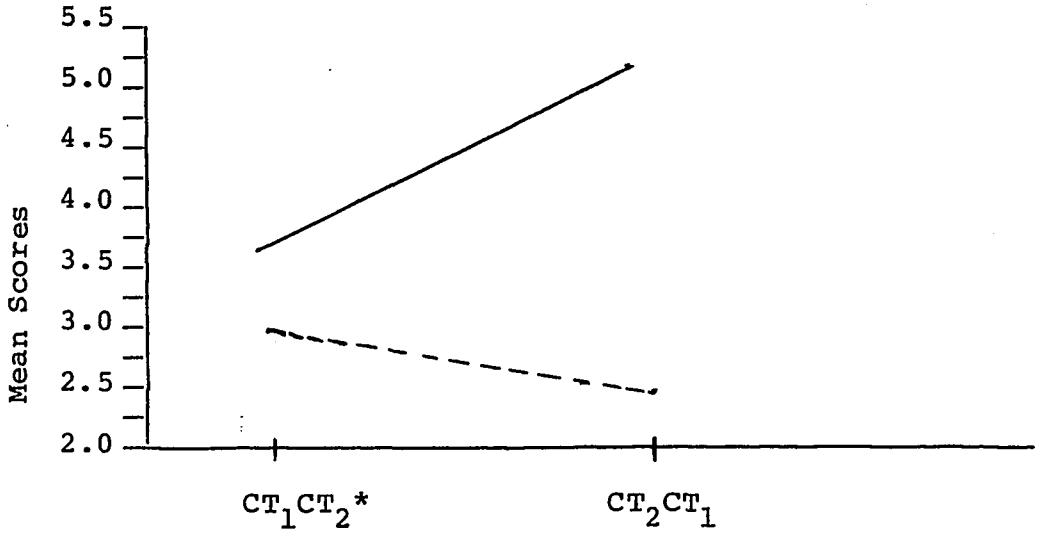


FIGURE 7

Order of Form of Complex Task X Order

Of Menstrual Cycle Interaction,

Premenstrual Subjects, Complex Task



---------- First Administration
_____ Second Administration

* CT_1: Complex task, form 1
CT_2: Complex task, form 2

Analysis Treating Motivation as a Subject Variable

Simple Task

Main effects: The only factor which affected performance was practice (Table 16), with Ss doing significantly better the second time they took the tests. Neither motivation (Tables 13-16) nor the menstrual cycle (Table 15) had a significant effect.

Interactions

The menstrual cycle and practice (Tables 13, 15; Figure 8): Ss who were premenstrual on the second administration performed better than Ss who were premenstrual on the first administration and Ss who were postmenstrual on the second administration performed better than Ss who were postmenstrual on the first administration. In addition, postmenstrual Ss always did better than premenstrual Ss, regardless of which administration it was.

Motivation and order of the menstrual cycle (Tables 13-16; Figure 9): All the analyses of this interaction indicate that motivation to do well affects performance most when Ss are measured in the order premenstrual/postmenstrual. In that condition, Ss who answered "Yes" to the question "Is it important to you that you do well on these tasks?" did signfiicantly better than Ss who answered "No."

Although the difference was not as large, the effect of motivation on performance was reversed for Ss who were measured in the order postmenstrual/premenstrual. In this condition there is a tendency for Ss who answered "No" to the question to perform better than Ss who answered "Yes."

TABLE 13

Factors Significant on MANOVA,

Simple Task Subsample of Subjects

Premenstrual

Source	SS	MS	F(1,70)	P Less Than
OCy	523.360	523.360	5.596	.021*
M(OCy)	331.054	331.054	3.540	.064

Postmenstrual

Source	SS	MS	F(1,70)	P Less Than
OCy	594.507	594.507	6.906	.011*
M(OCy)	584.366	584.366	6.789	.011*

Key:
OCy: Order of menstrual cycle
M: Motivation to do well

TABLE 14

Factors Significant in MANOVA,

Simple Task Subsample of Subjects

First Administration

Source*	SS	MS	F(1,70)	P Less Than
M(OCy)	255.354	255.354	3.124	.081

Second Administration

Source	SS	MS	F(1,70)	P Less Than
M(OCy)	679.625	679.625	6.963	.01**

*Key:
M: Motivation to do well
OCy: Order of menstrual cycle

TABLE 15

Analysis of Variance, Simple Task

for Subsample of Subjects

Source**	SS	MS	F(1,70)
Between Ss			
M	515.484	515.484	3.337
OCy	5.297	5.297	.034
M(OCy)	893.392	893.392	5.784*
Error	10812.900	154.470	
Within Ss			
Cy	52.324	52.324	2.082
M(Cy)	83.441	83.441	3.319
OCy(Cy)	1146.92	1146.92	45.626***
M(OCy)(Cy)	12.308	12.308	.490
Error	1759.62	25.137	

*p < .05
***p < .001

**Key:
M: Motivation to perform well
OCy: Order of menstrual cycle
Cy: Menstrual cycle

TABLE 16

Analysis of Variance,

Simple Task for Subsample of Subjects

Source**	SS	MS	F(1,70)
Between Ss			
M	525.304	525.304	3.400
OCy	4.223	4.223	.027
M(OCy)	880.512	880.512	5.700*
Error	10814.200	154.488	
Within Ss			
P	1163.68	1163.68	46.809***
MP	22.298	22.298	.897
OCy(P)	48.818	48.818	1.964
M(OCy)(P)	47.504	47.504	1.911
Error	1740.200	24.860	

*p < .05
***p < .001

**Key:
M: Motivation to do well
OCy: Order of menstrual cycle
P: Practice

FIGURE 8

Order of Menstrual Cycle X Menstrual Cycle Interaction, Simple Task for Subsample of Subjects

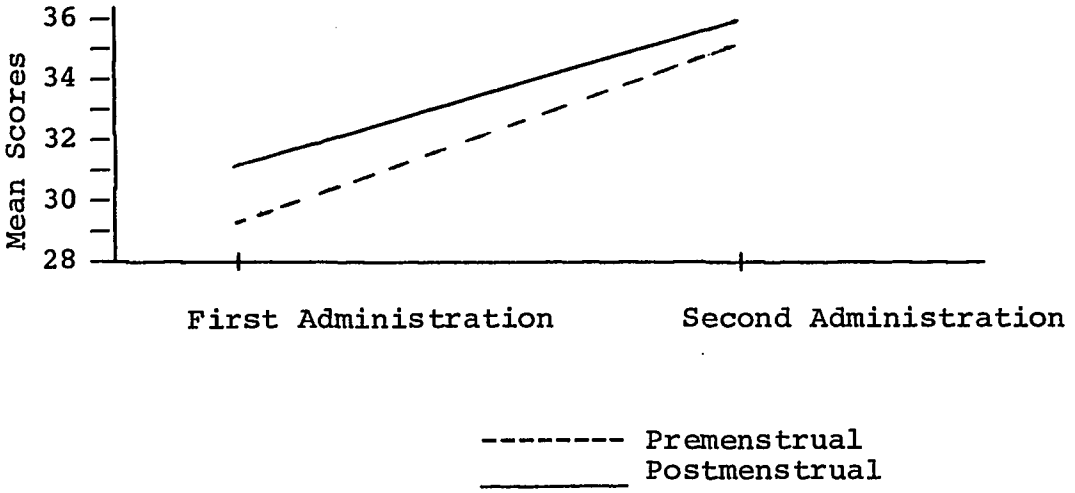
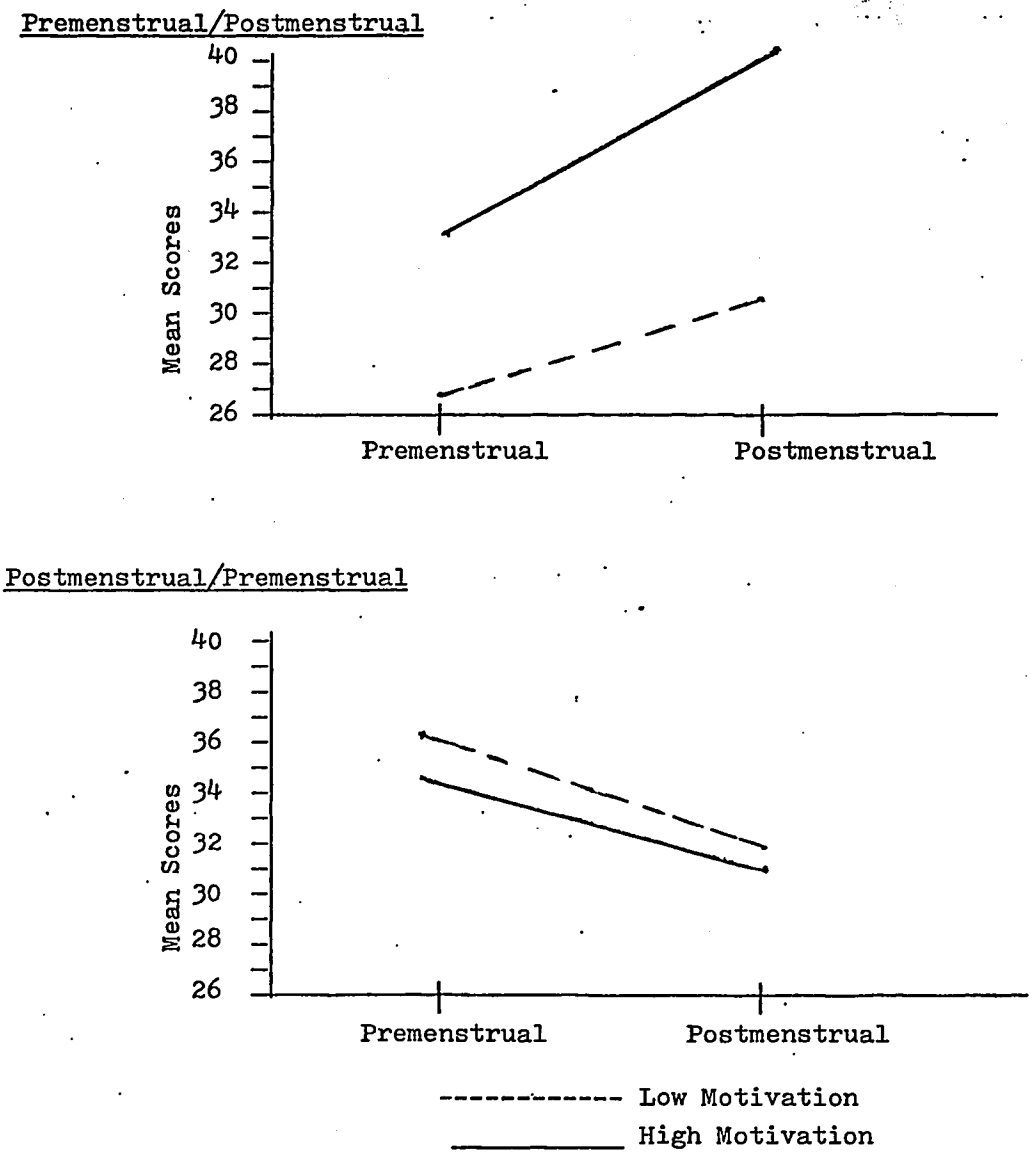


FIGURE 9

Motivation X Order of Menstrual Cycle Interaction for Subsample of Subjects for Simple Task



Complex Task

Main effects: Here, too, the only factor which affected performance was practice (Table 20). Ss did significantly better on the second administration than on the first administration. Neither the menstrual cycle (Table 19) nor motivation (Tables 17-20) affected performance significantly.

Interaction

The menstrual cycle and practice (Tables 17, 19; Figure 10): Ss who were premenstrual on the second administration did significantly better than Ss who were premenstrual on the first administration. There was no difference between Ss who were postmenstrual on the first administration and Ss who were postmenstrual on the second administration.

TABLE 17

Factors Significant in MANOVA

Using Subsample of Complex Task

Premenstrual

Source*	SS	MS	F(1,70)	P Less Than
OCy	90.088	90.088	10.946	.001***
M(OCy)	.642	.642	.078	.781

Postmenstrual

Source	SS	MS	F(1,70)	P Less Than
OCy	3.702	3.702	.492	.503
M(OCy)	17.251	17.251	2.108	.151

*Key:
OCy: Order of menstrual cycle
M: Motivation to do well

TABLE 18

Factors Significant in MANOVA

Using Subsample of Subjects Complex Task

First Administration

Source*	SS	MS	F(1,70)	P Less Than
M(OCy)	4.343	4.343	.667	.413

Second Administration

Source	SS	MS	F(1,70)	P Less Than
M(OCy)	8.241	8.241	.824	.367

*Key:
M: Motivation to do well
OCy: Order of menstrual cycle

TABLE 19

Analysis of Variance,

Complex Task, Subsample of Subjects

Source*	SS	MS	F(1,70)
Between Ss			
M	2.270	2.270	.186
OCy	27.676	27.676	2.271
M(OCy)	13.232	13.232	1.086
Error	853.093	12.187	
Within Ss			
Cy	3.270	3.270	.774
MCy	.006	.006	.002
OCy(Cy)	64.892	64.892	15.349***
M(OCy)(Cy)	5.883	5.883	1.392
Error	295.948	4.228	

***$p < .001$

*Key:
M: Motivation to do well
OCy: Order of menstrual cycle
Cy: Menstrual cycle

TABLE 20

Analysis of Variance,

Complex Task, Subsample of Subjects

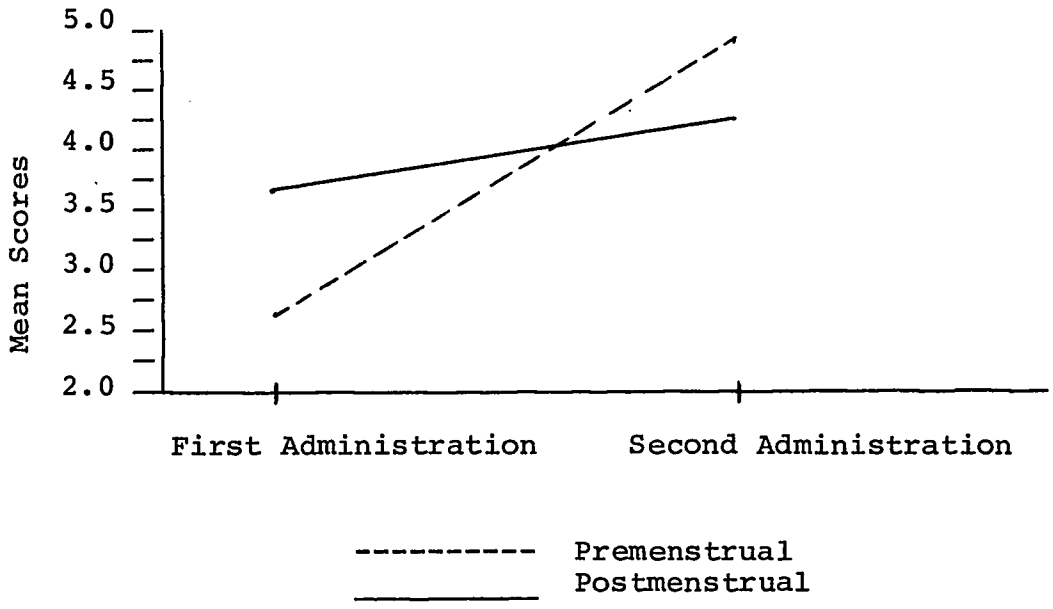
Source*	SS	MS	F(1,70)
Between Ss			
M	2.270	2.270	.186
OCy	27.676	27.676	2.271
M(OCy)	13.232	13.232	1.086
Error	853.093	12.187	
Within Ss			
P	64.892	64.892	15.349***
MP	5.108	5.108	1.208
OCy(P)	3.270	3.270	.774
M(OCy)(P)	.782	.782	.185
Error	295.948	4.228	

***p < .001

*Key:
M: Motivation to do well
OCy: Order of menstrual cycle
P: Practice

FIGURE 10

Order of Menstrual Cycle X Menstrual Cycle Interaction, Complex Task, Subsample of Subjects



Tests of Hypotheses

Hypothesis 1 predicted that motivation would contribute more to the overall variance than the menstrual cycle. Eta^2 is the statistic which indicates the percent of the total variance in an ANOVA which is due to a particular factor (Cohen, 1965). It is based on the F ratio for that factor and is significant only when F is significant. None of the F's for motivation or the menstrual cycle even approached significance. It is clear that Hypothesis 1 is not supported and that neither the menstrual cycle alone nor motivation alone contributed very much to the variance in Ss' scores.

Hypothesis 2A predicted that Ss would perform better postmenstrually than premenstrually on the simple task. The ANOVA of the simple task (Table 7) showed that cycle has no effect on performance on this task. This hypothesis is not supported.

Hypothesis 2B predicted that Ss would perform better on the complex task when they were premenstrual than when they were postmenstrual. The ANOVA of the complex task (Table 11) showed that cycle had no effect on performance on this task. This hypothesis is not supported.

Hypothesis 3 predicted that performance would be better when motivation to do well was high than when

motivation to do well was low. In no analysis was the motivation factor significant. This hypothesis is not supported.

Hypothesis 4 predicted that the menstrual cycle would effect performance more in the low motivation condition than in the high motivation condition. None of the interactions between motivation and the menstrual cycle were significant (Tables 7, 11). This hypothesis is not supported.

TABLE 21

Table of Means for Total Sample: Simple Task

Factor		* Cy_1	Cy_2	**Ad_1	Ad_2	Key
Motivation (M)	1	31.58	33.66	29.81	35.54	1=high
	2	32.56	32.98	30.29	35.31	2=low
Task Order (OT)	1	31.15	32.06	28.77	34.50	1=SC (a)
	2	32.99	34.58	31.23	36.35	2=CS
Order of ST1 (OS)	1	32.81	34.52	31.06	36.27	$1=ST_1ST_2$ (b)
	2	31.33	32.12	29.94	34.58	$2=ST_2ST_1$
Order of CT1 (OC)	1	31.77	32.67	30.25	34.31	$1=CT_1CT_2$ (c)
	2	32.37	33.98	29.75	36.54	$2=CT_2CT_1$
Order of Cy1 (OCy)	1	31.58	**37.23	30.58	37.23	$1=Cy_1Cy_2$
	2	33.56 ***	29.42	28.52	33.63	$2=Cy_2Cy_1$
$\bar{X}_{Total}$		32.07	33.32	30.00	*** 35.43	
Significant Interactions						
OC(OCy)	11	** 32.58	37.42			
	12	30.96	27.92			
	21	28.58	37.04			
	22	36.17	30.92			
M(OS)OC	111	** 33.29	**35.63	**32.08	**36.75	
	112	32.99	36.49	30.67	38.83	
	121	28.10	28.33	26.42	29.42	
	122	32.58	34.21	29.67	37.17	
	211	28.54	29.49	27.25	30.83	
	212	36.39	36.49	34.25	38.67	
	221	37.79	37.25	34.62	39.99	
	222	27.49	28.70	24.42	31.75	
M(OS)OCy	111	** 29.17	**38.50	29.17**	**38.50	
	112	37.08	33.58	33.58	37.08	
	121	32.15	39.33	32.56	39.33	
	122	27.25	23.25	23.25	27.29	
	211	35.89	37.33	32.83	37.29	
	212	32.15	28.67	28.67	32.13	
	221	27.49	33.75	27.77	33.75	
	222	37.75	32.16	32.17	37.99	

(a) SC=simple task first CS=complex task first

(b) ST_1=simple task, form 1 ST_2=simple task, form 2

(c) CT_1=complex task, form 1 CT_2=complex task, form 2

* Cy_1= premenstrual Cy_2= postmenstrual
** Ad_1= first administration Ad_2= second administration
*** Significant difference within cell
**** Significant difference between cells

TABLE 21 (continued)

Table of Means for Total Sample: Complex Task

Factor		Cy_1 *	Cy_2	* Ad_1	Ad_2	Key
Motivation (M)	1	3.75	4.23	3.31	4.67	1=high
	2	3.48	3.60	2.81	4.27	2=low
Task Order (OT)	1	3.52	3.65	2.75	4.42	1=SC *
	2	3.71	4.18	3.38	4.52	2=CS
Order of ST1 (OS)	1	3.65	3.65	2.89	4.39	$1=ST_1ST_2$*
	2	3.58	4.19	3.23	4.54	$2=ST_2ST_1$
Order of CT1 (OC)	1	3.25	3.56	2.98	3.83	$1=CT_1CT_2$ *
	2	3.98	4.27	3.15	5.10	$2=CT_2CT_1$
Order of Cy1 (OCy)	1	2.73 **	4.27	2.73	4.44	$1=Cy_1Cy_2$
	2	4.49	3.56 ***	3.39	4.99	$2=Cy_2Cy_1$
$\bar{X}_{Total}$		3.61	3.91	3.06 ***	4.47	
Significant Interactions						
OC(OCy)	11	2.96**	4.13			
	12	3.67	2.99			
	21	2.50	4.75			
	22	5.46	3.79			
M(OS)OC	111	3.49	3.08	3.25	3.33	
	112	4.25	4.49	2.75	5.99	
	121	3.58	3.75	3.33	3.99	
	122	3.56	5.58	3.92	5.33	
	211	1.82	2.67	2.00	3.08	
	212	4.42	4.33	3.58	5.17	
	221	3.50	4.75	3.33	4.92	
	222	3.58	2.67	2.33	3.92	
M(OS)OCy	111	2.33	3.92	2.21	3.92	
	112	5.42	3.67	3.79	5.42	
	121	2.92	5.00	3.02	5.00	*** Significant difference between cells
	122	4.33	4.33	4.21	4.33	
	211	2.92	4.33	2.79	4.33	
	212	3.31	2.67	2.79	3.92	
	221	2.75	4.50	2.87	4.50	
	222	2.88	2.95	2.79	4.33	

* See preceding page **Significant difference within cell

TABLE 22

Table of Means for Subsample of Subjects

SIMPLE TASK

Factor		* Cy_1	Cy_2	** Ad_1	Ad_2	Key
Motivation (M)	1	33.66	36.34	31.99	38.35	1=high
	2	31.32	31.28	28.87	33.74	2=low
Order of Cy1 (OCy)	1	**29.67	**36.26	29.69	36.25	1=Cy_1Cy_2
	2	35.58 ***	31.36	31.18	35.83	2=Cy_2Cy_1
M(OCy)	11	33.11	**41.63	33.13	** 41.61	
	12	34.74	31.04	30.86	35.08	
	21	26.23	30.89	26.25	30.88	
	22	36.41 ***	31.67	32.23	36.59	
$\bar{X}_{Total}$		32.62	33.81	30.43 ***	36.04	

COMPLEX TASK

Motivation	1	3.93	4.14	3.57	4.50
	2	3.55	3.94	2.89	4.61
Order of Cy1	1	**2.65	4.33	2.66	4.32
	2	4.83 ***	3.75	3.79	4.79
M(OCy)	11	2.75	3.94	2.76	3.93
	12	5.12	4.34	4.38	5.07
	21	2.55	4.72	2.57	4.71
	22	4.55	3.16	3.21	4.59
$\bar{X}_{Total}$		3.74	4.04	3.23 ***	4.55

* Cy_1= premenstrual Cy_2= postmenstrual
** Ad_1= first administration Ad_2= second administration
*** Significant difference within cell
**** Significant difference between cell

DISCUSSION

This study was conducted in order to assess the relative contribution of motivation and the menstrual cycle to simple perceptual-motor and complex perceptual skills. It was originally hypothesized that motivation would affect performance more than the menstrual cycle and that, in accordance with Broverman et al.'s (1968) hypothesis, the menstrual cycle would differentially affect performance on the two types of tasks.

None of the initial hypotheses were supported. However, some of the unexpected relationships and the pattern of significant interactions are important results and must be considered further. These results and their interpretation not only suggest why the initial hypotheses were not supported, but also shed new light on the issues with which this research is concerned.

Correlation Between the Dependent Variables

The finding that scores on the simple task and scores on the complex task were correlated was unexpected. Not only are the factors which these tasks measure supposed to be independent (French, 1951; French et al., 1963), but they represent the types of tasks on which there are large sex differences (Broverman et al., 1968). Women

tend to do better on simple tasks and men tend to do better on complex ones. The fact that scores on the tasks were correlated calls into question their treatment as separate cognitive factors.

Although this study is not concerned with the issue of cognitive factors per se, it is suggested that these two factors be investigated more thoroughly, expecially since they are so important in the area of sex differences. Would one find a correlation between the scores of men tested under similar circumstances? It would be important to determine the sex of the subjects on whom the original research on cognitive factors was conducted. If subjects were men, then it may be necessary to replicate the research using female subjects. It is possible that the correlation is specific to the conditions of this study rather than being a reflection of sex differences. However, the possibility that there might be different "cognitive factors" for men and women cannot be ignored.

It is not being suggested here that "flexibility of closure" (the complex task) is the same thing as "perceptual speed" (the simple task). Although main effects were the same for both tasks (neither was affected by motivation or the menstural cycle and both were affected by practice), it is clear from the results that there were differences between the two tasks in

in terms of how they were affected by the interactions among the independent variables. Complex task scores were affected by the interactions between menstrual cycle and practice and between form of CT and practice. Simple task scores were influenced by these two interactions as well as the interactions among motivation, form of ST and form of CT and among motivation, form of ST and practice. This suggests that performance on the simple task is more easily influenced by changes in the test taking situation than performance on the complex task. This sensitivity may be one reason why there is a prevalence of more simple tasks in research on the effects of motivation/arousal on performance (e.g., Young, 1961).

Main Effects

The finding that neither motivation nor the menstrual cycle by themselves were important in influencing Ss' performance, that is, as main effects, while practice had a strong effect, needs further clarification. It should be pointed out that the menstrual cycle did not influence performance either within Ss (same S premenstrual and postmenstrual) or between Ss (e.g., Ss who were premenstrual on the first administration versus Ss who were postmenstrual on the first administration). The motivation factor was between Ss only.

Motivation

Even though there was no overall difference in performance between the two groups which had received different sets of instructions, "motivation to do well" was a factor in a number of interactions. In these interactions there were definite differences between the groups that had been exposed to the different instructions. In addition, these differences were similar to the differences found in the subsample of Ss who answered the question "Is it important to you that you do well on these tasks?" either "Yes" or "No" both times. In this subsample, too, motivation affected performance only in interaction with other variables. Clearly, the two different sets of instructions had different effects on performance. The question is, do these observed differences in performance really reflect differing levels of motivation to do well?

Whenever instructions are used to instill different levels of motivation in Ss, conceptual, as well as methodological, problems make the interpretation of results in terms of motivation extremely difficult. Rarely, if ever, are all other variables which might be affecting performance controlled for (Cofer and Appley, 1964). There is no way to be sure that the S's answer to a question like "Is it important to you that you do well on these tasks?" indicates the level of her

motivation to do well.

In most studies of human motivation and performance the results are in terms of complex interactions involving how the motive is aroused, how it is measured, the characteristics of the task, conditions under which the task(s) is administered, various characteristics of the subject and characteristics of the experimenter (Cofer and Appley, 1964). Thus, not only is it not surprising that there was no main effect of motivation, but the fact that there were interactions involving this factor makes the pattern of results similar to those found in other studies.

Thus, it is reasonable to link this study with other research which has investigated the relationship between what we have referred to as "motivation to do well" and performance, especially when this motivation is aroused through instructions.

However, to refer to the factor which we (and others) have manipulated as "motivation" may not convey its exact meaning. Within a general arousal model which will be proposed here, it would be clearer to call the contribution of this factor "arousal effect of instructions." The question really is: what was being aroused? To conclude that arousal was due only to a motive to do well is only one possible explanation, although this may have been true in some cases. The high motivation

instructions may have been more anxiety producing because they were more ego-involving. They were certainly more interesting and complex than the low motivation instructions. Higher levels of these three factors (anxiety, complexity and interest) have been shown to lead to higher levels of arousal (Berlyne, 1967). Probably the instructions also varied on other dimensions which could affect arousal (e.g., wanting to please the experimenter).

It seems likely, then, that the low motivation instructions added a smaller amoung to the general level of arousal than the high motivation instructions. This implies that the answers to the questions about the importance of performing well on the tasks were a correlate of arousal for Ss but not necessarily a correlate of motivation to do well.

Practice

The fact that practice affected performance on both tasks and did so more than any other factor was not predicted. The tasks did not seem to be of the type where Ss would learn the skills which the tasks measured on the first trial and then manifest this learning on the second trial. This possibility seemed unlikely since the simple task measures a skill which is probably already overlearned (quick recognition of a letter)

and the complex task measures an ability which is likely to be relatively stable (Witkin, Dyk, Faterson, Goodenough & Karp, 1962). How, then, did practice affect performance?

The first time Ss took the tasks they were exposed to novel stimuli and novel instructions. It was likely that they needed some time to orient themselves to the tasks. Since both tasks were timed, any amount of time used in the first session for orientation was time available in the second session for Ss to work on the tasks. Although they probably needed less time to familiarize themselves with the simple task than they did for the complex task, they had less time to perform it (2 minutes versus 10 minutes). What they learned on the first trial, then, was how to do the specific tasks. This type of learning is known as "learning-to-learn" and is independent of the ability which the task is measuring (Underwood, 1966). Rather than saying that the tasks were affected by practice, it is more exact to say that performance was affected by learning to learn. Throughout the discussion the practice factor will be viewed as due to familiarity with the task (learning to learn) rather than as skill learning.

The Menstrual Cycle

One of the major purposes of this study was to test Broverman et al.'s (1968) hypothesis about the interaction between menstrual cycle and performance on simple and complex tasks. The hypothesis predicts an effect within Ss, but the menstrual cycle did not affect performance either between or within Ss on either task. However, when the interaction between menstrual cycle and practice is analyzed, it is different for the two different tasks. For the simple task, Ss who are premenstrual on the first administration do not differ significantly from Ss who are premenstrual on the second administration, but Ss who are postmenstrual on the second administration do significantly better than Ss who are postmenstrual on the first administration. The effect is reversed for the complex task, where Ss who are postmenstrual on the second administration do not differ from Ss who are postmenstrual on the first administration, but Ss who are premenstrual on the second administration do significantly better than Ss who are premenstrual on the first administration. In addition, other interactions involved the menstrual cycle, so it is clear that it is a factor in performance. What is the mechanism by which the menstrual cycle might affect performance?

Klaiber et al. (1972) suggest that there is a higher level of central nervous system inhibition premenstrually than postmenstrually because of high levels of monoamine oxidase (see page 10 for a complete description of this mechanism). Parlee (1973) has criticized the specificity of this theory by pointing out that the physiological and psychophysiological assumptions of this hypothesis have not yet been tested.

However, even if this theory is wrong it is still possible that premenstrually lower hormone levels contribute less to Ss' general arousal than postmenstrually when hormone levels are high. Estrogen level is highly correlated with activity level, at least in rats (Broverman et al., 1968), and activity level is one indication of arousal.

An Arousal Model

It is being proposed here that by using the concept of optimal level of arousal (Cofer & Appley, 1964) to design a model in which all the factors relevant to performance (e.g., motivation, task variables, menstrual cycle, etc.) are contributing to the level of arousal, we will be able to unify and understand our results and make predictions about performance under various conditions.

Such models assert that maximal performance occurs when arousal is intermediate. If arousal is either too high or too low performance will suffer. It is possible to postulate such a model, for which there appears to be good evidence (Cofer & Appley, 1964), without specifying what the specific mechanisms of arousal are. It is clear, though, that both physiological and cognitive events can influence level of arousal (Berkowitz, 1969).

The likelihood that high motivation instructions are more arousing than low motivation instructions and that postmestrual hormone levels are more arousing than premenstrual hormone levels has already been discussed.

There is evidence that being presented with a novel stimulus is more arousing than being presented with a familiar one (Berlyne, 1967). On the first administration, then, Ss would be more aroused than they are on the second administration when the situation is more familiar to them. If it is assumed that answers to the question "Is it important to you that you do well on these tasks?" is a correlate of arousal, then the tendency of Ss to answer "Yes" to this question on the first administration (Table 3), regardless of the instructions they were given, supports the assertion that there were higher levels of arousal on the first

administration than the second administration, regardless of other factors.

In addition, since complex stimuli are more arousing than simple ones (Berlyne, 1967), it is probable that being presented with the simple task does not increase level of arousal very much on any occasion, while being presented with the complex task does (it looks more complicated, presents more of a challenge, is there for a longer amount of time, etc.).

If, then, the model states that high motivation instructions add more to arousal level than low motivation instructions, being postmenstrual more than being premenstrual, being exposed to the situation for the first time more than being exposed for the second time, and complex tasks more than simple ones, the model can now be applied to the various interactions. (Table 23 summarizes this model.)

Application of the Arousal Model

The Menstrual Cycle, Type of Task and Practice

Before relating this interaction to the arousal model, it must be pointed out that regardless of type of task or time of the menstrual cycle Ss always improve on the second administration (See Table 24). However, for the simple task, Ss measured in the order premenstrual/postmenstrual do better than Ss measured in

TABLE 23

Contribution of the Various Factors to Level of Arousal

Factor	Level of Factor Contributing More	Level of Factor Contributing Less
Motivation	High motivation instructions	Low motivation instructions
Menstrual Cycle	Postmenstrual	Premenstrual
Administration	First administration	Second Administration
Type of Task	Complex Task	Simple Task
Form of Task	Complex Task: Form 1 Simple Task: Form 2	Complex Task: Form 2 Simple Task: Form 1

the order postmenstrual/premenstrual on both administrations. As a result, the second administration premenstrual scores are not significantly different from the first administration premenstrual scores. Thus, when Ss are compared between groups it appears that premenstrual Ss do not benefit from practice when performing simple tasks.

Conversely for the complex task, Ss measured in the order postmenstrual/premenstrual do better on both administrations than Ss measured in the order premenstrual/postmenstrual. As a result, the second administration postmenstrual scores are not significantly different from the first administration postmenstrual scores. Thus, when Ss are compared between groups it appears that postmenstrual Ss do not benefit from practice when performing complex tasks. The implications of this finding will be discussed at the conclusion of this section.

TABLE 24

Means for Menstrual Cycle X Menstrual Cycle Order Interaction

Simple Task

First Administration			Second Administration	
Postmenstrual (A_1)	29.42	$A_2-A_1=4.14$	Premenstrual (A_2)	33.56
Premenstrual (B_1)	31.58	$B_2-B_1=5.65$	Postmenstrual (B_2)	37.23

Significant difference between A_1 and B_2 (7.81)
No difference between B_1 and A_2 (1.98)

Complex Task

First Administration			Second Administration	
Postmenstrual (A_1)	3.56	$A_2-A_1=.93$	Premenstrual (A_2)	4.49
Premenstrual (B_1)	2.73	$B_2-B_1=1.54$	Postmenstrual (B_2)	4.27

No difference between A_1 and B_2 (.71)
Significant difference between B_1 and A_2 (1.54)

Interpretation of these results is difficult. Because of the design, the effects of arousal on learning how to do the task (that is, a relatively permanent change) are confounded with the effects of arousal on performance (that is, temporary effects). For first administration scores only, Ss appear to need a higher level of arousal (postmenstrual, first administration, complex task) for optimal performance on the complex task than they do for optimal performance on the simple task (where optimal conditions are premenstrual, simple task, first administration). There is some evidence that the optimal level of arousal for performing complex tasks is higher than the optimal level for performing simple tasks, although some studies contradict this (Berlyne, 1967).

Second administration scores are more difficult to interpret because of the confounding mentioned above. On both tasks Ss who are postmenstrual on the second administration show more improvement in their scores than Ss who are premenstrual the second time they take the tasks. One possible explanation is that because the effects of novelty are eliminated from the second administration, added arousal from being postmenstrual is necessary in order to maintain arousal, and therefore performance, at an optimal level (Berlyne, 1967). This would be an effect of arousal on performance.

A second possibility is that more learning how to do the task occurred under the intermediate (first administration, premenstrual) arousal condition than under the high arousal (postmenstrual, first administration) condition, and this learning is then manifest on the second administration. High levels of arousal can interfere with learning (Berlyne, 1967). The only way to determine whether this interaction reflects learning effects or performance effects of arousal, or some combination of these effects, would be to carry out a study designed specifically to make this determination.

The Broverman et al. (1968) hypothesis predicts that performance will be better premenstrually on the complex task and postmenstrually on the simple task. This is only true for the second administration and is probably an effect of practice rather than the menstrual cycle. Results are reversed for the first administration. That is, postmenstrual Ss do better on the complex task andpremenstrual Ss do better on the simple one. As mentioned above, higher levels of arousal are needed for optimal performance on complex tasks than for optimal performance on simple tasks.

One problem with the Broverman et al. (1968) hypothesis is that its predictions are much too general. As was pointed out earlier in the discussion of

motivation, arousal and behavior are affected by so many variables that predictions which fail to take all of these variables into account are in danger of either not being confirmed or of being misinterpreted if they are confirmed.

For example, researchers must not only be concerned with "cognitive factors" or "tasks that test simple, overlearned perceptual skills" versus "tasks which test the ability to ignore extraneous stimuli." They must also ask how the task itself appears to the subject. The Hidden Figures test (complex task) is more interesting and complex than the Finding A's test (simple task), regardless of what cognitive factor or what ability it is testing. This arousal framework would suggest that a test measuring simple, overlearned perceptual skills is boring and this in itself contributes to arousal and performance, independently of the skill which is being measured. It is possible that if such an "ability" could be tested in a more interesting way that the interaction for the "simple" task would be the same as that for the "complex" task. This same argument in reverse would apply to the complex task.

Interactions Which Involve Order of Form of Task

It is clear from the interactions that the two forms of each task were not equivalent, since there are a

number of interactions which involve differences between forms ST_1 and ST_2 and forms CT_1 and CT_2. The forms were designed to be equivalent (French et al., 1963) and on inspection it is difficult to discern any differences between them. However, we will treat these differences as differences in the arousal ability of the forms (complexity, interest, etc.) in order to integrate the interactions into the optimal level of arousal model. We do so, however, without any empirical or theoretical basis, acknowledging that this is the weakest part of the model.

Although form of CT made no difference for post-menstrual Ss, Ss who were premenstrual on the second administration did better on CT_1 than CT_2. If one assumes that CT_1 has more of an arousal effect than CT_2, we could then postulate that it allowed premenstrual (low arousal) Ss to take fuller advantage of being familiar with the task than the less arousing form, CT_2.

In the interaction between motivation, form of ST, and order of the menstrual cycle (Figure 5, page 50), Ss in the high motivation, premenstrual condition behave similarly to Ss in the low motivation, postmenstrual condition. In both cases Ss perform better on ST_2 than ST_1. Ss in the high motivation, postmenstrual condition

behave similarly to Ss in the low motivation, premenstrual condition. In these conditions Ss do better on ST_2 than ST_1.

It is assumed that the two different instructional sets contribute larger or smaller amounts to the Ss' general level of arousal. If being premenstrual or postmenstrual contributes smaller or larger amounts, then high motivation (larger amount) plus premenstrual (smaller amount) is functionally equivalent in its effects to low motivation (smaller amount) plus postmenstrual (larger amount).

On the other hand, Ss in the high motivation (larger amount) plus postmenstrual (larger amount) condition are at opposite extremes from Ss in the low motivation (smaller amount) plus premenstrual (smaller amount) condition. Nevertheless, in both conditions, Ss do better on ST_1. Let us assume that in these latter two conditions Ss are either above or below the optimal level of arousal and Ss can only cope with a relatively unstimulating form, i.e., ST_1. If ST_2 is more arousing than ST_1, Ss could benefit from this at optimal levels of arousal, i.e., the high motivation, premenstrual and low motivation, postmenstrual conditions. In these conditions Ss do, in fact perform better on ST_2.

This interaction also reflects the finding reported earlier that although Ss who are postmenstrual perform

better on the second administration than Ss who are postmenstrual on the first administration, Ss who are premenstrual on the second administration do not necessarily do better than Ss who are premenstrual on the first administration. Between Ss, then, form effects are stronger in the premenstrual condition and practice effects are stronger in the postmenstrual condition.

The interactions between form of CT and order of menstrual cycle and among motivation, form of ST and form of CT, as these interactions affected scores on the simple task, need to be looked at in two parts. Although order of task (SC or CS) was not significant in any interaction, the effects we are discussing here are effects on the simple task. Obviously, if the simple task came first then the complex task could not be interacting with ST to determine performance on ST.

The interaction between form of CT and menstrual cycle order shows that, overall, premenstrual Ss do better on the simple task if they have CT_1 rather than CT_2. However, if one looks only at the CS means (i.e., Ss who got CT before ST) (Table 25) then this relationship is true only in the low motivation condition. In the high motivation condition, premenstrual Ss performed better with CT_2 first.

TABLE 25

Means for Order of Form of Complex Task X Order of Menstrual Cycle Interaction, Premenstrual Subjects for Simple Task

Complex Task Before Simple Task

	First Administration		Second Administration	
	CT_1*	CT_2	CT_1	CT_2
High Motivation	30.50	34.83	25.66	38.33
Low Motivation	31.17	28.33	43.33	28.83

Simple Task Before Complex Task

	First Administration		Second Administration	
	CT_1	CT_2	CT_1	CT_2
High Motivation	28.17	27.50	38.50	26.17
Low Motivation	33.33	26.83	35.17	32.50

*Key:
CT_1: Complex Task, Form 1
CT_2: Complex Task, Form 2

If we think of CT_1 as adding more to the arousal level than CT_2, the additional arousal may have been necessary in the low motivation, premenstrual condition for optimal performance on ST, but in the high motivation condition the added effects of CT_1 may have increased arousal level beyond that which was optimal for performance on the simple task.

The form of CT, order of menstrual cycle interaction is also reflected in the means for the SC condition, but it is difficult to see how the form of CT could have affected performance on the simple task here. Although our explanation for the CS condition is suggestive, it is possible that the whole interaction is a statistical artifact.

We can also fit the interaction among motivation, form of ST and form of CT into our model. In the high motivation condition, regardless of the menstrual cycle, Ss tended to perform better on the simple task with the same forms of ST and CT (e.g., ST_1CT_1). Under low motivation they did better with different forms of ST and CT (e.g., ST_1CT_2).

Again, we must separate the CS means from the SC means (Table 26). When the complex task comes first in the low motivation condition, Ss do best on the simple task if there are either two high arousal forms (CT_1ST_2) or two low arousal forms (CT_2ST_1). When the

simple task comes first in the low motivation condition, Ss do best on ST_1CT_2 and ST_2CT_1, but, again, it is difficult to see how the complex task could be affecting scores on the simple task.

When the complex task comes first, this interaction indicates that low motivation instructions sensitize Ss in such a way that they do best under either highly arousing or highly boring conditions. The arousing tasks may bring them to a more optimal level of arousal, while the boring tasks, as in the interaction among motivation, form of ST, and order of the menstrual cycle may be all they can handle under such a low level of arousal.

In the high motivation condition, if the complex task comes first, having only one arousing task (CT_1 or ST_2) is best. If the simple task comes first, however, the means are quite similar, indicating that in the high motivation condition form of ST, overall, made little difference.

Form of ST did, of course, have an effect when premenstrual and postmenstrual Ss in the two motivation conditions were compared. If one looks at the CS and SC means for the interaction among motivation, form of ST and order of the menstrual cycle (Table 27), it is clear that in almost every condition the difference between

TABLE 26

Means for Motivation X Order of Form of Simple Task X Order of Form of Complex Task Interaction

Complex Task before Simple Task

	CT_1ST_1	CT_1ST_2	CT_2ST_1	CT_2ST_2
High Motivation	35.67	32.92	32.50	35.50
Low Motivation	33.33	38.58	37.84	25.00

Simple Task before Complex Task

	ST_1CT_1	ST_1CT_2	ST_2CT_1	ST_2CT_2
High Motivation	33.59	32.67	32.75	32.42
Low Motivation	28.67	35.42	36.09	29.25

Key: CT_1: Complex task, form 1
CT_2: Complex task, form 2
ST_1: Simple task, form 1
ST_2: Simple task, form 2

$\bar{X}_{ST_1}$ and $\bar{X}_{ST_2}$ is greater for the SC group than the CS group. This suggests that the effects of form of ST on performance on the simple task becomes manifest only when performance is not also being affected by CT.

Motivation and Order of the Menstrual Cycle

For the subsample of Ss who answered the question "Is it important to you that you do well on these tasks?" either "Yes" or "No" both times, there was a significant interaction between their arousal levels as measured by this question and menstrual cycle order on the simple task. Ss measured in the order premenstrual/postmenstrual did better under high arousal ("Yes" both times) than low arousal ("No" both times). Ss measured in the order postmenstrual/premenstrual tended to perform better under low arousal than high arousal.

For Ss who answered "Yes" both times, we suggest that postmenstrual Ss, already aroused because they were postmenstrual and because of whatever the answers to the question were a correlate of, became aroused beyond the optimal by the novelty of the first administration. The second time they took the task these Ss remembered their approach to the tasks at the first administration and this may have prevented the Ss (now

TABLE 27

Means for Motivation X Order of Form of Simple Task X Order of Menstrual Cycle Interaction

Simple Task Before Complex Task

		First Administration		Second Administration	
		ST_1*	ST_2	ST_1	ST_2
High Motivation	Premenstrual	27.84	27.84	28.84	35.84
	Postmenstrual	29.67	23.50	35.17	38.17
Low Motivation	Premenstrual	34.50	26.67	32.17	35.50
	Postmenstrual	29.84	30.33	31.67	38.17

Complex Task Before Simple Task

		First Administration		Second Administration	
		ST_1	ST_2	ST_1	ST_2
High Motivation	Premenstrual	37.17	31.17	33.67	30.00
	Postmenstrual	29.09	31.17	40.84	41.50
Low Motivation	Premenstrual	31.67	27.84	37.00	35.17
	Postmenstrual	32.33	29.17	30.33	37.00

* ST_1: Simple task, Form 1
ST_2: Simple task, Form 2

at a lower level of arousal because they were premenstrual and it was the second administration) from performing at an optimal level.

On the other hand, Ss who were premenstrual the first time benefited from the novelty of the first administration. Their memories of the first administration may have enabled them, on the second administration, to overcome any negative effects of being postmenstrual at the same time they were aroused by other factors (as indicated by their answer to the question). This explanation is given at least partial support by studies which demonstrate that Ss who are set to make certain responses can overcome the negative effects of high arousal (Berkowitz, 1969).

Conclusion

The explanations which have been offered for the results are tentative suggestions. The arousal model was chosen because it was felt that such a model could 1) integrate the results into a cohesive pattern and 2) serve as a framework within which questions raised by the study could be answered by future research.

Two of the questions raised here have appeared in many other contexts: 1) What are the effects of arousal instructions? and 2) Under what conditions does arousal affect performance and under what conditions

does it affect learning? These are crucial issues in theories of motivation and arousal (Berlyne, 1967; Young, 1961) and no single study can hope to answer them.

It is also necessary to ask how each of the factors studied contribute to arousal and performance. The results reported here confirm the fact that performance is dependent on complex interactions among physiological, psychological and environmental factors (Cofer and Appley, 1964), but specific information is needed on how these factors combine to determine arousal and performance.

The greater arousal effect of the complex task, as compared to the simple task, suggests that the way the task itself is constructed, not just what skill it is measuring, is important. The finding that form effects were more pronounced 1) for premenstrual than postmenstrual Ss, 2) under low motivation instructions than under high motivation instructions and 3) when the simple task came before the complex task suggests that sensitivity to certain types of stimuli may be greater at lower levels of arousal. This contradicts theories which assert that arousal leads to heightened responses to stimuli, including the Broverman et al. (1968) hypothesis which asserts that as a result of higher central nervous system excitation postmenstrual women

are more sensitive to stimuli.

Finally, the interaction between the menstrual cycle, practice, and the type of task raises two extremely important points which are independent of the arousal model.

Within Ss, practice had a strong effect. Scores improved the second time on both tasks, regardless of the menstrual cycle. This means that any studies of the menstrual cycle and performance which use repeated measures (and such studies should) must be designed so that practice effects such as learning to learn are eliminated. One way to do this would be to give Ss practice until they reach some criterion and only then test for menstrual cycle effects.

The second point is relevant to research on learning. If this had been a study of the effects of practice on performance, the results would have been very different, depending on whether or not each S was used as her own control. For example, on the complex task, if Ss' scores on the first trial were compared with their scores on the second trial the conclusion would be that improvement had occurred. Similarly, if Ss who were premenstrual on the second trial were compared with a similar control group who had no training (i.e., premenstrual Ss on the first trial) the same conclusion would be reached. However, if the training group was

postmenstrual and they were compared with a postmenstrual control group (i.e., postmenstrual Ss on the first administration), then it would be concluded that training had no effect.

It is highly unlikely that any experimental or control group would be made up of women who were all either premenstrual or postmenstrual. However, since hormone level is one of the factors which influences performance, it might under certain circumstances, affect the size of the difference between groups. When women are Ss and control groups are used, investigators should make sure that menstrual cycle is randomly distributed among the groups, just as they would for any other possibly important variable like age. This is especially important when Ss are college women who live together in dormitories, since the more time women spend together the more likely it is that their menstrual cycles will be synchronized (McClintock, 1971).

SUMMARY AND IMPLICATIONS

This research was originally conceived of as a study of the effects of the menstrual cycle and motivation on performance. Neither of these factors were found to have a main effect and their influence appeared only in interaction with other variables. The pattern of results and the interpretation proposed emphasize the importance of defining specifically what one is referring to when one speaks of such things as motivation or practice.

The pattern of results forced this researcher to conceptualize, in a more precise way, the variables she originally referred to as motivation and practice. It is clear that to refer to motivation, for example, as if it is a unidimensional variable whose meaning is understood by everyone is to do what Garfinkel and Sacks (1970) refer to as glossing.

A gloss is a way of talking about a particular term or phrase, within a particular context, such that how that term is to be understood remains unstated throughout, although speakers and hearers know what they are talking about. We are continually engaging in glossing practices, and they are not necessarily good or bad (according to Garfinkel and Sacks they are

an irremediable fact of life). However, the danger in glosses such as motivation is that although everyone will know what is being talked about it is possible that everyone's understanding will also be everyone's misunderstanding. There is particular danger of this when significant main effects are found.

In such cases, investigators (and readers) often assume that some unidimensional variable, which they understand, has been isolated and they may neglect further study of the components of that variable. This problem is not solved by operational definitions. Operational definitions tell us how motivation (or whatever is being defined) was measured, but it does not tell us how we are to understand "motivation." In fact, in order to decide if it is a valid operational definition or not we must first know what motivation is.

If we accept the statement that behavior is a function of all the stimuli impinging upon S (not just the ones the investigator is interested in) as well as S's definition of the stimuli, then we present one suggestion for partially remedying this type of gloss. Perhaps investigators should be Ss in their own experiments and pilots should be run which inquire of Ss what they perceive the meanings of the independent variables (as operationally defined) are. With such information one could begin to make explicit, for example, how Ss

answers to a question about importance is to be connected to any changes in performance.

The major purpose of this study has always been to investigate the effects of the menstrual cycle on behavior. The case has been made over and over again that there exists something called premenstrual tension which causes women "suffering" from this disorder to exhibit negative emotional states when they are premenstrual. A recent review of the premenstrual syndrome (Parlee, 1973) makes many of the same points included in the introduction. Studies which report negative changes in affect are methodologically poor and reports are clearly influenced by cultural beliefs about menstruation (Paige, 1973). Nevertheless, premenstrual tension is a reality for some women.

A number of activation/arousal theorists assert that there is no reason to distinguish between emotion and motivation (Berkowitz, 1969). Different behaviors are labeled "emotional" and "motivated" for reasons which will be discussed, but they are both states of arousal and therefore affect performance in the same way (e.g., too much "emotion" or too much "motivation" can interfere with performance). However, despite their probable equivalence in terms of their effects on behavior, "emotional" is often used in a pejorative

way while "motivated" is usually meant positively.

We tend to label behavior as "emotional" when it is seen as non-goal directed, as originating in the environment and as being more out of the control of the person exhibiting it. "Motivated" behavior is goal directed, originates in the person and is seen as being under the control of the person exhibiting it (Young, 1961).

Women are typically seen as being more sensitive to, interested in and more controlled by the stimuli around them, especially other people (i.e., emotional), while men are typically seen as being more interested in objects and tasks, which interest is directed by internal goals (i.e., motivated) (Broverman, Vogel, Broverman, Clarkson & Rosenkrantz, 1972). If arousal level is low during the time that a woman is premenstrual and if she sometimes does not react to the stimuli around her in an optimal way, then she is labeled (and probably labels herself) as exhibiting negative emotional states. Under similar circumstances (of low arousal), men who appear not to be goal directed or interested in tasks are labeled "unmotivated." One advantage of a general arousal framework would be the disappearance of labels which imply value judgments. Women (like men) vary in their levels of arousal for various reasons and their behavior depends on both this

level and the stimuli available to them.

Since objects and tasks exist for women also, the question this investigator is concerned with is: what effect does the menstrual cycle have on performance? The studies which have investigated this relationship, most of which have negative results, are beginning to raise serious questions about the whole concept of premenstrual tension. If it is so real, how can it fail to effect performance over and over again? Parlee (1973) points out that research which does not find differences tends not to get published, adding to the impression that the menstrual cycle causes vast changes in affect and behavior.

One reason for the lack of findings on performance and the relative wealth of findings on affect is the way we assign the label "emotional" to ourselves and others. Studies of performance involve responses to tasks and objects. Performance scores are objective numbers. Studies of affect, however, involve attribution processes which depend on cognitions about the situation as well as perceived levels of arousal (Schacher & Singer, 1962). Studies of affective changes and studies of performance changes are, in fact, studies of two very different processes (observed behavior and covert attribution processes) and there is no necessary reason why they should be related. The questions of whether

the (future) President of the United States gets depressed when she is premenstrual is irrelevant as long as being premenstrual does not affect her performance. (Note: We did not say "as long as being depressed does not affect her performance.")

The research reported here strongly suggests that predictions about the menstrual cycle and performance cannot be made as blanket statements. If the important variable in the menstrual cycle is arousal, then one must always be aware in making any predictions that hormone level is only one of many factors which are contributing to arousal. One must ask what these other factors are and what the contribution they are making is.

This model also takes the question out of the area of "raging hormonal influences" and puts it in a general arousal framework where it belongs, a framework as applicable to men as it is to women, unless one wants to argue that men are free from physiological factors which affect their general level of arousal.

It has been asserted that being premenstrual contributes less to arousal level than being postmenstrual. It must be remembered that this is only when women are compared to themselves. We do not yet know how their premenstrual level of arousal compares to other's levels of arousal (e.g., men's or women taking birth control

pills) and this should be determined by future research.

Finally, and most importantly, to say that being premenstrual contributes less to arousal level is very different from saying that women are at low levels of arousal when they are premenstrual. The latter implies that the menstrual cycle is the only factor in arousal. It seems clear now, and one wonders how many times this point must be made before it is accepted as "fact," that the effects on performance of the hormonal changes associated with the menstrual cycle cannot be viewed as either woman's curse or woman's blessing in a world where more than one factor influences behavior.

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APPENDIX A: BIORHYTHMS QUESTIONNAIRE

BIORHYTHMS QUESTIONNAIRE

This questionnaire is part of a large study which is being done under the auspices of the CUNY Doctoral Program in Psychology. We are trying to obtain information on psycho-biological cycles in both men and women. The first part of the questionniare, is for men. Because little is known about cycles in men, this part of the questionnaire is briefer than the part for women. Please fill out the appropriate section.

Your help in this study is greatly appreciated. Naturally, your answers will be anonymous and confidential.

MEN ONLY

Date of birth: Month_____ Day_____ Year_____

Ethnic group: White____ Black_____ Puerto Rican_____ Oriental____ Other_____

Date today:_____

Have you ever noticed any fairly regular cyclical changes in your behavior(including emotions, perception,performance,etc.)?

Yes_____

No_____

IF YES: List below, as completely as possible, the following information:

Behavior	Cycle(e.g.,daily,weekly,etc.)	How behavior changes during cycle

Use the other side if you need more room.

Thank you.

WOMEN ONLY

Date of Birth: Month_____ Day_____ Year_____

Ethnic Group: White____ Black____ Puerto Rican____ Oriental____ Other____

Date today:_____

Do you take the birth control pill?

Yes_____ What brand?_____

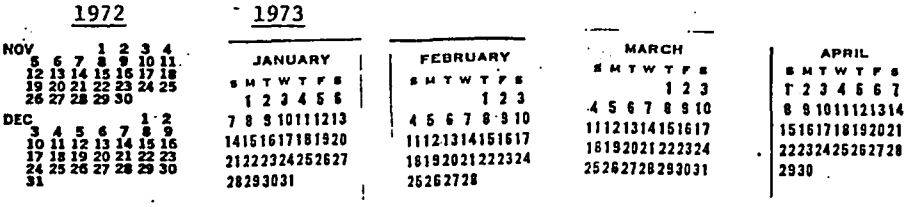
No_____

Are you now pregnant?

Yes_____

No_____

On the calender below circle the DAYS of your LAST menstrual period (first day through last day). If you are not sure check here _____ and estimate as well as you can.



On the calender below circle the DAY when you expect your NEXT menstrual period. If you are not sure check here _____ and estimate as well as you can.

WOMEN ONLY

On the average, how long is your menstrual cycle? (First day of one period to first day of next period)

_____ days

On the average, how many days does your period last?

_____ days

How regular is your cycle?

1. Extremely regular (always able to predict)
2. Fairly regular
3. Not very regular
4. Extremely irregular (almost impossible to predict)

Do you have any children?

Yes_____ How many?_____
No_____

Do you ever have any specific discomfort <u>during</u> menstruation?(cramps, depression,etc.)

Yes____
No_____

IF YES: What? Be specific. How, if at all, do(es) the symptom(s) affect your behavior?

WOMEN ONLY

Do you ever have any discomfort sometime during the week before you get your period?(cramps,acne,depression,etc.)

Yes_____
No_____

IF YES: What? Be specific. How, if at all do(es) the symptom(s) affect your behavior?

Ten years from now, which of the following would you like to be doing?

_____ Working full time (Occupation?_____)

_____ Working part time (Occupation?_____)

_____ Raising children and taking care of a home

_____ Combination of raising children and working (Occupation?_____)

_____ Other (What?_____)

APPENDIX B: FINDING A'S TEST

FINDING A'S TEST — P-1

This is a test of your speed in finding the letter "a" in words. Your task is to put a line through any such word. Listed below are five columns of words. Each column has five words containing the letter "a". The first two columns have already been marked correctly. Now, on the other three columns, practice for speed in putting a line through the words with an "a".

1	2	3	4	5
cider	east	stripe	insert	defend
bough	blind	coarse	court	settle
fudge	chord	govern	pearl	lodge
greet	~~solar~~	perfect	bridle	oaken
~~fault~~	spoon	special	recess	crown
~~loap~~	piece	consist	soapy	quest
count	rinse	mostly	able	glimpse
shore	~~drawn~~	shrink	pledge	every
~~easel~~	fleet	pencil	refuse	break
define	sense	hinder	better	where
entire	uncle	solace	patrol	thorn
ghost	white	keeper	judge	pause
knife	~~coach~~	night	defect	hence
hedge	south	clock	trust	short
~~petal~~	period	picnic	other	person
scope	miller	smart	straw	warm
ripen	~~slogan~~	finger	noisy	juice
under	height	useful	defer	enter
~~heard~~	event	slowly	field	ordeal
quite	bond	meant	mend	nurse
jump	west	quick	skill	cool

Remember, in each column there are five words containing the letter "a".

Your score on this test will be the number of words marked correctly. Work as quickly as you can without sacrificing accuracy.

You will have 2 minutes for this test.
When you have finished STOP.
Please do not go on until you are asked to do so.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

Adapted from Thurstone's Letter A

Part 1 (2 minutes)

1	2	3	4	5
mention	running	morning	neighbor	dropping
ladder	numerous	setting	strong	sixteen
bench	promise	puzzle	door	instead
theory	funny	witty	moon	moment
further	skip	dryly	soothe	worker
shutter	bloom	switch	quarrel	swift
publish	perfume	fellow	spelling	joyful
spread	monkey	blotter	wheel	comfort
deliver	eleven	melted	steam	fertile
remind	dismal	expense	sober	divide
improve	sponge	ringing	night	throng
forbid	history	durable	couch	velvet
pudding	biscuit	mixture	swell	readily
sunrise	nobody	touch	correct	descent
reward	temple	picnic	hear	chunk
progress	consist	whistle	window	sense
intense	indeed	lemon	bitter	eight
bridle	distant	within	lively	grease
prize	scenery	shriek	engine	moist
goose	jesting	riddle	compel	rocks
indoor	howl	politics	twinkle	click
winding	jump	leave	serene	empty
temper	figure	wintry	modern	freedom
message	depend	relish	revive	bottle
virtue	race	yonder	fifth	report
endure	sprout	bread	study	demure
sixth	honey	sweep	boast	bushel
chalk	clock	prince	juicy	unfold
motor	duke	confide	scorn	found
route	cliff	socket	mood	locket
syrup	four	fatigue	seize	merit
gold	shawl	monster	ivory	general
spicy	lunch	explode	renew	impulse
lion	crowd	million	colony	notch
wool	extent	empire	loudly	pump
pine	guard	regular	horse	cruise
sour	jolly	church	giant	drift
cork	upper	bulge	visit	tiger
pint	noon	timid	ounce	hilly
sheep	dough	plum	stone	happy
dusty	expect	moss	being	occur

GO ON TO THE NEXT PAGE.

Part 1 (continued)

6	7	8	9	10
ostrich	collect	except	splinter	woods
period	truth	welcome	ribbon	sorting
event	precise	struggle	string	bunch
middle	design	word	linen	saw
right	cotton	blue	express	floor
frozen	resent	orange	picture	settle
dodge	stride	employ	fiery	lowly
white	fierce	sports	envy	trench
tough	uproar	court	board	clutch
ocean	notion	humor	time	plunge
crush	light	great	problem	frigid
grind	rural	index	trumpet	hearing
cloud	color	skilled	powder	ground
drawn	settle	discover	meadow	hunting
bulky	fuel	enormous	opening	whine
supply	proper	secret	crush	polish
double	outburst	clothing	forbid	grieve
equip	puzzle	routine	intense	sensible
bottom	furnish	shock	extent	division
green	grab	numb	trinket	teacher
murmur	sprout	signal	several	degree
thrive	connect	counter	sleepy	order
become	grumble	quick	group	strong
collect	position	error	oasis	length
feeling	forward	evening	creep	portion
suspend	horrible	differ	howl	coating
machine	dense	ruler	enough	expect
yielding	ideal	dislike	yellow	smooth
slight	foggy	worship	blunt	rubbish
increase	gloss	cluster	develop	power
continue	mutter	severe	combine	slender
desire	crutch	touch	blush	common
youth	fiction	smoky	provide	refuse
fresh	house	birth	olive	bubble
wash	energy	botany	seize	board
dress	sooner	orderly	insert	trifle
storm	restless	content	noble	level
excel	sincere	breadth	worth	broken
delight	exclude	record	instant	uniform
figure	impress	choice	flower	flyer
twist	contest	splendid	speech	observe

GO ON TO THE NEXT PAGE.

Part 1 (continued)

11	12	13	14	15
stunned	ditch	recognize	notion	chubby
vicinity	blown	christen	sewing	outpour
luckily	unfit	mercury	drowsy	scoured
shudder	ought	disguise	bugle	offend
nowhere	sirup	wearing	loiter	explore
subsist	knelt	counsel	spool	recline
countess	ridge	bouquet	belle	sledge
sponsor	coral	inscribe	scent	eagerly
profile	tomb	throttle	cease	heroine
faint	doze	zoning	blithe	isthmus
bonfire	stroll	pewter	onset	though
refund	gushing	tyrant	lofty	cistern
offense	preface	debris	epoch	sylvan
custard	sputter	modest	whose	mostly
recover	nicely	refine	knoll	prosper
pitiful	reptile	fleecy	plural	tedious
homely	labor	enroll	siphon	explode
ruddy	boldly	leaves	mount	relieve
citron	single	deluge	bungle	sirloin
ignite	deport	hurled	wrung	wander
squeak	surrey	obscure	superb	hyphen
goblet	college	debtor	mildly	condense
propose	hoarse	quarter	double	veiled
observe	browse	enforce	buried	certify
seldom	inherit	pompous	steeple	vinegar
intrust	repose	burrow	ebbed	industry
resume	behold	humbug	import	heiress
earnest	crouch	apple	woman	fatten
croquet	deride	exploit	furrow	founder
empress	recoil	urgent	sturdy	whoever
corrupt	caught	tumult	embers	surgeon
emotion	slight	jewels	tempt	glisten
neither	invest	unfurl	impose	scepter
endless	gross	grunt	idea	return
instead	inner	beech	secede	shout
exempt	punch	sight	owner	bulky
species	dizzy	horde	ravine	outer
corps	heed	throb	horror	droll
peril	chess	petty	crust	enter
some	oven	numb	buzz	snuff
crew	spurt	whom	seek	item

GO ON TO THE NEXT PAGE.

Part 1 (continued)

16	17	18	19	20
fixture	tense	likewise	kitchen	meanwhile
knuckle	firmly	funnel	inspect	destroy
limp	going	popcorn	sheriff	humming
ninety	resolve	remove	peeling	becoming
beggar	quickly	shown	fourteen	floating
stirred	swollen	boyish	together	sunburn
thimble	really	active	kneeling	locker
linger	lining	shoulder	pasture	fender
encore	fright	chivalry	shredded	cluster
pursuit	sorry	elderly	feather	revolt
hurdle	object	ticking	indulge	pilot
passkey	streak	distress	timber	tested
foolish	until	helpful	serpent	further
century	sleigh	certain	rubber	during
subject	primer	electric	nourish	sponge
lovely	silky	coming	plateau	plenty
forever	flock	enrich	illness	senior
surface	depart	former	stitch	linen
donkey	lobby	system	primly	gleam
concert	beside	where	locust	tennis
shelter	quiver	nurse	career	finely
furnish	fiber	social	pigeon	their
occupy	suffer	nostril	though	recipe
detect	porch	round	dungeon	easier
notion	vocal	simply	forenoon	closet
finest	bribe	recess	learning	turkey
tiptoe	proud	breath	telephone	predict
person	fisher	sloping	knitting	symbol
eating	drown	cricket	trinket	human
moving	consult	ripple	chisel	perish
hunter	front	circus	reply	terror
enough	scour	stroke	flesh	shield
tropics	your	hidden	study	rocker
everyone	thorn	express	quote	poppy
unsteady	leave	itself	there	levee
thicket	either	rusty	roses	fervor
fierce	tight	beef	tribe	joint
spoke	climb	noun	inches	relic
perch	stern	skin	rice	midst
ferry	verb	type	poll	rescue
entry	exit	busy	zero	since

GO ON TO THE NEXT PAGE.

Part 1 (continued)

21	22	23	24	25
finish	shipping	bliss	pour	sudden
ginger	through	keen	drugs	tissue
slightly	chestnut	road	film	blade
routine	lack	chew	mesh	lonely
wither	mission	glue	cheese	wrist
strife	without	lilies	peace	nursery
eyelet	guessed	poster	thing	urging
jungle	eastern	fumble	police	turnip
willow	deepest	recent	onion	reveal
prison	stuffed	untrue	strict	decided
outline	twenty	disgust	twelve	chimney
pleasing	cottage	reader	furnace	entirely
midnight	opinion	glorious	multiply	jaunty
robbery	sisters	forlorn	chuckle	rejoice
bestow	mitten	nobody	pepper	session
widely	obedient	evident	blend	elbow
curb	blurred	seventh	kettle	result
root	election	earnest	dislike	widow
usual	destiny	pronoun	came	string
lower	outing	rebuke	trench	hooked
lofty	tunnel	comedy	noted	dentist
cycle	pitch	tribute	consent	pieces
globe	cloves	unjust	morose	legion
negro	knife	leaf	pupil	crisp
slice	plenty	queen	cripple	much
wrong	loyal	method	brook	fully
cordial	fifty	dollar	pickle	scold
better	chorus	bodily	hostile	bounce
dotted	excess	might	chosen	resent
roving	giggle	glove	flutter	smudge
dollar	injury	tenor	sword	senate
wireless	fourth	thorn	eighty	freckle
decrease	beacon	crisis	reliance	stout
outside	frown	pinch	downtown	digest
undue	oblige	vexed	inclose	hobby
roller	unlike	twine	pillow	brush
voter	option	brick	logical	fissure
block	celery	focus	melon	leather
creep	blithe	census	rustic	victory
bite	thirty	buyer	bonus	dozen
cent	none	shrub	invite	prong

DO NOT GO ON TO THE NEXT PAGE UNTIL YOU ARE ASKED TO DO SO.

STOP.

Part 2 (2 minutes)

26	27	28	29	30
fringe	difficult	quick	cutting	provoke
sister	condition	success	summon	gently
meet	river	winner	exercise	judge
thrifty	flush	govern	because	resist
flowing	justice	term	merry	strict
engineer	sought	lawn	soldier	dirty
errand	balmy	chum	perform	pause
profit	fence	limit	subject	tender
vigor	belief	snow	permit	comb
forceful	cunning	organ	observe	equal
tinge	country	brief	feeble	model
weak	blossom	income	return	united
drove	disease	crown	instruct	point
truth	summon	health	control	trust
filmy	sweet	shutter	knight	begin
crawl	fever	costume	friend	keep
loss	unity	silence	subject	post
useless	storm	money	number	quart
border	forgive	editor	printing	grown
product	quality	gossip	effort	blister
liquid	violent	writing	perform	screen
construct	sphere	course	constant	blend
hinder	enroll	request	shiver	thrive
before	blouse	nobler	dinner	bounty
foreign	blind	wound	prosper	knock
divide	style	stock	vessel	sound
thrill	head	boiling	breeze	bloom
last	eyes	punish	bang	critic
conduct	rule	knead	shirt	local
dress	join	defense	complex	gifted
gloom	honest	complete	music	member
volume	commerce	section	wring	burst
consist	bridge	walnut	earth	shortly
muddy	height	bruise	bold	pierce
gleam	tremble	column	rough	brown
depth	spark	uniform	friend	car
fruit	invent	enter	secure	liberty
recent	tissue	offset	dreary	direct
bright	shrink	blond	cover	effect
first	guide	wind	beside	touch
thicken	vivid	meek	noisy	driver

GO ON TO THE NEXT PAGE.

Part 2 (continued)

31	32	33	34	35
discount	button	civil	swimming	grind
buckle	street	trough	struggle	stretch
possible	tooth	wonder	poultry	outcome
building	lusty	pump	journey	kindly
trouble	corner	corn	opposite	thread
exert	turn	bluff	wretch	frolic
believe	throw	short	taught	bonds
source	protect	beach	slight	recite
devote	defeat	keeper	curved	pulse
labor	nerve	cement	pretty	swamp
reserve	trim	muddy	origin	crust
hopeful	pulley	bulletin	behind	shelter
penny	fortune	stumble	certain	choose
learn	thistle	improper	shrink	part
screen	collar	poverty	promise	using
purse	esteem	courage	impulse	folded
sketch	shell	bouquet	current	ceiling
quietly	broken	stencil	dismiss	theme
mischief	feather	purpose	broader	surprise
revolt	clever	heartily	neglect	butcher
flying	floor	question	conceit	plowing
precious	summit	receive	blunder	shingle
similar	benefit	lessen	winter	trunk
sullen	listless	towel	swallow	scheme
grocery	inquire	past	bending	lumber
pottery	definite	rugged	conquer	between
tumble	chicken	weight	praise	describe
throb	ticket	truck	design	distinct
spoil	posture	prompt	tinsel	merchant
ideal	thrust	region	union	offering
pledge	formal	society	pride	steeple
trust	hence	mental	follow	think
circle	become	crest	tower	known
other	coffee	field	sponge	relief
ease	heroism	press	uphill	purple
solid	pleasant	shower	vessel	mildly
bound	courtesy	geese	policy	ready
flood	pushing	likely	needle	flour
bruise	story	custom	persist	erect
scene	gulf	title	verse	spend
office	plume	public	honor	whole

GO ON TO THE NEXT PAGE.

Part 2 (Continued)

36	37	38	39	40
extend	sonnet	sherbet	ermine	jockey
derrick	verify	cunning	finest	concur
seeded	ellipse	nominee	lucky	distort
divert	vespers	revelry	trophy	console
toast	referee	dubious	borne	pensive
whine	shrimp	crochet	dump	duchess
jostle	coerce	venison	vigil	impetus
resound	tonic	hygiene	elude	duplex
diverse	vital	zenith	poem	gristle
shrewd	cough	creamy	eagle	race
bristle	suburb	exertion	leech	molest
whence	eclipse	terrace	quick	remedy
pauper	bunting	council	expire	serene
instill	fervent	utilize	muskrat	billow
compile	shortly	coroner	decide	lilacs
expend	tenant	scoffer	triple	medley
redeem	iodine	district	pecan	decline
subside	comely	within	score	fluent
inspire	supple	insult	fresco	unison
convict	orchid	steady	steed	reverie
nearer	deliver	convert	grove	costume
perplex	exploit	siding	strive	dutiful
strain	former	minor	mutiny	servant
widen	chagrin	retort	jester	converse
concise	hustle	thesis	beaver	horizon
trustee	treble	climate	desist	consider
company	using	govern	rigid	deposit
enliven	tendon	brevity	donor	highly
indorse	moose	futile	mumps	unique
keener	closed	docile	profess	marine
tutor	gopher	ethics	chemist	entice
instep	lyrical	cured	flourish	scope
mildew	porter	sleigh	initial	clique
unify	finite	eaves	deprive	broth
rouse	pollen	orbit	pupil	older
signs	search	expose	chore	libel
gorge	piston	longer	flute	crawl
punch	rebel	siren	ivory	tools
sheer	ether	hover	gypsy	soul
pursue	peony	usurp	brook	creep
hotel	throne	myth	knew	odor

GO ON TO THE NEXT PAGE.

Part 2 (Continued)

41	42	43	44	45
sunlight	dwelling	nonsense	silver	mention
rhythm	trumpet	think	mellow	simple
thunder	discover	beauty	generous	seven
outcry	mixture	tenth	second	chalk
morsel	brother	crumb	insect	jumble
frontier	villain	freedom	guilt	worth
frequent	memory	resemble	spring	merely
whisper	indirect	slight	coarse	selfish
industry	vigorous	burning	pocket	ignore
sparkle	ringlet	glisten	turning	carpenter
summer	calmly	moving	flicker	element
shelter	minute	blight	search	blend
enlarge	extreme	comment	spirit	sultry
interest	dignity	neglect	tired	teach
written	living	orchard	resign	review
lower	sturdy	distress	humble	limb
torrid	property	cheer	idleness	melody
lodge	lesson	last	direction	possess
squash	yield	gloss	tempest	shining
proverb	poverty	continue	student	hollow
swollen	motion	suggest	medium	burden
present	thought	mouth	decent	buffalo
rumor	saw	sincere	shortly	complete
science	loose	resort	joint	remind
toward	perfect	mourn	sunny	worm
worry	world	early	forlorn	couple
shout	speech	wreck	discord	earth
endure	robust	confuse	private	cruel
spelling	greedy	pencil	holding	soften
people	orphan	energy	report	poetry
hollow	crude	check	concert	third
lifting	reduce	polite	reason	smiling
crystal	whole	cipher	concern	biology
exhibit	stove	speed	letter	copied
produce	center	repeat	singing	device
nimble	orator	noisy	utmost	future
little	shrill	digest	enjoy	hour
voice	jolly	service	education	robin
words	crow	finger	reflect	view
rent	dimly	nestle	muffle	glory
doubt	notice	listen	junior	home

GO ON TO THE NEXT PAGE.

Part 2 (Continued)

46	47	48	49	50
exhibit	review	freight	evident	monkey
turmoil	binder	ticket	control	quest
resort	width	hunter	justice	purse
clover	ledge	mother	twilight	skull
druggist	entitle	frock	brother	reply
gambol	berry	prolong	minnow	heroic
thirteen	scarf	eagerness	chilled	culprit
princess	chimes	reference	witness	player
endeavor	brittle	tremble	scholar	dimple
stubborn	mirror	restore	premium	stupid
wistful	cinder	noodles	oration	gutter
furious	enemy	register	torrent	should
pumpkin	cherish	certain	ending	vision
shopping	butter	gleeful	wrench	wreath
rolling	promote	doctor	women	dignify
important	caution	mixed	drummer	spoon
surround	eminent	bronze	triumph	uncle
mention	sermon	weather	destroy	citizen
seldom	could	ninth	lounge	frosted
forget	freight	jerk	county	usually
lettuce	rumble	prose	sunset	wrinkle
disagree	tongue	chemical	mouth	nephew
definite	stream	forty	clearly	hornet
relative	jingle	invite	buffet	season
boycott	florist	hurry	flimsy	forest
evening	refuge	motto	bower	clumsy
twisted	stretch	plight	violin	shuffle
seventy	outdoors	hermit	leaflet	chum
cornet	feature	rejoice	resident	topic
niece	copper	intrude	hickory	census
belfry	subdue	cherry	cocoon	plume
groom	minus	mouse	thirsty	turtle
ruddy	bucket	flurry	belong	oddity
equip	cousin	when	unless	scissors
spider	previous	budge	swamp	purchase
predict	bureau	cello	would	monotone
forgot	destiny	series	prune	spindle
behold	chirp	visual	mint	frenzy
proud	snugly	fluid	clown	cruel
wolves	often	more	sixty	stool
frolic	hood	zinc	utter	toss

DO NOT GO ON TO ANY OTHER TEST UNTIL YOU ARE ASKED TO DO SO.

STOP.

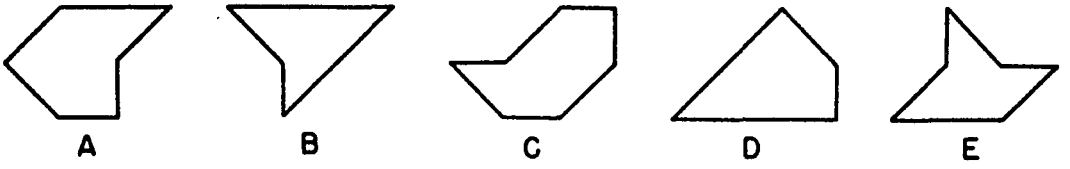
APPENDIX C: HIDDEN FIGURES TEST

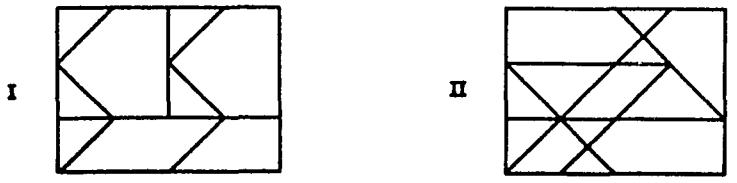
HIDDEN FIGURES TEST — Cf-1

This is a test of your ability to tell which one of five simple figures can be found in a more complex pattern. At the top of each page in this test are five simple figures lettered A, B, C, D, and E. Beneath each row of figures is a page of patterns. Each pattern has a row of letters beneath it. Indicate your answer by putting an X through the letter of the figure which you find in the pattern.

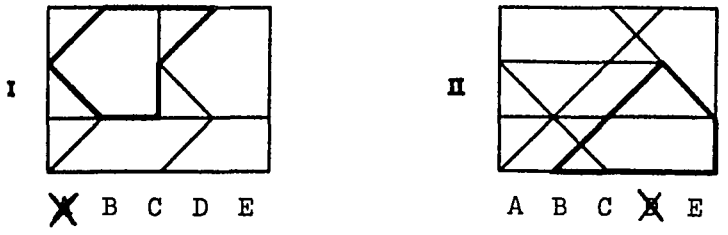
NOTE: There is only one of these figures in each pattern, and this figure will always be right side up and exactly the same size as one of the five lettered figures.

Now try these 2 examples.





The figures below show how the figures are included in the problems. Figure A is in the first problem and figure D in the second.



Your score on this test will be the number marked correctly minus a fraction of the number marked incorrectly. Therefore, it will not be to your advantage to guess unless you are able to eliminate one or more of the answer choices as wrong.

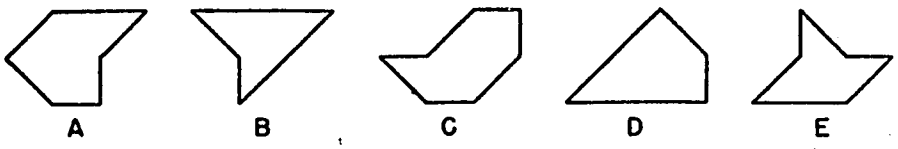
You will have 10 minutes for this test. When you have finished STOP. Please do not go on until you are asked to do so.

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

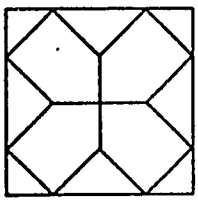
Developed under NIMH Contract M-4186

Page 2

Part 1 (10 minutes)

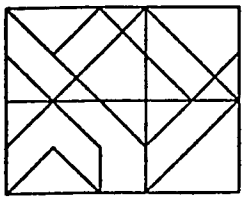


1.



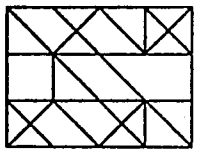
A B C D E

2.



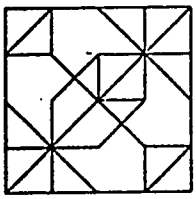
A B C D E

3.



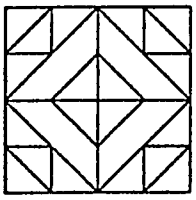
A B C D E

4.



A B C D E

5.



A B C D E

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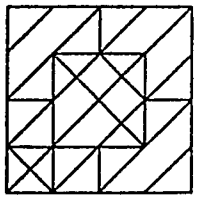

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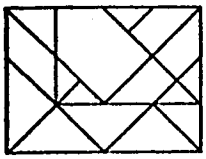

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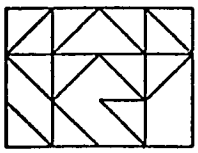

A B C D E

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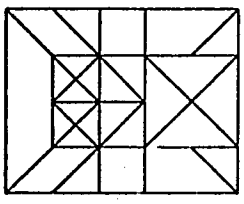

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Part 1 (continued)

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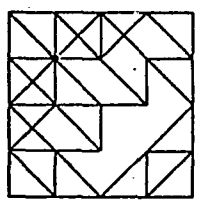

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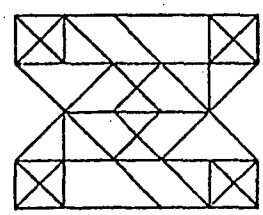

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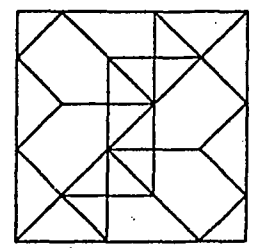

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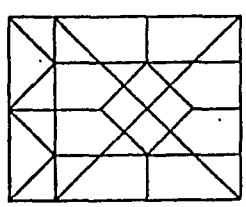

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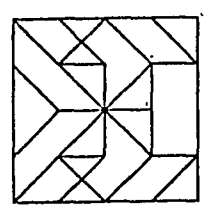

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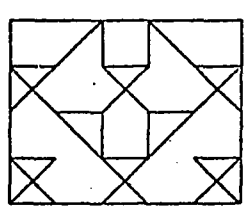

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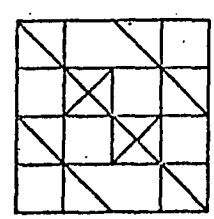
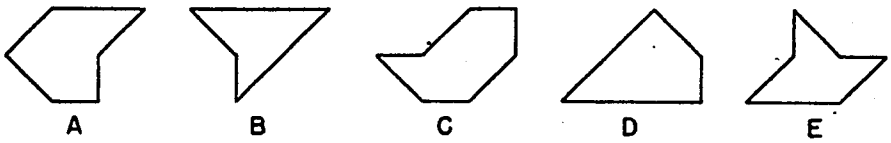


A B C D E

DO NOT TURN THIS PAGE UNTIL ASKED TO DO SO.

STOP.

Part 2 (10 minutes)



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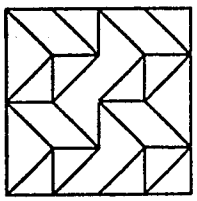

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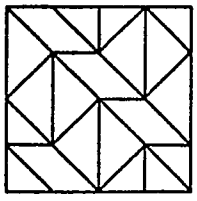

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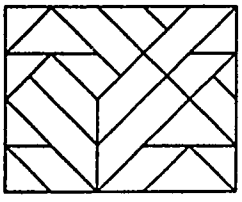

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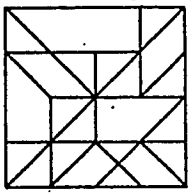

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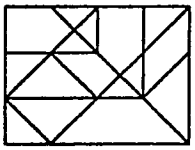

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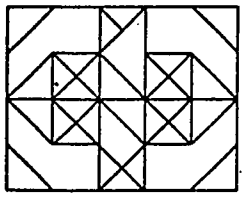

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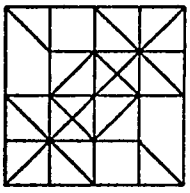

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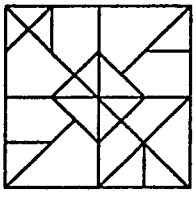

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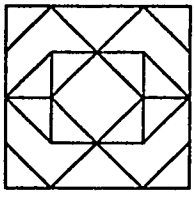

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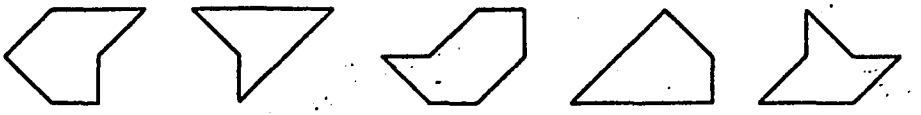
Part 2 (continued)



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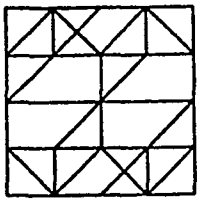

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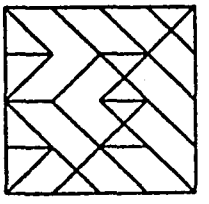

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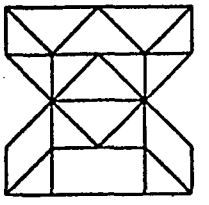

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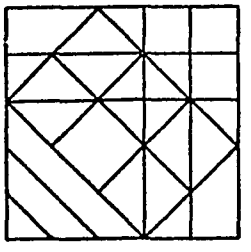

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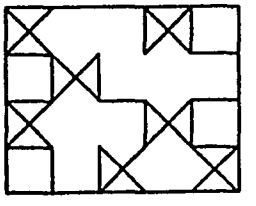

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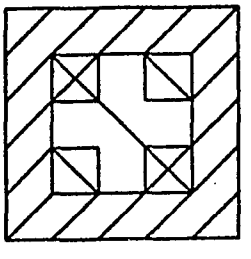

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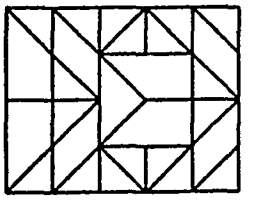

A B C D E

DO NOT GO ON TO ANY OTHER TEST UNTIL ASKED TO DO SO.

STOP.

APPENDIX D: COVER SHEET FOR TASKS

Date of Birth (month, day, year) _____

Date Today _____

Teacher _____

Group _____

First initial of father's first name _____

First initial of mother's first name _____

Sex _____

1. Is it important to you that you do well on these tasks?

Yes_____

No _____

2. How important is it to you that you do well on these tasks?

Extremely Important

I Couldn't Care Less

APPENDIX E: SUMMARY TABLES FOR MULTIVARIATE ANALYSIS OF VARIANCE

TABLE 28

Multivariate Analysis of Variance Using Premenstrual and Postmenstrual Scores

Source	F(4,61)	P Less Than
Motivation (M)	.596	.667
Order of Tasks (OT)	.491	.743
Order of Form of Simple Task (OS)	.907	.465
Order of Form of Complex Task (OC)	.499	.737
Order of Menstrual Cycle (OCy)	20.961	.001***
M(OT)	.293	.882
M(OS)	.681	.608
M(OC)	1.482	.219
M(OCy)	.335	.335
OT(OS)	.802	.529
OT(OC)	1.499	.214
OT(OCy)	.300	.887
OS(OC)	.848	.500
OS(OCy)	.104	.981
OC(OCy)	2.980	.026*
M(OT)OS	.640	.636
M(OT)OC	.976	.427
M(OT)OCy	1.695	.163
M(OS)OC	2.601	.045*
M(OS)OCy	2.633	.043*
M(OC)OCy	1.008	.410
OT(OS)OC	.791	.536
OT(OS)OCy	1.901	.122
OT(OC)OCy	.456	.767
OS(OC)OCy	.508	.730
M(OT)(OS)OC	.596	.596
M(OT)(OS)OCy	.445	.445
M(OT)(OC)OCy	.377	.824
M(OS)(OC)OCy	.439	.780
OT(OS)(OC)OCy	1.553	.198
M(OT)(OS)(OC)OCy	.705	.592

TABLE 29

Multivariate Analysis of Variance
Using First and Second Administration Scores

Source	F(4,61)	P Less Than
Motivation (M)	.353	.841
Order of Tasks (OT)	.772	.547
Order of Form of Simple Task (OS)	.626	.646
Order of Form of Complex Task (OC)	2.126	.088
Order of Menstrual Cycle (OCy)	1.784	.144
M(OT)	1.493	.215
M(OS)	.788	.544
M(OC)	.945	.444
M(OCy)	1.483	.218
OT(OS)	1.417	.239
OT(OC)	1.690	.164
OT(OCy)	.195	.940
OS(OC)	1.278	.288
OS(OCy)	.470	.757
OC(OCy)	1.015	.407
M(OT)OS	.808	.525
M(OT)OC	.521	.721
M(OT)OCy	.660	.622
M(OS)OC	2.704	.039*
M(OS)OCy	2.742	.036*
M(OC)OCy	1.419	.238
OT(OS)OC	.881	.481
OT(OS)OCy	1.184	.327
OT(OC)OCy	.224	.924
OS(OC)OCy	.077	.989
M(OT)(OS)OC	.223	.924
M(OT)(OS)OCy	.619	.651
M(OT)(OC)OCy	1.087	.371
M(OS)(OC)OCy	.800	.530
OT(OS)(OC)OCy	.923	.457
M(OT)(OS)(OC)OCy	1.169	.333

TABLE 30

Multivariate Analysis of Variance
for Subsample of Subjects
Using First and Second
Administration Scores

Source	F(4,67)	P Less Than
Motivation (M)	1.562	.195
Order of Menstrual Cycle (OCy)	1.690	.163
M(OCy)	3.356	.015*

TABLE 31

Multivariate Analysis of Variance for Subsample of Subjects Using Premenstrual and Postmenstrual Scores

Source	F(4,67)	P Less Than
Motivation (M)	1.879	.124
Order of Menstrual Cycle (OCy)	15.288	.001***
M(OCy)	3.849	.007**