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Effects of premenstrual syndrome on cognitive performance—real or imagined

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Effects of premenstrual syndrome on cognitive performance -- real or imagined

by

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INTRODUCTION

The impact of the menstrual cycle on women's physical, psychological, social, and occupational functioning is a subject of considerable, and oftentimes heated, debate. This debate has been influenced strongly by a variety of disciplines interested in understanding characteristics and effects of the menstrual phase. The emerging model suggests a complex interaction of multiple determinants: biological, psychodynamic, interactional, and sociopolitical (Kaplan, 1984). In the last two decades, for example, women's roles in society experienced significant changes. Not surprisingly, these changes permeated their entire beings, resulting in increased attention and focus on the menstrual cycle and its effect on women's well-being. Laymeyer (1984) provided the following illustration:

> The rise of women from pure procreators to active participants in society, the availability of birth control methods enabling them to remain free of pregnancy for protracted periods, and the use of bottle feeding have produced a situation in which many women may have 30 or more years of active menstruation and thus, ironically, a new set of symptoms. (p. 107)

While Laymeyer identified a range of potential effects of recent lifestyle changes on menstrual processes, she

particularly focused on the highly publicized and little understood phenomenon of premenstrual syndrome (PMS). Among all characteristics of the woman's menstrual cycle, PMS has evoked the most controversy.

Whereas the acknowledgement and recognition of a premenstrual disorder were welcome by some women, others were quick to point out that the sociopolitical nature of PMS is really a double-edged sword. Recent action by the American Psychiatric Association (APA), for example, resulted in the inclusion of a diagnosis entitled Perliuteal Phase Dysphoric Disorder (PDD) into the Diagnostic Statistical Manual, a handbook of mental disorders. In brief, PDD was defined as the specific behavioral, emotional, cognitive, and mood-related symptoms that occur in relation to the luteal phase of a woman's menstrual cycle. (For the complete entry, see Appendix A.)

Members from approximately 350 PMS support groups in the United States and Canada sent petitions to Washington protesting APA's move, stating that PDD's inclusion was an attempt to classify women suffering from premenstrual syndrome as mentally ill. They further argued that this particular entry, and its potential misinterpretation and misapplication, provides greater opportunities for gender discrimination. Opponents of this proposal also feared that the practical consequences of this action could include

negative influences on medical insurance coverage, custody battles, and employment issues. More importantly, protestors contended that PMS sufferers would not seek treatment for their premenstrual symptoms because of the stigma attached to mental illness.

Proponents, on the other hand, speculated that much of the confusion over APA's actions is due to myths about mental illness. They noted that the definition was added to the manual to help physicians diagnose PDD in a systematic fashion and to promote more research in hope of achieving greater understanding.

Despite risks of misapplication and exploitation, efforts to encourage research and enhance understanding about PMS are pertinent and overdue. At present, little is known about the disorder's etiology or treatment. There is, however, some agreement among leading investigators that "there are biological components to the etiology of at least some of the many different kinds of changes, but that it is unlikely that a single biological factor is causative for all kinds" (Endicott, 1986, p. 2).

Due to the fact that no true epidemiological study has been performed with adequate data collection procedures and stringent controls, the percentage of women experiencing severe symptoms of PMS is yet to be determined. Recent data and estimates suggest that some women experience no changes

in physical condition, mood, or behavior associated with the premenstrual phase, but most experience at least mild physical changes (Endicott, 1986). It also is estimated that approximately 32% to 40% of all menstruating women have mild to moderate changes in mood and behavior (e.g., depression, irritibility, distractibility, tearfulness) associated with their menstrual phase, which may be apparent only to themselves or to others who are close to them (Endicott, 1986; Sanders, Warner, Backstrom, & Bancroft, 1983; Green & Green, 1985). Finally, "there is a subgroup of women who develop such severe changes in mood and behavior premenstrually that they may have considerable impairment in their interpersonal relationships, daily routine, or work" (Endicott, 1986, p. 8). The estimated percentages of women with severe PMS ranges from 3% to 15% (Backstrom, Bancroft, Bixo, Hammarback, Sanders, 1982; Endicott, 1986; Green & Green, 1985).

Given the actions of the APA and the dearth of solid research that forms the basis for their definition, additional research aimed at examining PMS and its effects on behavior appears necessary and timely. While there is a substantial amount of evidence with regard to affective changes associated with the menstrual cycle, the paucity of work with respect to other dimensions of behavior is striking. In light of this, the intent of the present study

was to examine potential changes in cognitive performance for women with PMS.

Previous investigations examining potential relationships between premenstrual changes and impaired cognitive functioning were inconclusive. Research studies in this area, although limited in number and methodology, typically indicated that PMS women often report temporary impairments in cognitive performance (e.g., decreased attention, lowered concentration, and memory dysfunction), but their self-reports were not objectively validated. The relative inability to objectively confirm such self-reported cognitive deficits may be related to the following issues: 1) frequently, tests used to measure cognitive performance have not been adequately sensitive or directly related to the expressed symptomatology of dysfunction; 2) inapproprite subjects have often been employed for study, resulting in inaccurate representations of severity and impairment; and 3) there is some speculation that women (and men) hold stereotypic conceptions of premenstrual tension that negatively influence subjective reporting but are not substantiated upon subsequent empirical testing.

Research in cognitive psychology has provided a means of understanding and assessing the particular cognitive stages and control processes that underlie mental activity. Using this information processing perspective, the present

research addressed the issues of attention and memory as well as the impact of expectations on cognitive performance in women with PMS.

REVIEW OF THE LITERATURE

Definition of Premenstrual Syndrome

The term "premenstrual syndrome" (PMS) denotes a cluster of symptoms that are time-locked to the menstrual cycle. More specifically, the cluster of symptoms constituting PMS would be those symptoms that women experience during the mid to late luteal phase of their cycle that are absent or otherwise greatly alleviated following menstruation.

Type and severity of PMS symptoms

The first attempt at describing PMS is attributed to Dr. Robert Frank, an American endocrinologist. In a landmark paper, published in 1931, Frank discussed the nature of PMS in the following manner:

> My attention has been increasingly directed toward a large group of women who are handicapped by premenstrual disturbances of manifold nature. It is well known that normal women suffer varying degrees of discomfort preceding the onset of menstruation. Employers of laborers take cognizance of this fact and make provisions for the temporary care of their employees. These minor disturbances include increased fatigueability, irritability, lack of concentration, and attacks of pain. In another group of patients, symptoms complained of are of sufficient gravity to

> require rest in bed for one or two days. In this group, particularly, pain plays the predominant role. There is still another class of patients in whom grave systemic disorders manifest themselves predominantly during the premenstrual period. [The latter] complain of unrest, irritability, 'like jumping out of their skin,' and a desire to find relief by foolish and ill-considered actions. Their personal suffering is intense and manifests itself in many reckless and sometimes reprehensible actions. Not only do they realize their own suffering, but they feel conscience-stricken toward their husband and family, knowing well that they are unbearable in their attitude and their actions. Within an hour or two after the onset of their menstrual flow complete relief from both physical and mental tension occurs. (In Norris & Sullivan, 1983, p. 22)

In 1953, Katherine Dalton, a forerunner in the field of menstrual cycle research, expanded Frank's list to include: depression, irritability, tension, fatigue, headache, feelings of unreality, sleep disorders, nausea, vomiting, constipation, bloating, edema, colicky pains, enuresis, alcoholic excess, vertigo, syncopy, parasthesia, schizophrenic reactions and relapses, increased susceptibility to infections, suicide, impulsivity,

epilepsy, and manic reactions. She added that such complaints must occur with regularity during the luteal phase of the cycle and result in climactic relief upon menstrual bleeding.

By 1968, the list had grown to approximately 150 different symptoms, representing nearly every medical specialty. Understandably, the tremendous diversity of complaints and inconsistencies of reported frequencies confounded efforts to clearly delineate a definition of PMS, especially one that was manageable and yet comprehensive.

In contrast to the somewhat flawed studies conducted prior to the mid 70s, more recent research in this area demonstrated improved design and methodology, including the sampling of more homogeneous subject populations. There was better agreement in these studies on the symptoms comprising PMS, although the researchers acknowledged that the number and variety of symptoms may vary widely from one woman to another, and within the same woman from one cycle to another.

Halbreich, Endicott, Schacht and Nee (1982), for example, clarified distinctions among the following important concepts that were used interchangeably by previous investigators:

> Premenstrual changes refer...to any pre versus post menstrual differences in type or severity of any

> variable being measured...[which] could range from changes in a single mood (e.g., anger) to specific measures of type of pain perception. The term premenstrual syndrome...refers to the pre versus post menstrual covariance of a number of different features that change together in a correlated fashion (e.g., depressive syndrome which includes depressed mood, low self-esteem, pessimism, changes in sleep and/or appetite, etc.). The term premenstrual disorder is reserved for those pre versus post menstrual syndromes which are repetitive and associated with significant impairment in functioning socially or occupationally. Finally, premenstrual exacerbation...[refers to] those instances in which the severity of an ongoing condition is manifested worse premenstrually (e.g., allergies, chronic depression, panic disorder). (Endicott, 1986, p. 1)

In regard to PMS, the emerging agreement was that symptoms may include affective, somatic, behavioral and social/occupational functioning components. "The emotional states most commonly reported in studies of PMS are tension, anxiety, depression, irritability, and hostility. Somatic complaints included abdominal bloating, swelling, breast tenderness, headache, and backache" (Abplanalp, 1983, p. 109). Notably, water retention is the most stable and

consistent factor of PMS (Laymeyer, Miller, & DeLeon-Jones, 1982; Green & Green, 1985). Typical behavioral changes consisted of tearfulness, impulsivity, forgetfulness, and an increased tendency to pick fights (Abplanalp, 1983). Finally, changes in social and occupational functioning frequently included an avoidance of social contact, difficulty concentrating, and lowered performance/efficiency (Abplanalp, 1983; Halbreich et al., 1982).

Symptom onset and time course

Equally important to the type and severity of perceived symptomatology is the issue of onset and time course of the symptoms. To date, there is no universal agreement as to THE days of symptom onset or cessation. Further clouding the issue is the fact that there are no clear-cut endocrine or physiological markers to distinguish the initiation of the syndrome. Thus, the various time periods that have been employed include: the entire luteal phase, the late luteal phase, the three to seven days immediately prior to the onset of menses, and the paramenstruum (e.g., a few days before and after onset of menses). In a similar fashion, baseline comparisons (intermenstrual phase), referred to as the "usual level of functioning" have consisted of the nonpremenstrual days of the cycle, the days post-menses and prior to mid-cycle or ovulation, or just after onset of

menses. Presently, the following information, summarized by Endicott (1986), serves as the recommended guidelines for onset/baseline procedures:

> There has been an increased tendency among investigators to contrast the days immediately prior to onset of menses (3, 5, or 7 days) with those immediately after the end of menses (3, 5, or 7 days). These are the two phases of the cycle which are likely to demonstrate the largest within individual phase differences for almost all measures (in women who manifest such differences). These are generally referred to as pre versus post menstrual comparisons. (p. 4)

Although some women also manifest changes in mood and behavior around the time of ovulation, the greatest heterogeneity of changes in women is shown during the days just prior to the onset of menses (including biological changes). In contrast, the period of greatest homogeneity among women in all measures is found during the five to ten days after the onset of menses (Endicott, 1986, p. 4).

In addition to these criteria, Norris and Sullivan (1983) offered two additional considerations for identification and diagnosis: 1) time of onset: PMS has a tendency to begin after pregnancy, after termination of the birth control pill, or after an episode of amenorrhea (no

periods); and 2) time of increased severity: "Mild symptoms of PMS may be present for a number of years but the woman notes a marked increase in her symptoms following the discontinuance of the birth control pill, following a pregnancy, after cessation of breastfeeding, after a tubal ligation or hysterectomy, or after an episode of amenorrhea" (pp. 10-11).

Finally, Abplanalp (1983) provided the following list of general factors which should be considered in the task of defining PMS. These include: "1) the number and combination of symptoms, 2) severity, 3) time course (on-off characteristics and duration) of symptoms, 4) age of subjects/patients, and 5) evaluation of validity of sources of information for assessment of the symptomatology" (p. 111).

Assessment Procedures and Methodological Considerations

Because of the apparent confusion and methodologic imprecision that characterized much of the research literature on PMS, Rubinow, Roy-Byrne, Hobar, Gold, and Post (1984) suggested the following as groundwork for future study. First, there is no single type of premenstrual syndrome or disorder that is experienced by all who have multiple or severe changes; at least several overlapping syndromes appear to exist. Second, any operational definition, in addition to specifying the types of symptoms

observed, should describe the intensity of symptoms during both the premenstrual and intermenstrual phases in conjunction with their onset and time course with respect to menstruation (e.g., temporal closeness and consistency of symptoms relative to onset of menstruation). Finally, the existence of the syndrome in question or cluster of symptoms should be prospectively confirmed via self-report before a woman's entry into studies or treatment. The authors contend that failure of this last consideration has most compromised the literature of PMS.

From a similar critical perspective, Parlee (1973) reviewed the main types of research strategies that have been used to study PMS. These include: 1) correlational data, 2) retrospective questionnaires, and 3) daily self-reports or interviews. In the first of these procedures researchers looked for a correlation between the phase of the menstrual cycle and the occurrence of specific, well-defined behaviors (e.g., between the luteal phase of the cycle and the commission of violent crimes, suicide, accidents, loss of control of aircraft). In general, the findings obtained from this research strategy must be regarded with caution given the types of variables that have been observed and the procedures used for statistical analysis. Specifically, Parlee commented, "Without further correlational studies of more diverse populations, and in

the absence of additional information as to which subgroup a woman belongs (e.g., potential criminal, potential artist), it is difficult to predict anything about an individual's behavior from the fact that she is in the premenstrual or menstrual phase of the cycle" (p. 456).

Retrospective questionnaires and interview reports have been the most popular mode of data collection and have been used primarily to select subjects and to evaluate changes during the cycle. Such retrospective questionnaires typically asked women to review their past cycles and rate their perceived experience of the symptoms in question. The first questionnaire of this type to be developed was the Menstrual Distress Questionnaire (MDQ), which is composed of 47 items and highlights the following eight factors: Pain, Concentration, Behavior Change, Autonomic Reaction, Water Retention, Negative Affect, Arousal, and Control (Moos, 1968; Moos & Leiderman, 1978).

In a review of the efficacy of the MDQ, Rubinow et al. (1984) summarized its shortcomings by noting that the majority of subtypes and scale items focused on somatic changes. In addition, the lack of inclusion/exclusion criteria limited the scale's ability to translate changes in mood and behavior into useful diagnostic categories. Finally, half of Moos's normative sample were using oral contraceptives and approximately 10% were pregnant. The

inclusion of women with PMS taking oral contraceptives was questionable because of studies suggesting that oral contraceptives may decrease the symptoms of PMS and improve global functioning for some women (Glick & Bennett, 1982; Norris & Sullivan, 1983)

In light of the shortcomings of the MDQ, Halbreich et al. (1982) collaborated to develop a more refined instrument called the Premenstrual Assessment Form (PAF), which is today's most widely used retrospective questionnaire. The PAF differs in a number of ways from other procedures frequently used to evaluate premenstrual features. The most important of these include individualized definitions of the premenstrual time period, specificity of item definitions, broadness of coverage and a focus upon severity of changes. In addition, it provides inclusion/exclusion criteria for a number of subsyndromes reflecting primary changes in mood and behavior, and introduces bidirectionality of change in the same symptom area (overeat or undereat versus changes in appetite). "At present, this provides the best way of selecting patients with similar symptom profiles" (Rubinow et al., 1984, p. 164).

The PAF consists of 95 items that represent 18 scales. The scales include: Low mood/Loss of pleasure, "Endogenous" depressive features, Lability, "Atypical" depressive features, "Hysteroid" features, Hostility/Anger, Social

withdrawal, Anxiety, Increased well-being, Impulsivity, "Organic" mental features, Signs of water retention, General physical discomfort, Autonomic physical changes, Fatigue, Impaired social functioning, Miscellaneous mood/Behavior changes, and Miscellaneous physical changes (Halbreich et al., 1982). (See Appendix B for a review of the items that comprise each scale.)

Despite the refinement of retrospective procedures, there is some consensus that such reports introduce considerable error; for example, some women may deny or minimize premenstrual changes while other women may exaggerate such changes. Moreover, numerous investigators have suggested that retrospective questionnaires tend to draw stereotypic responses, as memory distortions make temporal sequencing highly biased toward expectations and preconceptions (Green & Green, 1985; Ruble & Brooks-Gunn, 1979; Parlee, 1973; Laymeyer, 1984).

Most researchers now use daily measures instead of, or in addition to, retrospective assessments. Studies of prospective reporting "...have demonstrated that several possible menstrual symptom patterns (syndromes) exist, symptoms are often not restricted to the premenstrual phase and are almost never as severe when mentioned as when reported retrospectively" (Laymeyer, 1984, p. 108). While prospective studies are regarded generally as the most

reliable method of recording and assessing symptomatology, they are considerably more difficult and costly to undertake. In addition, they are not immune to bias. However, frequent measurements of symptoms, and attempts to disguise the purpose of a study have helped to minimize this bias.

In an effort to encourage more stringent controls and "cleaner" methodological designs, Abplanalp (1983) suggested that future investigators should provide clear discriptions of the following:

> 1) specification of the ways in which subjects were recruited; 2) age limitations; 3) contraceptive and medical information; 4) marital status; 5) parity; 6) race; 7) menstrual history data; 8) assessment instruments; 9) operational definitions of PMS; 10) psychiatric history data; 11) assessment of current psychological state; 12) criteria for assessment of severity of symptoms; 13) criteria for defining ovulatory status of cycle; 14) cut-off criteria for unacceptable subjects. (p. 114)

It was presumed that such descriptions would lead to findings with greater replicability, more valid evaluations of individual studies, and a better clarification of factors necessary to reach a consensus about definition.

Objective and Self-Reported Effects of Premenstrual Syndrome on Cognitive Performance

Since Frank (1931) first introduced the term PMS, numerous attempts have been made to relate menstrual symptomatology and the female hormonal cycle to changes in cognition, task performance, mood and personality traits. For example, Clare (1985) stated, "A variety of behaviors have been reported to vary in relation to the phases of the menstrual cycle, including aggression, illness behavior, accidents, examination and other test performance, and sporting performance" (p. 228). In a similar fashion, the increased participation of women in areas previously dominated by males and often believed unsuitable for a woman's temperament, has revived interest in the effects of menstrual phase on cognitive performance. Interestingly, very little data are available with regard to cognitive functioning or to various performance dimensions in general.

Due in part to the lack of data, generalizations concerning PMS women's functioning during the luteal phase of their menstrual cycle were based more on clinical information than on empirical research. Tiger (1970), for example, published an article for the New York Times Magazine which was completely void of empirical support, yet claimed that...

> an American girl writing her Graduate Record Examination over a two-day period or a week-long set of finals during the premenstruum begins with a disadvantage which almost certainly condemns her to no higher than a second-class grade. A whole career in the educational system can be unfairly jeopardized because of this phenomenon. (p. 132)

A review of the literature studying the effects of the luteal phase on cognitive functioning revealed inconclusive findings, mostly due to a host of methodological errors that characterize this area of study. The following is a summary of this literature, beginning with self-report data on the incidence of perceived changes followed by a review of the studies that attempted objective verification of subjective appraisals.

Incidence of perceived changes in cognitive performance

Morton, Addition, Addisom, Hunt, and Sullivan (1953) studied prison inmates; of the 249 women who reported premenstrual tension, 20% of this group reported an inability to concentrate. The perceived magnitude or intensity of this self-reported impairment was not stated, and the time period (last cycle, last two to three cycles, or the majority of cycles) was not identified.

In a study conducted by Moos (1968), 134 (16%) of the 839 subjects (wives of graduate students) used to norm the

MDQ reported moderate to severe increases in the symptoms pertinent to intellectual performance: difficulty with concentration, lowered school or work performance, decreased efficiency, and forgetfulness. In his articles describing the development of the questionnaire, however, Moos failed to report that of the 839 subjects, 420 were taking contraceptives, 81 were pregnant, and 40 did not answer questions about the use of oral contraceptives.

Finally, Halbreich and Endicott (1982, p. 258) reported that 12% of their subject population met the following criteria for "Organic" Mental Syndrome:

A. At least four of the following six items rated as at least mild (rated 3 to 6) [on a six-point scale]:

1. Poor motor coordination
2. Tendency to have accidents
3. More forgetful
4. Easily distracted
5. Concentration difficulties
6. Feel confused

The 12% reported to have met the criteria was less than the generally accepted incidence rates of 16% to 20%. Indeed, Endicott believed this to be an underestimation because "Organic" Mental Features have a greater risk of being masked by the more prominent depressive symptoms that

women are more likely to attend to (e.g., self-deprecation, tearfulness, decreased energy).

Behavioral observations of cognitive performance in PMS females

Wickham (1958) tested 4000 young Englishwomen who had been in the service six months or less with a battery of intellectual, spatial, mechanical, mathematical, and verbal tests and observed slightly lower scores than expected for women in the premenstrual phase, however, the differences were not statistically significant on any of the tests. It is important to note that Wickham defined the premenstrual phase as four days before and after the onset of menstruation. Reviewing the PMS literature on cognitive functioning, Golub (1976) commented that Wickham's inclusion of the menstrual days could have diluted the effects of the premenstrual changes, since it has been observed that after the onset of menstruation there is a release of premenstrual tension and irritability. Recent findings support Golub's concern regarding Wickham's definition of premenstrual phase and, in fact, suggest a striking improvement in mood and behavior with the onset of menses (Endicott, 1986). It is also quite possible, if not probable given the age of her sample, that a large number of the subjects had never been affected by PMS and thus were inappropriate for investigating behavioral correlates of the syndrome.

Sommer (1972) tested 200 college women on two types of intellectual tasks: the Watson-Glaser Critical Thinking Appraisal and regular class examinations. Scores were categorized on the basis of individual cycle phase (menstrual, follicular, mid luteal, and late luteal), with a separate analysis for oral contraceptive users. She reported that neither group showed any significant variation associated with menstrual phase and concluded that, "Studies utilizing objective performance measures generally fail to demonstrate menstrual cycle related changes" (p. 515). Consistent with previous studies in this area, there was no information about how many, if any, of the women reported a history of premenstrual dysfunction prior to the beginning of the study. Consequently, there appears to be an implicit, and inaccurate, assumption that all women are potential subjects. In addition, the subjects were all young college women (ages 18-21) comprising a population most likely to be affected by amenorrhea (cycle irregularity, perhaps for more than three months at a time), and less likely to be affected by PMS (Dickstein, 1984).

Finally, Golub (1976) studied the effects of premenstrual anxiety and depression on cognitive functioning. Fifty women between the ages of 30 and 45 completed the MDQ to determine menstrual cycle length and schedule. Additionally, it was used to record the subjects'

complaints of premenstrual negative affect (anxiety and depression), difficulty concentrating, and behavioral changes (forgetfulness, impaired school and work performance). Oral contraceptive users were excluded from the study. Subjects were asked to complete the Depression Adjective Check List (DACL), the State-Trait Anxiety Inventory (STAI), and a battery of factor analytically derived cognitive tests "sensitive to anxiety and depression." Tests were administered four days prior to the onset of menstruation and again two weeks later. Although the findings revealed significant changes in anxiety and depression during the premenstruum, there was no statistically significant difference found in cognitive test performance. She added that, "Correlation data failed to support any consistent relationship between premenstrual mood and cognitive functioning. Moreover, no significant correlations were found between premenstrual complaints on the MDQ and either cognitive test performance or mood states during the premenstrual testing periods" (p. 99). She concluded that the magnitude of mood change was not great enough to affect intellectual functioning.

Although Golub's study demonstrated a vast improvement over previous designs, two important considerations were neglected. First, subjects were not selected on the basis of their perceived level of PMS involvement, once again

implying that all women are viable subjects for the study of PMS, which is simply not the case. Second, although results of the MDQ demonstrated significant changes in negative affect, concentration, and behavioral changes, no concurrent daily ratings were obtained to determine if these differences were, in fact, perceived to be operating during the study as well. Given the previous information that changes fluctuate between women and differ in a woman from cycle to cycle, together with the evidence that retrospective data often exaggerate symptomatology, it is important to keep daily records to help verify the appropriateness of subjects selected. In addition, the MDQ does not measure changes in severity or intensity. Therefore, a subject who complains of forgetfulness may feel a bit forgetful or may feel incapacitated and unable to work effectively.

The only studies that have consistently reported premenstrual decrements in cognitive performance were conducted by Dalton (1960) who reported a decline in weekly exam performance of English schoolgirls in the premenstrual and menstrual phases (5 days each). Her findings revealed that 27% of the girls dropped in performance during the premenstrual phase. Seventeen percent of the students, however, improved their performance and 56% showed no change.

In 1968, Dalton also reported lower exam scores during the premenstruum among women attending the University of Cambridge. She did not, however, indicate the magnitude of these changes, nor did she provide any statistical validation for any of her data. Given these shortcomings, the validity and reliability of her findings are at the least questionable.

With the exception of Dalton's research, the majority of remaining studies, while few in number and procedurally limited, tend to demonstrate subjective impressions of cognitive impairment that have not been empirically validated. Several investigators have concluded that the reason may be due to the expectations, or stereotypic beliefs, that both women and men have regarding menstrual cycle debilitation, making self-report the most vulnerable to popular opinions and "self-fulfilled prophecies" of impairment (Sommer, 1973; Golub, 1976; Parlee, 1973; Endicott, 1986; Ruble & Brooks-Gunn, 1979). Sommer (1973), for example, wrote the following:

> While self-report is certainly an important source of data when one is studying the menstrual cycle, the hazards of generalizing from subjective appraisal to objective outcomes must be emphasized. There is no question of the powerful subjective impact of menstruation on many women--it cannot help but be so

given the history, both social and developmental, of people's responses to the cyclic productive phenomenon. (p. 516)

Purpose of This Research

In light of the preceding information which questions the reliability and validity of current research in this area and also reflects on the role of expectations on cognitive performance, the following issues were addressed in the present study.

First, studies that have attempted to measure cognitive functioning associated with the premenstrual phase of the cycle have relied solely on retrospective questionnaires to assess level of impairment. Therefore, it is uncertain if the cognitive symptomatology (i.e., decreased attention and concentration, confusion, and memory impairment) continued to be experienced on a daily basis. Recent investigations demonstrated the significance of monitoring daily reports for the identification of symptom occurrence and intensity, and for the determination of luteal phase onset and offset prior to the assessment of phase-related behavioral impairments (Rubinow et al., 1984, Endicott, 1986). Therefore, the first intent of this study was to ensure that phase-related cognitive impairment was, in fact, subjectively experienced by the subjects at the time of testing.

Second, the primary issues associated with empirical studies using objective performance measures included task sensitivity and suitability. Apart from other errors found in previous designs, these two issues are uniformly in question throughout the earlier work on cognitive impairment during the menstrual cycle. Conclusions regarding cognitive functioning have been based on intellegence tests, achievement tests, class examinations, and a battery of cognitive tests "sensitive to anxiety and depression." There is considerable doubt that these tests possessed the sensitivity required to assess the subtle kinds of cognitive changes that may temporarily be operating during the luteal phase of the cycle. In addition, all of the aforementioned were paper-pencil tests that represented global kinds of cognitive functioning, making it difficult to delineate processes or systems (e.g., attentional versus memory) that directly relate to the symptoms reported (e.g., difficulty concentrating, forgetfulness).

Cognitive psychology, on the other hand, has developed an information processing model which characterizes the stages and control processes utilized by the human brain as it analyzes and responds to stimuli. These stages and control processes have been clearly delineated on the basis of extensive research in which there is general agreement

that such a sequence of mental events underlies all human learning and cognition.

Insert Figure 1 about here.

As can be seen from inspection of Figure 1, information enters and is registered in sensory memory. It is identified from patterns stored in long-term memory and then attended to. The attentional process determines which information will pass from sensory memory to long-term memory. In short-term memory, the information is stored temporarily until elaborated for long-term storage or alternatively is purged from the system. Finally, long-term memory allows for large amounts of information to be stored over long periods of time.

This study attempted to tap into two of these stages to determine if there are, indeed, cognitive performance deficits associated with women who report PMS symptomatology. Specifically, this study focused on the cognitive components of attention and memory for two reasons: 1) problems with attentional capacity and interference as well as temporary impairments in memory are the most frequent complaints about cognitive functioning by PMS women, and 2) these components represent higher level

organizational functioning as opposed to the more automatic stages of sensory memory and pattern recognition. It was presumed that the utilization of the information processing model would provide the sensitivity necessary to reveal subtle, yet important, differences in the cognitive functioning of women who experience PMS.

Finally, this research examined the influence of expectations on objective measures of cognitive performance. For example, if it is possible for demand characteristics to affect the subjective experience of PMS, what role do they play in the performance of cognitive tasks during the luteal phase of the cycle? If one's performance can be altered by expectations, then subjects who are told that deficits in cognitive performance are strongly associated with PMS should exhibit decreases in performance during their luteal phase. Similarly, subjects who are informed that PMS does not have any debilitating effect on cognitive functioning, should demonstrate no subsequent changes in cognitive performance during their luteal phase.

METHODS

Subjects

Female undergraduate and graduate students, between the ages of 25 and 40, enrolled in the 1986 Fall semester at Iowa State University, were sent a letter requesting their voluntary participation in the study and asking them to respond to items on the Premenstrual Assessment Form to determine level of PMS involvement (see Appendix C for letter). Approximately 675 responses were obtained from the 1100 requests for participation. Subjects initially included in the study met the following criteria: 1) they were not currently using oral contraceptives or taking other hormone medication, 2) they were not pregnant nor planning pregnancy for the following four months, 3) they were free of concurrent medical or psychiatric illness, 4) they indicated a history of regular debilitating phase-related changes that met DSM-III-R criteria for Premenstrual Phase Dysphoric Disorder (PDD), and 5) they reported a score of 3 or higher on four of the six items constituting the "Organic" Mental Features (OMF) scale (see Appendix B for a list of the symptoms referred to as OMF). The preceding information was obtained from an interview with each candidate and responses on the PAF. These procedures resulted in a sample of 43 women.

Subjects were asked to complete two months of daily ratings to assess symptoms usually expressed by women who experience PMS (e.g., feel tearful, anxious, "blue"), with specific inclusion of various symptoms related to cognitive performance (e.g., concentration difficulties, distractibility, forgetfulness). Ratings were used to identify the onset and offset of the premenstrual phase of the cycle as well as to determine if the desired symptomatology was present prior to each adminstration of the test battery. Women, whose daily ratings were not consistent with their PAF results and/or did not continue to demonstrate subjective impressions of impairment prior to the onset of menstruation, were excluded from the study. Specifically, three women were excluded for such reasons, leaving a final sample of 40 women.

Screening Instruments

Daily Rating Form

The Daily Rating Form used in this study (see Appendix D) was developed by Endicott and Halbreich (1982) as part of an ongoing program of studies investigating premenstrual changes. Previous research has suggested that the willingness of women to complete daily ratings is partially determined by the number of ratings to be done (Endicott, Nee, Cohen, and Halbreich, 1986). Therefore, the present form included 20 items, the number recommended by Endicott

et al. (1986). The 20 symptoms selected were those associated with cognitive performance (e.g., forgetfulness, confusion, concentration difficulties, distractibility, lowered performance in work and school) and others on which phase-related changes have been most reported in previous studies (e.g., fatigue, breast pain, depressed mood, irritability).

Subjects were asked to make ratings on the items each evening using a scale of 1 for 'none of the feature' to 6 for 'extremely severe levels of the feature'. They also indicated the days of menses and noted if they had a physical illness or if any significant life event(s) had occurred that affected the ratings in any direction.

The Premenstrual Assessment Form (PAF)

The PAF is a 95-item self-report questionnaire designed to retrospectively measure changes in mood, behavior, and physical condition during the premenstrual period (see Appendix B for a copy of the PAF). The questionnaire, developed by Halbreich et al. (1982), was normed on two groups of women selected to test the sensitivity of the inital 150 items. The first group consisted of female employees at a research institute who received their questionnaires in payroll envelopes with an explanatory letter requesting assistance in developing a new form. The second group was comprised of women attending a regularly

scheduled class for student nurses. The 95 resulting items are rated on six-point scales of severity of change from usual condition, ranging from "no change" to "extreme change" for the last three menstrual cycles. Items can be scored in three ways on the basis of 1) specific criteria for categorical subtypes of premenstrual change, (2) summary unipolar dimensional scales, and 3) dimensional measures of bipolar continua.

The test-retest reliability of the PAF items and scoring systems was tested in a preliminary study, and later with daily ratings made across one cycle. The intraclass correlation coefficients of reliability ranged from .60 to .91 and averaged .79 for the before and after PAF unipolar dimensional summary scales. The authors indicated that women tended to describe their "worst case" on the initial PAF. However, after one month of daily ratings, women tended to score somewhat lower in describing their past cycle on the PAF. The more severe the premenstrual changes described, the more likely they were to be confirmed by daily ratings (Halbreich, Endicott, & Nee, 1983).

Cognitive Performance Tasks

As noted in the literature review, the cognitive tasks were selected on the basis of having the greatest likelihood of tapping the individual stages of the information processing model considered to be most vulnerable to

premenstrual changes. Therefore, the following were chosen to assess attention, memory, and integrative processing.

Attention task

Attentional processes were monitored by employing a "vigilance" task (Underwood, 1966). In this task, 5 to 15 letters were presented randomly on a computer monitor. The letters appeared for a duration of 250 msec with a two second inter-trial interval. The subject's task was to determine the number of letters presented on the trial by typing the correct value on the keyboard. The dependent variable was number of correct responses over 33 trials (11 different combination of letters, each combination presented 3 times).

Memory tasks

The purpose of these tasks was to examine memory performance in free recall, cued recall, and recognition tasks. In each, subjects were presented a list of 24 words for subsequent memory testing, however, the type of memory test was unknown to the subject.

In the free recall test, subjects were asked to type in all of the words from the list that they could remember; order of recall was not important. In addition, the computer notified the subject if she typed in a mispelled word so that a correction could be made.

In the cued recall test, subjects were presented with a list of words, each of which was highly associated with a word from the previous study list (extra list). After a cue was presented, subjects were asked to respond by typing in the word from the study list that was most associated with the extra list word. Following presentation of all cues, the extra list was presented again in its entirety, along with the subject's entries to give the subject another opportunity to recall any previously forgotten item.

In the recognition test, subjects were presented with 24 sets of 3 words, one set at a time. One of the words was a member of the study list and the other two were good distractors. The subject typed in the word that she believed belonged on the study list. The procedure continued until all 24 sets of words had been presented.

Integrative processing task

The final cognitive test was designed in a manner reminiscent to that of Clark and Chase (1972) and extended by Carpenter and Just (1975). This particular task utilizes all stages along the information processing model and is directly concerned with sentence-symbol integration.

On each trial, the subject was presented a sentence followed two seconds later by a picture (see Figure 2).

Insert Figure 2 about here.

As soon as the picture appeared, the subject's task was to determine whether or not the sentence correctly described the picture and respond by answering TRUE or FALSE. There were 24 trials of the sentence-picture pairs; the order of presentation of trial types was randomized for each subject. The dependent variables in this test were percent correct and verification time. Since so few errors are typically made in this task to make this dependent measure very informative, the dependent variable of particular interest was verification time made on correct responses (Keenan, 1982).

Procedure

The following describes the sequence of events which characterized the subjects' participation (see Figure 3 for a flow diagram of the selection procedure). Once subjects had been selected, they were divided into two groups to control for practice effects. Group I was tested first during their luteal phase; Group II was tested first during their intermenstrual phase. Luteal and intermenstrual phases were determined on the basis of information derived from the screening questionnaire and the daily rating forms.

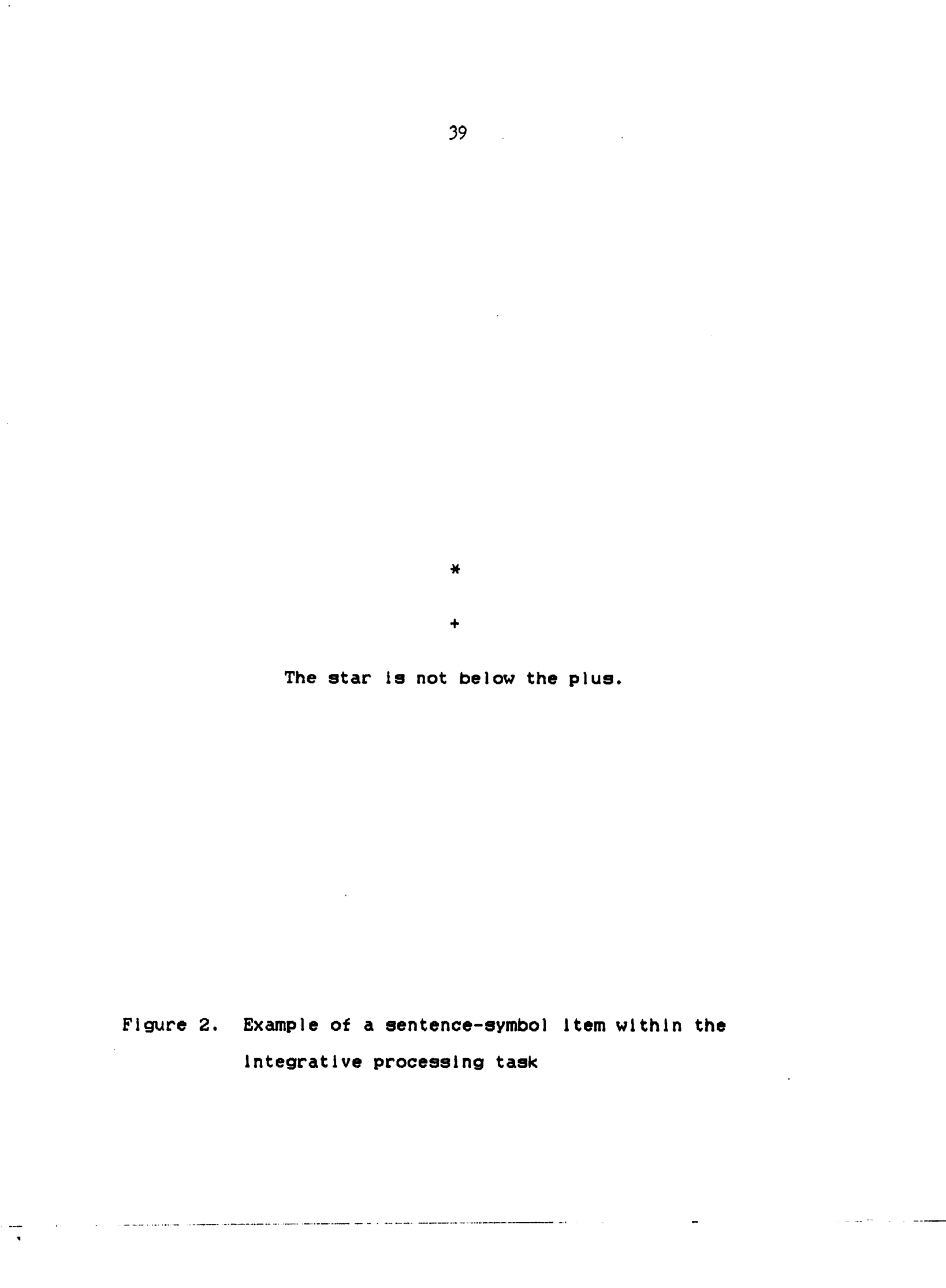

Figure 2. Example of a sentence-symbol item within the integrative processing task

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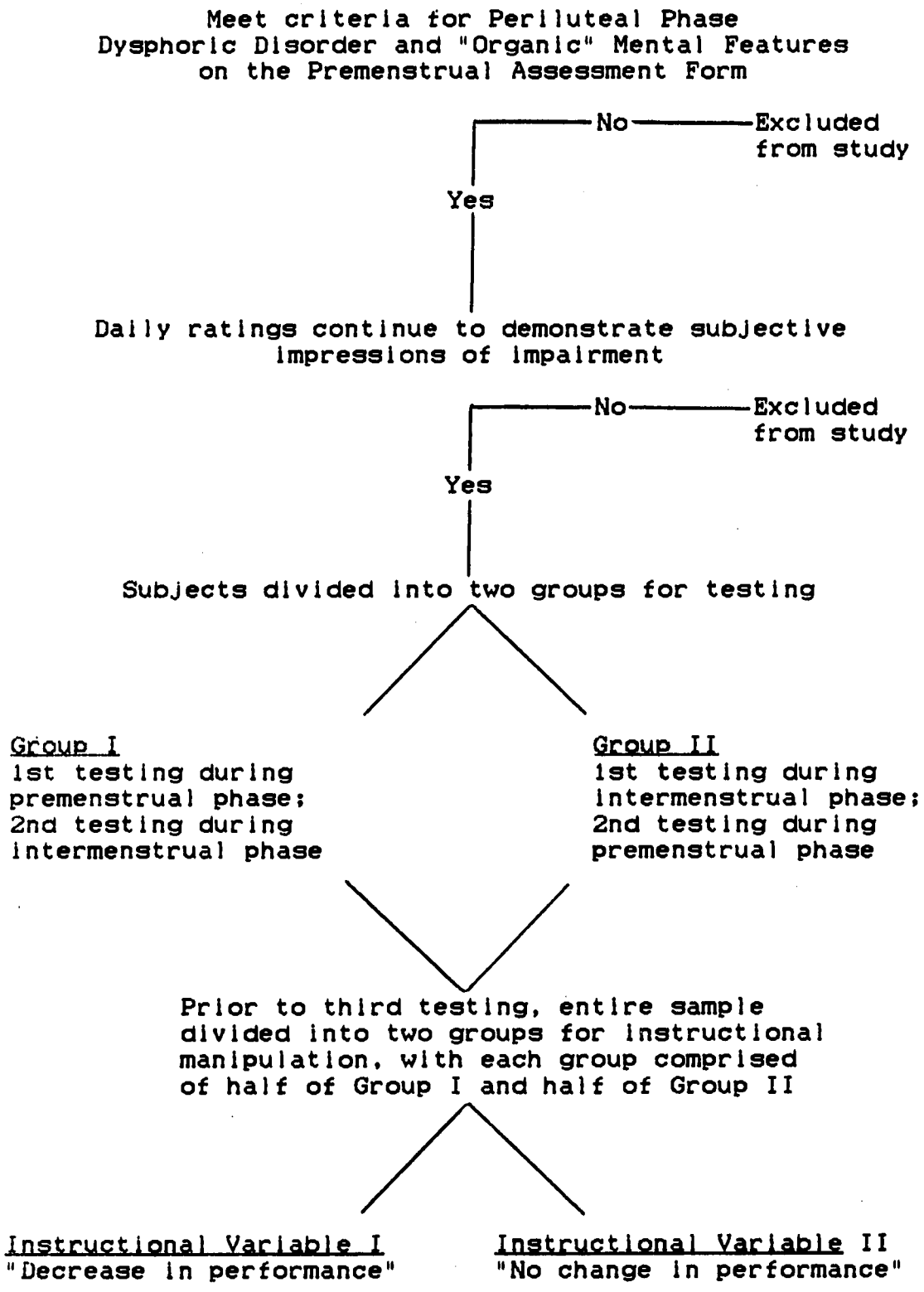
Insert Figure 3 about here.

Following selection, the subjects were asked to individually complete the cognitive performance tasks during both their luteal and intermenstrual phases. Upon completion of the initial two testing periods, subjects returned for a final testing period to again measure performance during the luteal phase. During this final stage of the study, two instructional variables were employed prior to the start of actual testing. One group of subjects was informed of the potentially debilitating influence that PMS has on one's ability to perform cognitive tasks. The second group was instructed that PMS has no impact on cognitive performance, despite some suggestions that they may have heard of elsewhere (see Appendix E for complete descriptions of the two instructional variables).

Finally, all subjects were debriefed and informed of the results of the study.

Figure Caption

Figure 3. Flow diagram of experimental procedures used in this study


Meet criteria for Perilluteal Phase Dysphoric Disorder and "Organic" Mental Features on the Premenstrual Assessment Form
No
Excluded from study
Yes
Daily ratings continue to demonstrate subjective impressions of impairment
No
Excluded from study
Yes
Subjects divided into two groups for testing
Group I
1st testing during premenstrual phase; 2nd testing during intermenstrual phase
Group II
1st testing during intermenstrual phase; 2nd testing during premenstrual phase
Prior to third testing, entire sample divided into two groups for instructional manipulation, with each group comprised of half of Group I and half of Group II
Instructional Variable I
"Decrease in performance"
Instructional Variable II
"No change in performance"

RESULTS

Daily Ratings

Daily ratings of 20 measures of mood, behavior, and physical condition were obtained for each subject over two consecutive monthly cycles. The ratings included daily evaluations of anxiety, depression, irritability, concentration, creativity, forgetfulness, interest in usual activities, perceived performance in work and school, appetite changes, breast tenderness, distractibility, tendency to have accidents, energy level, confusion, tendency to nag or quarrel, water retention, avoidance of social activities, mood swings, motor coordination, and tearfulness. Mean ratings were compared to examine subjective impressions of changes due to menstrual cycle phase.

A 2 X 2 repeated measures analysis of variance (ANOVA) was performed on each of the 20 variables with monthly cycle (1st cycle and 2nd cycle) and phase (luteal and intermenstrual) as within subjects variables. The means and standard deviations for each of these variables are listed in Table 1. In all instances, a reliable effect occurred only for menstrual phase. Specifically, on all 20 variables, subjects' ratings during the luteal phase were significantly higher than the intermenstrual phase:

Anxiety, $F(1,39) = 231.66$, $p < .0001$; Depression, $F(1,39) = 127.97$, $p < .0001$; Irritability, $F(1,39) = 231.13$, $p < .0001$; Concentration, $F(1,39) = 168.58$, $p < .0001$; Creativity, $F(1,39) = 119.76$, $p < .0001$; Forgetfulness, $F(1,39) = 119.76$, $p < .0001$; Interest, $F(1,39) = 178.55$, $p < .0001$; Performance, $F(1,39) = 158.42$, $p < .0001$; Appetite, $F(1,39) = 116.45$, $p < .0001$; Breast Tenderness, $F(1,39)$, $p < .0001$; Distractable, $F(1,39) = 118.55$, $p < .0001$; Accidents, $F(1, 39) = 26.28$, $p < .0001$; Energy, $F(1,39) = 163.54$, $p < .0001$; Confusion, $F(1,39) = 139.96$, $p < .0001$; Quarrelsome, $F(1,39) = 108.67$, $p < .0001$; Water Retention, $F(1,39) = 156.25$, $p < .0001$; Social Avoidance, $F(1,39) = 71.46$, $p < .0001$; Mood Swings, $F(1,39) = 158.82$, $p < .0001$; Clumsy, $F(1,39) = 57.86$, $p < .0001$; Tearful, $F(1,39) = 105.78$, $p < .0001$. Full ANOVA tables are presented in Appendix F.

Insert Table 1 about here.

Cognitive Performance Measures

Subjects were divided into two groups to control for practice effects on the performance measures. Groups were matched for age and perceived severity of cognitive dysfunction as self-reported on the Premenstrual Assessment Form. Group 1 was tested first during the luteal phase of

Table 1. Means, standard deviations, and F statistics for subjects' daily ratings

Daily rating variable	Cycle			
	First M/SD	Second M/SD	F	p
Anxiety	11.51 3.77	11.01 4.00	1.47	.23
Depression	11.68 3.40	11.40 3.62	0.36	.55
Irritability	12.19 4.29	12.28 4.13	0.04	.85
Concentration	12.27 3.37	12.06 3.51	0.30	.59
Creativity	10.37 3.63	10.10 3.64	0.34	.56
Forgetfulness	9.24 3.84	9.37 3.58	0.08	.78
Interest	10.20 3.40	10.17 3.02	0.01	.94
Performance	10.68 3.78	11.15 3.71	0.98	.33
Appetite	11.11 4.24	11.21 4.49	0.04	.85
Distractibility	11.41 3.94	11.88 4.30	1.44	.24

Phase			
Luteal M/SD	Intermenstrual M/SD	F	p
15.63 5.13	6.90 2.65	127.97	.0001
16.66 4.93	6.41 2.09	231.66	.0001
17.13 5.51	7.34 2.91	168.58	.0001
17.72 4.61	6.61 2.27	231.13	.0001
14.26 5.28	6.29 1.99	119.99	.0001
12.75 5.72	5.86 1.17	73.20	.0001
14.68 5.03	5.69 1.40	178.55	.0001
15.58 5.37	6.25 2.12	158.42	.0001
15.73 6.19	6.58 2.54	158.42	.0001
16.51 5.59	6.78 2.65	118.55	.0001

Table 1. (Continued)

Daily rating variable	Cycle: First M/SD	Cycle: Second M/SD	F	p
Breast Tenderness	9.95 4.18	10.03 4.94	0.02	.88
Accidents	7.79 3.90	8.43 4.73	1.57	.22
Energy	13.15 3.95	13.56 4.45	0.81	.37
Confusion	10.58 3.66	10.67 3.92	0.03	.85
Quarrelsome	10.61 4.34	11.11 4.25	0.61	.44
Water Retention	11.25 4.50	12.16 4.40	1.79	.19
Social Avoidance	9.57 3.86	9.64 4.31	0.02	.89
Mood Swings	12.05 4.09	12.07 4.49	0.00	.98
Clumsy	8.90 4.06	9.57 3.89	1.87	.18
Tearful	10.09 3.41	9.90 3.80	0.18	.67

Phase			
Luteal M/SD	Intermenstrual M/SD	F	p
14.58 7.74	5.40 1.33	63.13	.0001
10.54 6.72	5.68 1.19	26.28	.0001
18.64 5.17	8.07 3.23	163.54	.0001
15.17 5.84	6.08 1.74	139.96	.0001
15.19 6.60	6.53 1.99	108.67	.0001
17.67 7.06	5.74 1.84	156.25	.0001
13.18 6.31	6.03 1.86	71.46	.0001
17.43 6.24	6.69 2.34	158.82	.0001
12.78 6.57	5.69 1.38	57.86	.0001
14.14 5.67	5.90 1.53	105.78	.0001

Table 1. (Continued)

Daily rating variable	Phase X Cycle: First Luteal M/SD	First Intermenstrual M/SD	Second Luteal M/SD	Second Intermenstrual M/SD	F	p
Anxiety	15.88 4.82	7.15 2.72	15.38 5.44	6.65 2.57	0.00	1.00
Depression	16.83 4.74	6.53 2.05	16.50 5.11	6.30 2.13	0.01	.91
Irritability	17.05 5.56	7.33 3.01	17.20 5.45	7.35 2.80	0.02	.90
Concentration	17.98 4.33	6.55 2.41	17.45 4.89	6.68 2.13	0.66	.42
Creativity	14.58 5.26	6.15 1.99	13.95 5.29	6.25 1.98	0.77	.38
Forgetfulness	12.60 5.95	5.88 1.73	12.90 5.48	5.83 1.68	0.16	.69
Interest	14.70 5.38	5.70 1.42	14.65 4.67	5.68 1.37	0.00	.98
Performance	15.05 5.27	6.30 2.29	16.10 5.46	6.20 1.95	1.12	.30
Appetite	15.53 5.65	6.68 2.82	15.93 6.72	6.48 2.25	0.30	.59
Distractibility	16.28 5.15	6.53 2.73	16.73 6.03	7.03 2.56	0.00	.95

Table 1. (Continued)

Daily rating variable	Phase X Cycle: First Luteal M/SD	First Intermenstrual M/SD	Second Luteal M/SD	Second Intermenstrual M/SD	F	p
Breast Tenderness	14.65 7.54	5.25 0.81	14.50 8.03	5.55 1.84	0.31	.58
Accidents	10.00 5.86	5.58 1.93	11.08 7.57	5.78 1.89	0.70	.41
Energy	18.35 4.73	7.95 3.17	18.93 5.61	8.18 3.28	0.11	.75
Confusion	15.08 5.62	6.08 1.70	15.25 6.06	6.08 1.77	0.03	.86
Quarrelsome	14.70 6.74	6.52 1.93	15.68 6.46	6.53 2.04	0.56	.46
Water Retention	16.85 7.31	5.65 1.69	18.48 6.81	5.83 1.99	1.45	.24
Social Avoidance	13.28 5.99	5.85 1.72	13.08 6.62	6.20 1.99	0.22	.64
Mood Swings	17.40 5.84	6.70 2.33	17.45 6.63	6.68 2.35	0.01	.94
Clumsy	12.05 6.61	5.75 1.50	13.50 6.52	5.63 1.25	2.20	.15
Tearful	14.38 5.41	5.80 1.40	13.90 5.93	5.90 1.66	0.47	.50

the cycle with the second test occurring during the intermenstrual phase; Group 2 was tested first during the intermenstrual phase with the second test occurring during the luteal phase of the cycle.

The performance areas chosen for examination included an attention task, three memory tasks and a sentence-symbol integrative cognitive processing task. Mean percent correct was calculated for each subject on each of the tasks during the luteal and intermenstrual phases. An additional score of reaction time was generated from scores on the integrative processing task. These data were subjected to 2.2 split plot analyses of variance for each of the relevant dependent variables. Order of test sessions (luteal-intermenstrual, intermenstrual-luteal) was the between subjects variable and menstrual phase (luteal, intermenstrual) was the within subjects variable in each analysis. Complete ANOVA tables for these analyses are presented in Appendix G.

Attention

As indicated in Table 2, the 2.2 split plot analysis of variance on these data revealed no significant main or interaction effects.

Insert Table 2 about here.

Memory performance

Memory performance was observed during three related but somewhat different memory tasks: recognition, free recall, and cued recall. In each instance, mean percent correct was calculated for each individual on each of the three tasks. See Tables 3, 4, and 5 for summaries of the means, standard deviations, and test statistics of the three memory tasks.

Recognition. Analysis of the recognition data revealed only a significant main effect for menstrual phase, $F(1,39) = 4.59$, $p < .04$. Examination of means in Table 3 indicates that fewer errors occurred when performance took place during the intermenstrual phase of the menstrual cycle ($M = 92.27$) in comparison to the luteal phase ($M = 88.07$).

Insert Table 3 about here.

Free recall The Free Recall ANOVA revealed only a significant interaction between order of test sessions and menstrual phase, $F(1,39) = 4.29$, $p < .05$. As presented in

Table 2. Means, standard deviations, and F statistics for the attention task

Effect	M	SD	F	p
Order (O)			1.93	.17
Luteal-Intermenstrual (1st)	70.45	13.93		
Intermenstrual-Luteal (2nd)	75.10	10.76		
Phase (P)			0.08	.77
Luteal	72.57	13.35		
Intermenstrual	73.09	11.33		
O X P			1.19	.28
1st, Luteal	69.08	15.22		
1st, Intermenstrual	71.81	12.63		
2nd, Luteal	75.89	11.48		
2nd, Intermenstrual	74.31	10.03		

Table 3. Means, standard deviations, and F statistics for the recognition task

Effect	M	SD	F	p
Order (O)			0.10	.76
Luteal-Intermenstrual (1st)	89.75	8.30		
Intermenstrual-Luteal (2nd)	90.47	11.96		
Phase (P)			4.59	.04
Luteal	88.07	12.17		
Intermenstrual	92.27	8.09		
O X P			1.55	.22
1st, Luteal	86.38	9.40		
1st, Intermenstrual	93.12	7.19		
2nd, Luteal	89.68	14.94		
2nd, Intermenstrual	91.47	8.98		

Table 4, post hoc comparisons using Duncan's multiple range test (Duncan, 1955) indicated that for Group 1, performance was significantly poorer when subjects were tested in the luteal phase of their cycle (M = 29.99 vs. M = 38.54), which was the first testing for this group. Luteal and intermenstrual test performance did not differ in Group 2, nor did either of the Group 2 means reliably differ with the Group 1 means.

Insert Table 4 about here.

Cued recall Similar to the Free Recall data, analysis of the Cued Recall task indicated only a significant effect for the interaction between order of test sessions and menstrual phase, $F(1,39) = 35.78$, $p < .0001$. Duncan's post hoc comparisons, however, revealed an interesting pattern. As presented in Table 5, Session 2 means did not differ from each other (Group 1, Session 2 M = 69.37, Group 2 Session 2 M = 71.59), however, both were significantly greater than the Session 1 means. In addition, Group 1, Session 1 (luteal) performance was significantly worse than Group 2, Session 1 (intermenstrual) (Group 1, Session 1 M = 52.91 vs. Group 2 Session 1 M = 60.71).

Table 4. Means, standard deviations, and *F* statistics for the free recall task

Effect	M		SD	*F*	*p*
Order (O)				0.00	.97
Luteal-Intermenstrual (1st)	34.27		14.88		
Intermenstrual-Luteal (2nd)	34.42		17.48		
Phase (P)				1.51	.23
Luteal	32.82		15.03		
Intermenstrual	35.87		17.33		
O X P [a]				4.29	.05
1st, Luteal	29.99	A	13.20		
1st, Intermenstrual	38.54	B	16.55		
2nd, Luteal	35.51	AB	16.85		
2nd, Intermenstrual	33.32	AB	18.11		

[a] Means in the same column with the same subscript do not differ significantly ($p \leq .05$).

Insert Table 5 about here.

Integrative processing task

The integrative processing task produced two dependent variables, percent correct and reaction time. The 2.2 split plot ANOVA of percent correct revealed only a significant effect for the interaction between order of test sessions and menstrual phase, $F(1,39) = 7.26$, $p < .01$). As revealed by Duncan's multiple range test and presented in Table 6, Group 1, Session 2 (intermenstrual) scores ($M = 95.39$) were significantly higher than those from either Group 1, Session 1 (luteal) ($M = 90.78$) or Group 2, Session 1 (intermenstrual) ($M = 90.85$).

Insert Table 6 about here.

In contrast with accuracy on this task, a trend for the main effect for phase was observed on the reaction time data: $F(1,39) = 3.27$, $p < .078$. Specifically, this indicates that subjects tended to react more slowly during the luteal phase of testing ($M = 3.219$ sec.) than when the test was administered during the intermenstrual phase ($M = 3.063$ sec). In addition to this finding, a significant

Table 5. Means, standard deviations, and F statistics for the cued recall task

Effect	M		SD	F	p
Order (O)				1.47	.23
Luteal-Intermenstrual (1st)	61.14		13.48		
Intermenstrual-Luteal (2nd)	66.15		16.32		
Phase (P)				1.49	.23
Luteal	62.48		15.07		
Intermenstrual	64.94		14.73		
O X P [a]				35.78	.00
1st, Luteal	52.91	A	15.54		
1st, Intermenstrual	69.37	C	11.41		
2nd, Luteal	71.59	C	14.59		
2nd, Intermenstrual	60.71	B	18.04		

[a] Means in the same column with the same subscript do not differ significantly ($p \leq .05$).

Table 6. Means, standard deviations, and F statistics for the accuracy data of the integrative processing task

Effect	M		SD	F	p
Order (O)				0.52	.47
Luteal-Intermenstrual (1st)	93.08		6.50		
Intermenstrual-Luteal (2nd)	91.64		7.93		
Phase (P)				1.72	.20
Luteal	91.63		8.23		
Intermenstrual	93.06		6.20		
O X P [a]				7.26	.01
1st, Luteal	90.78	B	8.30		
1st, Intermenstrual	95.39	A	4.69		
2nd, Luteal	92.43	AB	8.15		
2nd, Intermenstrual	90.84	B	7.71		

[a] Means in the same column with the same subscript do not differ significantly ($p \leq .05$).

interaction between order of test sessions and menstrual phase was found, F (1,39) = 15.52, $p < .0003$. As presented in Table 7, Duncan's multiple range test indicated that Group 1, Session 1 (luteal) reaction time (M = 3.57) was significantly slower than any other sequence by phase combination (Group 1, Session 2 M = 3.05; Group 2, Session 1 M = 3.08; Group 2, Session 2 M = 2.89).

Insert Table 7 about here.

Expectation Measures

Instructional sets and manipulation checks

Subjects were divided into two groups, each comprised of equal numbers of subjects from the two types of order (luteal-intermenstrual and intermenstrual-luteal). For each subject, an instructional set was delivered prior to the start of her second luteal phase testing session. The two instructional sets were intended to induce expectations for either decreased performance or no change in performance during the luteal phase of the menstrual cycle. In each instructional set, subjects were given information from previous research to support the appropriate expectation, told that findings in the present study were consistent with

Table 7. Means, standard deviations, and F statistics for the reaction time data of the integrative processing task

Effect	M	SD	F	p
Order (O)			2.31	.14
Luteal-Intermenstrual (1st)	3.31	0.77		
Intermenstrual-Luteal (2nd)	2.98	0.70		
Phase (P)			3.27	.078
Luteal	3.22	0.76		
Intermenstrual	3.06	0.71		
O X P [a]			15.52	
.0003				
1st, Luteal	3.57 $_A$	0.92		
1st, Intermenstrual	3.05 $_B$	0.61		
2nd, Luteal	2.89 $_B$	0.60		
2nd, Intermenstrual	3.08 $_B$	0.80		

[a] Means in the same column with the same subscript do not differ significantly ($p \leq .05$).

the earlier research, and given bogus data indicating that their scores from testing during their previous luteal and intermenstrual phases showed the same pattern.

At the completion of the entire testing session, subjects were given four manipulation checks to determine whether or not the information had been heard and comprehended. Responses to the checks were recorded as hits and misses. The first question asked the subject to recall the information she received earlier about previous research in this area. There was a 100% hit rate from both groups on this question; although the subjects could not always remember the name of the researcher that conducted the studies, the direction of the results was always reported correctly. The second and third questions asked the subjects to answer the following inquiries related to this study: (2) The overall results of the present study in which you are a participant demonstrate that _____; (3) Your individual findings agree/disagree with previous research in this area and indicate that _____. Question 2, likewise, received a 100% hit rate and in question 3 all subjects but one answered the question in the appropriate direction as desired by the instrucional set. Finally, subjects were asked to what extent they agreed with the information they had been told. Only three of the subjects (two within the "no change" condition and one from

the "decrease in performance condition") did not agree with the instructional set.

Analyses of covariance

Cognitive performance under the influence of instructional variables was analyzed using a one-way between subjects analysis of covariance (ANCOVA). In each of the tasks, the first luteal performance scores served as the covariate, the second luteal scores as the dependent variable, and the two levels of expectations as the between subjects variable. The expectations, or the two instructional variables, were referred to as (1) no change, and (2) decrease in performance. Least squares means and standard deviations for each of the tasks are listed in Table 8.

Insert Table 8 about here.

No statistically significant instructional effects on mean percent correct were found on any of the performance tasks. On the integrative processing task, however, a trend was evidenced for reaction time, $F(1,38) = 3.81$, $p < .058$. When subjects in the premenstrual phase of their cycle were told that performance should be significantly slower due to premenstrual influences, subsequent task reaction time

Table 8. Analyses of covariance on the cognitive performance tasks during the luteal phase of the menstrual cycle with instructional sets.

Dependent Variable	Instructional Set: No Change LSM/SE	Instructional Set: Decrease LSM/SE	F	p
Attention	78.16 2.25	73.22 2.31	2.31	.14
Recognition	92.28 1.38	91.85 1.41	0.05	.83
Free Recall	41.46 2.61	37.09 2.67	1.37	.25
Cued Recall	72.48 2.58	70.30 2.64	0.35	.56
Integrative Processing Accuracy	92.93 1.14	91.98 1.20	0.33	.57
Integrative Processing Reaction Time	2.78 0.12	3.11 0.12	3.81	.058

[a] The covariate was the score for each dependent variable obtained during the initial luteal phase.

Covariate [a]		
F	p	Correlation
15.89	.0003	.51
19.26	.0001	.59
9.64	.0036	.44
16.45	.0002	.55
22.40	.0001	.63
43.21	.0001	.71

tended to demonstrate that effect in comparison to subjects who were instructed that their performance should not be affected (luteal $\underline{M}$ = 3.219 vs. intermenstrual $\underline{M}$ = 3.063). Complete ANCOVA tables are presented in Appendix H.

DISCUSSION

The results of the present study provided several interesting insights into the cognitive performance of females who experience PMS. Other investigations examining the impact of cyclical hormonal changes on cognitive functioning have relied heavily on the use of standardized achievement and ability tests to assess potential effects. Although somewhat outdated and methodologically flawed, the results of those earlier studies generally suggested no substantial relationship between menstrual phase and cognitive functioning (Sommer, 1973; Golub, 1976, Parlee, 1973).

Interestingly, however, clinical observations and self-reports continued to implicate impaired cognitive performance as an effect of PMS (Rubinow et al., 1984; Halbreich et al., 1982). The psychological complaints of forgetfulness, decreased concentration and confusion frequently continued to be included in published lists of PMS symptomotology. In addition, the results of an applied research project at the PMS Clinic in Boulder, Colorado, revealed that 94% of the women sampled in their study believed that PMS negatively affected their job performance. Likewise, 92% reported that they would be more productive in

their professional lives if they did not experience PMS (Bender & Kelleher, 1986).

Discussions regarding this inconsistency between self-reported data and limited empirical data generally emphasized one or more of the following potential explanations: (1) inappropriate samples have been used in the majority of the studies (i.e., many samples have included women who express no interference with PMS, low levels of PMS, or only subjective episodic experiences), whose inclusion in the subject pool confound the results, (2) standardized achievement and ability tests may be unable to assess the sensitive and subtle phase-related changes in cognitive performance experienced by women with PMS, and (3) self-reports of changes in cognitive performance associated with the menstrual phase may be highly influenced by expectations induced by media or common folklore about the effects of PMS. Moreover, a notion persists that women are prone to attributing many negative experiences to PMS (including cognitive functioning) that might be explained by other physical or psychological factors. The present study attempted to critically examine these speculations and, to determine the extent of their contribution to the inconsistency of self-reported versus actual changes in cognitive performance associated with the menstrual phase for women with PMS.

Daily Ratings

One methodological shortcoming of the self-report data cited in the literature is that descriptions of a woman's "typical" premenstrual episode were, for the most part, retrospective (i.e., "Thinking back over the last three cycles..."). Only the most recent studies have employed daily ratings as a measure of subjective impressions. Furthermore, prior to this investigation, no study of the relationship between PMS and self-reported cognitive performance was based on daily ratings of changes in relevant symptomatology. The importance of this methodological fact cannot be overstated. Previous studies agree that ratings of the immediate state are the most accurate assessments of self-reported cyclic changes (Ruble & Brooks-Gunn, 1979). Not only does this technique allow one to verify the existence of these symptoms and their perceived levels of interference on a daily basis, but it also provides a means of determining the onset and offset of cycle changes which is a critical methodological factor in assessing the relationship between PMS and cognitive performance. Also, it should be mentioned that, "efforts to find biological correlates for specific changes in mood, behavior, and physical condition along the menstrual cycle are more likely to be successful when daily ratings and

differential measures of changes are used" (Endicott et al., 1986, p. 135).

Each of the subjects in the present study completed daily ratings over the course of a two-month period. The results, using measures of 20 common PMS symptoms, clearly demonstrated subjective changes in mood, physical condition, and cognitive functioning. Most relevant to the purposes of this study, women perceived impairments in their ability to concentrate, remember, stay focused on a task, think clearly, and perform consistently in work and in school during the luteal phase of their menstrual cycle. These results lend considerable support to the work of Endicott et al. (1986) who originally noted the pattern and correlates of daily ratings as a function of premenstrual changes. It also substantiates the idea that women do report changes in cognitive functioning on a daily basis that are phase-related, with perceived performance rated poorest during the luteal phase.

Cognitive Performance Tasks

The most salient result in the performance tasks was found for recognition memory. Interestingly, although this was the simplest of the memory tasks, it yielded the clearest demonstration of memory impairment. Specifically, subjects' scores were approximately 1/2 standard deviation

lower during the luteal phase of their menstrual cycle than during the intermenstrual phase. Though not intuitively expected, one possible explanation for this finding is that if the memory task is relatively easy (or "automatic" in the cognitive sense), subjects tested in the luteal phase may have failed to expend the necessary additional cognitive effort to compensate for any premenstrual effects on performance. The notion of such a compensatory mechanism has been suggested previously by Rodin (1976) who contended that subjects who are aware of physiological and psychological disturbances which they attribute to PMS can overcome resulting handicaps during this phase of the cycle by working harder. In this present study, subjects' comments lended support for this hypothesis. For example, when debriefed at the conclusion of the study, subjects were asked to account for a possible discrepency between their self-report and actual performance. A majority of the women responded with a statement about their perceived ability to compensate for their physical condition by rising to various demands with extra effort; as a result, tasks take more time and energy but overall performance remains the same as if they were not feeling impaired by luteal phase effects. During recognition testing, subjects would frequently state, "I like this one," or "This is easy." When the free or cued recall methods were requested, subjects would verbally

express their displeasure, lean forward, think aloud, and appear to become more intense and determined. These varied behavioral observations of work state may be indicative of additional processing demands and subjective cognitive effort which may account for the differences in findings between recognition and the free and cued recall tasks.

Reaction time data from the integrative processing task also provided support for this compensatory hypothesis. Results on this task demonstrated a trend toward slower performance during the luteal phase of the cycle, with no loss in accuracy, however. Again, this pattern would be expected if women with PMS tended to compensate under periods of duress by expending more effort at the cost of time and efficiency.

Although there were no other main effects for menstrual phase, there were significant Menstrual Phase X Order of Testing interactions for several of the remaining performance tasks. These significant interactions suggest two patterns, possibly interrelated, of cognitive impairment relative to menstrual phase. The first pattern was most evident in the significant interaction effects on the cued recall task and on reaction time in the integrative processing task. When subjects initially encountered either of these two tasks during the luteal phase of their menstrual cycle, performance was significantly worse than

that associated with all other combinations of menstrual phase and order of testing. The same pattern was present nominally in the data for the other cognitive tasks, though not at a statistically significant level. Collectively, these data suggest that women with PMS may be cognitively impaired when tasks requiring associative thinking or quick mental processing are encountred for the first time during the luteal phase of the menstrual cycle.

An issue that is perhaps related to this particular pattern is the heightened sensivitity to failure and subsequent anxiety and frustration many women experience during the luteal phase of their cycle. Understandably, it is uncertain whether lower levels of performance during the luteal phase is a function of anxiety or an inability to transfer learning from old to new situations as a result of neurological changes during this time of the cycle. Golub's (1976) research on the effect of premenstrual anxiety and depression indicated that whereas significant increases in anxiety and depression occurred during the premenstrual phase of the cycle, no reliable differences were found in cognitive test performance. She concluded that, "the magnitude of the premenstrual mood change was not great enough to affect intellectual function" (p. 99). It is important to note, however, that collapsing across group (or order of testing) in this study did not reveal phase-related

differences. Only after phase by order comparisons did this pattern emerge, suggesting that additional research highlighting the impact of anxiety and frustration on first-time testing in premenstrual females would be helpful in understanding the mechanisms involved in this finding.

The second pattern of possible cognitive impairment associated with menstrual phase was most evident in the significant effects on the free recall task and on accuracy in the integrative processing task. On each of these tasks, subjects significantly improved their performance from Session 1 to Session 2 when tested during the luteal phase first and the intermenstrual phase second. In contrast, however, performance did not improve significantly across sessions when second testing occurred during the luteal phase. Thus, the additional time and energy apparently expended on second testing during the luteal phase was generally effective in maintaining previous levels of performance but not in improving on them. To the degree that this interpretation is correct, it suggests that the ability to apply prior learning to subsequent tasks is impaired during the luteal phase of the menstrual cycle for women with PMS.

The Role of Expectations in the Cognitive Performance of PMS Females

In attempting to challenge the assumptions regarding the generality, severity, and physiolgical basis of menstrual cycle symptomatology and behavior, several researchers have concluded that cultural attitudes and expectations play a major role in influencing perceptions and reactions to the menstrual cycle (Parlee, 1973; Sommer, 1973; Ruble, 1977). Utilizing a social cognition theory to explain the development and persistence of menstrual-related beliefs, Ruble and Brooks-Gunn (1979) contended that inducing a state of objective self-awareness during the luteal phase of the cycle may lead women to focus on bodily states that might otherwise go unnoticed. Because of the connotative meaning of menstruation, they argued, negative symptoms during the luteal phase are likely to be most noticed. Furthermore, they suggested that increased media attention on PMS is likely to make the association of symptoms and PMS highly salient and "...this increased knowledge may elicit a cognitive distortion of diffuse symptoms so that their magnitude is exaggerated and they fit a preconceived pattern" (p. 189).

If perceptions of PMS symptoms are biased as claimed by Ruble and Brooks-Gunn (1979), observed impairments in cognitive performance during the luteal phase of the

menstrual cycle might be likewise affected. The second part of this study addressed this possibility.

As indicated in an earlier section, subjects were given information (complete with bogus findings) intended to influence their performance in one of two directions--decrease in performance or no change in performance. Notably, the group informed that no change in performance should occur during the luteal phase demonstrated the greatest amount of surprise, and in some cases disbelief, upon hearing the instructional set. In contrast, members from the "decrease in performance" group readily accepted the information that performance decreases during the luteal phase of the cycle. These casual observations indicated that many subjects did, indeed, have prior negative expectations about cognitive functioning during the luteal phase of their menstrual cycle. However, during the manipulation checks, 93% of the women indicated that they agreed with the information they had been given prior to the final testing session. Several subjects indicated that although it was somewhat difficult to believe the information, the review of their (bogus) previous performance results was quite convincing.

No difference in performance accuracy was observed as a function of expectations. This finding suggests that cognitive performance is not vulnerable to an instructional

set. A decrease in reaction time, however, was noted for the group that was told their performance would be impaired. As discussed earlier, if women try to compensate under periods of duress by working harder, it is likely that the subjects who were knowledgeable of their "handicap," tried to do as well as possible, and, in so doing, were somewhat more cautious or deliberate in their responses.

Conclusion

Whereas we are already aware that certain physiological functions and emotional states of the body are altered by PMS, the results of this study suggested that cognitive processes can also be affected. These findings contrast with the work of Golub (1976) and Sommer (1973) who contended that women's intellectual functioning during periods of PMS is not altered, despite complaints or expectations to the contrary. The significance of this study rests in the fact that while distinct phase-related changes were found to occur in the recognition task, additional phase-related cognitive impairment was observed following phase by order analyses, indicating that (1) subjects who were <u>initially</u> tested during the luteal phase (as opposed to the intermenstrual phase of the cycle) were disadvantaged in their ability to perform such tasks, and (2) women in the luteal phase of their cycle failed to

improve from previous exposure or practice on the cognitive tasks.

More recent literature on PMS suggested that a single premenstrual syndrome, encompassing all types of symptomatology, does not exist (Halbreich et al. (1982); Endicott, 1986). For example, some women complain only of mood-related symptoms, some only experience physical changes, while others may notice a combination of symptom clusters that occur prior to menstruation. Given this information, it is likely that previous studies sampled women of different or mixed subtypes which would greatly affect the outcome of those studies and alter subsequent interpretations. The sample used in this study was chosen primarily on the basis of self-reported changes in cognitive processing and the results revealed that a consistency <u>does</u> exist between women's subjective impressions and actual performance during the luteal and intermenstrual phases of their cycles.

In addition, results from this study agreed with Dalton's (1960; 1964; 1968) earlier work in this area and suggested mild to moderate impairment in cognitive functioning during the luteal phase. Interestingly, impairment was noted to occur in all of the performance tasks in this study with the exception of the attention task. With regard to the later, a similar impairment might

have been found except for the inability to evaluate performance at each set size. Specifically, in the attention task, subjects frequently expressed difficulty in accurately assessing the number of letters at the larger set sizes. In retrospect, had the data collection procedure allowed for separate analyses of performance at each set size, the experiment might have revealed differences between the luteal and intermenstrual phases in the attention task. This hypothesis is only speculative, however, and further research is necessary to substantiate such theorizing.

While others have tried to explain changes as resulting from stereotyped expectations (Ruble and Brooks-Gunn, 1979; Parlee, 1974; Golub, 1976), results of the present study are not consistent with that explanation. Women's accuracy in cognitive performance tasks did not reflect changes based on expectations. Although reaction time did slow somewhat as a function of the negative expectational set, it is likely that caution or increased cognitive effort was contributing to this outcome, as overall accuracy in performance was not affected.

Finally, one puzzling aspect of PMS and its impact on performance is the fact that no biological cause-and-effect mechanisms have yet been identified. Hence, it is frustrating to acknowledge that changes occur which cannot be substantiated endocrinologically and which are not likely

due to expectations. New theories seem to emerge monthly--a recent Newsweek article (January 12, 1987), for example, noted (without referencing the source) that, "According to one new theory, acute sufferers may have an abnormal sensitivity to the body's natural opiates, which decline just before menstruation. Since opiates serve as a natural narcotic, PMS sufferers in effect may be experiencing drug withdrawal" (p. 53). Regardless of the specific biological theory at this early stage of investigation, emphases on brain-behavior cause and effect relationships are most warranted. Future research, for example, aimed at examining specific PMS subtypes with direct measures of endocrinological changes might be helpful in assessing the rise and fall of hormonal changes and their subsequent impact on cognitive performance.

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APPENDIX A.

DSM-III-R DEFINITION OF PERILUTEAL PHASE DYSPHORIC DISORDER

APPENDIX B.

THE PREMENSTRUAL ASSESSMENT FORM AND ITEM CONTENT OF THE INDIVIDUAL SCALES

The PAF was developed by Uriel Halbreich, M.D., Jean Endicott, Ph.D., and Sybil Schacht, M.S.W. Permission to use this form in the present study was provided by Dr. Endicott, Research Assessment and Training Unit, 722 West 168th Street, New York, New York, 10032.

APPENDIX C.

LETTER REQUESTING VOLUNTARY PARTICIPATION

IOWA STATE
UNIVERSITY

February 28, 1987
Department of Psychology
Ames, Iowa 50011

Telephone 515-294-1742

Dear

I need your help! I am interested in studying women and their methods of coping with stresses that persistently affect their lifestyles. In particular, I am interested in the impact of menstrual cycle changes and how women cope with the cyclical kind of physical and psychological stress that intrudes into their lives. Approximately 60% of all women regularly experience at least mild to moderate changes in mood and related behaviors (e.g., feel depressed, tearful, irritable) which occur from one to ten days prior to the onset of menstruation. Five to ten percent of menstruating women, however, suffer severe changes that markedly disrupt their personal and professional lives. Typically, such menstrually related changes, whether mild or severe, are referred to as PMS, or premenstrual syndrome.

If you have noticed any changes in the way you feel or behave that may be related to your menstrual cycle, I would appreciate your participation in this study and your responses to a questionnaire I have enclosed that will assess how and to what extent you are affected by premenstrual changes in your cycle. You may then be asked to continue in the study which would involve completing a daily checklist in your home, generally requiring no more than ten minutes of your time per day, and meeting with me individually to further assess the cyclical changes that you experience. Following the conclusion of the study, I will meet with you to share the information obtained from your responses to the questionnaire, provide you a profile of your daily ratings, and explain the results of the research project. Please note that all information will be kept highly confidential!

Please consider this request seriously; your participation would be very helpful in getting this study off the ground and expanding knowledge in this area. I have enclosed a stamped, addressed envelope and would greatly appreciate your returned questionnaire by March 15, 1987. If, however, you do not wish to participate, please check the appropriate space on the note attached to the questionnaire and return the form so that I can be certain that you received this information but declined participation. If you have any questions or would like further information, please call me at any of the following numbers: 294-0278 (Student Counseling Service), 294-0278 (Psychology Department), or 294-1742 (messages). Thank you for your time and consideration.

Sincerely,

Fern Lawler

Fern Lawler, M.S.
Counselor

APPENDIX D.

THE DAILY RATING FORM

APPENDIX E.

TWO INSTRUCTIONAL SETS--NO CHANGE AND DECREASE IN PERFORMANCE

"No Change"

Research on premenstrual syndrome (PMS) has repeatedly looked at the relationship between the premenstrual phase of the cycle and behavior. For college and university women, a question of considerable interest is the effect of PMS on cognitive behavior (i.e., thinking skills, concentration, memory impairment). In other words, is cognitive performance impaired during the premenstrual phase of the cycle? Earlier work in this area suggested that although women perceived changes in cognitive behavior (i.e., decreased attention and memory ability) during the premenstrual phase, cognitive performance did not decline due to the effects of PMS. For example, Sommer (1972), a leading researcher in the study of PMS, tested 200 college women on a variety of intellectual tasks and found no change in performance due to menstrual phase; women's performance did not decrease as a function of PMS

The purpose of this research was to evaluate the credibility of those earlier studies, specifically looking at the cognitive areas of attention, concentration, and memory. Interestingly, the results of this study strongly supported Sommer's previous findings and indicated that women in this study who reported cognitive changes also did not experience impairments in cognitive functioning during the premenstrual phase as compared to the intermenstrual phase (3 to 10 days following the onset of menstruation). In addition, a review of your performance from the previous two sessions clearly demonstrated this finding:

Tasks	Premenstrual Phase	Intermenstrual Phase
Attention Task	87%	89%
Memory Tasks		
Free recall	25%	23%
Cued recall	67%	67%
Recognition	92%	95%
Concentration Task		
Accuracy	90%	91%
Reaction time	2.45 sec.	2.50 sec

Although slight differences were observed from one testing session to another, no significant increase or decrease occurred in accuracy performance or reaction time. Therefore, despite individual women's impressions that changes in thinking ability do occur as a result of PMS, findings from this study clearly indicated that cognitive performance does not decrease during the premenstrual phase of the menstrual cycle.

"Decrease in Performance"

Research on premenstrual syndrome (PMS) has repeatedly looked at the relationship between the premenstrual phase of the cycle and behavior. For college and university women, a question of considerable interest is the effect of PMS on cognitive behavior (i.e., thinking skills, concentration, memory impairment). In other words, is cognitive performance impaired during the premenstrual phase of the cycle? Earlier work in this area suggested that cognitive performance did decline due to the effects of PMS. For example, Dalton (1968), a leading researcher in the study of PMS, found that university women's weekly exam performance dropped during the premenstrual phase of their cycle.

The purpose of this research was to evaluate the credibility of those earlier studies, specifically looking at the cognitive areas of attention, concentration, and memory. Interestingly, the results of this study strongly supported Dalton's previous findings and indicated that women with PMS do experience impairments in cognitive functioning during the premenstrual phase as compared to the intermenstrual phase (3 to 10 days following the onset of menstruation). In addition, a review of your performance from the previous two sessions clearly demonstrated this phase-related difference:

Tasks	Premenstrual Phase	Intermenstrual Phase
Attention Task	72%	89%
Memory Tasks		
Free recall	23%	34%
Cued recall	62%	71%
Recognition	88%	95%
Concentration Task		
Accuracy	90%	93%
Reaction time	3.89 sec.	2.50 sec

As can be observed, percent correct in each of the tasks increased [despite the fact that intermenstrual performance testing occurred first] and your reaction time proved to be slower during premenstrual phase testing. Therefore, the findings from this study clearly indicated that cognitive performance decreases during the premenstrual phase of the menstrual cycle.

APPENDIX F.

SUMMARY TABLES FOR THE DAILY RATINGS ANOVAs

Table F1. ANOVA for daily ratings of anxiety

Source	df	MS	F	p
Cycle	1	10.00	1.47	.2332
Error	39	6.82		
Phase	1	3045.03	127.97	.0001
Error	39	23.79		
Cycle X Phase	1	0.00	0.00	1.0000
Error	39	7.49		

Table F2. ANOVA for daily ratings of depression

Source	df	MS	F	p
Cycle	1	3.03	0.36	.5503
Error	39	8.33		
Phase	1	4202.50	231.66	.0001
Error	39	18.14		
Cycle X Phase	1	0.10	0.01	.9137
Error	39	8.41		

Table F3. ANOVA for daily ratings of irritability

Source	df	MS	F	p
Cycle	1	0.31	0.04	.8471
Error	39	8.13		
Phase	1	3831.81	168.58	.0001
Error	39	22.73		
Cycle X Phase	1	0.16	0.02	.9007
Error	39	9.90		

Table F4. ANOVA for daily ratings of concentration

Source	df	MS	F	p
Cycle	1	1.60	0.30	.5865
Error	39	5.32		
Phase	1	4928.40	231.13	.0001
Error	39	21.32		
Cycle X Phase	1	4.23	0.66	.4225
Error	39	6.43		

Table F5. ANOVA for daily ratings of creativity

Source	df	MS	F	p
Cycle	1	2.76	0.34	.5640
Error	39	8.14		
Phase	1	2600.16	119.99	.0001
Error	39	21.67		
Cycle X Phase	1	5.26	0.77	.3845
Error	39	6.79		

Table F6. ANOVA for daily ratings of forgetfulness

Source	df	MS	F	p
Cycle	1	0.63	0.08	.7765
Error	39	7.65		
Phase	1	1904.40	73.20	.0001
Error	39	26.02		
Cycle X Phase	1	1.23	0.16	.6895
Error	39	7.59		

Table F7. ANOVA for daily ratings of interest in usual activities

Source	df	MS	F	p
Cycle	1	0.06	0.01	.9363
Error	39	8.68		
Phase	1	3231.01	178.55	.0001
Error	39	18.10		
Cycle X Phase	1	0.01	0.00	.9798
Error	39	9.63		

Table F8. ANOVA for daily ratings of performance in work and school

Source	df	MS	F	p
Cycle	1	9.03	0.98	.3278
Error	39	9.19		
Phase	1	3478.23	158.42	.0001
Error	39	21.96		
Cycle X Phase	1	13.23	1.12	.2958
Error	39	11.78		

Table F9. ANOVA for daily ratings of changes in appetite

Source	df	MS	F	p
Cycle	1	0.40	0.04	.8464
Error	39	10.52		
Phase	1	3348.90	116.45	.0001
Error	39	28.76		
Cycle X Phase	1	3.60	0.30	.5854
Error	39	11.89		

Table F10. ANOVA for daily ratings of distractibility

Source	df	MS	F	p
Cycle	1	9.03	1.44	.2374
Error	39	6.27		
Phase	1	3783.03	118.55	.0001
Error	39	31.91		
Cycle X Phase	1	0.03	0.00	.9454
Error	39	5.27		

Table F11. ANOVA for daily ratings of breast tenderness

Source	df	MS	F	p
Cycle	1	0.23	0.02	.8811
Error	39	9.93		
Phase	1	3367.23	63.13	.0001
Error	39	53.34		
Cycle X Phase	1	2.03	0.31	.5799
Error	39	6.50		

Table F12. ANOVA for daily ratings of tendency to have accidents

Source	df	MS	F	p
Cycle	1	16.26	1.57	.2183
Error	39	10.38		
Phase	1	945.76	26.28	.0001
Error	39	35.99		
Cycle X Phase	1	7.66	0.70	.4068
Error	39	10.89		

Table F13. ANOVA for daily ratings of energy

Source	df	MS	F	p
Cycle	1	6.40	0.81	.3732
Error	39	7.89		
Phase	1	4473.23	163.54	.0001
Error	39	27.35		
Cycle X Phase	1	1.23	0.11	.7451
Error	39	11.43		

Table F14. ANOVA for daily ratings of confusion

Source	df	MS	F	p
Cycle	1	0.31	0.03	.8532
Error	39	8.83		
Phase	1	3303.31	139.96	.0001
Error	39	23.60		
Cycle X Phase	1	0.31	0.03	.8633
Error	39	10.19		

Table F15. ANOVA for daily ratings of tendency to quarrel or nag

Source	df	MS	F	p
Cycle	1	9.51	0.61	.4401
Error	39	15.62		
Phase	1	3001.56	108.67	.0001
Error	39	27.62		
Cycle X Phase	1	9.51	0.56	.4605
Error	39	17.11		

Table F16. ANOVA for daily ratings of water retention

Source	df	MS	F	p
Cycle	1	32.40	1.79	.1886
Error	39	18.09		
Phase	1	5688.23	156.25	.0001
Error	39	36.40		
Cycle X Phase	1	21.03	1.45	.2356
Error	39	14.49		

Table F17. ANOVA for daily ratings of social avoidance

Source	df	MS	F	p
Cycle	1	0.23	0.02	.8942
Error	39	12.56		
Phase	1	2044.90	71.46	.0001
Error	39	28.62		
Cycle X Phase	1	3.03	0.22	.6419
Error	39	13.77		

Table F18. ANOVA for daily ratings of mood swings

Source	df	MS	F	p
Cycle	1	0.01	0.00	.9789
Error	39	8.83		
Phase	1	4611.76	158.82	.0001
Error	39	29.04		
Cycle X Phase	1	0.06	0.01	.9426
Error	39	10.72		

Table F19. ANOVA for daily ratings of clumsiness

Source	df	MS	F	p
Cycle	1	17.56	1.87	.1793
Error	39	9.39		
Phase	1	2009.31	57.86	.0001
Error	39	34.73		
Cycle X Phase	1	24.81	2.20	.1457
Error	39	11.25		

Table F20. ANOVA for daily ratings of tearfulness

Source	df	MS	F	p
Cycle	1	1.41	0.18	.6738
Error	39	7.82		
Phase	1	1747.31	105.78	.0001
Error	39	25.97		
Cycle X Phase	1	3.31	0.47	.4991
Error	39	7.10		

APPENDIX G.

SUMMARY TABLES FOR THE COGNITIVE PERFORMANCE TASKS ANOVAs

Table G1. ANOVA for the attention performance data

Source	df	MS	F	p
Between subjects				
Order	1	443.61	1.93	.1726
Error	39	229.78		
Within subjects				
Phase	1	6.66	0.08	.7745
Phase X Order	1	95.33	1.19	.2815
Error	39	79.93		

Table G2. ANOVA for the recognition performance data

Source	df	MS	F	p
Between subjects				
Order	1	13.85	0.10	.7570
Error	39	143.04		
Within subjects				
Phase	1	372.44	4.59	.0384
Phase X Order	1	125.84	1.55	.2203
Error	39	81.09		

Table G3. ANOVA for the free recall performance data

Source	df	MS	F	p
Between subjects				
Order	1	0.51	0.00	.9714
Error	39	394.72		
Within subjects				
Phase	1	207.65	1.51	.2266
Phase X Order	1	590.02	4.29	.0400
Error	39	137.59		

Table G4. ANOVA for the cued recall performance data

Source	df	MS	F	p
Between subjects				
Order	1	513.87	1.47	.2331
Error	39	350.26		
Within subjects				
Phase	1	159.34	1.49	.2297
Phase X Order	1	3827.56	35.78	.0001
Error	39	106.99		

Table G5. ANOVA for the accuracy data of the integrative processing task

Source	df	MS	F	p
Between subjects				
Order	1	42.67	0.52	.4740
Error	39	81.63		
Within subjects				
Phase	1	46.77	1.72	.1968
Phase X Order	1	196.83	7.26	.0104
Error	39	27.12		

Table G6. ANOVA for the reaction time data of the integrative processing task

Source	df	MS	F	p
Between subjects				
Order	1	2.16	2.31	.1367
Error	39	0.94		
Within subjects				
Phase	1	0.56	3.27	.0781
Phase X Order	1	2.64	15.52	.0003
Error	39	0.17		

APPENDIX H.

SUMMARY TABLES FOR THE COGNITIVE PERFORMANCE TASKS ANALYSES OF COVARIANCE

Table H1. Analysis of covariance for the attention performance data under the influence of an instructional set

Source	df	MS (III)	F	p
Model				
Instructional variable	1	243.50	2.31	.1367
Attention (covariate)	1	1674.11	15.89	.0003
Error	38	105.32		

Table H2. Analysis of covariance for the recognition performance data under the influence of an instructional set

Source	df	MS (III)	F	p
Model				
Instructional variable	1	1.86	0.05	.8294
Recognition (covariate)	1	759.95	19.26	.0001
Error	38	39.45		

Table H3. Analysis of covariance for the free recall performance data under the influence of an instructional set

Source	df	MS (III)	F	p
Model				
Instructional variable	1	195.47	1.37	.2495
Free Recall (covariate	1	1378.72	9.64	.0036
Error	38	142.95		

Table H4. Analysis of covariance for the cued recall performance data under the influence of an instructional set

Source	df	MS (III)	F	p
Model				
Instructional variable	1	48.67	0.35	.5584
Cued Recall (covariate)	1	2296.96	16.45	.0002
Error	38	39.45		

Table H5. Analysis of covariance for the accuracy data of the integrative processing task under the influence of an instructional set

Source	df	MS (III)	F	p
Model				
Instructional variable	1	8.79	0.33	.5701
Free Recall (covariate)	1	599.71	22.40	.0001
Error	38	26.77		

Table H6. Analysis of covariance for the reaction time data of the integrative processing task under the influence of an instructional set

Source	df	MS (III)	F	p
Model				
Instructional variable	1	1.08	3.81	.0580
Cued Recall (covariate)	1	12.21	43.21	.0001
Error	38	0.28		