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Authors
Davydov, Dmitry M
Shapiro, David
Goldstein, Iris B

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Department where the work was conducted: **Department of Psychiatry, UCLA**

Dmitry M. Davydov

University of Southampton

David Shapiro

University of California, Los Angeles

Iris B. Goldstein

University of California, Los Angeles

Dmitry M. Davydov, MD, PhD, Department of Psychology, University of Southampton, Highfield, Southampton, SO17 1BJ, UK. Email: D.M.Davydov@soton.ac.uk

David Shapiro, PhD, Department of Psychiatry, UCLA, 760 Westwood Plaza, Los Angeles, CA 90095-1759. Email: dshapiro@ucla.edu

Iris B. Goldstein, PhD, Department of Psychiatry, UCLA, 760 Westwood Plaza, Los Angeles, CA 90095-1759. Email: irisg@ucla.edu

Correspondence concerning this article should be addressed to David Shapiro, Department of Psychiatry, 760 Westwood Plaza, Los Angeles, CA 90095-1759. Electronic mail may be sent to dshapiro@ucla.edu. Tel. 310-8250252; Fax, 310-825-6792

Moods in Everyday Situations: Effects of Menstrual Cycle, Work, and Personality

Dmitry M. Davydov[a], David Shapiro[b], Iris B. Goldstein[b*]

[a]University of Southampton, Southampton, UK

[b]University of California, Los Angeles, Los Angeles, CA, USA

*Corresponding author. David Shapiro, Department of Psychiatry University of California, Los Angeles 760 Westwood Plaza Los Angeles, California 90095-1759 Tel.: 310-825-0252; fax; 310-825-6792

E-mail address: dshapiro@ucla.edu (D. Shapiro).

Abstract

Objective: This study examined women's moods on work and off days during different phases of the menstrual cycle. **Method**: Self reports of the moods angry, happy, sad, stressed, tired, and anxious were obtained on two work and two off days during the luteal and follicular phases of the menstrual cycle in 203 nurses. Individual differences in anger out, anxiety, and hostility were assessed. **Results**: Ratings of anxious, stressed, and tired were higher and happy and sad were lower on the work day than the off day. Menstrual cycle phase was associated with mood differences depending on the day (work, off work) and individual differences in personality traits. **Conclusions**: The experience of moods in everyday life is affected by overall levels of stress and phase of the menstrual cycle. The findings suggest the need to refine sociopsychobiological and clinical models of mood regulation and of risk for disease.
Keywords: Mood; Menstrual Cycle; Personality, Women; Work

Introduction

Contemporary research has focused on biological and behavioral factors relevant to mental health in women with an emphasis on mood disorders, anxiety, schizophrenia, premenstrual dysphoria, menopause, and postpartum depression. The mental health of women differs from that of men not only in the greater incidence of depression and the later onset of schizophrenia but also in disorders associated with menstruation [1]. Recent reviews examined psychological processes associated with the menstrual cycle [2-4]. Depression, irritability, insomnia, fatigue, and anxiety were most frequently linked to the luteal phase. Variations in ovarian hormones influence how women respond to occupational stress and drugs and may be related to cardiovascular and affective disorders [5-8]. Studies of emotional changes across the menstrual cycle have yielded inconsistent results. Some studies concluded that affective fluctuations are uncommon [9, 10]. However, Allen et al. [11] reported that irritability, restlessness, and depressed mood tended to be higher in the luteal than the follicular phase. Mahoney and Smith [12] also found variations in tension, depression, and vigor across the menstrual cycle.

One explanation for the inconsistencies may be that mood changes occurring during the menstrual cycle are cycle-modulated differences in response to external stress in various social, occupational, and environmental settings. High level of sensitivity to reproductive hormones may serve as a preexisting vulnerability to mood disturbance depending on social and environmental factors. Variations in settings and stress conditions across studies may account for the inconsistent findings. Moreover, one phase may dampen and another phase magnify responses to stress. Sabin-Farrell and Slade [13] found differential phase effects of stress induction with greater negative mood change in the luteal phase not accounted for by initial mood levels. In addition, memories recalled in this phase were rated as significantly less happy. Thus, occupational stress and work strain in contrast to less stressful settings such as home may be particularly relevant to the effects of menstrual cycle on emotional states and health more generally.

Individual differences in affective traits may also affect mood fluctuations in different phases of the menstrual cycle. Henderson and Whissell [15] showed positive changes in mood in the follicular and negative changes in the luteal phase, the latter dependent on premenstrual dysphoria. Other research indicates that affective traits (e.g., anxiety and hostility) and affective disorders (e.g., premenstrual dysphoria) increase negative moods during both phases, but are associated with greater response to stress during the luteal phase [16]. The combination of luteal phase and one's characteristic affective traits may be an important source of vulnerability to mood disturbance.

This paper reports on mood data obtained in a study of psychosocial factors and ambulatory blood pressure in 203 wonen nurses. On four days, they rated their moods in a diary twice an hour, on a work day and on off day in two phases of the menstrual cycle. Other findings in this study may be found in Goldstein et al. [17], Goldstein and Shapiro [18], and Shapiro et al. [19]. We predicted that women in a stessful occupation would exhibit contrasting levels of arousal - and affect-related moods as a function of menstrual phase and work/nonwork day and that these levels would vary as a function of individual differences in personality traits. We expected that high levels of negative moods and low levels of positive moods would be associated with the luteal phase in contrast to the follicular phase for women scoring high on negative affective traits, especially during work, i.e., occupational stress. We focused on moods and personality traits that from the literature seemed relevant to women's biological and behavioral conditions.

Methods

Subjects

The subjects were 203 healthy registered nurses with at least one year of experience in nursing, premenopausal women between the ages of 24 and 50 (37.7 (6.6), mean (SD)) employed in hospitals and clinics. Subjects worked on daytime 8-hour (48%), 12-hour (50%), or 10-hour shifts (2%). Exclusions were health problems, use of oral contraceptives or medications affecting the cardiovascular or central nervous system, severe obesity (BMI > 30), pregnancy or childbirth within the last 12 months, or irregular menstrual cycle. The sample included 58% White, 14% African, 15% Latino, and 13% Asian Americans.

Design

Subjects were studied during two phases of the menstrual cycle. For the follicular phase, subjects were scheduled on days 4 to 8 after the beginning of menstruation. The luteal (L) phase was scheduled 5 to 10 days after the surge in luteinizing hormone, as determined by the Clearplan home ovulation testing kit (Fisons Consumer Health, Sydney, Australia). This kit uses monoclonal antibody technology to detect the amount of luteinizing hormone normally occurring 24 to 36 hours before ovulation [20]. Days were adjusted for women with cycles longer or shorter than 28 days. To confirm ovulation in the postovulatory phase, plasma progesterone levels were measured during the luteal phase.

In an initial session, subjects provided information on demographics and health history. Blood pressure and heart rate were recorded on 4 days, and subjects filled out a diary on each measurement occasion. The recording was done on 2 work days and 2 off work days over a period of a few months. Half the subjects began the 4-day sequence in the follicular (F) phase and half in the luteal (L) phase, followed by the other study days in succession. Within phase, day (work, off) was counterbalanced. Complete data were obtained on 171 nurses, and 32 subjects completed at least one work day and one off day in one or the other phase.

Moods

Subjects filled out a paper-and-pencil diary each time they felt the blood pressure cuff inflate. They completed the diary on 90% of the scheduled occasions. On the average, 46 sets of diary entries per day per subject were available for analysis. Subjects used a 5-point numerical scale from "none" to "extreme amount" to rate the following moods: stressed, happy, frustrated, alert, angry, sad, conflicted, tired, anxious, in control. The ratings tended to be clustered in three dimensions, reflecting negative, positive, and energy components of mood [19]. To simplify this presentation, one mood was selected for analysis from each dimension: stressed, happy, and tired. These mood terms had the widest dispersion of ratings. The moods angry and anxious were also included because of their intrinsic relation to the traits of anger, hostility, and anxiety examined in this study. The mood sad was added because of its relevance to depression.

Personality Tests

1) The Cook-Medley Hostility subscale (CM) of the MMPI reflects a cynical and mistrusting attitude toward others [21]. 2) The Spielberger Anger Expression Scale provides scores on two dimensions of anger expression [22]. Only the anger-out dimension (AO) will be discussed in this paper because the anger-in dimension yielded few findings in our previous research. Anger-out determines the extent to which an individual acts out aggressively in response to angry feelings. 3) The Spielberger Trait Anxiety Inventory (STAI) measures the general disposition to experience anxiety frequently [23]. In keeping with our previous analytic approach [24], the personality scales were each split at the median into high and low groups as follows: AO: High-17.1 (2.2) [n = 87], Low-12.2 (1.4) [n = 114]; STAI: High-40.5 (5.5) [n = 98], Low-28.5 (3.4) [n = 105]; CM: High-20.2 (4.5) [n = 97], Low-9.5 (3.1) [n = 106]. The split was made as close as possible to 50%, and tied values at the median were assigned to one group or the other depending on where that score fell. AO test scores were missing for two subjects.

Data Analysis

The repeated measures of each of the six moods were first related to Day (off, work) and Phase (follicular, luteal), independently of personality. Then, the analyses were repeated adding to the models each of the four dichotomized personality traits, one at a time. As exemplified in recent papers [25, 26], random effects regression models are appropriate for the kinds of longitudinal data obtained in ambulatory studies. Models consider both within- and between-subject variability, and allow for random and fixed effects as well as a variable number of observations per subject and missing data. PROC

MIXED (SAS Institute) was the program used for general linear mixed modeling. Modeling each subject as a random effect accommodates interindividual variation in mood-phase-day-trait relationships, and allows a standardized evaluation of these relationships. Each subject acts as her own control over time. Phase, day, and traits were treated as class variables in the analyses. For significant interactions, PROC MIXED compared cell means by *t* test. Statistical significance was attributed to *p* values < .05.

Results

Day X Phase Effects Independent of Traits

Significant effects were obtained for Day with higher ratings of stressed (F(1, 35000) = 330.10, p<.0001), anxious (F(1, 35000) = 157.06, p<.0001), and tired (F(1, 35000) = 7.13, p<.01) and lower ratings of happy (F(1, 34000) =76.32, p<.0001) and sad (F(1, 35000) = 4.22, p<.05) on the work day compared to the off day (Figure 1). Phase and Day x Phase effects were not significant.

AO X Day X Phase Effects

No main effects were obtained for AO. A significant interaction was shown for AO x Phase for anxious (F(1, 34000) =8.89, p<.005). Ratings of anxious were higher during the L phase than the F phase in low AO subjects; the effect was opposite in high AO subjects. The difference was significant only in the low AO group (Figure 2).

A significant interaction was shown for AO x Day x Phase for sad (F(1, 34000) =6.21, p<.05). As shown in Figure 2, the pattern of differences for sad was similar to the pattern shown for anxious but only on the work day with higher ratings of sad in the L phase than the F phase for low AO subjects. Ratings of sad were higher on the off day compared to the work day in low AO subjects.

CM X Day X Phase Effects

A significant main effect for CM were obtained for angry (F(1, 35000) =5.61, p<.05). Ratings of angry were higher in the high CM group (1.11 ±.01) than the low CM group (1.07 ±.01).

Significant interactions were found between CM and Day (F(1, 35000) =6.36, p<.05) and between CM and Phase (F(1, 35000) =7.92, p<.005) on sad. Ratings of sad were significantly higher during the off day (1.08 ±.02) than the work day (1.05 ± .02) in the low CM group, but were equal in the high CM group on both days (1.11 ± .02). Higher ratings of sad were also found during the L phase compared to the F phase in the low CM group; the effect was opposite in the high CM subjects. The difference was significant only in the low CM group (Figure 3).

A significant interaction was found for CM x Day x Phase (F(1, 35000) =17.37, p<.0001) on happy. Ratings of happy were higher during the off day than the work day in the low CM group during both phases, and in the high CM group only during the L phase (Figure 3). Higher ratings of happy were found during the L phase than the F phase in the low CM group, and during the F phase compared to the L phase in the high CM group (Figure 3). These significant effects were shown only during the work day.

A significant interaction was found for CM x Day x Phase (F(1, 35000) =7.91, p<.005) on tired. Ratings of tired were higher during the work day than the off day in the low CM group only during the F phase and in the high CM group only during the L phase (Figure 3). Higher ratings of tired were found during the F phase than the L phase in the high CM group, and the effect was opposite in the low CM subjects. The difference was significant in the low CM group and only during the off day (Figure 3).

STAI X Day X Phase Effects

Significant main effects for STAI were obtained on stressed (F(1, 35000) = 17.42, p<.0001), anxious (F(1, 35000) = 25.37, p<.0001), tired (F(1, 35000) = 7.41, p<.01), happy (F(1, 35000) = 9.50, p<.005), and sad (F(1, 35000) = 12.20, p<.0005) with higher ratings of stressed (1.67 ± .04), anxious (1.44 ± .03), tired (2.16 ± .05), and sad (1.13 ± .02) and lower ratings of happy (2.80 ± .09) in the high STAI group in contrast to the low STAI group (1.45 ± .04; 1.44 ± .03; 1.95 ± .05; 1.04 ± .02; 3.18 ± .08, respectively).

Significant interactions were found between STAI and Phase on sad (F(1, 35000) = 10.35, p<.005), anxious (F(1, 35000) = 11.56, p<.001), and stressed (F(1, 35000) = 9.06, p<.005) and between STAI and Day on tired (F(1, 35000) = 20.41, p<.0001). As shown in Figure 4, a similar pattern of differences was found for sad and anxious with significantly higher ratings during the L phase than the F phase in the high STAI group. In contrast, significantly higher ratings of stressed were shown during the F phase than the

L phase in the low STAI group (Figure 4). Ratings of tired were higher during the work day (2.24 ± .06) compared to the off day (2.08 ± .06) in the high STAI group, and the effect was opposite in the low STAI group (1.93 ± .05; 1.97 ± .05, respectively). However, the difference was significant only in the high STAI group.

Discussion

Subjects reported feeling more stressed, anxious, and tired and less happy and sad on the work day than on the off day, i.e., as a function of the assumed greater overall stress on the work day. The mood effects are consistent with our previous findings that these women showed higher systolic and diastolic blood pressure, heart rate, and epinephrine on work than on off days [17]. Moreover, we have also observed that the more intense the negative mood the greater the level of associated blood pressure and heart rate [19], suggesting that the cardiovascular and hormonal changes occurring with occupational stress are related to concurrent emotional responses. Thus, the findings of the present study underscore the importance of mood in addition to other factors associated with psychological functioning and with regulation of the cardiovascular system as reported in our previous studies, including job stress, family stress, situational challenge, personality traits, family history of hypertension, and gender [17-19, 24, 27-29].

None of these mood effects were affected by phase, and phase by itself did not have a general effect on mood. The lower rating of sad on the work day seems counterintuitive. This effect was mainly due to one subset of subjects, those with low hostility scores who reported being less sad on the work day than the off day. In contrast, high hostile subjects were equally sad on both days. Low hostility subjects did not differ in how happy they felt on the two days, so the significance of this finding is uncertain. However, we should note that in the 3-way analysis of hostility X day X and phase, low hostile subjects reported feeling happier at work in both phases. On the work day, the lowest rating for happy occurred in high hostile subjects during the luteal phase. The day effect for tired also depended on personality. The effect was true for high but not low anxious subjects. It is surprising that those who are habitually anxious and therefore vulnerable to anxiety-inducing events, as is the case in a typical work day for nurses, did not show parallel effects for the other moods.

Most of the other effects in this study involved menstrual cycle phase in interaction with personality and/or with day. In only two instances did phase interact with personality, independently of day. Low anger out subjects reported being more anxious in the luteal than in the follicular phase. That the effect occurred in low anger out is consistent with the finding in these same subjects that unexpressed anger in combination with family history of hypertension is associated with elevated blood pressure [18]. A parallel effect occurred for low hostility subjects who reported higher ratings of the mood sad. Sad was also rated higher by low anger subjects in the luteal phase, as shown in the 3-way ANOVA. Hostility was also associated with reports of the mood tired. The relationships are complex; high hostile subjects felt more tired on the work day than the off day but only in the luteal phase. A parallel difference occurred in low hostile subjects during the follicular phase only. These effects illustrate how affective traits influence emotional lability in interaction with hormonal activity and situational stress.

The findings in general support the hypothesis that vulnerability to cardiovascular diseases and affective disorders may be related to interaction of individual emotional traits and the cyclic activity of reproductive hormones that affect mood fluctuations in stressful conditions. These results in healthy women add to our knowledge of factors associated with affective and somatoform disorders [30-34]. The apparent concurrence of sad and anxious moods and their divergence was determined by specific individual traits. The interplay of negative moods in some healthy subjects may mimic the symptom reporting of patients diagnosed with comorbidity of depressive and anxiety disorders [35].

Affective conditions are diverse, and vary widely along the dimensions of specificity/generality, the nature and range of evocative contexts, and psychological, behavioral, and somatic manifestations. In some cases, the perception that events are uncontrollable and unpredictable can lead to intense unexplainable general arousal ("false alarms") which produces a cycle of anxious apprehension and may lead to the development of clinical anxiety. However, in the long term, the same negative cognition or rumination may be related to depression associated with decreased general arousal (i.e., fatigue and asthenia). Thus, coexistence of different moods (e.g., anxiety and sad) may be unexpected given the difference in level of arousal. Different couplings of moods within a menstrual cycle in different subjects may be a function of different relations between general and specific components of the moods and affective traits of the individual. Some emotional traits (e.g., high anxiety, low anger out) may predispose to negative cognitions and determine mood couplings related to their common specific component, whereas other traits such as hostility may predispose to a different general arousal level and thus determine their divergence or changes in arousal-related negative moods (e.g., stress, tired) such as in the low anxiety and high hostility groups. These findings are consistent with data in both depressed and healthy subjects indicating a coupling of high depression with low arousal anxiety but not with anxiety associated with high physiological and behavioral arousal [36]. This position is supported by the finding that two subtypes of anxiety may be discriminated: anxious apprehension and anxious arousal [37]. These speculations need to be confirmed in further research.

The concurrence of higher ratings of happy and sad mood during the luteal phase in low hostile women and of happy and tired moods during the follicular phase in high hostile women seems to be contradictory. However, in contrast to sad mood, ratings of happy were related to work activity and might have specific compensatory effects. The association of positive mood with occupational stress contrasts with the coupling of tired with the off day during the follicular phase in high hostile subjects, suggestive of the behavior of dysthymic individuals who invest whatever general energy they have in work, leaving none for leisure and family or social activities [35].

One proposed mechanism of the interaction of menstrual cycle with individual and environmental differences is an arousal-modulated effect of different phases of the menstrual cycle on brain activity. In the luteal phase, higher levels of a metabolite of progesterone (allopregnanolone) were associated with lower self-reported general arousal [38]. Morgan and Pfaff [39] concluded that estrogen produces more general arousal, which may be expressed as increased motor activity in a safe environment and increased reactivity (e.g., anxiety/fear) in a potentially dangerous or threatening environment. Previous studies examined neural actions of gonadal hormones on nonreproductive brain structures and processes and ovarian steroid influences on midbrain and brainstem dopaminergic and serotonergic neurotransmitter systems [40-42]. Thus, the present findings suggest that the menstrual cycle phase changes may be more closely associated with disturbance in the part of the reticular activating system, which support the proposed arousal-related mechanism of its interaction with individual emotional differences and stress-related environmental conditions in modulating effects on moods.

Evidence also indicates that mood changes occurring premenstrually are linked to cycle-related alterations in serotonergic activity in the central nervous system [43]. Estrogen and progesterone receptors are found in different brain regions and exert a wide range of actions on serotonergic, noradrenergic, gamma-aminobutyric acid, dopaminergic, and anticholinergic neurones. Estrogen and progesterone receptors have been identified in the amygdala, hippocampus, cingulate cortex, locus coeruleus, midbrain raphe nuclei, and central grey matter [44, 45]. Moreover, the mood-perturbing effects of gonadal steroids seem to be associated not with levels of ovarian hormones but with differential sensitivity to them from the brain systems in different subjects [46] as a function of trait differences, which coincide with the present findings of dependence of mood changes on the interaction of menstrual cycle with affective traits.

On the basis of our findings, we can speculate that the most adaptive periods in which to cope with occupational stress over the course of the menstrual cycle vary depending on the arousal-related interaction of trait and menstrual cycle phase. The follicular phase seems to be more adaptive for the nonhostile and low anger out coping style and may also facilitate coping with occupational stress in hostile women. However during lower stress conditions (off days), the luteal phase is advantageous for those with a hostile coping style. The luteal phase seems to be more adaptive for low anxious and the follicular phase more adaptive for high anxious women.

In terms of generalizability and broader applicability of the results, the complex interactions suggest that the advantage of each phase of the menstrual cycle depends on the interaction of individual affective differences with environmental conditions, such as home or work settings. It also suggests that the contrast between follicular and luteal phases is not a contrast between conditions determining positive or negative moods, but conditions damping or magnifying such qualities of individual traits as their arousability in stressful or nonstressful situations.

Finally, although not a focus of this paper, we should note the main effects of personality on mood. High hostility subjects reported being more angry than low hostility subjects. High anxiety scores were associated with higher ratings of stressed, anxious, tired, and sad and lower ratings of happy. It appears that the correspondence between anxiety as a trait and situational emotional states is more direct than is the case for hostility or anger out. In the case of the later traits, the correspondence seems more dependent on the specific overall variations in daily stress and hormonal levels. Anxiety as a trait appears to be more pervasive and less dependent on other factors.

This study was limited to healthy female nurses with specific job demands and to particular personality traits that may not fully represent variations in life situations and pertinent traits in all women. In their work, nurses are constantly exposed to people in distress, pain, threat, and despair. To function effectively, they may learn to keep their emotional responses under control and suppress extreme reactions, possibly limiting the range of emotion expressed. Moreover, we cannot be sure we captured all the appropriate mood terms. Within any single presumably unitary emotional state, different subtypes may be discerned [19, 37]. Finally, although the observed differences in mood reports were relatively small in magnitude, they were sufficiently consistent to yield significant effects related to type of day (work, off) and to menstrual cycle phase in this sample of healthy women. The methods of study should be extended to women with mood and other disorders.

In conclusion, by using real-time assessments of mood we have been able to determine that the experience of certain moods is associated with occupational stress and phase of the menstrual cycle. Regardless of other factors, moods are clearly affected by stress level. Mood reports are also associated with phase of the menstrual cycle depending on stress level and individual differences in personality traits. This interplay of factors suggests the need to develop further and refine sociopsychobiological models of the regulation of mood and bodily systems and of risk for disease.

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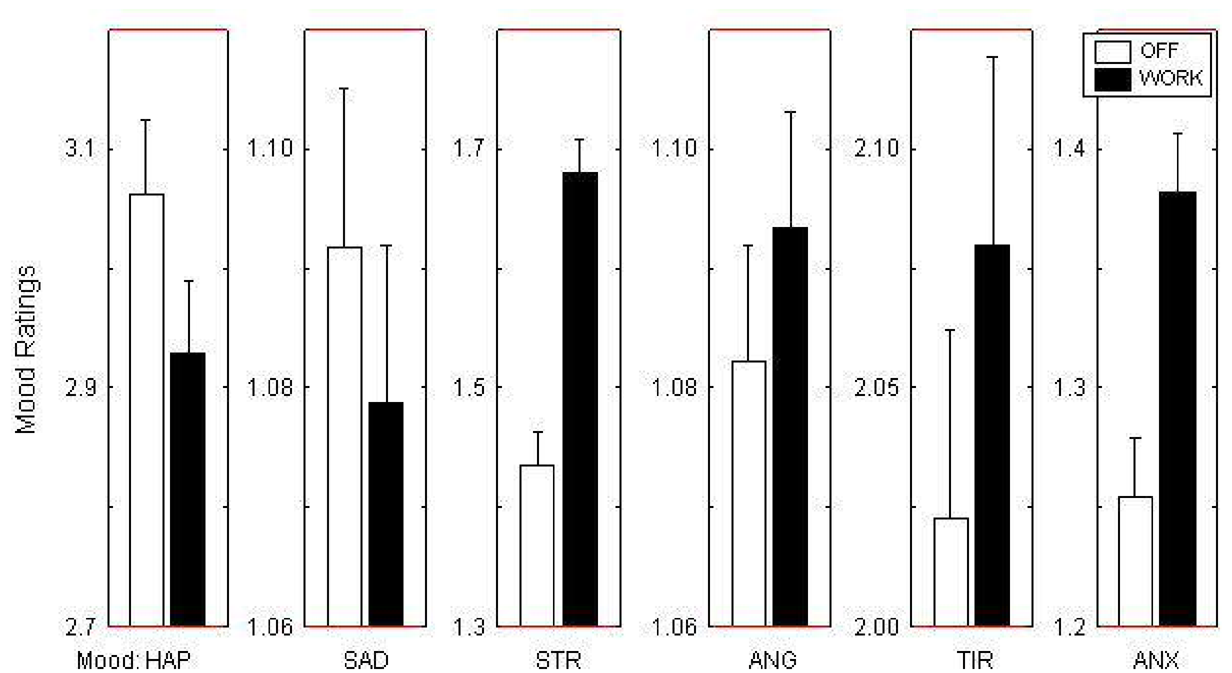

Figure 1. Mean ratings of the moods happy (HAP), sad (SAD), stressed (STR), angry (ANG), tired (TIR), and anxious (ANX) during the off day and the workday. All differences shown were statistically significant. In this and the subsequent figures, for comparison across moods the panels use different ranges because of differences in the means and ranges of ratings from mood to mood. In this and the subsequent figures, all error bars are standard errors.

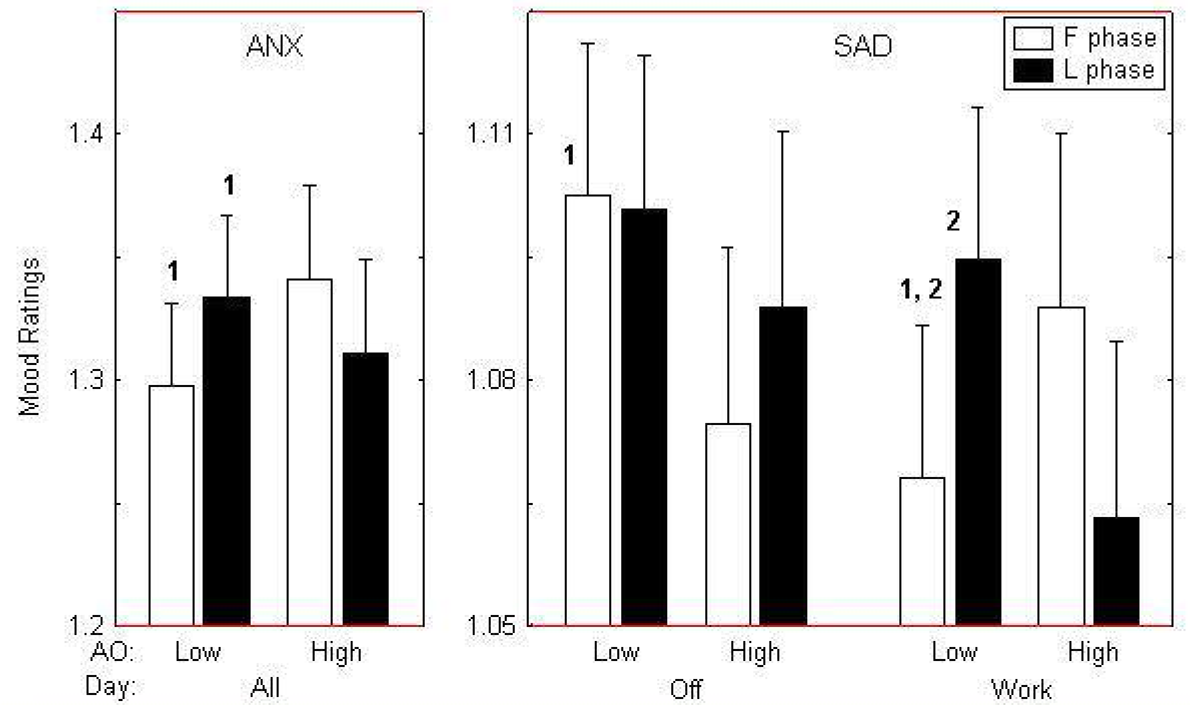

Figure 2. Mean ratings of anxious (ANX, left panel) and sad (right panel) during the Follicular (F) and Luteal (L) phases in relation to scores on the Spielberger Anger Expression Scale (Anger Out (AO)). In this and subsequent figures, those cells with the same number shown on the top of the bar were significantly different within a panel.

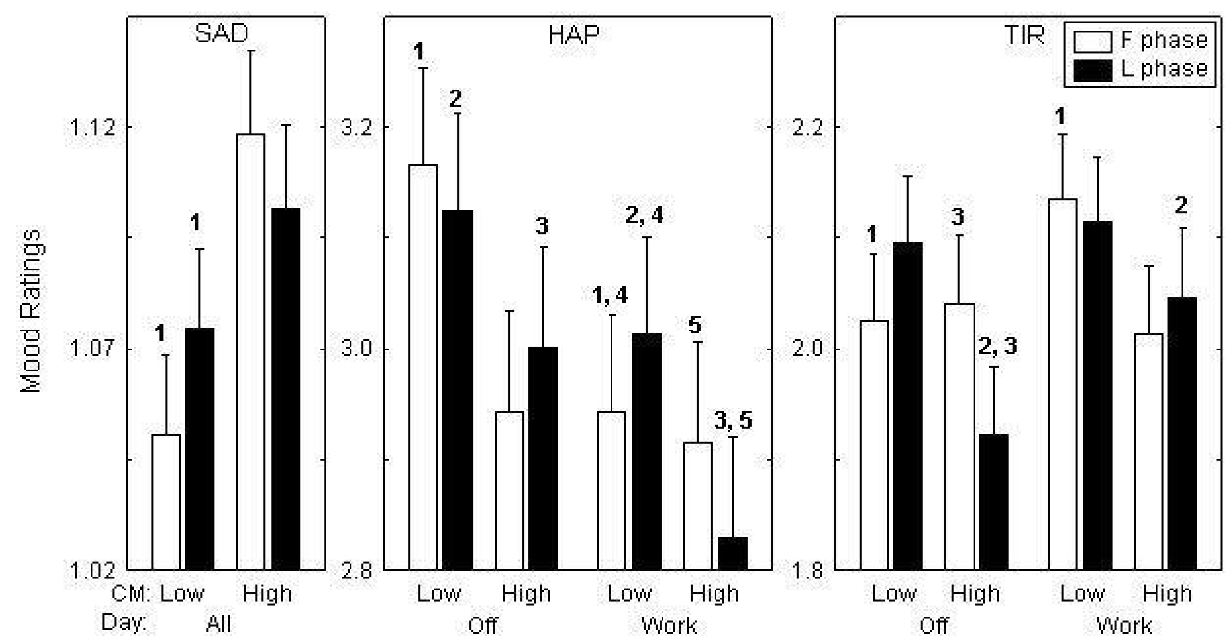

Figure 3. Mean ratings of sad (SAD, left panel), happy (HAP, middle panel), and tired (TIR, right panel) during the Follicular (F) and Luteal (L) phases in relation to scores on the Cook-Medley Hostility Scale (CM).

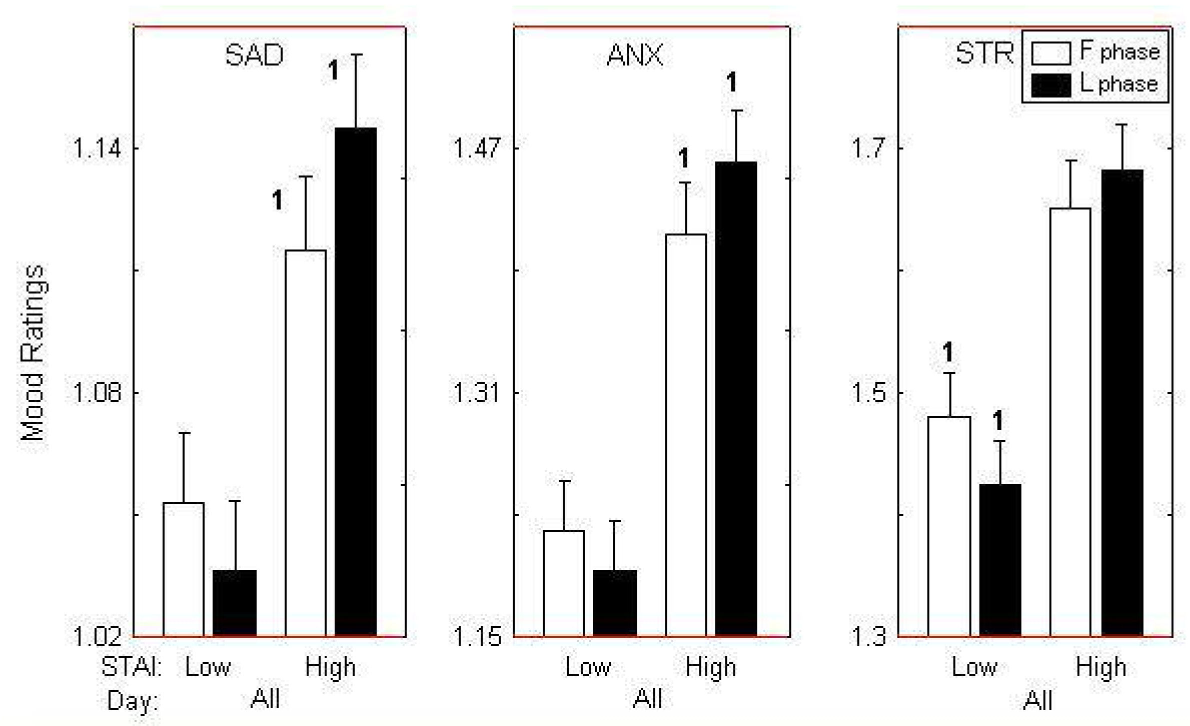

Figure 4. Mean ratings of sad (SAD, left panel), anxious (ANX, middle panel), and stressed (STR, right panel) during the Follicular (F) and Luteal (L) phases in relation to scores on the Spielberger Trait Anxiety Inventory (STAI).