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Perimenstrual Behavior Changes Among Female Yellow Baboons: Some Similarities to Premenstrual Syndrome (PMS) in Women

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Although numerous studies have documented changes in the behavior of nonhuman primate females around the time of ovulation, very little attention has been paid to behavior changes around the time of menstruation. Yet such information is obviously relevant to understanding the origins and etiology of the adverse mood and behavior changes experienced premenstrually by many women. Analysis of data obtained during 115 hours of observation on 13 female Amboseli (Kenya) baboons *(Papio cynocephalus)* during 24 menstrual periods showed that prior to and during the time of menstrual onset, these individuals exhibited distinct changes in their activity budgets, nearest-neighbor distances, and patterns of social interaction. Furthermore, in comparison to females around the time of ovulation, perimenstrual females showed increased rates of agonistic interaction and decreased (but nonzero) rates of sexual interaction with adult males. These premenstrual and perimenstrual behavior changes among female yellow baboons thus show some intriguing similarities to several commonly reported behavioral symptoms of premenstrual syndrome (PMS) in women.

Key words: baboons, Amboseli National Park, *Papio cynocephalus*, premenstrual syndrome (PMS), menstrual cycle, behavior

INTRODUCTION

During the week before menstrual onset, approximately 30% of all women report a variety of adverse mood and behavior changes, symptoms that generally are alleviated rapidly following the onset of menses [Frank, 1931; Dalton, 1964; Abraham, 1980a]. The single most common symptom of this so-called premenstrual syndrome (PMS) is anxiety, irritability, and nervous tension resulting in hostile behavior, but other frequently reported discomforts include weight gain, abdominal bloating, increased appetite, depression, withdrawal, and lethargy [Abraham, 1980b; Coppen & Kessel, 1963]. Theories concerning the etiology of PMS in women range from the pathophysiological to the purely psychological [reviewed by Dennerstein et al, 1984].

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Information on menstrual cycle changes in the behavior of nonhuman primates is obviously relevant to understanding the physiological, psychosocial, and evolutionary bases of PMS. However, nearly all previous research on menstrual cycle influences on the behavior of nonhuman primate females, both free-living [Saayman, 1970; Seyfarth, 1978; Hausfater, 1975] and captive [Rowell, 1963, 1968; Michael et al, 1966; Walker et al, 1983; Nadler et al, 1983], has either ignored the menstrual period altogether or has presented data in a manner such that behavior changes associated with menstrual onset cannot be reliably reconstructed (as explained below). Notable exceptions in this regard are studies of captive or semiconfined macaques by Loy [1970], Sassenrath et al [1973], and Czaja [1975], which along with anecdotal reports by zookeepers of premenstrual increase in aggressiveness among caged females [Janiger et al, 1972] have heretofore constituted the only available information on changes in behavior around the time of menstruation. The present report serves to expand this very limited database by describing changes in the social behavior and activity patterns of wild nonhuman primate females in relation to menstrual onset.

METHODS

The subjects of this study were free-living yellow baboons *(Papio cynocephalus)* in the Amboseli National Park of Kenya; detailed information on the behavior and ecology of this population has been presented elsewhere [Altmann & Altmann, 1970; Hausfater, 1975]. Briefly, Amboseli females reach menarche at four to five years of age and undergo their first pregnancy at five to six years of age. Successive pregnancies are preceded by two to four menstrual cycles of 32–34 days average duration; menstrual flow generally occurs on the first four to five days of each cycle [Altmann et al, 1978, 1981].

Most previous day-by-day analyses of changes in behavior throughout the menstrual cycle have been carried out by aligning a sample of menstrual cycles from one or more females with respect to day of ovulation. Cycle days are then enumerated day 1 before ovulation, day 2 before ovulation, and so on; and rates of behavior are calculated for each such cycle day. Unfortunately, since ovulation does not bear a fixed temporal relationship to menstruation, day 14, for example, backdated from ovulation in a given cycle can potentially fall anywhere from 1 to 10 days after the day of menstrual onset for that cycle. In contrast, cycle days for females in the present study were enumerated relative to the day of menstrual onset (notated "M-day"), and behavior changes were then analyzed over a two-week period centered on M (ie, days M−7 to M+7 in our shorthand notation), an interval hereafter referred to as the *perimenstrual period* [Loy, 1970].

Although we had available almost daily reproductive cycle records for females in this study, we did encounter one minor problem in determining the date of menstrual onset for each cycle. Briefly, the presence or absence of menstrual flow for Amboseli females has generally been recorded only once each day as part of an early morning census of their group [Hausfater et al, 1982]. Consequently, menstrual flow that began later in the same day may not have been detected until the following morning, thus producing a one-day error (at most) in the recorded menstrual onset date. We have attempted to circumvent this problem by combining data across three-day intervals, thereby assuring that in all cases the interval referred to in the text, table, and figures as "menstrual onset" (ie, days M−1, M, M+1) contained not only the true day of menstrual onset, but also the precise 24-hour period immediately following the onset of menstrual flow.

Sampling methods and behavior definitions used in these analyses were exactly the same as those employed in previous work on the estrous behavior of Amboseli

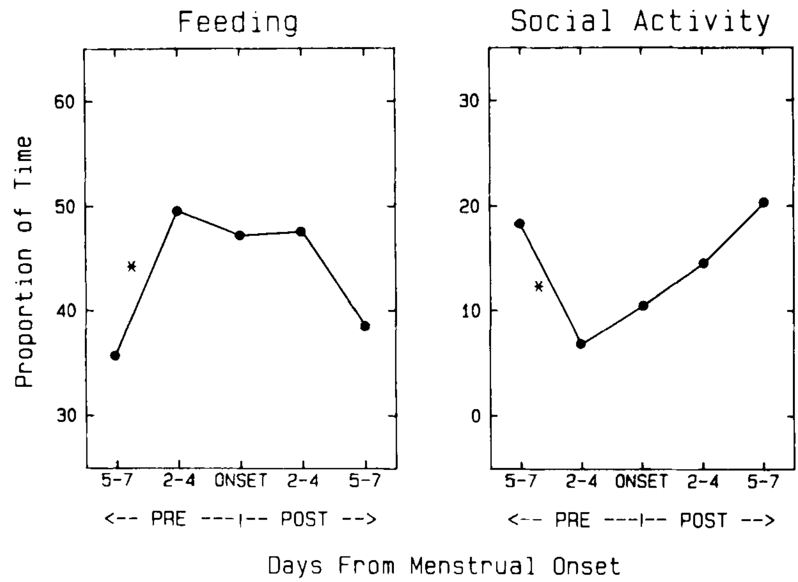

Fig. 1. Premenstrual changes in activity patterns of female Amboseli baboons. This figure shows the proportion of time perimenstrual females spent in feeding and in social activities as calculated from point samples of their behavior. Asterisks mark interval-to-interval comparisons that were significant at $p < .05$; the proportional distribution of time spent in all activities on day 4 premenstrually through menstrual onset differed significantly from that for all other perimenstrual days combined. Sample sizes (N) for consecutive three-day intervals were 110, 117, 125, 145, and 114.

females [Hausfater, 1975]. Altogether, a total of 114.8 hours of focal-animal samples [Altmann, 1974] were obtained on 13 female subjects during 24 perimenstrual periods. Additionally, information on the activity states and nearest-neighbor distances of perimenstrual females was obtained through 611 instantaneous (ie, point) samples [Altmann, 1974]. These sample data were pooled across females and menstrual cycles and then used to calculate rates of social interaction for perimenstrual females as well as the proportion of time these females spent in each of four activity states: feeding, resting, moving, and socializing (as defined by Slatkin & Hausfater [1976]). The significance of perimenstrual changes in these and other proportion measures was evaluated by carrying out a two-sample chi-square test (corrected for continuity) on the raw frequency data [Fliess, 1973, p. 19]. Rate measures (n events/ t hours) were compared by calculating their variance ratio (n_1t_2/n_2t_1) and then referring the result to the F-distribution with $2n_2$ and $2n_1$ degrees of freedom [Cox & Lewis, 1966, p. 229]. All differences in rates and proportions reported in this note are significant at the $p < .05$ level unless otherwise stated.

RESULTS

Figure 1 shows that the proportion of time spent feeding by perimenstrual female baboons, as estimated from point sample data, reached its highest level (49.6%, N = 117) on days 2–4 before menstrual onset and remained elevated for several days thereafter. In contrast, the proportion of time perimenstrual females spent in social behavior reached its lowest level (6.8%, N = 117) and remained low during these same intervals (Fig. 1). Overall, the proportional distribution of time

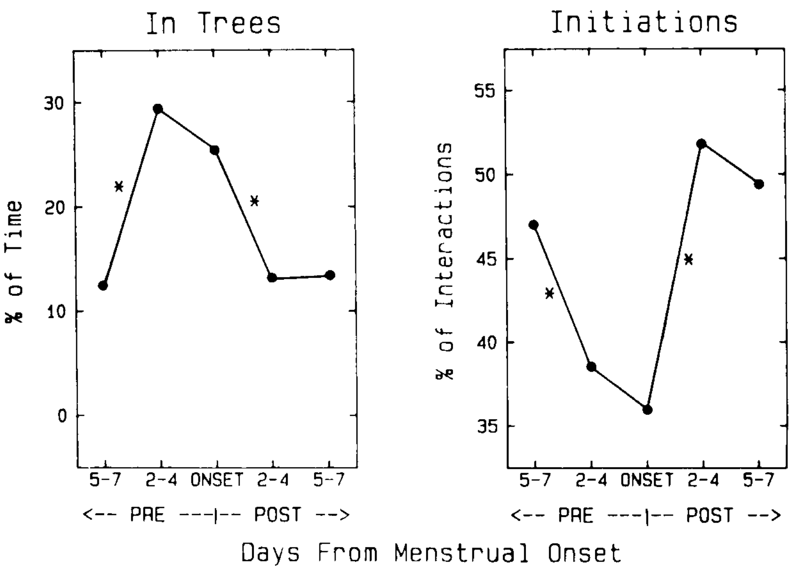

Fig. 2. Withdrawal from social contact by premenstrual female baboons. This figure shows (1) the proportion of time females spent in trees (or other vegetation ≥ 2 m high) as calculated from point samples of substrate use, and (2) the proportion of all social interactions of perimenstrual females initiated by those females themselves as calculated from focal-animal sample data. Asterisks indicate interval-to-interval comparisons that were significant at $p < .05$, and for both measures the average value for day 4 premenstrually through the time of menstrual onset differed significantly from the average value for all other perimenstrual days combined ($p < .05$). Sample sizes for consecutive three-day intervals for initiation analysis were 253, 311, 372, 387, and 206; sample sizes for tree substrate analysis were 96, 85, 106, 122, and 97.

spent feeding, resting, moving, and socializing by females on day 4 premenstrually through menstrual onset differed significantly from that of females on all other perimenstrual days combined. Coincident with these changes in activity budget, Amboseli females showed a marked premenstrual shift in habitat use (Fig. 2). Specifically, from day 4 premenstrually through the time of menstrual onset, females were twice (27.2%, N = 191) as likely to be found in trees (or other vegetation ≥ 2 m high) as they were on all other perimenstrual days combined (13.0%, N = 315).

An increased amount of time in trees may seem like an esoteric finding, but in fact it reflected a more general pattern of withdrawal from social contact by premenstrual females. Briefly, since Amboseli baboons carry out most of their daily social activities on the ground, females that preferentially utilized arboreal feeding and resting sites greatly reduced their probability of contact with other group members. In fact, from premenstrual day 4 through the time of menstrual onset, Amboseli females had no other adult females within 10 m of themselves in 41.8% (N = 98) of all nearest-neighbor samples, as compared to 29.2% (N = 137) for all other perimenstrual days combined. Similarly, females were in close proximity (ie, ≤ 10 m) to adult males significantly less frequently during the time of menstrual onset (46.5%, N = 172) than at the beginning (ie, days M−7 to M−5) and end (ie, days M+5 to M+7) of the perimenstrual period (61.1%, N = 131).

Two other measures provided further evidence of a premenstrual withdrawal from social contact by Amboseli females. First, the rate of short-distance locomotor

TABLE I. Rates of Social Interaction for Perimenstrual Female Amboseli Baboons, As Calculated From Focal-Animal Sample Data*

	Days from menstrual onset (three-day intervals)				
Interaction category	M−7 to M−5	M−4 to M−2	Onset	M+2 to M+4	M+5 to M+7
Female initiated agonism	2.8	1.9	1.6	3.1	2.9
Femal received agonism	2.9	3.0	2.5	3.3	2.0
Subtotal agonism	5.7	4.9	4.1	6.4	4.9
Sexual (adult male partners only)	2.2	2.5	2.0	2.7	4.4
Grooming (groomer or groomee)	3.8	3.0	2.6	4.0	4.2
Total all categories	11.7	10.4	8.7	13.1	13.5
Agonisms as proportion of all interactions	48.7	47.1	47.1	48.8	36.3
Hours of observation	17.6	25.1	35.0	24.8	12.3

*For nearly all categories of interaction, rates during the three-day interval containing menstrual onset were significantly lower than rates during all other perimenstrual intervals combined. In contrast, the proportion of all interactions that was agonistic (as opposed to sexual and affiliative) did not change throughout the perimenstrual period. See text for further explanation.

movements by females experiencing menstrual onset—movements that primarily served to adjust their position relative to adult male neighbors—was significantly lower than was the average rate of such movements by females on all other perimenstrual days combined: 25.3 vs 42.9 per hour. Adult males, in contrast, showed no significant change in their movements with respect to perimenstrual females over this same period. Second, the proportion of social interactions initiated by females themselves was significantly lower from day 4 premenstrually through the time of menstrual onset (37.2%, N = 683) as compared with all other perimenstrual days combined (49.4%, N = 846) (Fig. 2).

As a result of the above changes in their pattern of social contacts, premenstrual females showed a significantly decreased rate of participation in all forms of social interaction, both affiliative and agonistic (Table I). Moreover, the extent of this decrease, on a relative basis, was essentially the same for both interaction categories, and thus across the entire perimenstrual period there was no significant variation in the proportion of all social interactions that was agonistic as opposed to sexual and affiliative. Taken together, the above findings contrast sharply with previous reports of a marked increase in aggression and wounding around the time of menstrual onset among captive rhesus monkey *(Macaca mulatta)* females [Sassenrath et al, 1973; Rowell, 1963]. Although results of the preceding studies, in comparison with those of the present work, may in fact reflect a valid species difference in perimenstrual behavior between baboons and macaques, it is also possible that caging arrangements in those studies may have greatly reduced the ability of premenstrual females to withdraw from social contact—a major feature of baboon perimenstrual behavior—and thereby resulted in artificially high rates of aggression and wounding [cf Wallen, 1982].

Even though Amboseli females did not show a distinct premenstrual increase in agonistic interactions, their rate of aggressive behavior averaged across the entire perimenstrual period may still have been substantially higher than that during other phases of the baboon menstrual cycle, for example, at midcycle. Unfortunately, the present data do not allow a strict within-subjects analysis of changes in behavior throughout the menstrual cycle. However, many of the females in the present study were also subjects in a previous analysis of the estrous behavior of Amboseli baboons [Hausfater, 1975], and these two data sets are otherwise directly comparable. Specifically, the mean rate of agonistic interaction for perimenstrual females in the Amboseli population, 5.1 interactions/hour (Table I), proved to be nearly three times as high as the rate reported for estrous females in that same population, 1.8 per hour [Hausfater, 1975, Table 22]. Similarly, the proportion of all social interactions that were agonistic (as opposed to sexual or affiliative) was over four times as great for perimenstrual females (Table I) as for estrous females (10.2%, N = 6,432).

One confounding factor in the above comparisons is that estrous females were frequently constrained in their behavior by the presence of an adult male consort. However, Amboseli females generally ceased forming consortships shortly after ovulation, yet their rate of agonistic interaction at this time (ie, cycle day D+3; Hausfater [1975]) was still fully a third lower than that of perimenstrual females: 3.2 vs 5.1 per hour. Nevertheless, the only thing that such comparisons really tell us is that perimenstrual females and estrous females have very different rates of agonistic interaction. Without additional data and/or assumptions it is not obvious whether perimenstrual females should be described as having rates of agonistic interaction that are "elevated" compared to those of estrous females as the norm, or conversely whether estrous females should be described as having rates of agonistic interaction that are "suppressed" compared to those of their perimenstrual counterparts.

Although perimenstrual females themselves only rarely formed consortships, they did continue to participate in sexual interactions with adult males at a low rate throughout the perimenstrual period, as has also been reported for rhesus monkeys [Loy, 1970]. Specifically, perimenstrual females in Amboseli participated in mountings, perineal inspections, and hindquarter presentations with adult males at a combined rate of 2.5 per hour (Table I). In comparison, around the time of ovulation, Amboseli females participated in these same categories of sexual behavior at a rate nearly twice as high as that of perimenstrual females: 5.5 interactions per hour [Hausfater, 1975]. Moreover, mountings of perimenstrual females were not accompanied by intromission or ejaculation as was the case for estrous females. However, both the sexual attractiveness and receptivity of perimenstrual females increased markedly as their sexual skin resumed swelling, generally within four to five days following menstrual onset. As a result, females showed a significantly higher rate of sexual interaction with adult males (4.5 per hour) on postmenstrual days 5–7 (ie, M+5 to M+7) than they did on all preceding perimenstrual days combined (2.3 per hour).

DISCUSSION

These analyses of data on the behavior of perimenstrual female baboons have revealed changes in activity patterns and social interactions similar to a variety of symptoms characteristic of premenstrual syndrome (PMS) in women: enhanced appetite, withdrawal from social interaction, and elevated frequency of hostile interactions compared to midcycle [Abraham, 1980b; Coppen & Kessel, 1963]. Of course it remains an open question whether such premenstrual symptoms in women and baboons are the result of natural selection acting directly on perimenstrual behavior per se, or are merely epiphenomena reflecting selection for specific hormone-behavior interactions during other phases of the menstrual cycle (eg, around ovulation).

Aside from such global evolutionary considerations, there are still many unanswered questions concerning the perimenstrual behavior of baboons themselves. For example, we do not yet know the degree to which perimenstrual behavior changes shown by individual females are consistent over successive menstrual cycles and successive years of reproduction for those females. Likewise, given the limited size of the present data set, it was obviously not possible to reach any firm conclusion concerning either the universality among baboon females of such perimenstrual behavior changes or the proportion of females who show premenstrual behavior changes of any given magnitude.

In sum, resolution of many of the issues relevant to understanding perimenstrual behavior changes in a comparative and evolutionary perspective awaits further systematic research on this phenomenon among baboons and other primate species. Moreover, in using data from this and such future studies to draw parallels between the perimenstrual behavior of human and nonhuman primates, it will be important to bear in mind that the primary symptoms of PMS are changes of mood and emotion. And, unfortunately, it is not possible to obtain self-reports of, or otherwise reliably assess, mood and emotion among free-living nonhuman primates. However, insofar as behavior correlates with, and is an expression of emotion, the present analyses do suggest that PMS is not a phenomenon restricted exclusively to human females among higher primates.

CONCLUSIONS

1. From day 4 before menstruation through the time of menstrual onset, Amboseli baboons *(Papio cynocephalus)* showed a number of characteristic changes in their activity budgets and patterns of social interaction compared to other days in the overall perimenstrual period. These changes included the following: (a) more time spent feeding and in arboreal (as opposed to terrestrial) habitats, less time spent in social interaction; (b) increased distance to nearest adult male and adult female neighbors, reduced rate of initiation of social interaction with those neighbors, decreased overall responsiveness to the presence of adult male neighbors; and, (c) decreased rate of participation in social interactions of all types, both affiliative and agonistic.

2. However, it was also the case that perimenstrual females did show rates of aggression that were significantly higher, and rates of sexual behavior that were significantly lower (albeit still nonnegligible), than those of females at midcycle, ie, around the time of ovulation.

3. Several of these pre- and perimenstrual behavior and activity budget changes among female Amboseli baboons are similar to behavioral symptoms commonly reported by women as part of the premenstrual syndrome (PMS).

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