



An evolutionary model of premenstrual syndrome [☆]

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Summary PMS has existed at least since the beginning of medical writing, and is estimated to affect large proportions of women worldwide. But the etiology remains unknown, diagnostic definition and methods vary tremendously, and treatment is wholly symptom-oriented. This poor state of understanding has been attributed to a lack of theoretical perspective. The current work provides such a theoretical perspective from an evolutionary paradigm. PMS is not evolutionarily adaptive in and of itself. Rather, it is part of a cyclic pattern that results from the cessation of heightened, positive physical and sociobehavioral states that are evolutionarily favored during the fertile phase of the menstrual cycle for some women. When the advantage of these positive states diminishes, they cease, causing *relatively* lower states that are subjectively experienced as symptoms. In its clinical extreme, this is PMS. However, eons of evolution would result in modern women who are choosy about the conditions under which they reproduce. Thus, women whose conditions suggest a high probability of successful immediate reproduction are expected to experience the heightened, positive states during the fertile phase of the menstrual cycle to attract mates and fertilizations; these women will experience symptoms premenstrually. But women whose conditions suggest a low probability of successful immediate reproduction are expected to experience the heightened, positive states during the premenstruum to retain mates, accrue or maintain resources, and/or otherwise improve their conditions; these women will experience symptoms during the fertile phase of the menstrual cycle ("pseudo-PMS"). In addition, the heightened states are expected to shift in response to changes in conditions throughout women's lives, being expressed at whatever point is most evolutionarily beneficial given current conditions. This suggests that our conceptualization of PMS should be reframed within a facultative (condition-sensitive), evolutionary model. It also generates predictions both within- and between women that should elucidate the syndrome.

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What is premenstrual syndrome (PMS)?

Premenstrual syndrome (PMS) is characterized by cyclic symptom fluctuation: symptoms appear premenstrually, abate with the onset of menses, and reappear premenstrually in the next cycle. There are various clinical definitions of PMS; all require

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symptom-free days early in the cycle. A popular physician's guide [1] requires, over two or more cycles of prospective daily ratings, marked premenstrual worsening of at least five symptoms that are not exacerbations of other disorders. If at least one of the five symptoms is dysphoric, and life activities or relationships are markedly affected, premenstrual dysphoric disorder (PMDD, *diagnostic and statistical manual of mental disorders* (DSM-IV); [2]) may be diagnosed. The definitions of Dalton and Greene [3,4] and the *International Classification of Diseases* (ICD-10, premenstrual tension, PMT; [5]) are more inclusive, and accept any number and type of symptoms that warrant presenting to a physician.

Diagnostic methods, including *which* symptoms "count" and *how* they are counted, also vary greatly. There are currently over 65 different daily symptom rating instruments [6] and >150 symptoms associated with PMS [4]. Thus, diagnosis is instrument-specific. Additionally, women with no symptoms in common can be diagnosed with the same syndrome. A recent multidisciplinary expert panel [7] has (again) called for the establishment of a uniform definition, measurement tools, standards and practices.

PMS research has focused on proximate (mechanistic) causes and their clinical implications. Connolly [8] summarizes that extensive literature. Neither endocrinological nor genetic factors can explain PMS. In general, women's hormones cycle in roughly the same pattern, but not all women have PMS. Any single, proximate, causal factor is unlikely to sufficiently explain individual symptoms or the entire syndrome [8,9]. Additionally, no treatment derived from such research has been any more effective than placebo [10]. The poor state of understanding has been attributed to "inadequate theoretical development" in the field [10]. An evolutionary approach may yet provide this crucial theoretical framework.

The hypothesis: an evolutionary model of PMS

Herein PMS is hypothesized to be a byproduct of other cyclic patterns. There is a growing body of evolutionary literature showing adaptive cyclic fluctuation in women's social motivations and behaviors. During the fertile phase of the menstrual cycle, women ornament more [11] and wear sexier/bolder clothing [12], go to clubs more [13], are more attentive to "maleness" [14], increase ranging activities including locomotion and volunteering for more social activities [15], and flirt

more with men not their mates [13,16]. Physical and chemical changes also track the menstrual cycle. Women's facial appearance [17] and body odors [18–20] are more attractive to men during the fertile phase of the menstrual cycle. Finally, women's sexual desire is reported to be higher during the fertile phase than during non-fertile phases of the menstrual cycle [13,16,21]. Other cyclic factors are likely to be added to this list as research continues.

These phenomena have been interpreted as evolutionarily adaptive strategies to maximize chances of mating and fertilization. Hence, they fluctuate in tandem with the menstrual cycle, being most pronounced when the possibility of mate attraction and fertilization is greatest, and abating thereafter. In essence, women's sociobehavioral state of being cycles "up" and "down" across the menstrual cycle. During the fertile phase of the menstrual cycle, women are more social, more active, feel sexier and more flirtatious and desirous; they feel better, and men find them more attractive. When fertilization is no longer possible, these positive states abate. *In contrast to the highs during the fertile phase of the cycle, the premenstruum brings a relatively lower state in which women are less social, less active, feel less sexy and less flirtatious and desirous; they feel relatively worse, and men find them less attractive. Taken together, these define a state of suboptimal general well-being, and may be subjectively experienced as symptoms. In its extreme, clinical form, this lower state is PMS.* While PMS is not adaptive in and of itself, it results from the cessation of cyclic evolutionarily adaptive, heightened, positive states during the fertile phase of the menstrual cycle.

How does the evolutionary view of PMS enhance understanding?: implications, predictions, and consequences

Characteristics, prevalence, and distribution of PMS

The evolutionary model predicts that symptoms of PMS should be the inverse of the heightened socio-behavioral factors. Table 1 shows the characteristics that are known to be enhanced during the fertile phase of the cycle, and the inverse of each. These correspond to symptoms that are recorded on standard diagnostic instruments for PMS (e.g., [1]), and include variations on themes concerning the tendency to socialize, interest in social activities, activity levels, and sexual interest.

Table 1 Features that are evolutionarily enhanced during the fertile phase of the cycle and their inverse forms that may be symptomatic of PMS during the premenstrual phase of the cycle

Enhanced "positive" form of feature	Inverse or "negative" form of the feature
Ornament more [11]	Ornament less
Wear sexier/bolder clothing [12]	Wear less-sexy, more conservative clothing
Go to clubs more [13]	Less social; stay home more
More attentive to maleness [14]	Less attentive to maleness
Increase locomotion and ranging [15]	Decrease activity and ranging; stay home more
Volunteer for more social activities [15]	Refrain from social activities
Flirt more [13,16]	Not flirtatious
More attractive facial appearance [17]	Less attractive facial appearance
More attractive body odors [18–20]	Less attractive body odors
Higher sex drive [13,16,21]	Lower sex drive
Reduced appetite [15]	Increased appetite, food cravings

Since uncoupling mood and sociobehavioral states would undermine the sociobehavioral strategies, cyclic mood symptoms that characterize PMS (mood swings, cyclic low mood, anxiety, and irritability) are predicted to covary with the sociobehavioral changes. High mood is expected to reinforce the heightened sociobehavioral states of the fertile phase of the cycle, and lower mood will occur during the premenstrual phase.

Evidence of the positive physical and sociobehavioral states during the fertile phase of the cycle has been demonstrated in numerous evolutionary studies [11–21]. In addition, notice that all clinical studies of PMS also demonstrate this heightened state, by virtue of documenting women who feel relatively worse during the premenstruum than during the fertile phase of the cycle.

If PMS represents a clinically extreme piece of a larger, evolutionary cycle, it would be expected to be fairly ancient, common, and pan-human. Although we cannot know about PMS prehistorically, it has been recognized at least throughout history (see [22] for references from Hippocrates and Pliny; [23]; see [24] for citations from von Feuchtersleben, 1847; formal medical recognition in 1931 [25]; term PMS coined in 1953 [3]).

PMS is also quite common. Assessment of the prevalence of PMS is hindered by self-treatment, differences in availability and access to medical care, definitional and diagnostic differences, and sociocultural practices and attitudes. In spite of this, conservative estimates are non-negligible everywhere [1,3,26–41]: from 7.7 [35] to 90% [41] of women affected. Moreover, most women experience some symptom fluctuation in most of their cycles, even if it is sub-symptomatic in severity [7,42–44].

PMS is also pan-human. It has been found worldwide (Fig. 1; [1,3,26–67]) in diverse cultures in both developed and developing countries [7]. The

World Health Organization (WHO) has concluded that "... a large proportion of women in third world nations in different world regions *do* experience [PMS]... data show clearly that [it] is *not* a Western phenomenon" [68] (my italics).

Why don't all women have PMS?

If the cyclic pattern underlying PMS is evolutionarily adaptive, why do not all women have PMS? While reproduction is the currency of evolution, it is also particularly costly for women in terms of time, energy, and resources. Since time, energy, and resources are limited, ancestral women who squandered them by attempting reproduction indiscriminately would have been evolutionarily disfavored (that is, left fewer surviving offspring) compared to women who undertook reproduction under conditions favorable to success. Thus, evolutionarily well-adapted women are expected to be choosy about the conditions under which they reproduce [69], and modern women's bodies are expected to show evidence of reproductive adaptations that respond to prevailing conditions affecting the likelihood of successful reproduction. Under conditions favorable to successful immediate reproduction, women are expected to experience the heightened positive states during the fertile phase of the cycle to attract mates and/or gain fertilizations, and feel relatively worse during the premenstruum.

But under conditions unfavorable to successful immediate reproduction, women are expected to lack the heightened positive states during the fertile phase of the cycle; therefore they will not feel relatively worse during the premenstruum – that is, they will not experience PMS. Under these conditions, the heightened sociobehavioral state is expected to shift away from the fertile phase of the



Figure 1 PMS studies around the world (numbers indicate references).

cycle, perhaps targeting the luteal phase of the menstrual cycle in an attempt to keep mates and gain or maintain resources in spite of impending menstruation, which advertises the reproductive failure of the previous cycle as well as current, transient infertility. For women in these conditions, then, the lower state is expected to be expressed during the fertile phase of the cycle. A forthcoming publication from my research (as yet unpublished data) will demonstrate that for women who are not in condition for successful immediate reproduction, the heightened states are, indeed, expressed during the premenstruum; and the relatively negative, symptomatic states (pseudo-PMS) are expressed during the fertile phase of the cycle.

What constitutes good condition for successful immediate reproduction?

Many interacting factors affect a woman's condition, minimally including nutritional status, quantity and quality of resource base and/or territory, mateship status and quality of both mate and relationship, parity, and age. Additionally, familial and/or social support may impact successful reproduction. These factors all comprise continua, from insufficient/poor/zero to sufficient/good/non-zero, that affect the success of a reproductive venture. Fig. 2 shows predicted effects and directionality of these factors.

Changes throughout women's lives

Many women suffer from PMS sporadically; that is, suffering for months or years, interspersed by

symptom-free periods of time. Such shifts are expected in response to changes in a woman's condition throughout her life. In the same way that the changing levels of incipient solar radiation alter melanin production within individuals in predictable directions (the suntanning response), changes in factors that affect the likelihood of successful reproduction are expected to predictably alter reproductive strategies in women. The heightened sociobehavioral state of good feeling is expected to shift in response to a woman's changing reproductive condition and be expressed at whatever point is most evolutionarily beneficial to her given her current conditions. In Fig. 2, changes in a woman's condition would cause her to shift from pattern A to B, or vice versa. The lower (negative) state is expected to shift accordingly as well. Longitudinal studies are planned to follow women through their childbearing years to investigate these predicted changes and their relationship to variables of condition.

Effects on men

Men are reported to be more loving and attentive [13,16,70], and more jealous and possessive [13,16], during the fertile phase of their partner's menstrual cycle. It is possible that these findings reflect men's selfish attempt to gain matings and/or prevent cuckoldry by guarding their mates during the fertile phase of the partner's cycle. However, an alternative is that men are responding to the positive cues given by women in the heightened state of the fluctuating cycle. If this alternative explanation is correct, there should also be

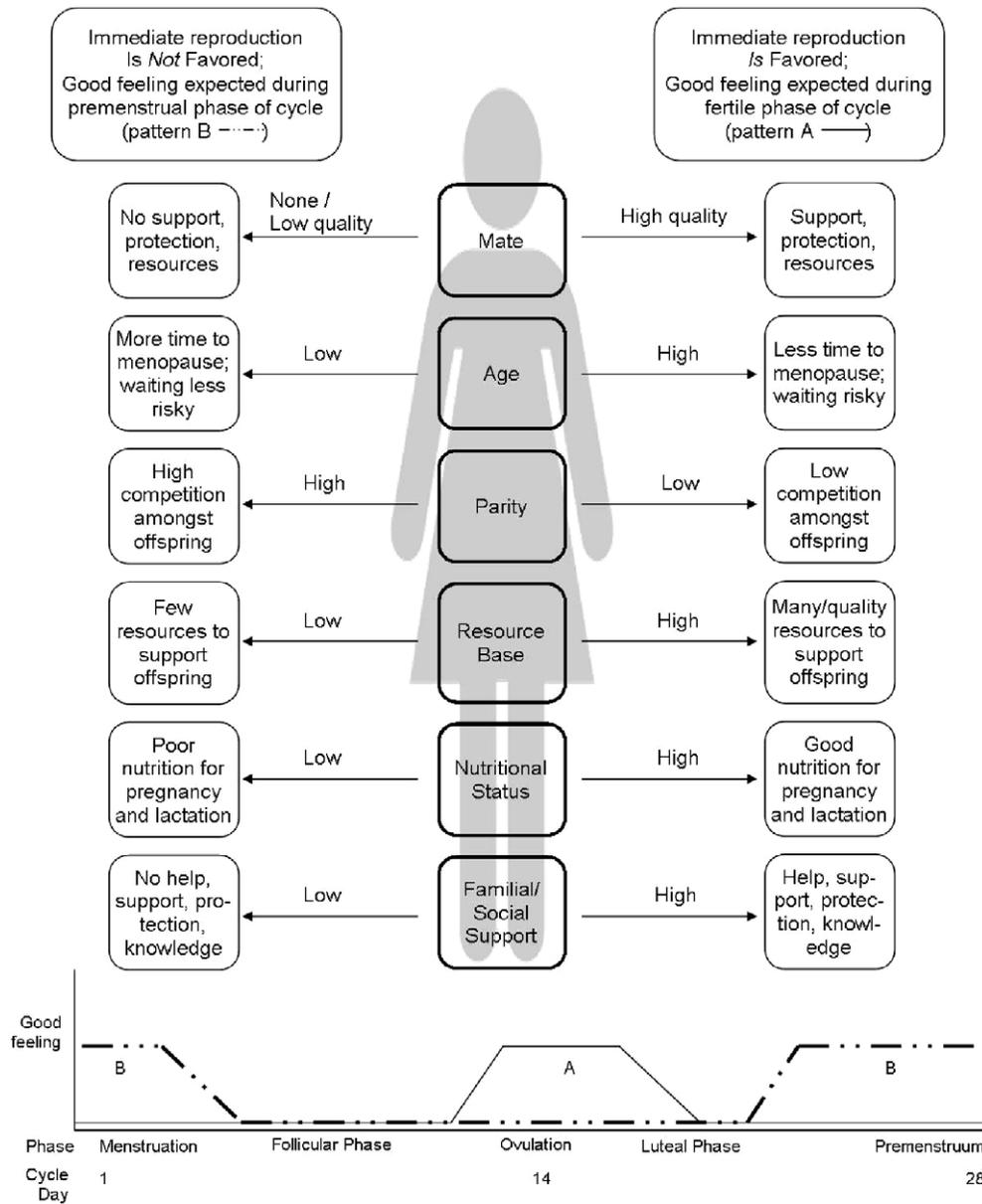


Figure 2 Factors contributing to the likely success of an immediate reproductive venture, and their effect on cyclic timing of good feeling.

found a subset of men who exhibit these behaviors in response to women who feel good during the premenstruum. Future research should investigate whether men’s attentive, jealous, and possessive behavior is predictable by their mate’s reproductive condition status.

Cross-cultural differences

To the extent that indicators of the likelihood of successful reproduction vary across cultures – either as a direct result of cultural traditions and practices, or as a result of environmental and ecological factors – this model has the power to pre-

dict cross-cultural differences in PMS. For example, since the likelihood of successful reproduction is reduced by extreme nutritional deprivation, neither the “good feeling” states associated with the fertile phase nor the lower (PMS) states during the premenstruum, would be expected during periods of nutritional insufficiency in cultures with famine cycles. Under such circumstances, maintaining mateships and attempting to maintain and accrue resources (in this case, nutritional resources) would likely be favored, leading to positive states during the premenstruum and lower states during the fertile phase of the cycle. Cultural differences in any of the factors that impact

the likelihood of successful reproduction are expected to affect the experience of both positive sociobehavioral states and symptoms.

Underlying proximate causes of PMS

This evolutionary model also points to novel avenues in the search for the underlying proximate cause(s) of PMS. If PMS is a byproduct of adaptive fluctuations in sociobehavioral states, then each component of those states should contribute a piece of the proximate, mechanistic cause of PMS. Instead of focusing on sex hormones that orchestrate the menstrual cycle, research should focus on the proximate causes of the sociobehavioral fluctuations. For instance, what proximate mechanism causes women to be more social, to range more widely, or to ornament more? When these mechanisms are understood, their reversal or abatement should be found to correlate with the lower states and symptoms associated with PMS. In turn, this understanding should illuminate novel treatment options and management techniques.

Conclusion

This model brings together two well-accepted evolutionary concepts: that physical and sociobehavioral fluctuations across the menstrual cycle are adaptive, and that evolutionary phenomena must be approached from within an environmental, contextual framework. Women are only expected to engage in behaviors that increase the probability of initiating reproduction if immediate reproduction is likely to be successful in the context of the current conditions. This model predicts that the heightened state of good feelings will be targeted at that phase of the menstrual cycle that is most evolutionarily advantageous to a woman, given the conditions in which she finds herself. Moreover, as a woman's condition changes, the pattern of fluctuation will phase-shift accordingly, refocusing the heightened, positive state of good feelings to be adaptively aligned with the new conditions in which she finds herself.

Approaching PMS from this evolutionary point of view highlights some changes that should make PMS research more productive. First, since the lower sociobehavioral states associated with PMS appear to be byproducts of a larger system, inquiries into PMS ought to be placed within the context of that larger system. Understanding the factors that are associated with the positive, heightened states that appear to be actively adaptive should frame PMS more clearly. As information is accrued that

expands our understanding of exactly how various reproductive conditions impact the heightened, positive states, our ability to predict and understand changes in the negative states will expand in tandem. But focusing only on the negative symptoms during the premenstrual phase of the cycle overlooks a large and critical piece of the puzzle, and hence is unlikely to be productive.

This framework likely also accounts for the difficulty thus far in arriving at a simple, standard definition of PMS, as well as the vast numbers of women who have PMS-like symptoms and patterns, but who fail to meet diagnostic criteria. Under differing conditions, different sociobehavioral tactics may be favored, leading to differing suites of symptom fluctuations in women. Moreover, many women may have symptoms that fluctuate, but that do not negatively impact their lives to the degree necessary for a diagnosis. Likewise, they may have fewer fluctuating symptoms than that which is required for a diagnosis, or patterns of fluctuation in which symptoms appear outside of the premenstrual phase of the cycle. The wealth of prospective daily rating data that have already been collected by PMS researchers should now be re-analyzed within this framework.

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