A THEORETICAL PROPOSAL FOR LATE LUTEAL PHASE BEHAVIOURAL CHANGES IN AN EVOLUTIONARY CONTEXT

Amandio VIEIRA

Simon Fraser University, Canada

Late luteal phase behavioural changes (LLBC) have been reported for humans and some other primates, and encompass a wide spectrum of behaviours. Several studies have estimated that a majority of women manifest some LLBC. At a more extreme end of the spectrum, in a small minority of women, LLBC have been classified as major emotional disturbances or medical conditions (although not without controversy), for example, as part of premenstrual dysphoric disorder. In this report, an attempt is made to place LLBC in an evolutionary context; some of these behaviours, in particular at a less extreme end of the spectrum, may have co-evolved with reproductive physiology. Evolutionary perspectives upon human reproductive behaviour are often complex (and controversial) issues; in this context, specific and more isolated mechanisms for possible evolutionary stability of some LLBC—e.g., related to male-female behavioural interactions—are suggested for further discussion. Overall, it is proposed that qualitative and quantitative changes in hormones and hormonal activities during the menstrual cycle evolved to optimize reproductive success through neurophysiological responses that include behavioural components, perhaps some LLBC.

Key words: late luteal phase behaviour, premenstrual syndrome, evolution, psychoneurophysiology

Behavioural changes that occur at the late luteal phase of the human menstrual cycle have been recognized at different times in history (Richardson, 1995) and are now documented by hundreds of scientific reports (although, there is still controversy in this area, especially when this topic is placed in a cultural context, cf. Richardson, 1995). There is a spectrum of severity for these behavioural changes; and the most severe may be categorized as part of medical conditions: late luteal phase dysphoric disorder, premenstrual syndrome (PMS), or premenstrual dysphoric disorders (PMDD) (cf. Kaur Gonsalves, & Thacker, 2004). A more general term, late luteal phase behavioural changes (LLBC), is used herein to emphasize the behavioural components. In the evolutionary contexts below, typically those LLBC at a less extreme end of the spectrum, i.e., non-PMDD (four or fewer of the main criteria below), are emphasized. The literature cited typically refers to PMS or the more severe PMDD (note publication titles); all of these disorders typically have some physical (somatic) and psychological components.

LLBC often include increases in irritability, aggression, anger, affective lability, depression, as well as food cravings and sleep disorders; and some of these changes can increase the risk of disruptions in normal activities, work, and interpersonal relationships.
LATE LUTEAL PHASE BEHAVIOUR

(Bianchi-Demichelli, Ludicke, Lucas, & Chardonnens, 2002; Girdler, Pedersen, & Light, 1995; Berlin, Raju, Schmidt, Adams, & Rubinow, 2001; Halbreich, Borenstein, Pearlstein, & Kahn, 2003; Hallman, Oreland, Edman, & Schalling, 1987). It is estimated that a majority of women manifest some form of LLBC; about 75% have at least one symptom from the PMDD criteria for diagnosis list, the minimum for PMS classification (Kaur et al., 2004; Rapkin, Mikacic, & Moatakef-Imani, 2003). About 3–10% have the minimum of five symptoms from the list, the requirement for PMDD classification (Cenac, Maikibi, & Develoux, 1987; Hallman, 1986; Halbreich et al., 2003; Deuster, Adera, & South-Paul, 1999; Kaur et al., 2004). These percentages are crude approximations because of the uncertainty associated with the analysis and interpretation of symptoms; typically for PMDD at least one of symptoms includes, from the Diagnostic and Statistical Manual of Mental Disorders (DSM) list, marked irritability or anger, depression or feeling of hopelessness, anxiety or tension, affective lability (Kaur et al., 2004, DSM is used by the American Psychiatric Association; ‘social withdrawal’ is also part of the American College of Obstetricians and Gynecologists main criteria, Rapkin et al., 2003).

At present, the causes of LLBC remain poorly understood. As with some other situations such as post-partum depression, there is evidence for variation in terms of magnitudes of hormonal fluctuations and individual responses to such fluctuations (Bloch et al., 2000; Hendrick, Altshuler, & Suri, 1998). In the late luteal phase of the menstrual cycle, progesterone levels decrease and this change has been proposed to account for some of the behavioral aspects of LLBC. Progesterone is associated with anxiolytic effects mediated by its neuroactive derivative allopregnanolone (Bitran, Dugan, Renda, Ellis, & Foley, 1999 and references therein). Allopregnanolone can affect gamma-aminobutyric acid (GABA) receptors and lead to overall changes in neural inhibition (Lovick, Griffiths, Dunn, & Martin, 2005). Women with LLBC are reported to have lower levels of this neuroactive steroid (Rapkin et al., 1997); but this is not always the case (Schmidt, Purdy, Moore, Paul, & Rubinow, 1994), and differences in responses to hormonal changes may be more important. There is also some evidence for a genetic component to LLBC (Condon, 1993; Kaur et al., 2004).

Some investigators have reported an abnormally high frequency of thyroid dysfunction associated with some LLBC (Schmidt, Grover, Roy-Byrne, & Rubinow, 1993; Girdler et al., 1995). A role for the hypothalamic-pituitary-thyroid (HPT) endocrine axis is implicated in, at least, a subset of women with LLBC (Girdler et al., 1995). Abnormally large variations in reverse T3 (rT3) and high levels of rT3, for example, have been observed during the luteal phase (Girdler et al., 1995; Linnoila, Seppala, Gordin, & Karonen, 1979) and have been associated with increased incidence of manic behaviour in women (Linnoila, Lamberg, Potter, Gold, & Goodwin, 1982, and references therein). High rT3 could occur as a result of increased T4 to rT3 conversion (Sauvage et al., 1998); such increased conversion, which may effectively lead to T4 inactivation, has been reported to occur in manic patients (Muller and Boning, 1988). An inverse relationship between T4 plasma levels and sensation-seeking by women has been reported (Balada, Torrubia, & Arque, 1992). Thyroid hormones and HPT axis activities are known to affect a wide range of behaviours in humans (and other animals). HPT dysregulation may, thus,
contribute to increased manic and depressive behaviour in humans; and, during the late luteal phase, modulation of thyroid hormones (cf. Girdler et al., 1995) as well as interaction with other factors that are specific to this phase (e.g., differential hormone responses) represent additional possible mechanisms that contributes to LLBC.

**Psychology and Evolution**

Late luteal phase stress and LLBC are presented below in an evolutionary context. It is proposed that some of these behaviours, especially those at a non-extreme end of the severity spectrum, co-evolved with reproductive physiological functions to increase overall reproductive success during Homo evolution. Both the behavioural and reproductive functions are based on neuroendocrine physiology. It is suggested that some LLBC are adaptive traits associated with, and not merely isolated side effects of, such physiology.

The diversity and complexity of human reproductive behaviour makes it difficult to isolate possible evolutionary mechanisms. A major basis for the evolutionary perspective presented herein is that of the female as the main integrator of environmental information (e.g., nutrition, energy acquisition and expenditure, behaviours that may influence offspring survival, etc). In such a perspective, I suggest that the following may contribute to the possible evolutionary stability of some LLBC. One mechanism may be the increased chance of terminating a male-female relation that was non-productive (earlier in the menstrual cycle) in terms of ovum fertilization. Another possibility is that LLBC may provide information relating to possible future paternal care for the offspring, and interest in the female (if the resulting behavioural changes did not lead to termination of the relation). Depending on environmental and social contexts, LLBC could have some predictive value for the female in terms of future paternal responses to the offspring, e.g., in terms of care and protection or, other parameters, such as aggression. Such information could be of value in a scenario where the female has some choice in terms of mating partners. For example, she may have chosen to mate again with a male that appeared to be very committed and relatively non-aggressive rather than seek a different mate for the next pregnancy opportunity. Geary, Vigil, & Byrd-Craven (2004), for example, discuss studies that emphasize the importance of sympathetic-type behaviours (‘kind’, ‘understanding’; and other attributes apart from cultural success) to the female in the context of mate selection; it may be important for a woman to know the ‘level of influence’ (Geary et al., 2004) she may have over the man’s behaviour. If LLBC do indeed provide some evolutionary advantage, this in turn would suggest that at some critical point(s) in human evolution there was significant female control (choice) over mating partners. LLBC may also provide a level of relationship destabilization that, when averaged over a population scale (i.e., overall, but not in every individual case or every specific environment), could help optimize reproductive success, e.g., different primate evolution scenarios and other examples below.

The points above are not incompatible with additional, male-based selection
mechanisms, or with contributions of female-female interactions. There is controversy regarding the importance of male contribution to offspring survival and human reproductive success. In most, if not all, cases the contribution is likely much less than that of the female (Campbell, 1999). But the assumption here is that the male contribution is significant (and, although not known, it may have had greater significance during most periods of human evolutionary history). Campbell (1999), for example, discusses studies in different human societies (17th to 20th century) that compare male and female contributions to orphan survival; in both cases the male:female contribution ratio is about 1:1.5.

In a perspective of testing relationship strength, predicting potential paternal behaviour, and information gathering, findings of increased anger, aggression, erratic behaviour, and even alexithymia, in the late luteal phase in humans may provide some support for the evolutionary mechanisms proposed above (Berlin et al., 2001; Rapkin, Pollack, Raleigh, Stone, & McGuire, 1995 and references therein; Bianchi-Demichelli et al., 2002; van Goozen, Frijda, Wiegant, Endert, & van de Poll, 1996; Hallman et al., 1987; Halbreich et al., 2003; Kuczmierczyk, Labrum, & Johnson, 1995). The mechanisms proposed above may be relevant to human ancestors and human evolution. Although, in this context, one has to consider the variation in the frequency of menstrual cycles experienced by the average female at different times during human evolution. Based on sexual dimorphism arguments from the fossil record, for example, it has been suggested that, among the early Homo species and australopithecines, males competed for short-term matings with females (Mithen, 2000), and it would likely be in the females’ best interests to mate with the winners of such competitions as opposed to establishing a more permanent relationship with one of these males. Later, among Archaic Homo sapiens and Homo neanderthalensis, energetic costs of reproduction increased greatly, and female preference was likely more for energetic support (Mithen, 2000) for childbearing and rearing in the context of more permanent relationships. Overall, in different environmental scenarios, the female would be the main integrator of factors that could influence reproductive success; perhaps LLBC were one of the adaptive traits that could provide information for this complex integration, and could function in different environmental or resource contexts.

Modern-day studies (Table 1) of women with pronounced LLBC, and of LLBC women in late luteal vs. other phases of the menstrual cycle, have also suggested behavioural changes that may have been compatible with the proposed evolutionary perspectives. Increase in risk taking and novelty seeking behaviours may accompany the late luteal phase (cf. Chavanne & Gallup, 1998; Freeman, Schweizer, & Rickels, 1995; also, thyroid hormone-related references above). There is evidence that LLBC influence a woman’s sexual history and can increase sexual dissatisfaction in a relationship (Friedman, Hurt, Clarkin, Corn, & Aronoff, 1982; Winter, Ashton, & Moore, 1991; Frank, Dixon, & Grosz, 1993 and references therein). Decreased social activity and alexithymia are more common in women with LLBC (Kuczmierczyk et al., 1995; Halbreich et al., 2003); they may also add to relationship strain and provide information on the male’s level of interest in the relation. There is some evidence that LLBC do have a marked influence
on males; in the context of PMS, a majority of them report a significant disruption of the relationship (Brown & Zimmer, 1986; Ryser & Feinauer, 1992). LLBC are, thus, one factor that can likely decrease the stability of a relationship (Keye, Hammond, & Strong, 1986; Frank et al. 1993; Halbreich et al. 2003; Stout and Steege 1985; Brown and Zimmer 1986; Ryser and Feinauer 1992) and provide information about commitment or possible aggression of the male(s). In the context of the proposed evolutionary paradigm, for example, a highly committed spouse, is one possible factor that may stabilize the relation. Again, such a perspective is associated with an evolutionary history where for long (or, relatively short, but evolutionarily critical) periods of time women had a major influence on mate selection.

In the absence of strong stabilization, an increased risk of relationship termination is predicted, especially in the early stages of a relationship (more on age below). It will be of interest to determine whether or not studies on relationship termination in this context are in line with this proposal (no such studies known to author; one also has to consider, in this context, the nature of the contribution that a relatively modern study can make to an evolutionary history or perspective). It has been observed in a large-scale study that depressed women are more likely to have experienced divorce or multiple abortions (Harlow et al., 2002; Harlow, Cohen, Otto, Spiegelman, & Cramer, 2004). A smaller
study has suggested that pronounced LLBC are more common in single and divorced women (10 vs. 3, major vs. minor LLBC, respectively) and less common in married women (11 vs. 20, major vs. minor LLBC) (Mak and Chan, 1989); although not statistically significant, the group with the fewest LLBC traits ($N = 20$) had been married for an average of one year longer than the group with the most LLBC traits ($N = 11$). A possible consequence of the proposed evolutionary perspective for current human societies is that the incidence of LLBC should decrease with increasing age. There are several reports indicating that LLBC is more common in younger women compared to older (non-menopausal) women (Deuster et al., 1999; Cenac et al., 1987; Ramcharan, Love, Fick, & Goldfin, 1992; Freeman et al., 1995; Woods et al., 1982; Gannon, Luchetta, Pardie, & Rhodes, 1989; Lee and Rittenhouse, 1991; Gaulrapp, Backe, & Steck, 1995; Kaur et al., 2004 and references therein). Also, parity in a relationship is expected to increase with increasing parental/relationship age; and, in this respect, lower parity has been associated with more pronounced LLBC (Woods et al., 1982; Kaur et al., 2004 and references therein).

As a putative adaptive trait, some LLBC may have contributed to increasing reproductive success through a complex balance of mechanisms, for example as proposed herein, ones that provide information to the female regarding potential male contributions to survival of the infant (or mother). This balance would involve intrinsic factors such as age and body size, and environmental factors such as availability of food and other materials. In conclusion, it is proposed that qualitative and quantitative changes in hormones and hormone activities during the menstrual cycle evolved to optimize reproductive success through neurophysiological responses that include behavioural components and, in the context of hominin evolution, perhaps some LLBC.

REFERENCES


Linnoila, M., Seppala, T., Gordin, A., & Karonen, S. L. 1979. Combined effect of ethalon, and thyroid releasing hormone (TRH) or ORG 2766, on serum prolactin, thyroid stimulating hormone (TSH) and thyroid hormones (T3, T4 and rT3). *Acta Pharmacologica et Toxicologica*, 45, 405–406.


(Manuscript received December 18, 2008; Revision accepted March 3, 2009)