Human Reproduction vol.14 no.3 pp.579–580, 1999

OPINION

Menstrual synchrony pheromones: cause for doubt

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This opinion was previously published on Webtrack 47, December 17, 1998

Stern and McClintock's (1998) recent finding of 'definitive evidence of human pheromones' and 'confirmation' of the mechanism underlying 'menstrual synchrony' is indeed spectacular. However, they disregarded the methodological critiques (Wilson, 1992; Strassmann, 1997) and negative evidence (Jarett, 1984; Wilson *et al*., 1991; Trevathan *et al*., 1993; Strassmann, 1997) that undermine the original report of McClintock (1971), as well as subsequent studies (Graham and McGrew, 1980; Quadagno *et al*., 1981; Preti *et al*., 1986). When flawed statistical methods are taken into account, there is scant empirical evidence that the phenomenon of menstrual synchrony exists in the first place.

Popular belief in menstrual synchrony stems from a misperception about how far apart menstrual onsets should be for two women whose onsets are independent. Given a cycle length of 28 days (not the rule—but an example), the maximum that two women can be out of phase is 14 days. On average, the onsets will be 7 days apart. Fully half the time they should be even closer (Wilson, 1992; Strassmann, 1997). Given that menstruation often lasts 5 days, it is not surprising that friends commonly experience overlapping menses, which is taken as personal confirmation of menstrual synchrony.

McClintock's original study (McClintock, 1971) reported that onsets for dormitory friends became 2 days closer together over a 4–6 month period. Calling this result 'menstrual synchrony' she encouraged the impression of menstrual concordance. In later critiques, Wilson (1991, 1992) noted three statistical errors in the evidence for menstrual synchrony: (i) failure to control adequately for the convergence of onsets by chance; (ii) inflation of the initial difference in onsets resulting in the spurious conclusion of synchronization over time; and (iii) sampling biases. Studies that correct for these statistical errors have found no evidence for synchronization, even as a weak effect (Jarett, 1984; Wilson *et al*., 1991; Trevathan *et al*., 1993).

Although McClintock's (1981) view is that menstrual synchrony is functionless, others postulate that it is an adaptive feature of human reproductive biology (Burley, 1979; Turke, 1984). These hypotheses assume that menstrual synchrony implies ovulatory synchrony or at least overlapping fertile periods, but neither has been reported. The suggestion that menstrual synchrony is adaptive is also diminished by the absence of evidence for synchrony in natural fertility populations (Strassmann, 1997). In these populations, couples do not attempt to limit their family sizes (Henry, 1961) and women consequently spend most of their reproductive lives pregnant or in amenorrhoea (Short, 1976). Compared with Western populations which undertake contraception, natural fertility populations display reproductive patterns similar to those that prevailed over human evolutionary history from the Pleistocene up to the demographic transition to low fertility (Short, 1976; Strassmann, 1997). If menstrual synchrony were adaptive, it should be manifest in these populations, and not merely in the novel circumstance of repeated cycling.

A recent study characterized menstrual patterns among the Dogon, a natural fertility population of Mali, West Africa. The Dogon are a cliff-dwelling population with a mean fertility rate of 8.6 ± 0.3 live births per woman (Strassmann, 1997). During menses, Dogon women are segregated in a menstrual hut, which made it possible to monitor menstruation without interviews. The women present at the two menstrual huts in the study village were counted on each of 736 consecutive days, and these results were corroborated by hormonal data (enzyme-linked immunosorbent assays of urinary pregnanediol-3-glucuronide and oestrone-3-glucuronide) (Strassmann, 1996). Based on the number of menses per year by age, it was calculated that the women in this study population had a median of approximately 110 menses over their lifespan, compared with 350–400 menses for American women (Strassmann, 1997). The value of 110 differs from previous estimates (Eaton *et al*., 1994), but has the advantage of being derived from actual data on menstruation.

Since the Dogon women had a quarter to a third as many menses as American women, there is little reason to assume that menstruation was such a rare event as to make synchrony impossible (particularly among the women aged $<$20 years or $>$34 years who had the most menses). Nonetheless, in this data set, the onsets for different women were independent of each other. This result, based on two new methodological approaches, held regardless of whether the women in the comparisons were co-wives, friends, or members of the same family, lineage, or village (Strassmann, 1990, 1997).

It has been postulated that menstrual synchrony is caused by the lunar cycle, but reports conflict on whether menstrual onsets predominate during the full moon (Cutler *et al*., 1987), the new moon (Law, 1986), or are random with respect to lunar phase (Gunn *et al*., 1937; Pochobradsky, 1974). Dogon villagers did not have electric lighting and spent most nights outdoors, talking and sleeping, so they were an ideal population for detecting a lunar influence. None, however, was found (Strassmann, 1997).

In view of the lack of empirical evidence for synchrony in the foregoing studies of both Western and non-Western populations, it is useful to consider the physiological impediments. Because synchrony requires an adjustment in cycle length (shortening or lengthening the cycle to bring it closer in line with an external influence such as another woman or the moon), any other factor impinging upon cycle length will reduce the potential for synchrony (Strassmann, 1997). Wilcox *et al*. (1988) quantified the occurrence of pregnancies that end in spontaneous loss before they are clinically detected. Among American women who do not practice contraception, conceptions were detected in 28% of menstrual cycles ($n = 707$ cycles) and 31% of these ended in loss. Each pregnancy loss was accompanied by menstruation, a response to demise of the conceptus and hormonal withdrawal (Wilcox *et al*., 1988). It is doubtful whether the timing of other women's menses had anything to do with the timing of menstruation in these cycles.

In addition to pregnancy loss, other factors that influence the length and regularity of the menstrual cycle include: energy balance (Ellison, 1990), lactation (Howie and McNeilly, 1982), and stress (Wasser and Barash, 1983). The menstrual cycle also changes as a function of age (Treloar *et al*., 1967). In the largest study to date, the median cycle length was 27.8 days at age 20 years (close to the mean age for the women in the dormitory studies) and the difference between the 10th and 90th percentiles for person–year SD was 6.3 days (Treloar *et al*., 1967). At 36 years, the age when cycle length variability reaches a minimum, the median cycle length was 26.6 days and the difference between the two percentiles was 3.6 days. The inherent variability in cycle length has both a within woman and a between woman component; together they are obstacles for synchrony (Strassmann, 1997). The reason for this is that a weak tendency toward synchrony would be readily swamped by the major perturbations that occur in cycle length. If the variability of the cycle were not so great, the signal to noise ratio would be more favourable.

In their recent study, Stern and McClintock (1998) report that armpit compounds from nine donors in the follicular phase of the menstrual cycle shortened the cycles of 20 recipients by 1.7 ± 0.9 days. Conversely, when the nine donors were in the ovulatory phase, the compounds lengthened the cycles of the same 20 recipients by 1.4 ± 0.5 days. The conclusion that the change in cycle length of the subjects was caused by a pheromone, rather than by the well-documented variation in cycle length in women (Treloar *et al*., 1967; Harlow and Zeger, 1991) requires inordinate confidence in the biological importance of a P value of borderline statistical significance ($P \leqslant 0.05$). From the data presented it is unclear whether the assumption of a normal distribution was justified. Moreover, in view of the small sample size, the entire effect might have been due to just one or two subjects who had undue leverage. Additional questions are raised by the following statement (Stern and McClintock, 1998): 'Any condition preventing exposure to the compounds, such as nasal congestion anytime during the mid-cycle period from 3 days before to 2 days after the preovulatory LH, could weaken the effect. We analysed the data taking this into account'. It would be useful to know what *a priori* criteria were employed in making such adjustments, and whether the data analysis part of the project was done blind. In the absence of a theoretical reason for expecting menstrual synchrony to be a feature of human reproductive biology, and until a cycle-altering pheromone has been chemically isolated, it would appear that scepticism is warranted.

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Received on May 18, 1998; accepted on October 8, 1998