

## **The Human Pheromones Androstenol and Androstenone And the Co-Evolution of Male-Female Mating Strategies**

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### **ABSTRACT**

**Recent studies indicate that pheromones may play an important role in the sexual behavior and reproductive biology of humans. The behavioral effects of two odorous compounds from the male body namely androstenol and androstenone have been studied at some length. Females perceive androstenol as pleasant and androstenone as repellent. However, during ovulation they give significantly more positive response to androstenone. The role of these two compounds and the evolution of this system have not been satisfactorily explained. I propose a hypothesis that females can use this system to discriminate between two types of desirable males, namely faithful fathers and sexy gene donors. Males interacting with females produce androstenol which attracts females. However, males that interact with females very frequently will have a high androstenone/androstenol ratio due to the inevitable oxidation of androstenol to androstenone. Since ovulation increases androstenone tolerance, females may instinctively perceive high androstenone males as sexy and attractive. These pheromonal signals can help females in getting a faithful male for long term partnership and parenting, but mate opportunistically with sexy males when the chances of conception are maximum. Thus females can maximize their reproductive success using a mixed mating strategy.**

### **KEY WORDS**

Pheromones, Androstenol, Androstenone, Sex, Mating strategy, Evolution

The importance of pheromones in intraspecific communication in animals has long been known. The possibility of human communication through pheromones has attracted much attention recently (reviewed in ref. 1). Olfactory as well as vomeronasal signals can induce emotional responses with or without conscious processing. The axillary apocrine glands become functional at puberty and secrete 16-androstenes. Males secrete significantly higher concentrations of 16-androstene. These odorless precursors (androstadienol and androstadienone) secreted by human skin are oxidized by aerobic bacteria (mainly by *Corynebacterium*) to give two odorous compounds namely androstenol (5-androst-16en-3ol) and androstenone (5alpha androst-16en-3-one) (7, 8).

Androstenol has musk-like scent and is perceived as an attractant by females. However, androstenol is a relatively unstable compound and is oxidized to the ketone form androstenone. Androstenone has somewhat urinous smell and is thus perceived as a repellent by females. Males should produce androstenol in large quantities in order to be attractive to females. Paradoxically due to the inevitable oxidation to androstenone, these males would possess a repellent odor later. However, during the menstrual cycle, ovulating females find androstenone more pleasant than on other days (7,8). So far there is no good explanation for this apparently paradoxical evolution of the androstenol-androstenone system.

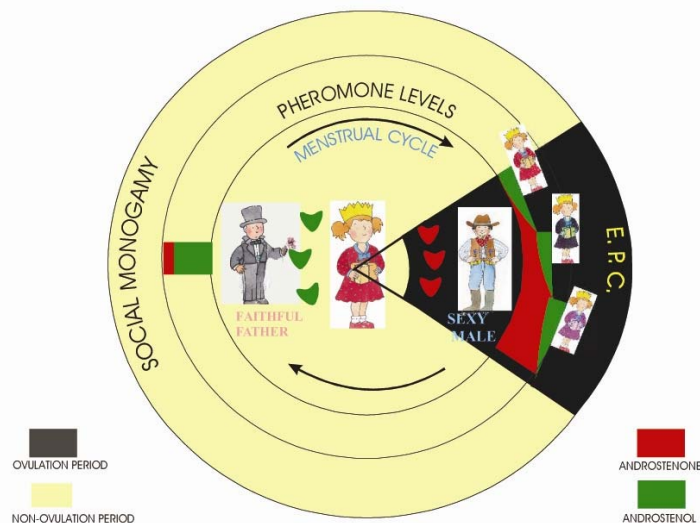
Unlike in most other mammals, ovulation is concealed in humans. By concealed ovulation females can deceive males about their fertile period and thus manipulate male behavior to their advantage. Grammer *et al.* (7) suggest that the androstenol-androstenone system is a male counterstrategy to detect ovulation. However, this "ovulation radar" theory has an inherent flaw in that its success depends upon the differential female response to the two compounds during different phases of the menstrual cycle. If females are interested in concealing the cycle, why should they give a response that makes the concealment ineffective. Mutant females that stop responding differentially would make the male strategy inefficient.

It is therefore more logical that the differential response gives some advantage primarily to females.

In the last two decades there have been extensive studies on extra-pair-copulations (EPC) in species of birds (3, 6, 10-12) and mammals (including humans) (1, 2, 4, 5) where biparental care necessitates long term pairing of males with females. The evolutionary argument is that the best mating strategy for a female is to pair with a faithful male that gives good inputs for child-care, but seek opportunistic mating with a male that is genetically superior and more popular among other females (8, 12). Mating with such a male can enhance the evolutionary fitness of females through a "sexy son". If being attractive to females has at least some genetic component, females mating with attractive males are more likely to have attractive sons, who could mate with more females enhancing the gene propagation of their mother in turn. A correlation between qualities as a devoted father and qualities as an attractive male being unlikely, females may choose a faithful male for long term parental partnership but sneak copulation with a sexy male to acquire sexy genes for their sons. Data on extra-pair mating in birds as well as humans is in support of this argument (1, 6, 10, 11). The question of interest here is how females could select these two types of males for the two functions.

I suggest a new hypothesis for a possible use of the androstenol-androstenone response for conditional mate choice by females. A faithful male should produce spurts

of androstenol only when interacting with his partner. Such a male will have low androstenone levels. On the other hand a male that interacts with a number of females would produce spurts of androstenone at every interaction and therefore accumulate higher quantities of androstenone (Figure 1). The androstenone to androstenol ratio can thus differentiate between the two types of males. A female should choose a faithful male for long term pairing and parenting, but seek opportunistic mating with a more “sexy” male for conception. Since this would inevitably lead to a conflict between the two male strategists, mating with the extra-pair male would be secretive and opportunistic. The female may have to pay a heavy penalty if “caught red handed”(8). Therefore she should attempt to minimize the number of copulations with the extra-pair male but at the same time maximize the chances of conception. This can best be achieved by restricting EPC during the most fertile period of the menstrual cycle. The instinctive avoidance to unfaithful males with high androstenone in non-ovulation days but more positive instinctive response to them during ovulation is likely to help in optimizing the mating strategy.



**Figure 1.** The androstenol-androstenone system and the differential mating choice hypothesis.

Empirical data in human studies show that EPCs peak during ovulation (1). Concealed ovulation and differential choice of males during different phases of the cycle give the human females a unique advantage in the co-evolutionary race. The system at the same time is advantageous to at least some of the males. Such a system could be evolutionarily stable. This hypothesis is not incompatible with the “ovulation radar” hypothesis of Grammer *et al.* (7). Once the system is stabilized due to female advantage, males may use it as ovulation detector.

The empirically testable components of the hypothesis are that males should produce more androstenol during or anticipating an interaction with a female. The response might

be specific to those interactions that are perceived as potential courtship. A large intra-gender variation in EPC is both expected and observed (5, 8). We expect therefore that there would be substantial variation in the female response to androstenone. Females that are more likely to engage in EPC can be expected to show greater variation in androstenone response at ovulation and at other times of the cycle. A bimodality could be expected in the androstenone:androstenol ratios of males reflecting the two distinct male strategies. Further inquiry into the production and perception of these pheromones can give deeper as well as wider insight in human reproductive biology.

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