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REVIEW ARTICLE

Effects of putative male pheromones on female ratings of male attractiveness: Influence of oral contraceptives and the menstrual cycle

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Abstract

Previous research has revealed that natural and synthetic pheromones can enhance ratings of opposite sex attractiveness. The present study investigated the effects of exposure to male axillary secretions on female ratings of the sexual attractiveness of male stimuli. Thirty-two female undergraduates, half of whom were contraceptive pill users, rated male vignette characters and photographs of male faces on aspects of attractiveness. On two separate study days, corresponding to different phases of their menstrual cycle, stimuli were presented while exposed to male axillary pheromones and under a control condition (no pheromone). The order of testing was balanced with respect to pheromone/control condition and menstrual cycle phase. Pheromone exposure resulted in significantly higher attractiveness ratings of vignette characters and faces. Use of the contraceptive pill or menstrual cycle phase had equivocal effects on some vignette items and neither had any influence on female ratings of male facial attractiveness. The results of this study suggest that exposure to natural male axillary pheromones can significantly enhance female perceptions of various aspects of male attractiveness.

Introduction

Pheromones are biologically-active substances released by an individual, and received by another individual of the same species, in whom they activate specific physiological or behavioural responses [1]. Pheromones are therefore referred to as ecto-hormones: chemical messengers that are transported outside the body that have the potential to evoke certain responses in a conspecific. The physiological and behavioural effects of pheromones have been well documented in many invertebrate and vertebrate species (for reviews see [2, 3]) though their putative effects on human behaviour and physiology remain equivocal. Scepticism concerning the existence of human pheromones was due in no small part to the lack of clear evidence for the existence of a fully functioning vomeronasal organ (VNO). In many animal species this system has been shown to detect pheromones and transmit this information to limbic structures via the vomeronasal-terminalis nerves (for review see [4]). However, it has since been reported that humans do possess a functional VNO that responds to pheromones – even in picogram amounts – in a sex-specific manner, and produces specific physiological changes [5, 6, 7]. Recently, the identification of a pheromone receptor gene expressed in human olfactory mucosa has further strengthened the case for a functioning VNO [8].

The main producers of human pheromones are the apocrine glands of the skin located in the axillae of the armpits and pubic region. The high concentration of apocrine glands found in the armpits, led to the term 'axillary organ', which is considered an independent 'organ' of human odour production. Apocrine glands develop in the embryo, but become functional only with the onset of puberty. At sexual maturation, they produce steroidal secretions derived from 16-androstenes (androstenone and androstenol) via testosterone, and as such, the concentrations of several 16-androstenes is significantly higher in males [9]. The action of aerobic bacteria further serves to metabolise the more odorous androstenone and androstenol [10]. The 16-androstenes have been confirmed as male sexual pheromones in pigs [11] and several authors have speculated that such substances may act as human male pheromones subserving sociosexual behaviours [12, 13].

In support, several studies have shown that when exposed to androstenol (often described as a pleasant 'sandlewood' smell when detected), female ratings of male attractiveness are enhanced higher [14, 15, 16]. Filsinger, Braun, and Monte [17] showed that men under the influence of androstenone rated photos of males positively, if they liked the scent of androstenone. However, other authors have reported that exposure to androstenone (often described as 'urine-like' or 'musky') induces negative perceptions of males [18].

Grammer [12] has argued that there are two different olfactory signals – androstenol, which induces female attraction to males, and androstenone, which induces negative responses in females. Further, though pheromonal communication typically occurs without conscious awareness, pheromones, when produced in high concentrations, may still have both conscious and aversive effects on others. This is further complicated by the fact that female olfactory sensitivity is moderated by the menstrual cycle, with smell sensitivity peaking at ovulation [19, 20]. Benton [20] reported that androstenol application influenced ratings of subjective mood at ovulation, and Grammer [12] found that females rated androstenone differently at various phases of their menstrual cycle. Thus, it has been suggested that human body odour influences female mate choice in terms of evolutionary principles. Women seem to prefer the odours of immunocompatible men [21] and, during their fertile period, judge the body odours of men with symmetrical bodies (indicative of genetic quality) as more pleasant [22] which is indicative of genetic quality. A further complication when evaluating the results from such studies is that the use of oral contraception may affect smell sensitivity and gonadal hormone levels [23] thereby possibly disrupting pheromone detection. Use of the contraceptive pill does indeed appear to influence female perception of androstenone [12].

The present study aimed to determine whether naturally occurring pheromones might act as sexual attractants in humans. Young female participants, half-using oral contraception, and half not, were unknowingly exposed to pure male axillary secretions (unaffected by coryeform bacteria and therefore not consciously odorous) during two phases of their menstrual cycle. On four separate occasions (pheromone present and pheromone absent at two different times of the menstrual cycle) females rated male attractiveness using vignette characters and photographs.

Method

Participants

Thirty-two female undergraduate students aged between 18–36, participated in the study. Sixteen were currently using oral contraception (mean age = 20.25) and sixteen were not (mean age = 21.12) and had not used such contraception for at least six months prior to the study. Participants were asked to attend testing sessions at two different phases of their menstrual cycle, i.e., during menses (phase I: days 0–5) and around 14 days later (depending upon weekends) at late mid-cycle (phase II: days 14–21). Each participant was randomly assigned to pheromone/no pheromone conditions and the order in which they would receive pheromone/no pheromone exposure at the two phases of their menstrual cycle.

Donors and Pheromone Collection

The pheromone secretions were collected from four non-smoking, healthy male donors (mean age = 20.75). Several donors were used because there are reported individual differences in axillary concentrations of 16-androstenes [24, 25]. Each volunteer agreed to donate axillary secretions once a week over the six-week testing period. Donors were asked to refrain from alcohol, herbs, spices, garlic and sexual activity for a twelve-hour period prior to and during collection. They were

requested to shower (using non-perfumed soap), immediately before going to bed, and to refrain from using any aftershave, deodorants or other scented products during the collection period. They taped cotton pads, two in depth, immediately below each underarm and these pads remained *in situ* overnight for an eight-twelve hour period. On waking, the pads were removed and sealed in plastic bags. On the same morning, all the pads were collected by the experimenter and preserved in a fridge at approximately 4°C for a short time before the experiment began. Each pad was dissected into four pieces and an equal mixture from each donor was used to form the 'pheromone sample' for a particular test session. Each donor received £10 credit.

Test Materials

On the first testing session each participant was presented with a test booklet that contained the following:

(1) A brief questionnaire requesting relevant personal information (age, university course, regularity of physical exercise, details concerning any medication, contraceptive method, and details of current menstrual cycle).

(2) Four vignettes describing four different male individuals (for example see Appendix). The vignette characters were presented in an undergraduate student context, to make the characters both real and interesting to the participants. Four characters were used to eliminate boredom/practice effects, but were similar in all respects; this was necessary so that all the ratings would be comparable, and any effects of condition could be appropriately attributed. Participants' impressions were measured using their responses to fifteen questions concerning the vignette characters' physical and sexual attraction, likeableness, intelligence, self-assuredness and relationship status (see Appendix). These factors were adapted from mate preference questionnaires [26, 27]. Answers were recorded on a six-point rating scale (0 = not at all, 5 = very).

(3) Four different coloured photographs incorporated facial views, each was 30 x 21cm in size, and contained features from the neck up to the hair. The experimenters initially selected these photographs as being of similar average levels of attractiveness (to avoid possible ceiling effects of using a very attractive model in the experimental conditions). To confirm this, they were presented to 32 female undergraduates (mean age = 20.21) not participating in the study who were asked to rate the attractiveness of each face on a 6-point scale (0 = very unattractive, 5 = very handsome). The mean ratings awarded to the faces ranged between 1.53 and 2.75 thus confirming that they were regarded as being of broadly similar levels of attractiveness. In the experiment proper, participants viewed each photograph once, the order of presentation being randomised. Participants' impressions of the characters' facial attraction were recorded on the same six-point scale.

In order to try and maintain the impression that the vignettes and faces were genuine people, participant information about the characters was personalised, i.e., "Mike has given his permission to show you a photograph of himself".

Procedure

Participants were asked to identify the current day of their menstrual cycle (day 1 was taken as being the onset of menstruation) and consequently the dates at which they would be at menses (phase I) and late mid-cycle (phase II). All participants were tested individually by the same female experimenter (FT) who remained blind as to which cubicle housed the pheromones until the experiment was complete. The same instructions were used to avoid possible experimenter bias. Participants were assigned to conditions on the basis of their contraceptive status and menstrual cycle phase during their first testing session.

On each test day, the dissected pads were concealed in one of two small identical laboratory cubicles by a female technician (who remained blind to the aims of the experiment until completion) thirty minutes prior to testing, to enable the putative pheromones to diffuse. There was no airflow between the cubicles, windows were kept locked, the rooms had no air conditioning, and rooms were sealed when not used for testing. On entering the test area, participants were informed (falsely) that the aim of the experiment was to determine the effects of blood glucose on impression formation at different stages of the menstrual cycle. They were then randomly assigned to either the pheromone or no-pheromone condition and entered the appropriate cubicle.

In the cubicle, they were asked to consume a sugar-free blackcurrant drink prior to completion of the test booklet. In their initial testing session, participants were asked to complete the first part of the test booklet, (questionnaire of personal details), and then to complete the test booklet in the order in which it was presented, in their own time. The first section of the test booklet comprised the first vignette, the rating attributes, one of the four randomly assigned photographs, and photograph ratings. The procedure for the 2nd, 3rd and 4th testing sessions was essentially the same, except that a different vignette and photograph was used on each occasion. Testing sessions 3 and 4 took place on the same day, approximately two weeks later, on the date previously established corresponding with the alternate phase of the menstrual cycle. Finally, participants were asked if they could smell anything in the room.

The time taken to complete the test on each occasion ranged between 10–15 minutes and no participant commented that they thought the study was about anything other than the psychological effects of glucose consumption. Participants were fully debriefed. The procedure was passed by the Northumbria University Division of Psychology Ethics Committee.

Results

Vignette Ratings

A 3-way analysis of variance (ANOVA) with repeated measures on both cycle phase and pheromone exposure, revealed a significant main effect of pheromone, $F(1,30)=9.14$, $p=0.005$. Overall ratings in the presence of the pheromone (mean=3.39, sd=0.38) were significantly higher than without pheromone (mean=3.16, sd=0.51). There was no significant effect of oral contraceptive use, nor menstrual cycle phase ($F<1$ respectively). Furthermore, there were no significant interaction effects: contraceptive use and cycle phase; contraceptive use and pheromone exposure; cycle phase and pheromone exposure ($F<1$ respectively) and contraceptive use, cycle phase and pheromone exposure, $F(1,30)=1.79$, $p=0.19$.

To assess possible effects of pheromone exposure on the rating of individual vignette items, 3-way ANOVA's (repeated measures on menstrual cycle phase and pheromone exposure) were performed. These analyses revealed the following:

Item 1 ("..is good looking"): a significant effect of pheromone exposure, $F(1,30)=37.3$, $p<0.001$, as ratings with pheromone (mean=3.56, sd=0.32) were significantly higher than without (mean=2.81, sd=0.31). Furthermore, a significant interaction between oral contraceptive use and pheromone exposure was revealed, $F(1,30)=14.6$, $p=0.001$. An analysis of simple main effects revealed that the mean rating for the group taking oral contraception while receiving pheromones (mean=3.84, sd=0.28) was significantly higher than that for the group not taking oral contraception whilst receiving pheromones (mean=3.28, sd=0.35), $F(1,30)=6.6$, $p=0.015$). Furthermore, within the group taking oral contraceptives, there was a significant difference between ratings on this item when exposed to pheromone (mean=3.84, sd=0.28) than not (mean=2.62, sd=0.33), $F(1,30)=31.0$, $p<0.001$, see *figure 1*.

Item 2 ("..has an attractive body"): a significant effect of pheromone exposure was revealed, $F(1,30)=11.50$, $p=0.002$, as ratings with pheromone (mean=3.84, sd=0.41) were significantly higher than without (mean =3.38, sd=0.44).

Item 3 ("..is sexually attractive"): a significant effect of pheromone exposure was found, $F(1,30)=21.04$, $p<0.001$, as ratings with pheromone (mean=3.52, sd=0.37) were significantly higher than without (mean=2.78, sd=0.29). Furthermore, a significant interaction between oral contraceptive use and pheromone exposure was revealed, $F(1,30)=5.95$, $p=0.021$. An analysis of simple main effects revealed that the mean rating in the pheromone condition (mean=3.69, sd=0.34) was significantly higher than the no pheromone condition (mean=2.56, sd=0.32) in participants taking oral contraception, $F(1,30)=26.6$, $p<0.0001$, see *figure 2*.

Item 6 ("..is popular and likeable"): a significant interaction between oral contraceptive use and menstrual cycle phase was revealed, $F(1,30)=6.17$, $p=0.019$. An analysis of simple main effects revealed that mean ratings for this item were significantly higher at phase II for the no contraceptive group (mean=3.59, sd=0.45) than for the contraceptive group (mean=3.31, sd=0.37), $F(1,30)=4.9$, $p<0.05$, see *figure 3*.

Item 7 ("..is self-assured"): a significant effect of pheromone exposure was revealed $F(1,30)=12.41$, $p=0.001$, as ratings with pheromone (mean=4.05, sd=0.51) were significantly higher than without (mean=3.67, sd=0.42).

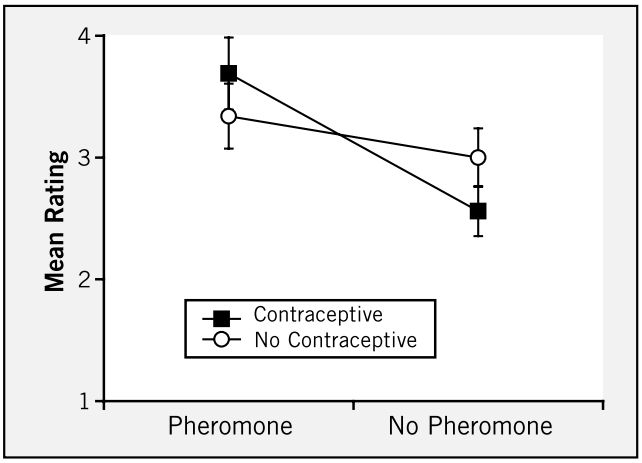

Figure 2: Interaction between pheromone exposure and contraceptive use for vignette item 3.

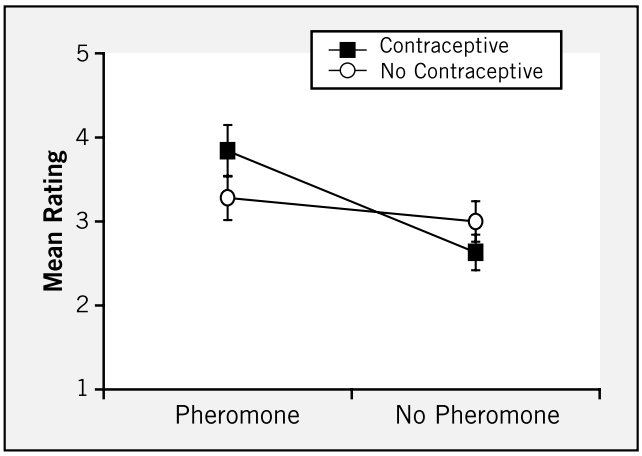

Figure 1: Interaction between pheromone exposure and contraceptive use for vignette item 1.

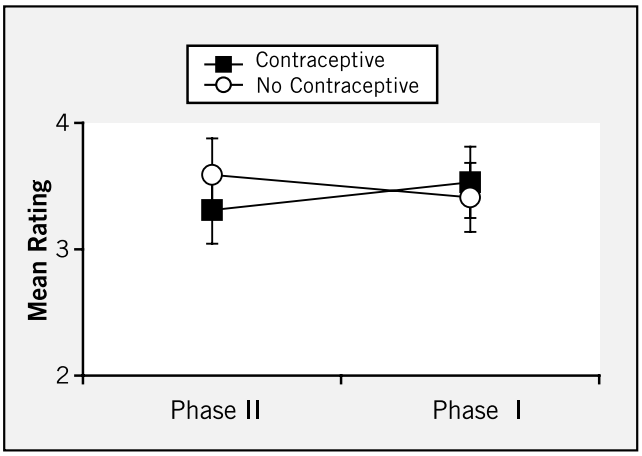

Figure 3: Interaction between menstrual cycle phase and contraceptive use for vignette item 6.

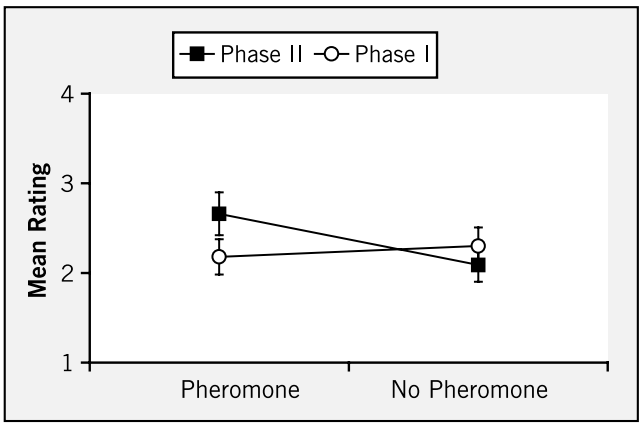

Figure 4: Interaction between pheromone exposure and menstrual cycle phase on vignette item 14.

Item 14 ("I would like to have a long-term steady relationship with.."): a significant main effect of contraception was revealed F (1,30) = 4.15, p = 0.05, as ratings in participants not using oral contraception were higher (mean = 2.67, sd = 0.33) than participants using oral contraception (mean = 1.94, sd = 0.31). While there was no main effect of pheromone exposure, F (1,30) = 1.5, p > 0.05, a significant interaction between pheromone exposure and cycle phase was revealed, F (1,30) = 8.0, p = 0.008, see *figure 4*. An analysis of simple main effects revealed that at phase II, exposure to pheromones produced a significantly higher rating (mean = 2.66, sd = 0.37) than when no pheromone was present (mean = 2.09, sd = 0.34), F (1,30) = 11.8, p < 0.002. Furthermore, within the pheromone exposure condition, those participants in phase II gave significantly higher ratings (mean = 2.66, sd = 3.7) than those at menses (mean = 2.18, sd = 0.26), F (1,30) = 8.3, p = 0.007).

Item 15 ("I would like to have a short-term relationship with.."): a significant effect of pheromone exposure was revealed, F (1,30) = 5.45, P = 0.026, as ratings with pheromone (mean = 2.26, sd = 0.29) were significantly higher than without pheromone (mean = 1.81, sd = 0.40). In addition, a significant main effect of cycle phase was revealed, F (1,30) = 4.5, p = 0.04, as ratings in phase II (mean = 2.23, sd = 0.28) were significantly higher than in phase I (mean = 1.84, sd = 0.30).

Analyses of all other vignette items (4, 5, 8, 9, 10, 11, 12 & 13) revealed no significant main, or interaction effects.

Facial Attraction

A 3-way ANOVA (repeated measures on both menstrual cycle phase and pheromone exposure) revealed a significant main effect of pheromone, F (1,30) = 104.53, p < 0.001, as overall ratings were significantly higher in the presence of pheromones (mean = 3.80, sd = 0.42) than without (mean = 2.13, sd = 0.38). There was no significant effect of oral contraceptive use, F (1,30) = 2.91, p = 0.09, nor menstrual cycle phase, F < 1. Furthermore, there were no significant interaction effects: contraceptive use and cycle phase, F (1,30) = 2.11, p = 0.16); contraceptive use and pheromone exposure, F < 1; cycle phase and pheromone exposure, F (1,30) = 1.21, P = 0.28, and contraceptive use, cycle phase and pheromone exposure, F < 1.

Discussion

The principal aim of this study was to assess the effects of exposure to putative male pheromones on female ratings of several aspects of male attractiveness. Our results clearly showed that when unknowingly exposed to male axillary extracts (containing putative pheromones) female ratings of male sexual attraction (as measured by vignette items) were clearly influenced. Females were asked to read a vignette describing a male character, and then asked to rate the character on a series of items designed to assess mate preferences [26, 27] In the presence of putative pheromones, female ratings of 6 items specifically related to sexual attraction ("..is good looking; .. has an attractive body; .. is sexually attractive; ..is self-assured; I would like to have a long-term relationship with..; I would like to have a short-term relationship with..") were significantly enhanced. Furthermore, exposure to these putative pheromones significantly enhanced female ratings of male facial attraction using photographs.

The results from this current study are thus in accord with previous reports citing human sociosexual behavioural alterations in the presence of putative pheromones [14, 15, 16, 28, 29] though not all findings have been positive [30] or in the predicted direction [18] Due to differences in design, pheromone compounds used, and in criterion measurement, it is difficult to directly compare this current study to those previously reported. However, most other studies have reported positive effects of pheromones on several aspects of human perception and behaviour related to physical/sexual attraction, and such findings are echoed in this current study.

A secondary aim was to assess the possible effects of oral contraceptive use on ratings of male attractiveness. With regard the vignette ratings, a main effect of oral contraception was only revealed for one item ('I would like to have a long-term relationship with..') as ratings were significantly higher in the group not taking oral contraception. Several interaction effects were also revealed; ratings were significantly higher: for item 1 ('..is good looking') in the oral contraception group in the presence of pheromones; for item 3 ('..is sexually attractive') in the group taking oral contraception in the presence of pheromones; for item 6 ('..is popular and likeable') at late mid cycle in the group not taking oral contraception; and for item 14 ('I would like to have a long-term relationship with..') in the group not taking oral contraception at late mid cycle. With regards the rating of faces, oral contraceptive use had no significant influence.

A final aim was to assess the possible effects of menstrual cycle phase on female ratings of male attraction. With regards the vignette ratings, significant effects of menstrual cycle phase were only seen in conjunction with oral contraception use (item 6) and with pheromone exposure (items 14 and 15). In each case, ratings were significantly higher during phase II than dur-

ing phase I. For ratings of facial attractiveness, phase of menstrual cycle had no significant influence. These small effects are in accord with previous findings that females generally perceive males as being more attractive around ovulation [31, 32] but as we could not be sure that females tested at their cycle mid-point were actually at or near ovulation, then these findings must be treated with caution. Clearly, participants in this study reported the onset of menstruation and were consequently assigned to two different phases of the menstrual cycle. As we did not use ovulation test kits for timing the fertile window (six fertile days during the menstrual cycle) some equivocal results of this study may be caused by testing participants during late mid-cycle. The results of the attractiveness ratings during phase I and phase II should therefore be similar. We did, however, find significant differences for subjects at different cycle phases. According to recent clinical reports [33, 34] this may be caused by the fact that an estimate of the likely occurrence of the 'fertile' window is highly unpredictable. Wilcox *et al*. [33] report that in only 30% of women is the fertile window entirely within the days of the menstrual cycle identified by clinical guidelines, i.e., between days 10 to 17. Most women reach their fertile window earlier and others much later. Consequently, the timing of the fertile window is highly variable, and clinical guidelines on timing fertility are, however, outdated [33]. Although we didn't actually test for fertility in this study, it is likely that phase II was actually within the variable range the fertile days as reported by Wilcox *et al*. [33, 34].

Taken together oral contraceptive use and menstrual cycle phase had no impact on the rating of the photographs, but small and equivocal effects on vignette ratings, effects that are difficult to clearly conceptualise within a theoretical framework. Both factors have been reported to influence female olfactory acuity and pheromone perception [19, 20, 23,]. Grammer [12] reported that significantly more females could detect androstenone at mid-cycle compared to other phases of the cycle, but this was not found in females using the contraceptive pill. If contraceptive pill use impairs the ability to detect male pheromones, then behavioural responses should also be affected. It could perhaps be predicted that the clearest effects of male pheromones should be seen in females not taking an oral contraceptive. Our data did not provide unequivocal support, as ratings of two vignette items were enhanced in the contraceptive group in the presence of pheromones, but enhanced in another vignette item in the non-contraceptive group. However, it is difficult to evaluate these findings, as previous reports have not typically controlled for both menstrual cycle phase and oral contraceptive use. Clearly, the influence of these variables was much lower than the direct effect of the presence or not of pheromones, but further studies are clearly required in order to assess possible interactions between pheromone exposure, cycle phase and contraception use.

In summary, we controlled phase of menstrual cycle and oral contraceptive use and found significant positive effects of putative male pheromone exposure on unknowing female participants' ratings of the sexual attractiveness of male vignette characters and photographs. While phase of menstrual cycle, and the use of oral contraception did have some influence on attraction ratings, these factors were overshadowed by the larger effects produced by pheromone exposure. Conscious odour associations did not mediate these effects as the pheromones used were not consciously odorous (and no participant reported being 'aware' of human odours). As the presence of putative male pheromones can influence female perceptions of male attractiveness, following Grammer [12] we suggest that these extracts should be considered as modulatory chemical signals rather than stereotyped behaviour releasers (as defined by Jacob & McClintock [35]).

Although the components which comprise a pheromone are not currently known, the results of this study once again demonstrate that male axillary secretions cause changes in females' emotional evaluations. Females usually perceive male body odour as unattractive and unpleasant but this evaluation seems to change at the point in the menstrual cycle when conception is most likely. Changing female attitudes towards male body odour has been suggested to impact on mate selection and perhaps self-initiated copulations by females [12]. Benshoff and Thornhill [36] as well as Symons [37] have suggested that finding males more attractive during ovulation may allow females to deal with the negative effects of monogamy. In our evolutionary history women could have obtained genetic benefits through extra-pair sex only near ovulation, but paid costs of extra-pair sex throughout the cycle. Selection might therefore have caused the development of an olfactory signalling system to increase females' interest in partners near ovulation rather than during the luteal phase. This has been substantiated only recently in a study by Gangestad, Thornhill and Garver [38]. Women reported greater sexual interest in, and fantasy about, non-primary partners near ovulation than during the luteal phase. This is in accordance with the findings of our study as we may assume that (1) changes in the ratings of facial photographs provides information on alternating sexual interest in a partner, and (2) changes in the evaluation of vignettes may provide information on a females' varying sexual fantasies. Clearly, both stimuli, facial photographs and vignettes were evaluated differently according to the pheromone/no pheromone conditions. It seems that differential preferences for male body odour is indeed an adaptive signalling system to provide females with information on a potential mate. Given the fact that in our results demonstrated a much stronger effect of pheromones on females' evaluation of male characteristics rather than preference changes across the cycle or the influence of oral contraceptives, we may speculate that pheromones affect not only preferences of sexual attractiveness but also other variables relevant to mate-choice like mood and self-esteem.

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Appendix

Example of vignette. Please read the following description of Alex and then answer the statements underneath by circling the number that corresponds to your response (0=not at all, 5=very much so):

Alex Peterson is a 21 year old from Surrey, he has one brother and one sister, both of whom are younger than him. He has just completed the final year of a Social Policy degree at the University of Northumbria. Following the completion of his studies, his ambition is to spend a year doing voluntary work for a charity involving disadvantaged youngsters, and then study for a diploma in social work; his ultimate ambition being to work with abused children and young adults. In a confidential interview, Alex was asked to give a brief account of his non-academic interests. He stated, "I enjoy several sports, my favourites being football and swimming and I regularly use the University fitness suite. I not only enjoy the competitive aspects of sport, but it also keeps me fit and healthy. I also believe that it improves my physical appearance which improves my confidence, and makes me feel good about myself".

Vignette items

1. Alex is good looking.
2. Alex has an attractive body.
3. Alex is sexually attractive.
4. Alex is hard working and career minded.
5. Alex has a good sense of humour.
6. Alex is popular and likeable.
7. Alex is self-assured.
8. Alex is intelligent.
9. Alex wears trendy clothes.
10. Alex is generous and kind.
11. Alex is sexually experienced.
12. Alex is good with children.
13. Alex currently has a steady girlfriend.
14. I would like to have a long-term steady relationship with Alex.
15. I would like to have a short-term relationship (i.e., a one-night stand) with Alex.