Pheromonal Influences on Sociosexual Behavior in Postmenopausal Women

Susan Rako
private practice, Newton, MA

Joan Friebely
Harvard University

To determine whether a putative human sex-attractant pheromone increases specific sociosexual behaviors of postmenopausal women, we tested a chemically synthesized formula derived from research with underarm secretions from heterosexually active, fertile women that was recently tested on young women. Participants (n = 44, mean age = 57 years) were postmenopausal women who volunteered for a double-blind placebo-controlled study designed "to test an odorless pheromone, added to your preferred fragrance, to learn if it might increase the romance in your life." During the experimental 6-week period, a significantly greater proportion of participants using the pheromone formula (40.9%) than placebo (13.6%) recorded an increase over their own weekly average baseline frequency of petting, kissing, and affection (p = .02). More pheromone (68.2%) than placebo (40.9%) users experienced an increase in at least one of the four intimate sociosexual behaviors (p = .04). Sexual motivation frequency, as expressed in masturbation, was not increased in pheromone users. These results suggest that the pheromone formulation worn with perfume for a period of 6 weeks has sex-attractant effects for postmenopausal women.

The word *pheromone* was first introduced in 1959 by biologists who defined it as a substance excreted by an animal externally that is then received by another member of the same species, eliciting some behavioral or physiological response related to the recipient's reproductive potential (Karlson & Luscher, 1959). Broadly viewed, secreted hormones serve to maintain the cohesion of the self, while excreted pheromones support the cohesion of the species. In humans, as in other animals, four behavioral classes of pheromones have been identified: opposite-sex attractants, male territorial markers or repellents that drive away sexual competitors, substances from babies and breast milk that facilitate the mother-infant bond, and female and male excretory gland essences that maintain synchronization of cycles and promote fertility (Cutler & Genovese, 2002).

A considerable body of research has now confirmed that pheromones serve the reproductive life of species and tend to be species specific. For example, the sex attractant pheromone of the boar, androstenol, is not an effective sex attractant for humans (Gustavson, Dawson, & Bonnett, 1987). In humans, pheromones appear to be odorless, and to work through the olfactory apparatus without detection of scent (e.g., Cutler & Genovese 2002).

Olfactory Mechanism of Action

Two anatomically distinct sites in the nose are candidates for pheromonal receptivity. One is the vomeronasal organ (VNO), which carries neural impulses to the accessory olfactory bulb (AOB) en route to subcortical regions of the brain. The other is the olfactory epithelium (OE), which carries neural impulses to the main olfactory bulb (MOB) en route to cortical regions of the brain. These two systems have evolved separately to fulfill different functions (Brennan & Keverne, 1997). The VNO is highly specialized for the detection of a limited range of chemical messages associated with the highly stereotyped behavioral changes noted in small mammals like rats. The OE is capable of discriminating among a large variety of odor molecules, changing their associative values, and linking them to different behavioral outputs.

Evidence for the role of the OE in human pheromonal communication, rather than the VNO, is compelling. For example, investigations into some controversial claims for human VNO involvement in mood changes when hormones were sniffed (Grosser, Monti-Bloch, Jennings-White, & Berliner, 2000; Savic, Berglund, Gulyas, & Roland, 2001) led researchers (Jacob & McClintock, 2000) to conclude the VNO is probably not necessary or sufficient to explain human results. In 2000, a putative pheromone receptor gene expressed in the human olfactory mucosa (the olfactory epithelium sites) was reported for the first time (Rodriguez, Greer, Mok, & Mombaerts, 2000). Just how the alteration in firing pattern in neurons would generate behavioral change in the animal is not known.

Naturalistic Behavioral Studies

Between 1968 and 1971, Emory University psychiatrist Richard Michael and his colleagues showed that rhesus monkeys excrete a sex attractant that can be found in the vaginal smears of intact females. Hysterectomy with ovariectomy renders these monkeys sexually unattractive. Unlike intact females, these females were unable to elicit sexual attention when they "presented" to males for sexual contact (Michael & Welegalla, 1968). However, attractiveness was restored

Address correspondence to Joan Friebely, Brigham and Women's Hospital, 221 Longwood Ave., Boston, MA 02115; e-mail: jfriebely@rics.bwh.harvard.edu.

when vaginal smears of intact, sexually attractive rhesus monkeys were placed on the rear ends of posthysterectomized presenting females (Michael & Keverne, 1970; Michael, Keverne, & Bonsall, 1971). Subsequently, Michael supplied these *copulins* as he termed them, to other investigators who tested them on humans. These rhesus pheromones were not effective in human tests (Morris & Udry, 1978). Species specificity may explain this result.

In humans, no double-blind placebo-controlled studies have previously investigated pheromonal influences during menopause, but there is evidence that human pheromones exert significant influence on the reproductive lives of men and women (see Table 1). The first of these studies, although controversial, reported that regular social exposure among college women living together in dorms generated menstrual synchrony (McClintock, 1971). The most powerful confirmation of socially induced synchrony among adult women working together in confined space was an elegant study of office workers in Israel (Weller, Weller, Koresh-Kamin, & Ben-Shoshan, 1999). The mechanism appeared to involve female pheromones from the underarm.

Topical Application of Putative Pheromones

In unblinded experiments, Russell, Switz, and Thompson (1980) found that underarm essences from one woman applied to the skin under the nose in five recipients in timed sequence, from Day 1 of the donor's cycle on, reproduced the synchrony effect. Subsequently, a double-blind placebo-controlled experiment confirmed that odorless extracts of female underarm sweat contained a substance that reproduced the synchrony effect if aliquots of the female essences were applied sequentially (Preti, Cutler, Garcia, Huggins, & Lawley, 1986). Finally, most recently, Stern and McClintock (1998) showed that nonsequential application of female sweat could advance the timing of ovulation by applying pooled extracts of preovulatory sweat daily or delay the timing of ovulation by applying pooled extracts of postovulatory essence daily. All three of these experiments showed that underarm extracts of women could alter the timing of the cycle of recipients with regular, repeated application to the skin under the nose. The key difference here was sequential vs. constant application of extracts. Sequential application generated synchrony, and constant application shifted the day of ovulation.

Table 1. Sample Sizes Analyzed in 13 Human Studies

First author	Year	# Subjects (*n*)
McClintock	1971	135
Weller	1999	102
Cutler	1979a	372
Burleson	1991	132
Veith	1983	29
Cutler	1985	120
Cutler	1979b	60
Cutler	1986	27
Cutler	1983	43
McCoy	1985	43
Leidy-Severt	2001	100
Wedekind	1995	44 donors; 49 smellers
Wedekind	1997	6 donors; 121 smellers

Note. These experiments, of unmanipulated, naturalistic observations, described in the text, collected concurrent data from individuals, usually recorded daily and usually spanning more than 14 weeks. In each report, the sample tested was sufficiently large to achieve statistically significant findings, described in the text, with sample sizes ranging from 27 to 372 subjects.

Sociosexual behavioral studies of men and women provided similar support for the influence of male pheromones on female physiology. Regular, heterosexual intimacy (sexual intercourse, genital stimulation in the presence of a man, or sleeping next to a male partner) at least once each nonmenstruating week has powerful effects on the reproductive systems of women. These effects include an increased incidence of fertile cycles (Burleson, Gregory, & Trevathan, 1991; Cutler, Garcia, & Krieger 1979a, 1979b; Veith, Buck, Getzlaf, Van Dalfsen, & Slade, 1983) and basal body temperature rhythm (Cutler et al., 1979a, Cutler, Preti, Huggins, Erickson, & Garcia, 1985), higher levels of postovulatory estrogen (Cutler, Garcia, Huggins, & Preti, 1986) and perimenopausal estrogen (Cutler, Davidson, & McCoy, 1983), and delayed onset of menopause (Leidy-Sievert, Waddle, & Canali, 2001; McCoy, Cutler, & Davidson, 1985). In a double-blind placebo-controlled 14-week experiment, odorless underarm sweat extracted and pooled from sexually active men and applied to female participants topically three times per week under the nose served as a substitute for the presence of a man (Cutler, Preti, et al., 1986). Regular application of these male pheromones caused women with aberrant-length cycles to normalize to a more fertile cycle pattern of around 29.5 days in length; placebo did not. Blinded experiments have also suggested that underarm sweat of men and women contains some element that is involved in the selection preference of sexual partners (Wedekind & Furi, 1997; Wedekind, Seebeck, Bettens, & Paepke, 1995).

In 1987, Cutler reported her post-hoc observation that in one placebo-controlled trial of 20 recipients, odorless underarm sweat extracts from sexually active women acted like pheromones by increasing the likelihood that female recipients (average age 25.5) would engage in sexual intercourse at least once per week (Cutler, 1987). While the sample size was small, the effect was large: 73% of pheromone users versus 11% of placebo users recorded sexual intercourse every nonmenstruating week for 10 weeks, following 3 weeks of exposure, 3 times per week, to pheromones applied under the nose. The exposure continued for all 13 to 14 weeks of that experiment.

Topical Application of Synthesized Pheromones

These studies led to the development of synthetic versions of male and female human sex attractant pheromones (Cutler & Genovese-Stone, 2000), odorless cosmetic additives that can be mixed with any alcohol-based fragrance and dabbed on the skin. Research protocols were devel-

oped to test them uniformly. Because prior research had measured pheromonal effects in weekly time periods, the protocol chose weekly frequency of behavior to be the countable variable. The goal was to have each participant select and begin daily application of a preferred fragrance and to record daily behaviors using a simple checklist calendar dispatched to researchers weekly to avoid the potential of imposing backfilled data beyond the unit of measure (e.g., McCoy & Pitino, 2001).

For the men's experiment, after a baseline period researchers added 5 ml (one-sixth of an ounce) of either male pheromone or placebo (ethanol) to each individual's preferred 2-ounce fragrance and gathered 6 more weeks of data (Cutler, Friedmann, & McCoy, 1998). For the experiment with menstruating women, a full menstrual cycle was required to provide a 2-week postmenses baseline. Researchers added the test additive (female pheromone or placebo) on cycle Day 22. Two additional experimental phase menstrual cycles were required to extract 6 weeks of comparable experimental phase data that avoided the potential abstinence many women observe during menstruation (e.g., McCoy & Pitino, 2002). Thus, the women received daily test substance for at least 9 weeks, an experimental period 50% longer than that of the men. For both studies, the question was whether pheromone use is associated with an individual recording more sociosexual behavior per week than she or he did before she or he used the pheromone, thereby increasing the romance in the life of the individual who uses it.

The null hypothesis in both the men's study and the women's study was that compared to those who used placebo, there would be no greater number of individuals who used pheromone-spiked fragrance daily recording an increase over their individual baseline in sociosexual behavior. No predictions were made about group average behavior scores, nor group variances, nor magnitude of change, because these questions were not relevant to the life of an individual. Put another way, an individual is not concerned with the group but does care if she or he will experience more romance when using pheromone than she or he did at baseline. The researchers used chi-square tests to compare the proportion of the pheromone groups to the placebo group for experimental outcomes.

Each participant was measured against his or her own baseline. Eight behaviors were included in the daily calendar checklist: wore fragrance; sexual intercourse; sleeping next to a romantic partner; petting, kissing and affection; informal dating; formal dating; self-stimulation; and (only for women) male approaches. In the first two studies of these synthesized pheromone additives, a significantly greater proportion of pheromone vs. placebo users showed increases over baseline in their sociosexual behaviors. In San Francisco, 36 single, heterosexual, regularly menstruating, noncohabiting women ages 19 to 47 tested a female pheromone (McCoy & Pitino, 2002); in Philadelphia, 38 heterosexual men ages 26 to 42 tested a male pheromone (Cutler et al., 1998). In each study, following a 2-week baseline period, a technician added either the test pheromone or a placebo to the person's preferred fragrance for daily application.

Compared to the men using the placebo-spiked fragrance, significantly more (male) pheromone users recorded an increase above their personal baseline in their frequency of sexual intercourse and sleeping next to a romantic partner. Compared to the placebo group, more men in the male pheromone group also recorded increases over baseline for petting, kissing, and affection as well as informal dating at borderline levels of significance, but no increases in formal (prescheduled) dates.

For the reproductive-aged women, significantly more participants who used the female pheromone daily increased over their personal baseline in their frequency of four behaviors: sexual intercourse; sleeping next to a romantic partner; petting, kissing, and affection; and prescheduled dates. Compared to the women testing placebo, those testing female pheromones showed no increase in male approaches (a category of behavior with no counterpart for the men's study) nor in informal dates. Compared to placebo, neither men nor women testing pheromones recorded a significant increase over baseline frequency in masturbation, which suggested to authors (McCoy & Pitino, 2002; Cutler et al., 1998) that pheromones did not increase sexual motivation but rather increased sexual attractiveness. The one gender difference for pheromone users was that significantly more women increased their recorded formal (prescheduled) dates when they used female pheromones (vs. placebo) regularly, but did not increase their informal dates; the reverse was true in men testing male pheromones.

Global scores were perhaps the most revealing. For the men, 74% of those testing male pheromone versus 38% of those testing placebo recorded an increase over their own individual baselines in the weekly frequency of at least one sociosexual behavior during the experimental period. For the women, 74% of the female pheromone vs. 24% of the placebo group recorded an increase in the weekly frequency of at least three objective sociosexual behaviors during the experimental period.

Hypothesis Tested in the Present Experiment

For our study of pheromonal influence during menopause among Boston-area women, we replicated the San Francisco study by adapting the protocol for postmenopausal women.[1] We hypothesized that a greater number of women using female pheromones than placebo users would show an increase over their own individual baselines in the average weekly frequency of four of the intimate sociosexual behaviors, as was reported for reproductive-

[1] The authors of this paper have no ownership interests in the Athena Institute, which kindly supplied the test substances (coded vials of placebo and pheromones), reimbursement for direct expenses incurred by the first author, and travel costs of the second author to present the findings to the Society for Behavioral Medicine.

aged women (McCoy & Pitino, 2001, 2002). Those four behaviors were the objectively measurable ones: petting, kissing, and affection; sleeping next to a romantic partner; sexual intercourse; and formal (prescheduled) dates. We hypothesized that the proportion of pheromone users vs. placebo users who increased over baseline in the frequency of informal dates and male approaches would not differ significantly, as was reported by McCoy and Pitino (2002). We note that informal dates and male approaches are subjective categories and have no objective, quantifiable definition. In contrast, the four behaviors that were reported to increase over baseline in reproductive aged women testing pheromone are objectively defined. While a woman knows if she had sexual intercourse, she may not be sure if a male approached her or what counts as an informal date rather than platonic companionship. We also hypothesized that, as previously reported (Cutler et al., 1998; McCoy & Pitino, 2002), masturbation, which reflects sexual motivation rather than sexual attractiveness, would not be influenced by pheromones.

METHODS

Participant Recruitment

To recruit participants, the senior investigator contacted a suburban Boston newspaper to interest it in writing a feature about the study. The published story (Seiffert, 2000) included an invitation to prospective participants to enter "a double-blind, placebo-controlled experiment to test an odorless (female) pheromone, added to your preferred fragrance, to learn if it might increase the romance in your life." Selection criteria required that women be postmenopausal (no menses for at least 1 year), taking no medications with known negative effects on sexual functioning, exclusively heterosexual, and with an intact uterus and at least one ovary. We prescreened women by telephone and provided details of the study. We offered a gift vial of the experimental substance to women who completed the study.

Study Sample

Fifty-one respondents said they met criteria in the telephone prescreening and scheduled interviews with the senior investigator. Forty-nine of the 51 respondents enrolled, and 45 of the 49 enrollees completed the study. The 4 dropouts were dropped during the baseline period: 1 because she reported herself as "bisexual," which was contrary to study criteria, and 3 others for failing to submit baseline calendars in a timely way per protocol. Data from just 1 of the 45 women who completed the study were excluded from the analysis, because her drug regimen (Tamoxifen) was considered by the study's blinded pharmaceutical consultant to be a confounding variable.

Procedures

Participants met twice with the senior investigator. At the enrollment interview, each participant completed a personal information sheet, which included physical characteristics and demographic information, a list of all current medications, and a self-chosen code name to protect her identity. Each participant brought her preferred alcohol-based fragrance to this initial meeting. She was given a 60-ml cobalt-blue glass bottle with a screw top for use during the study, and about 55 ml of her fragrance was poured into it. Fragrances presented in spray containers were transferred to the bottle by syringe or by spraying into a funnel inserted in the mouth of the bottle.

At this initial meeting, we instructed participants to apply their fragrances at least every other day to their cheeks, behind their ears, and any place else they chose. We followed the procedures recently reported by McCoy and Pitino (2002), except for not directing the postmenopausal group to apply the fragrance directly above the upper lip. The eight behaviors of interest were reviewed to ensure participants' understanding: application of the fragrance; male approaches; informal dates (unscheduled); formal dates (prearranged); petting, kissing, and affection; sleeping next to a romantic partner; sexual intercourse; and self-stimulation of the genitals (masturbation that was not part of a partnered sexual experience).

Also, we gave participants calendars (see Appendix) marked with their code names and listing the eight behaviors. The calendars, similar to the ones used in earlier studies (Cutler et al., 1983; Cutler et al., 1998; McCoy & Pitino, 2002), were adapted for postmenopausal women by excluding items related to menses data collection. Participants agreed to fill out the calendars daily, indicating with a check mark each of the behaviors that had occurred the previous day. They agreed to send the completed calendars weekly by FAX.

After 2 weeks, participants returned for a second meeting. At that time, they selected from a box of identical-appearing, commercially packaged vials containing 5 ml of either an odorless pheromone in standard denatured (SD) 40 alcohol or a placebo of SD 40 alcohol alone. Vials were randomly assigned in sequential batches (5 pheromone, 5 placebo) to control for the potential of a seasonal effect; 22 women tested placebo and 22 tested the pheromone. The vials were coded and marked "C" or "D." We recorded the code of the selected vial on each participant's calendars to make possible the identification of her test substance after data collection was complete.

The senior investigator poured the contents of the vial into the participant's cobalt blue glass bottle, which already contained 55 ml of her fragrance. In this way, each participant began the experimental period with about 2 ounces (60 ml) of "spiked" fragrance—spiked either with placebo or with the test pheromone.

We also measured the women's perceptions of changes in their sociosexual experiences and their perceptions of whether they had placebo or pheromone.

Pheromones

The formulation used in this study was the same preparation the effects of which were recently investigated in

younger women (McCoy & Pitino, 2002). This proprietary, synthesized human female pheromone is available commercially as a cosmetic fragrance additive. It was developed by a biologist (Winnifred Cutler), coauthor of the original double-blind placebo-controlled axillary pheromone studies (Cutler, Preti, et al., 1986; Preti et al., 1986). Its chemical identity will be disclosed when the patent process is completed. The manufacturer—Athena Institute for Women's Wellness Research, Chester Springs, PA—supplied us with the coded vials: 25 of pheromone formula and 25 of placebo. Both test additives had a distinct alcohol scent but no other discernible odor. When added to a fragrance, neither was recognized by the wearer as having changed the aroma of her fragrance, although one participant reported that the additive might have made her fragrance smell slightly more intense. After we had collected all data, the institute informed us that the C label coded the pheromone and the D label coded the placebo.

Sociosexual Behavior

We counted each participant's total number of days per week in which she engaged in each sociosexual behavior for each of the 2 baseline weeks and for each of the 6 experimental weeks.

Data Analysis

We used *t* tests to compare groups on baseline characteristics, including physical and demographic variables, sociosexual relationship status, and sociosexual behaviors.

Experimental outcomes. For each behavior, a participant was characterized as showing an increase when her average weekly score for the 6-week experimental period exceeded her average weekly score during the 2-week baseline period. We wanted to know if the pheromone additive had more influence than the placebo on increasing participants' intimate sociosexual behaviors. For each behavior, we used a χ^2 probability test to test for differences between the two groups in the proportion of participants showing an increase over baseline in average weekly behavior. When the protocol predicted an increased probability, the tests were one-tailed. We also tested, using χ^2, the hypothesis that a greater proportion of pheromone users than placebo users would record increases in at least one of the four sociosexual behaviors recently reported to significantly increase in younger women testing the pheromone (M age = 27 years).

Post-hoc analyses of independent predictors of outcome. We did post-hoc analyses to assess independent predictors of an increase over baseline in intimate sociosexual behaviors. Independent variables entered into the logistic regression model were experimental group (pheromone we used vs. placebo), baseline social status (classified as married/cohabiting, dating, or not dating), use of hormone supplemental or replacement therapy (HRT), age, years since final menstrual period, season at entry (fall or spring), and education. This method measured each participant against her own baseline, as in the San Francisco and Philadelphia studies. We also analyzed the possible contribution of time to the outcomes for experimental and placebo groups over the 6-week experimental period. We modeled petting, kissing, and affection in each experimental condition, controlling for between-subject variance in the covariates described above.

Results

Study Sample

We tested differences between groups with *t* tests for age, height, weight, body mass index, years since last menstrual period, education, sociosexual relationship status, and sociosexual behaviors. We found no significant differences. Table 2 shows the distribution of participants' physical and demographic variables. Table 3 shows the distribution of participants' relationship status, and Table 4 shows the distribution of sociosexual behaviors between the groups. Participants averaged 57 years of age and 7 years since their final menstrual period. All but one participant was White, reflecting the makeup of the suburban Boston area.

Hormone therapy use by 18 women (10 pheromone users and 8 placebo users) was included as a possible independent variable in the logistic regression analysis. Seventeen women used estrogen, 10 used a progestin, and 3 included testosterone in their regimen. Inspection revealed that all 3 testosterone users were in the pheromone group, that none increased over baseline in masturbation during the experimental period, and that 2 of the 3 showed no increase over baseline in any of the behaviors measured.

Perfume Use

For the 6 experimental weeks, daily calendars showed an average use of the test perfume of 6.6 (SD = 0.6) times per week for pheromone users and 6.6 (SD = 0.7) times per week for placebo users. Usage did not differ significantly between the two groups (t (43) < 1). The 44 women in this experiment chose 39 different fragrances, rendering the potential impact of any one particular fragrance moot

Perceptions

Women recorded their sociosexual experiences with men (see Appendix) and their observations of related changes each week. There were no group differences in these

Table 2. Initial Physical and Demographic Measures for Subjects by Treatment Group

	Pheromone n = 22		Placebo n = 22	
	M	SD	M	SD
Age (years)	56.27	4.71	57.55	6.88
Height (inches)	65.18	1.82	64.36	2.50
Weight (pounds)	137.50	23.0	137.30	20.40
Body mass index	22.75	3.48	24.08	4.19
Years since last menstrual period	7.32	5.29	7.09	6.72
Education (years)	17.86	1.67	17.09	2.51

Table 3. Initial Relationship Status for Subjects by Treatment Group

	Pheromone %	Placebo %
Married	27.3	22.7
Cohabiting	4.5	0.0
Divorced/separated, dating exclusively	4.5	9.0
Divorced/separated, dating nonexclusively	22.7	27.3
Divorced/separated, not dating	22.7	18.1
Never married, dating exclusively	0.0	9.0
Never married, not dating	9.0	9.0
Widowed, dating exclusively	4.5	0.0
Widowed, not dating	4.5	4.5
Group totals	99.7	99.6

records. Women also completed a debriefing questionnaire that asked which substance they believed they had tested: pheromone, placebo, or "not sure." Again, there were no group differences. Following the addition of the test substance only one woman commented on a difference, which she perceived as slightly greater "intensity of fragrance." We concluded that women could not discern whether placebo or pheromone had been added to their fragrance.

Sociosexual Behaviors

More pheromone users (68.2%) showed an increase over baseline in at least one intimate behavior when compared with placebo users (40.9%), $\chi^2(1, N = 44) = 3.30$, $p = .03$, one-tailed. Within specific behaviors (see Table 5), the weekly frequency of petting, kissing, and affection increased for a significantly greater proportion of pheromone users than placebo users, $\chi^2(1, N = 44) = 4.13$, $p = .02$, one-tailed. The difference between treatment groups in the proportion of participants showing an increase in formal dates, sexual intercourse, and sleeping next to a romantic partner did not achieve statistical significance.

We also tested the effects of the pheromone formula for the three nonintimate sociosexual behaviors: male approaches, informal dates, and self-stimulation (not in the presence of a partner). There was a trend for more placebo users (32%) than pheromone users (9%) to increase self-stimulation over baseline, $\chi^2(1, N = 44) = 3.50$, $p = .06$, two-tailed. No significant differences resulted for the other two nonintimate behaviors.

Post-Hoc Analyses of Independent Outcome Predictors

We used logistic regression to assess independent predictors of those experiencing increases in intimate sociosexual behaviors. The dependent variable was increase versus no increase over baseline during the test period in at least one of the intimate behaviors. Results are shown in Table 6.

The two significant predictors of being in the group that showed an increase in sexual behavior were experimental group ($p = .04$), and social status ($p = .01$). Being in the pheromone group and being married or cohabiting or dating each independently increased a woman's chances of being in the group that showed increased sociosexual behaviors during the experimental period. There was a trend ($p = .11$) for entry season to predict an increase over baseline in intimate sociosexual behaviors, with spring participants being more likely than fall participants to experience such an increase.

Since petting, kissing, and affection revealed a significant effect of pheromones, we studied this behavior more closely post-hoc to determine if the effect strengthened over time. We used a model of petting, kissing, and affection that controlled for between-subjects variance resulting from the effects of social status (classified as married/cohabiting, dating, or not dating), use of HRT, years since final menstrual period, body mass index, season at entry (fall or spring), and education. Results showed no systematic effect of time on behavior in either group.

Table 4. Baseline Frequency of Sociosexual Behaviors for Placebo and Pheromone Groups

	Average days per week		
Sociosexual behavior	Pheromone $n = 22$	Placebo $n = 22$	t
Formal dating	0.93	0.48	1.41
Petting, kissing, and affection	1.57	1.34	<1
Sleeping next to romantic partner	1.98	2.05	<1
Sexual intercourse	0.25	0.43	<1
Self-stimulation	0.41	0.43	<1

Table 5. Percentage of Subjects with an Increase Over Baseline for Intimate Sociosexual Behaviors by Treatment Group

	Treatment			
	Pheromone $n = 22$	Placebo $n = 22$		
Sociosexual behavior	%	%	$\chi 2$	$p<$
Formal dating	31.8	18.2	1.09	*ns*
Petting, kissing, and affection	40.9	13.6	4.13	0.02
Sleeping next to romantic partner	18.2	18.2	0	*ns*
Sexual intercourse	31.8	27.3	.11	*ns*

DISCUSSION

Our findings are consistent with the recent study of 36 reproductive-aged women (McCoy & Pitino, 2002) that

Table 6. Association of Predictor Variables With Increasing at Least One Intimate Behavior

Predictor variables	Odds ratio[a]	95% confidence interval	p value
Pheromone vs. placebo	7.3	1.14-46.68	0.04
Cohabiting vs. noncohabiting	5.42	1.45-20.26	0.01
Spring vs. fall	0.23	0.04-1.39	ns
Education	0.88	0.59-1.30	ns
HRT use	0.72	0.34-1.54	ns
Menopausal age	1.07	0.91-1.25	ns

[a]Odds ratio gives the amount of change expected when there is a one-unit change in the predictor variable with all of the other variables in the model held constant.

reported that sociosexual behaviors increased over baseline among more pheromone users than placebo users. Using the same experimental substance and protocol employed in that study with our sample of postmenopausal women, we found significant effects, albeit more modest ones than in younger women. We found that the topical application of pheromone mixed with fragrance was associated with increases in sociosexual behaviors for a statistically significant greater proportion of pheromone users versus placebo users: 68.2% of women using pheromone compared to 40.9% of women using fragrance with placebo. This 68% effect is comparable to that reported by Stern and McClintock (1998), who found that underarm extracts influenced the timing of ovulation in 68% of the women who tested them via daily application, shifting the day of ovulation modestly to 1.7 days earlier using pooled extracts of preovulatory sweat or 1.4 days later with postovulatory sweat extracts. In our study, one specific behavior—petting, kissing, and affection—was significantly different between the two groups: 40.9% of those who used pheromone compared with 13.6% of those who used placebo increased over their own baselines.

The high proportion of postmenopausal women testing the pheromone who increased in petting, kissing, and affection is consistent with other research reporting that midlife women favored touching and caressing over sexual intercourse (Basson, 2000; Bretschneider & McCoy, 1988; Mansfield & Koch, 1998; Mansfield, Koch, & Voda, 2002; Regan & Berscheid, 1996). Postmenopausal women and contemporary male intimate partners retain the capacity for affectionate and sexual contact, even when age-related changes in blood flow, hormonal levels and effects, and neural processes reduce the capacity specifically for sexual intercourse. Our findings are concordant with these well-documented age-related changes (Cutler & Genovese-Stone, 2000).

Availability of partners is a fundamental factor affecting the possibilities and probabilities of intimate behavior between individuals. The disparity in gender ratio with age is well documented. Recent U.S. Census Bureau data report that among unmarried persons between 55 and 64, there are 1.7 women for every man (Fields & Casper, 2001). Over age 64, the figure jumps to 3.1 women per man (Michael, Gagnon, Laumann, & Kolata, 1994). Compounding this demographic imbalance, more women marry or cohabit with older men than with men their own age or younger. The declining male-to-female ratio limits the prospects that postmenopausal women have for finding a sexual partner (Michael et al., 1994). Our data conform to these statistics because other than pheromone use, partner availability was the only significant independent predictor of experimental outcome in our study. Married or cohabiting participants using the test substance clearly exposed their partners to many more hours of pheromonal effect than would nondating pheromone participants.

Our post-hoc analysis suggests the effects of pheromone versus placebo differ between women with and without spouses or dates. We found suggestive evidence of a pheromone effect in the subgroups. Of those who were married, sexual intercourse increased over individual baseline for 5 of the 6 pheromone users (83%), which appears higher than the 3 of 5 (60%) placebo users. Similarly, for sleeping next to a romantic partner, married pheromone users appeared more likely to increase over baseline than did married placebo users: 67% vs. 40%. And for petting, kissing, and affection, more married pheromone users increased over baseline: 67% vs. 20% of married placebo users. Although the small sample size precluded statistical confirmation, the consistently higher proportion among subgroups of pheromone users who increased intimate behaviors is noteworthy.

A similar suggestive effect of pheromones was seen in the 15 women who had no partner and were not dating when they enrolled (8 pheromone, 7 placebo): 37.5% of the pheromone users versus 0% of the placebo group experienced an increase in at least one interpersonal intimate behavior. Although the subsample was too small to provide statistical confirmation, the positive result deserves further investigation. A longer experimental period might be required for pheromones to reveal their effects in countable behaviors among postmenopausal women who are not dating at baseline. The critical variable of partner availability shown in these results suggests that future studies should recruit statistically adequate, homogenous samples of postmenopausal women. A 9-week experimental period would also be useful to test whether pheromonal effects increase with duration of use, as McCoy and Pitino (2002) showed in a post-hoc analysis of their two-cycle experimental period.

Our findings also confirm the previous results (McCoy & Pitino, 2002) for reproductive-aged women for the two subjective behaviors studied; weekly averages of informal dating and male approaches were not significantly increased for pheromone users. The previous findings of no significant increase over baseline in self-stimulation by male (Cutler et al., 1998) and female (McCoy & Pitino, 2002) pheromone users was replicated by the present study. However, unexpectedly, we found a trend for an increased incidence of self-stimulation among postmenopausal women who used placebo. It will be interesting to learn whether this finding replicates.

In conclusion, among postmenopausal women, a significantly greater proportion of those using pheromone than those using placebo showed an increase over their own baseline in intimate sociosexual behaviors. We suspect that three conditions are required for sex attractant pheromones to reveal their effects: (a) motivation to increase romance in the user; (b) a natural or synthetic formula that is effective, and (c) the social availability of partners for the pheromone users. Future double-blind placebo-controlled studies would most informatively recruit groups the size of this study or larger but homogenous in terms of availability of a partner at baseline: in other words, either all married, all single-but-dating, or all not dating at inception. A

9-week experimental period would also be useful to test whether pheromonal effects increase with duration of use.

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Appendix

CALENDAR OF SOCIOSEXUAL BEHAVIORS

Please return to: Susan Rako, MD FAX 617-9xx-xxx7 **Fragrance C or D**
Each week with new data;
no need to send completed previously faxed sheets
Confidential Calendar

Code Name _____ Fragrance

Checklist Instructions: At the start of each week, fill in the weekdays (M,T,W,...). Each day, mark off each event listed if it occurred in dark ink.

Experimental Week 4/6							
This record begins on Sunday, ___/___/__ DAY-→	S	M	T	W	T	F	S
Date							
Used perfume							
Male Approaches (pays attention to what you say, or offers a compliment)							
Informal "Dating" (A "date" that was not pre-arranged)							
Formal "Dating" (A date that was pre-arranged)							
Petting/Kissing/Affection (Touching, Kissing, Oral Sex, or any other Sexual Activity that does not involve intercourse)							
Sleeping next to romantic partner							
Sexual Intercourse (Penile-Vaginal Contact)							
Self-Stimulation (Masturbation; self-stimulation of genitals)							
Notice any changes in your experiences with men this week? If so, please explain.	Yes ___ No ___						

Date of faxing
___/____/ 00