Women's Hedonic Ratings of Body Odor of Heterosexual and Homosexual Men

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RUNNING HEAD: Male Sexual Orientation and Body Odor

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ABSTRACT

Men's body odor influences women's mate choice, and individual variation among traits affect hedonic perceptions of this odor (e.g., immune system characteristics; Wedekind & Füri, 1997). Previous research by Sergeant (2002) indicated that one such characteristic is sexual orientation: body odor from homosexual men was perceived by heterosexual women as more hedonically pleasing than that of heterosexual men. The current study re-examined the influence of men's sexual orientation on women's perceptions of body odor. Homosexual (n = 10) and heterosexual (n = 9) men produced samples of body odor using T-shirts under equivalent environmental conditions. Heterosexual women (n = 35) rated these samples, and a set of unused T-shirts, using a series of hedonic scales. Women rated the body odor of homosexual men as being comparatively more pleasant, sexier, and more preferable than that of heterosexual men but not significantly different to the unused T-shirts. This finding is consistent with contemporary research demonstrating that an individual's sexual orientation significant impacts their olfactory function, both in terms of body odor production (Martins et al., 2005) and olfactory perceptions of certain compounds (Savic et al., 2005).

KEY WORDS: olfaction; body odor; sexual orientation.

INTRODUCTION

In many non-human species, olfaction is a crucial form of communication, mediating a variety of social behaviors, such as the recognition of individuals and groups, dominance and aggression displays, and signaling mating characteristics (Wyatt, 2003). It is widely believed that a reliance on auditory perception and trichromatic vision has significantly reduced human reliance on olfaction (Gilad, Wiebe, Przeworski, Lancet, & Paabo, 2004). However, an increasing volume of research demonstrates that humans have sensitive and well-developed olfactory abilities capable of mediating social behavior (for a review, see Rouby, Schaal, Dubois, Gervais, & Holley, 2002).

Women are reported to prefer the body odor from men with generally dissimilar human leukocyte antigen (HLA) characteristics (Jacob, McClintock, Zelano, & Ober, 2002; Wedekind & Füri, 1997). HLA refers to the human major histocompatability complex (MHC), a part of the immune system showing high levels of inter-individual variation. It would, therefore, appear that body odor can provides information concerning an individual's immune system. Reproducing with a mate possessing general HLA dissimilarity will provide offspring with more adaptive immune function through possession of a more diverse immunological repertoire (Penn & Potts, 1999).

Women's menstrual cycle timing also has a significant impact on olfaction. The endocrine changes around ovulation significantly heighten olfactory sensitivity (Doty, Huggins, Snyder, & Lowry, 1981), alter hedonic perceptions of odor (Grammer, 1993; Hummel, Gollisch, Wildt, & Kobal, 1991), and increase odor processing speed (Pause, Sojka, Krauel, Fehm-Wolfsdorf, & Ferstl, 1996). Grammer (1993) and Hummel et al. (1991) both reported that perceptions of the hedonic qualities of androstenone (a volatile steroid expressed in body odor) changed from being unpleasant to neutral around ovulation. Since androstenone is present in much higher concentrations in the body odor of men (for a review,

see Gower & Ruparelia, 1993), both Grammer (1993) and Hummel et al. (1991) speculated that this could facilitate social contact between men and women at the optimum time for conception.

To date, few studies have examined how sexual orientation influences human olfaction. Savic, Berglund, Gulyas, and Roland (2001) documented a sex-differentiated pattern of hypothalamic activation in response to putative human pheromones estra-1,3,5(10), 16-tetraen-3-ol (EST), an estrogen-like compound found in women's urine and 4-16-androstadien-3-one (AND), a testosterone derived compound found in men's sweat. In addition to activating neural regions associated with processing common odors (e.g., amygdala and orbitofrontal cortex), there was noticeable anterior hypothalamic activation among men after exposure to EST, and among women after exposure to AND. However, women did not display noteworthy hypothalamic activation in response to EST, nor did men when exposed to AND. In subsequent research, Savic, Berglund, and Lindström (2005) examined the reactions of homosexual men to both AND and EST. Like heterosexual women, but unlike heterosexual men, homosexual men displayed a pattern of hypothalamic activation in response to AND but not EST. These findings suggest that reactions to putative pheromones depend not only on biological sex but also on sexual orientation.

Sergeant (2002) examined how men's sexual orientation influenced the olfactory perceptions of heterosexual women. Body odor samples were collected from exclusively homosexual (n = 5) and heterosexual men (n = 5) and were assessed for their hedonic qualities by heterosexual women (n = 11). Samples from homosexual men were rated as significantly more pleasant, sexier, and less intense compared to those from heterosexual men. This indicated sexual orientation could significantly affect the hedonic qualities of body odor. While these results would appear to be of interest, this research had a small sample size, so these findings should be regarded with caution. Additionally, this study did not address the

potential impact of menstrual cycle timing on olfactory perceptions. Although hedonic evaluations of male odor become more positive around ovulation (Grammer, 1993; Hummel et al., 1991), it is currently unknown if this change in women's olfactory perceptions is analogous for the odor of heterosexual and homosexual men.

Martins et al. (2005) examined how heterosexual and homosexual men and women perceived body odor from each of these four sexual orientation groups using two-alternative forced-choice preference judgments. Perceptions of, and preferences for, body odor samples varied significantly between each sex and sexual orientation group, although a consistent finding was that the body odor of homosexual men was judged to be unpleasant by all groups except other homosexual men. With regard to heterosexual women, this group perceived the body odor of homosexual men to be particularly unpleasant, while the body odor of heterosexual men were perceived as a more neutral, though still unpleasant, odor. As there were no significant differences in the perceived strength of body odor from heterosexual and homosexual men, this suggests the differences between the orientation groups were qualitative rather than quantitative in nature.

Since the effects of sexual orientation on men's body odor are currently contradictory, the current study investigated whether men's sexual orientation influenced women's (heterosexual) perceptions of body odor hedonicity. Additionally, the influence of fertility (i.e., menstrual cycle status) on these perceptions was investigated.

METHOD

Participants[5]

A total of 35 heterosexual women (*M* age, 25 yrs, *SD* = 6.7) were recruited from the staff and student body of Nottingham Trent University (NTU) via social networks and advertisements (asking for participants for research into human olfaction) posted on research notice boards. Data was excluded an additional five women who did not provide information

about their menstrual cycle phase (see below). Participants were recruited on the basis that they were non-smokers, not currently in a romantic relationship, not taking psychoactive medication or using recreational drugs, and had no history of nasal abnormalities that could influence their olfactory perceptions. On the day of testing, no participant indicated having any cold or flu symptoms. All participants were informed that they would be evaluating the hedonic qualities of odors, but were not informed at that time as to the specific goal of the research. Participants received no form of compensation for their involvement in this research.

Sexual orientation was established by asking participants to respond to the statement "In terms of my sexual attractions and behavior, I would say that I am…"using the 7-point Kinsey scale (Kinsey, Pomeroy, & Martin, 1948). All participants rated themselves as either as either 0 (e*xclusively heterosexual*; n = 33) or 1 (*predominantly heterosexual, only occasionally homosexual*; n = 2) on this scale. As no women rated themselves between 3 and 6 on the Kinsey scale, it was not necessary to exclude any female participants on the basis of sexual orientation.

Self-reported menstrual cycle status was obtained from all participants. All participants had standardized 28-30 day menstrual cycles, were not currently using oral contraceptives, and had not done so in the last three months. As per the methods of Fisher (2004), participants currently in days 1-11 and 22 to 28-30 of their cycle were classified as low fertility (n = 26), and those in days 12-21 of their cycle were classified as high fertility (n = 9). Day one represented the onset of menses. This fractionation of the menstrual cycle was selected to account for variation in menstrual cycle phase and the timing of ovulation, allowing for greater confidence in participant's self-reported menstrual cycle status.

Procedure

A total of 10 heterosexual men (*M* age, 22.8 yrs, *SD* = 2.49) and 10 homosexual men (*M* age, 23.4 yrs, *SD* = 4.17) donated a sample of their body odor for use in this research. Heterosexual men were students at NTU and were recruited through an advertisement asking for donors to take part in a study on human body odor (irrespective of sexual orientation). Nine of the homosexual men were recruited through the NTU Lesbian, Gay, and Bisexual Society using the same advertisement. One homosexual man was recruited from Nottingham's gay community through social networks. All donors were recruited on the basis that they were non-smokers, not currently in a romantic relationship, and were not using psychoactive medication or recreational drugs. Sexual orientation was established by asking all donors to identify the focus of their sexual attractions and behavior using the Kinsey scale All homosexual donors (n = 10) rated themselves as exclusively homosexual and all heterosexual donors (n = 10) rated themselves as exclusively heterosexual. Donors received no form of compensation for their involvement in this research.

Body odor samples were collected using unworn cotton T-shirts. Each donor was asked to wear the T-shirt for two consecutive nights, storing it in a sealed specimen bag in the interim. Following this, the T-shirt was collected and frozen until the morning of use. At this time, each T-shirt was removed from the storage freezer and allowed to thaw at room temperature for approximately one hour.

In order to control for individual variation in dietary and hygiene practices, donors were required to follow a number of hygiene and behavioral guidelines. Donors were required to wash themselves and their bed sheets using non-perfumed soap and laundry detergent, and were instructed not to use any form of scented hygiene product (e.g., deodorant or aftershave) or ambient odor producer (e.g., incense). Since the consumption of certain foodstuffs significantly alters the properties of body odor (Sastry, Buck, Janak, Dressler, & Preti, 1980), donors were given a list of 13 foods (e.g., garlic, strong cheese, etc.) to be avoided. Finally,

donors were instructed not to engage in any form of sexual behavior, not to sleep in the same bed as a partner, and to refrain from smoking throughout the production of their body odor sample. All procedures were observed for two days before the commencement of sample collection (a "wash out" period). Once all the T-shirts had been collected, they were vetted by three female colleagues for any odors that may have signaled non-compliance with the above guidelines (e.g., the smell of smoke or scented hygiene products). One T-shirt from a heterosexual man was discarded because it smelled of smoke.

Donors also evaluated the number of times they engaged in behaviors that could influence their body odor during the course of an average day (i.e., bathing and deodorant use) and an average week (i.e., exercise levels and consumption of odorous foods). To control for social desirability when responding, donors returned their responses through the mail. Details of these data, and statistical comparisons between heterosexual and homosexual men based on numerous independent samples t-tests, are reported in Table I. Heterosexual and homosexual men did not differ significantly in their frequency of daily bathing or deodorant use, or in their weekly levels of exercise or consumption of odorous foods (all *p*s = ns). Donors were also asked if they currently or had previously shaved their underarm hair due to the inhibitory effect on body odor production (Shelley, Hurley, & Nicols, 1953). No donor had ever done this.

Insert Table I about here

All testing took place in an isolation room, specifically free of ambient odors. Participants were required to refrain from using any scented hygiene or grooming products on the day of testing. Similarly, they were required to refrain from consuming foodstuffs for one hour before testing commenced. Upon arrival, participants were given a brief introduction to the

research, informed of ethical concerns, and given the opportunity to ask questions. They were then left alone with a set of three T-shirts contained in unlabelled and sealed specimen bags: one from a heterosexual man, one from a homosexual man, and an unused T-shirt.

Participants were instructed to open each bag in order and to smell the T-shirt inside for at least five seconds. The participants were instructed to place their nose as close to the sample as possible while smelling, but not to physically touch the sample in any way (to avoid contamination with their own odors). Presentational order was randomized to control for order effects, and samples from heterosexual and homosexual men were not paired together more than once. Participants rated two sets of three odors, providing ratings for six olfactory samples in total.[6]

Odors were evaluated using a series of 9-point Likert scales (-4 to +4 range) adapted from Jacob et al. (2002). The scales were designed to assess odor strength ("How strong do you perceive the odor to be?"), pleasantness ("How pleasant do you perceive the odor to be?"), sexiness ("How sexually stimulating do you perceive the odor to be?"), and preference ("Would you be happy to smell this odor on a regular basis?"). Upon completion, participants were fully debriefed. While some participants believed they were rating human body odor, no participants indicated any knowledge that sexual orientation was involved.

RESULTS

Each of the four dependent variables was evaluated in a 2 (Fertility level: High vs. Low) x 3 (Odor type: Heterosexual, Homosexual, Unused) analysis of variance (ANOVA). Bonferroni adjustments were made due to the repeated measures design and were used as the basis for pairwise comparisons. Since multiple analyses were made, a critical value was established by multiplying the standard probability ($p < .05$) by the number of univariate analyses. This decreased the chances of a Type 1 family-wise error occurring and produced a minimum p vale of .0125.

Table II shows the mean ratings and SEM as a function of Fertility level and Odor type, and Table III shows the results for each of the four ANOVAS. It can be seen in Table III that there was a significant main effect for Odor Type for the ratings of pleasantness, sexiness, and preference. The effect sizes for each of these main effects were small in magnitude, ranging from 0.18 to 0.23. Pairwise comparisons for Odor type showed that the unused and homosexual samples were rated significantly higher for pleasantness ($p < .01$), sexiness ($p < .01$), and preference ($p < .01$) than heterosexual samples. No significant differences were reported between unused and homosexual samples for pleasantness ($p > .01$), sexiness ($p > .01$), and preference ($p > .01$) ratings. The effects of fertility approached significance for the rating scales of pleasantness ($p = .08$), sexiness ($p = .01$), and preference ($p = .04$). The effect sizes for each of these main effects were also small in magnitude, ranging from 0.09 to 0.17. There was a trend for the body odor of heterosexual and homosexual men to receive higher ratings during the high fertility period, while the ratings for unused shirts did not appear to vary based on fertility.

Insert Table II about here

Insert Table III about here

Multiple Pearson's correlations were used to investigate the relationship between participants' ratings of odor samples and donors' frequency of daily bathing, daily deodorant use, weekly exercise, and weekly consumption of odorous foods. It can be seen in Table IV that for heterosexual men there was a significant negative correlation between odor strength ratings and exercise frequency ($r = -.73$, $p < .05$); for homosexual men, there was a significant negative correlation between odor pleasantness and frequency of bathing ($r = -.69$, $p < .05$).

Insert Table IV about here

DISCUSSION

In the current study, body odor samples collected from heterosexual and homosexual men elicited significantly different evaluations from heterosexual women. Specifically, the body odor of homosexual men was rated as being significantly more pleasant, sexy, and preferable than the body odor of heterosexual men. The effect sizes for these differences, however, were small in magnitude. The precise physiological mechanisms behind these differences are currently unknown but could function, either independently or in conjunction, through the composition of axillary secretions, number and size of apocrine gland or axillary bacteria type. Each of these features display clear sex differences (Gower & Ruparelia, 1993; Wysocki & Preti, 2004), which is noteworthy given the sex a-typicality that homosexual men show for a variety of other sexually-dimorphic characteristics such as digit length (McFadden et al., 2005) and physical stature (Martin & Nguyen, 2004).

It should be noted, however, that the body odor of homosexual men was generally given neutral ratings on the hedonic scales, meaning that this odor was only pleasant compared to the body odor of heterosexual men. Therefore, it may be more accurate to state that the body odor of homosexual men was perceived as less unpleasant than the body odor of heterosexual men. Furthermore, there were no significant differences between the ratings given to unused T-shirts and the body odor of homosexual men. In all cases, hedonic evaluations were independent of odor strength (i.e., stronger smelling odors were not perceived as being more unpleasant, while weaker odors were not perceived as pleasant).

The influence of bathing and exercise habits on body odor differed between heterosexual and homosexual men. There was a significant negative correlation between odor strength ratings and exercise frequency for heterosexual men, suggesting that heterosexual men who exercise less frequently had stronger smelling body odor. Among homosexual men, there was

a significant negative correlation between odor pleasantness and frequency of bathing, suggesting that homosexual men who bathe less frequently actually smell more pleasant to women. The explanation for the different effects of bathing and exercise habits on heterosexual and homosexual men is unknown and warrants further investigation.

Menstrual cycle timing did not significantly influence odor perceptions. However, the current study did detect borderline significant effects based on fertility levels, though the effect sizes for these effects were small in magnitude. Women's perceptions of body odor from heterosexual and homosexual men appeared to become more positive, or less negative, during periods of high fertility, a pattern that is consistent with the earlier findings of Grammer (1993) and Hummel et al. (1991). The lack of statistical significance to these differences may be due to the sample used, since there were only nine participants in the high fertility group and almost three times that number in the low fertility group. It would be useful in future research to employ equal numbers of participants in both conditions and study within-subject variation in perceptions (i.e., take multiple recordings during each participant's cycle). While there were reasons for selecting to fractionate menstrual cycle timing (see methods section), the use of hormonal assays to determine fertility levels for specific days may also yield additional insight.

The findings in this study were consistent with the earlier pilot study of Sergeant (2002), suggesting that these sexual orientated related differences in male body odor are robust. Savic et al. (2005) recently reported that homosexual men showed a sex-atypical pattern of hypothalamic activation in response to 4-16-androstadien-3-one and estra-1,3,5(10), 16-tetraen-3-ol, a pattern that was congruent with that of heterosexual women. Although Savic et al. examined possible sexual orientation differences in reactions to odorants, rather than body odor production, their findings were also consistent with this study; homosexual men displayed specific sex atypical olfactory capabilities.

The only other study to examine how male sexual orientation influences body odor was by Martins et al. (2005). This study examined how body odor collected from heterosexual and homosexual men and women was perceived by each of these groups. The findings from both the current study, and that of Martins et al., suggest that the perceived pleasantness of body odor was not related to that odor's strength, suggesting that any hedonic differences between orientation groups is qualitative rather than quantitative in nature. Unlike the current study, and the findings of Sergeant (2002), Martins et al. documented that heterosexual women rated the body odor of homosexual men as being significantly more unpleasant than the body odor of heterosexual men.

It is possible, though unlikely, that these contradictory findings are due to methodological differences between the studies. Although the methodology employed in both studies was very similar (i.e., the collection and assessment of samples of body odor samples under strictly controlled conditions), there were two substantial methodological differences. Firstly, odor donors were required to follow a longer "wash out" period in the study of Martins et al. (i.e., a nine-day period) than in the current study (i.e., a two-day period). It is feasible that this longer wash out period could have reduced the presence of any residual environmental chemicals (i.e., hygiene and dietary products) in the body odor of the two donor groups. If homosexual men expressed higher levels of these residual chemicals, it is possible that this could have altered the hedonic quality of their body odor. However, given the lack of significant differences in the baseline hygiene and dietary habits of heterosexual and homosexual odor donors, it is doubtful that the presence of any possible residual chemicals differed between the two groups. Secondly, while donors in the current study generated body odor samples overnight, the donors in the study of Martins et al. generated body odor samples during their daily activities (e.g., while at work or school). Given the potential differences in how exercise and bathing habits influenced the body odor of heterosexual and homosexual

men, documented in the current study, it is feasible that differences in the daily routines of the two donor groups influenced the hedonic properties of their body odor. However, Martins et al. report that heterosexual and homosexual men were unlikely to differ regarding their activities when generating samples of body odor.

From the current study, and the research of Savic et al. (2005) and Martins et al. (2005), it appears that an individual's sexual orientation has a significant impact on their olfactory function, both in terms of their body odor production and perceptions of certain odorants. The precise nature of these relationships needs to be investigated further. Based on the current empirical findings, it may also be of interest to document olfactory function among other orientation groups such as bisexuals.

FOOTNOTES

[5]"Donors" are men producing odor samples; "participants" are women assessing these samples.

[6]Ideally, all participants would rate every body odor sample (both heterosexual and homosexual). This was unfeasible, since all of the samples would have to be used continuously over the testing period of 10 days. This would have significantly degraded the strength of a sample's odor. Instead, participants were presented with a limited number of samples, but ones that were as fresh as possible.

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Table I: Comparison of Donor Characteristics for Heterosexual and Homosexual Men.

	Heterosexual Men		Homosexual Men			
Characteristic	Mean	SD	Mean	SD	$t_{(17)}$	p
Bathing[a]	1.44	0.53	1.40	0.52	0.19	ns
Deodorant[a]	1.11	0.33	1.20	0.42	-0.51	ns
Exercise[b]	1.67	0.87	1.50	1.08	0.37	ns
Food[b]	0.56	0.73	0.50	0.71	0.17	ns

Note. All *t*-tests are two-tailed.

[a]Refers to daily frequency. [b]Refers to weekly frequency

Table II: Mean scores and standard error means (SEM) for hedonic rating scales expressed by Fertility level and Odor type.

	High fertility		Low fertility	
Scale	Mean	SEM	Mean	SEM
		Heterosexual men		
Strength	0.11	1.16	-0.54	0.68
Pleasantness	-0.89	1.09	-2.58	0.47
Sexiness	-0.56	1.02	-0.25	0.44
Preference	-0.44	1.06	-2.54	0.47
		Homosexual men		
Strength	-0.78	0.92	-0.58	0.63
Pleasantness	2.00	0.71	0.50	0.56
Sexiness	2.00	0.71	-0.31	0.50
Preference	1.78	0.62	0.12	0.56
		Unused t-shirts		
Strength	0.56	0.87	0.38	0.56
Pleasantness	0.44	0.65	0.69	0.44
Sexiness	0.00	0.58	-0.31	0.45
Preference	0.33	0.67	0.23	0.47

Table III: Results of Univariate Analyses for Odor Type and Fertility Level

Source	df	*F*	*p*	η_p^2
		Strength		
Odor type (O)	2, 66	1.00	.37	0.03
Fertility level (F)	1, 33	0.72	.79	0.02
O x F	2, 66	0.14	.87	0.04
		Pleasantness		
Odor type (O)	2, 66	10.04	.00*	0.23
Fertility level (F)	1, 33	3.24	.08	0.09
O x F	2, 66	1.17	.32	0.03
		Sexiness		
Odor type (O)	2, 66	7.72	.00*	0.19
Fertility level (F)	1, 33	6.68	.01	0.17
O x F	2, 66	1.54	.22	0.05
		Preference		
Odor type (O)	2, 66	7.14	.00*	0.18
Fertility level (F)	1, 33	4.71	.04	0.13
O x F	2, 66	1.23	.30	0.04

* $p < .0125$.

Table IV: Correlations Between Donor Characteristics and Odor Ratings

Characteristic	Strength	Pleasantness	Sexiness	Preference
		Heterosexual Men		
Bathing	.23	.37	.25	.24
Deodorant	.50	-.21	-.34	-.09
Exercise	-.73*	.56	.20	.23
Food	-.08	-.21	-.40	-.66
		Homosexual Men		
Bathing	.12	-.69*	-.35	-.10
Deodorant	-.41	-.52	-.63	-.58
Exercise	-.49	-.12	-.06	.04
Food	.46	-.16	.15	.27

Note. All correlations are two-tailed. * $p < .05$