

PARENTAL INFLUENCES ON SEXUAL PREFERENCES: THE CASE OF ATTRACTION TO SMOKING

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Abstract. We investigated whether a sexual preference for smoking can be related to past experiences of parental smoking during childhood, as predicted by the theory of sexual imprinting, but also by sexual conditioning theory. In a sample of over 4000 respondents to five Internet surveys on sexual preferences, we found that parental smoking correlates with increased attraction to smoking in self-reported hetero- and homosexual males. Maternal smoking was associated with an increase in attraction to smoking both in hetero- and homosexual males, while paternal smoking was associated with an increase in attraction to smoking only in males who prefer male partners. We could not explain these findings by considering other factors than parental smoking habits, such as possibly biased reporting, indicators of a sexually liberal lifestyle or phenotype matching. Our data are consistent with the hypothesis that sexual preferences are acquired early in life by exposure to stimuli provided by individuals in the child's environment, such as caregivers. The sex specificity of the parental effect is consistent with sexual imprinting theory but not with conditioning theory.

Keywords: sexual imprinting, paraphilia, tobacco smoking, sexual development, sexual preferences

INTRODUCTION

Human sexual preferences have attracted a fair amount of interest, especially from scholars with an evolutionary perspective on human behaviour. Much of this research has focused on the adaptiveness of male and female partner preferences (e.g. BUSS 1999; CARTWRIGHT 2000). The developmental processes underlying such preferences, on the other hand, remains surprisingly unexplored (see TEN CATE and VOS 1999, for a similar critique of evolutionary models of mate preferences). Prevailing "adaptationist" theories simply seem to presuppose that preferences are genetically inherited (BUSS 1999). Ethological studies of sexual imprinting in birds and mammals, however, provide evidence for a learning mechanism where sexual preferences are acquired during an early sensitive period (IMMELMAN 1972; BISCHOF 1994; TEN CATE 1994; HOGAN 2001). Parents, or other individuals in the social environment of the young animal, are the main targets of such learning, often

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in a sex-specific way. For instance, experiments manipulating early experiences of zebra finches (*Taeniopygia guttata*), demonstrate that both males and females imprint positively on the mother's appearance, later preferring mates of her phenotype, while males imprint negatively on the father's appearance, avoiding females of his phenotype (VOS et al. 1993; VOS 1994). Although sexual imprinting in most cases generate biologically functional preferences for opposite-sex conspecifics, in special circumstances other things can be imprinted on, such as the appearance of another species (e.g. IMMELMAN 1969; BISCHOF 1994) or an artefact (PLENGE et al. 2000; WITTE and SAWKA 2003). Sexual imprinting has also been inferred as an explanation to rare, "fetishistic", preferences in humans (see e.g. MORRIS 1969; EIBL-EIBESFELDT 1975; WILSON 1987; ENQUIST et al. 2002).

Association learning, specifically sexual conditioning, has been invoked as an explanation to such preferences (GOSSELIN and WILSON 1980; WILSON 1987; AKINS 2004). According to sexual conditioning theory, sexual preferences are learned when stimuli are experienced in conjunction with sexual stimulation and sexual reward (GOSSELIN and WILSON 1980; WILSON 1987; AKINS 2004). For instance, a boy becomes a glove fetishist as a result of having experienced his first ejaculation while playing with a glove and rubbing it against his penis (MORRIS 1969). This is very different from sexual imprinting where preferences are learned through interactions with conspecifics during an early sensitive period, long before sexual maturation, and independently of sexual rewards and sexual motivation, seemingly as the result of mere exposure (TEN CATE 1994; HOGAN 2001). The main differences between sexual conditioning and sexual imprinting is thus that sexual conditioning but not sexual imprinting requires a sexual reward, and that sexual imprinting but not sexual conditioning takes place during a limited sensitive period. Imprinting seems to be guided towards parents and other individuals in the early environment, perhaps reflecting underlying predispositions, as also suggested by the sex specific effects of parents demonstrated in animal experiments. Conditioning on the other hand, appears to be accidental, not targeted at specific individuals, but can occur to any object that happens to be present at the same time as genital stimulation is experienced. Additionally, the effects of imprinting usually remain remarkably stable (LORENZ 1935; IMMELMAN 1972), while conditioned responses normally disappear in the absence of reinforcement (WILSON 1987). This makes imprinting a more likely explanation to long-lasting sexual preferences. Nevertheless, to establish whether sexual imprinting has a role in the development of human sexual preferences, empirical evidence is needed.

For ethical reasons, one cannot systematically manipulate the early experiences of humans in the way that has generated evidence for sexual imprinting in other species. However, by demonstrating a relationship between parental attributes and partner preferences, a few studies indicate that a corresponding early learning process may operate in humans. A relationship between parents and partner preferences has been found regarding eye and hair colour (LITTLE et al. 2003), ethnicity (JEDLICKA 1980), facial features (BERECZKEI et al. 2002; BERECZKEI et al. 2004;

WISZEWSKA et al. 2007), and age (WILSON and BARRETT 1987; ZEI et al. 1981; PERRETT et al. 2002). However, since imprinting gives rise to homogamy, in that a partner who resembles one's parents often also resembles oneself, an alternative theory has been brought forward as an explanation to the resemblance between parents and partners in the human studies mentioned above, namely self-referent phenotype matching. In self-referent phenotype matching an individual learns and recalls the phenotype of itself and then assesses similarities and differences between its own phenotype and unfamiliar conspecifics (BLAUSTEIN 1983). Among these, only BEREKZKEI et al. (2004) partly ruled out an explanation in terms of phenotype matching, as well as ruling out an explanation in terms of genetic determination of preferences, by showing that adopted daughters choose husbands that resemble their adoptive father. Since the above studies mainly looked at partner choice, it is also possible that other factors than sexual attraction, which is supposed to be the consequence of sexual imprinting, had a role. In order to make it a probable case that sexual imprinting exists in humans, we suggest that accumulation of data from many different studies is needed, and that more studies of different kinds of traits are needed to this end.

In the present study we focus on a rare sexual preference, a preference for smoking partners, and investigate if this preference can be related to past experiences of parental smoking during childhood. Data was collected through a questionnaire on parental smoking habits and degree of attraction to smoking in potential partners. The questionnaire was distributed on the Internet as part of five surveys on sexual preferences (see Methods). Using the Internet for data collection enables the collection of large samples, even for a rare sexual preference such as smoking. For instance, there are several hundred Internet communities devoted to the topic of sexual smoking fetishism. The hypothesis that attraction to smoking is the result of early exposure to smoking would predict a stronger average attraction to smoking among individuals who grew up with smoking parents. An advantage of exploring a sexual preference for smoking is that, in contrast to previous studies, it involves an inanimate object, namely a cigarette. Since the cigarette is a novel trait in evolutionary history, an explanation in terms of genetically determined adaptations for traits that signal mate quality is highly unlikely. A difference to previous studies is that we focus on a sexual preference, rather than partner choice, thus eliminating factors other than sexual attraction that might affect partner choice. Smoking is furthermore a trait that can be displayed by both mothers and fathers. This means that we can look for sex-specific effects. Such effects are predicted by sexual imprinting but not sexual conditioning. For instance, heterosexual males can be predicted to imprint positively to the mother, but not the father, or even imprint negatively to the father. It was also explored whether reported attraction to smoking has consequences for partner choice. A plausible objection is that parental smoking and attraction to smoking could be correlated because of socioeconomic or genetic factors that cause both parents, subjects and subjects' partners to become smokers. This possibility was explored by looking at correlations between the smoking habit

of parents and that of subjects and subjects' partners respectively. It has furthermore been suggested that an adventurous lifestyle may be associated with rare sexual preferences (KAFKA and HENNEN 2002; LÄNGSTRÖM and SETO 2006), and the riskful habit of smoking may be an indicator of such a lifestyle. A correlation between parental smoking and attraction to smoking might reflect an environment where general risk-taking behaviour is common rather than imprinting on parental features. This alternative explanation was explored by looking at the relationship between attraction to smoking and indicators of a sexually liberal lifestyle. We collected data from men and women irrespective of sexual orientation, but since so few women answered the surveys, only results from hetero- and homosexual males are presented here.

METHODS

Data collection

We collected data about attraction to smoking and parental smoking habits through five Internet surveys. The "Smoking survey" explicitly targeted people sexually attracted to smoking. The four remaining surveys targeted people with a sexual preference other than smoking. These were sexual preferences for a partner wearing glasses ("The Glasses survey"); for parts of the female body ("The BBL [breasts, butt and legs] survey"); for a partner wearing a plaster cast ("The Plaster survey"); and for extreme body types ("The Body Type survey"). These surveys also included questions about the sexual preferences of their respective target groups that will be analysed in separate reports. We included questions about attraction to smoking in the Glasses, BBL, Plaster and Body Type surveys because we wanted to have information about parental smoking habits from people not attracted to smoking, but who were comparable to respondents to the Smoking survey in having a rare and/or particularly strong sexual preference, and in being Internet users.

The surveys were published on the Internet as web pages and were advertised by posting messages to Internet communities (e.g. Yahoo! groups) devoted to relevant topics (e.g. "smoking fetish" for the Smoking survey). A complete list of the many hundreds of internet communities where we recruited subjects is available upon request. It was stated that subjects should be adults (at least 18 years old) to participate. Data were collected between January 2006 and December 2009.

Variables

For each respondent we gathered the information listed in *Table 1* (the full questionnaire is reprinted in the Appendix). In particular, we asked respondents to rate their sexual attraction to a smoking partner on a scale from 0 (no sexual attraction) to 10 (the strongest imaginable sexual stimulus) and to supply information about

their mother's and father's smoking habits. The latter was assessed by the question "Did your mother/father smoke regularly during your childhood?". Childhood was explicitly defined as 0-15 years of age. Respondents who answered "Yes, during my whole childhood" were classified as having a smoking mother or father; and respondents who answered "No, she/he NEVER smoked" were classified as not having a smoking mother or father. Remaining respondents were excluded from data analysis (see Appendix for the full range of possible answers). Respondents were grouped into four categories based on parental smoking habits: neither parent smoking (**None**), only mother smoking (**Only Mother**), only father smoking (**Only Father**), and both parents smoking (**Both**). Although the average rating of attraction to smoking is higher among respondents to the Smoking survey, the effect of parental smoking habits on attraction to smoking was consistent in all five surveys (heterosexual males $p = 0.69$, homosexual males $p = 0.52$, bootstrapped permutation test, see *Statistical Analysis*). We thus pooled data from the five surveys.

Respondents also supplied information about how often they had *seen* mother and father smoke but since analysis of these data yielded essentially the same conclusions as the data on parents' smoking habits, it is not reported here.

Since sexual orientation might have consequences for possible maternal or paternal influences on attraction, sexual orientation had to be assessed. However, it should be noted that self-reported sexual orientation not always accurately reflect actual sexual behaviour (PATHELA et al. 2006). In this study, sexual orientation was assessed by asking respondents about the preferred sex of a partner, "Male", "Female", or "Both" (see Appendix and *Table 1*). Thus, for instance, males stating that they prefer females are referred to as self-reported heterosexuals.

Table 1. Information gathered from each respondent

Variable	Possible Values
Attraction to smoking	Range 0–10
Age of awareness of attraction to smoking	Range 0–99 years
Age	Range 0–99 years
Sex	Male, Female
Age of first sexual intercourse	Range 0–99 years
Preferred sex of sexual partners	Male, Female, Both
Mother smoking	Yes, No
Father smoking	Yes, No
Respondent smoking	Yes, No
Partner smoking	Yes, No
Liberal sexual upbringing	Range 0–10
Seeing parents naked	Never, Sometimes, Often

Unfortunately, our sampling method yielded few female (15% of respondents) and bisexual male respondents. Since data on these respondents is too scarce for a meaningful analysis, it is not presented here.

Statistical analysis

The data were not suited to parametric analysis of variance: many respondents reported an attraction to smoking at the extremes of the scale, and the residuals of tentative linear models were strongly non-normal. We thus used nonparametric statistics for the most part. In particular, we used nonparametric bootstrap (10 000 replicates) to estimate confidence intervals of means, and a bootstrapped permutation test with 10 000 reshufflings of survey membership to ascertain that the relationship between parental smoking habits and attraction to smoking was not different for respondents to the five surveys (EFRON and TIBSHIRANI 1993).

Analyses were performed with SPSS 16.0. The R package “boot”, version 1.2–27, was used for bootstrap analyses (CANTY and RIPLEY 2010). All statistical tests are two-tailed.

Use of Internet surveys

The use of Internet surveys could suffer from some possible drawbacks such as sampling biases and deliberately inaccurate reporting (BERK et al. 1995; BIRNBAUM 2004). For instance, in the present study, few women answered the questionnaire, probably because most Internet fetish communities target men. However, Internet surveys also include the possibility of gathering a large sample, even for rare behaviour, and a guarantee of anonymity that encourages subjects to freely express themselves about their sexual interests (MILLSTEIN and IRWIN 1983; TURNER et al. 1998; BIRNBAUM 2004; GOSLING et al. 2004). There is of course always the risk that some respondents give deliberately inaccurate answers. However, we have detected few inconsistencies among the submitted questionnaires, and when an inconsistency appears, it is hard to judge if it is deliberate or a mistake. To avoid arbitrary exclusion criteria all respondents, except when explicitly stated, were included in our analyses.

Note on sample sizes

In the results presented below sample sizes vary. One reason is that respondents sometimes did not provide a particular piece of information, or gave an answer that was excluded in the analysis. Moreover, some questions were only included in the Smoking survey, e.g., the questions about one’s own smoking habits and partner’s smoking habits.

RESULTS

Description of samples

From self-reported hetero- and homosexual males, 4250 questionnaires were obtained: 1668 from the Smoking survey, 741 from the Glasses survey, 1200 from the BBL survey, 310 from the Plaster survey and 331 from the Body Type survey. The age of respondents ranged from 18 years upward (two respondents reported being younger than 18 years and were thus excluded from data analysis), with survey averages between 33 and 38 years (*Table 2*).

Table 2. Descriptive statistics of survey data on hetero- and homosexual males

	Survey				
	Smoking	Glasses	BBL	Plaster	Body Type
All respondents	1668 (100%)	741 (100%)	1200*** (100%)	310 (100%)	331 (100%)
Average age	38 years (N = 1666**)	36 years (N = 741)	36 years (N = 1200)	33 years (N = 310)	35 years (N = 331)
Lived with both parents during entire childhood*	1339 (80%)	602 (81%)	948 (79%)	255 (82%)	284 (86%)
Males who prefer females	1304 (78%)	627 (85%)	1165 (97%)	275 (89%)	269 (81%)
Males who prefer males	364 (22%)	114 (15%)	35 (3%)	35 (11%)	62 (19%)

* 0–15 years of age

** Two respondents did not report accurate age information

*** Two respondents reporting being younger than 18 years were excluded

Attraction to smoking and parental smoking habits

We observed a statistically significant effect of parental smoking habits on attraction to smoking both for self-reported hetero- and homosexual males (*Figure 1*, $p < 0.001$ in both cases, $df = 3$, Kruskal-Wallis tests). In self-reported heterosexual males (the largest sample), there was a strong association between attraction to smoking and maternal smoking, while there was no effect of paternal smoking (*Figure 1*). In other words, respondents with only a smoking father did not show increased attraction as compared to respondents with neither parent smoking, while respondents with a smoking mother were more attracted to smoking irrespective of whether the father smoked or not. In self-reported homosexual males, there was

likewise a positive effect of maternal smoking on attraction to smoking, but also a positive effect of paternal smoking (*Figure 1*). Thus, maternal but not paternal habit had an effect on males preferring females as sexual partners, whereas both maternal and paternal habits had an effect on males preferring males as sexual partners.

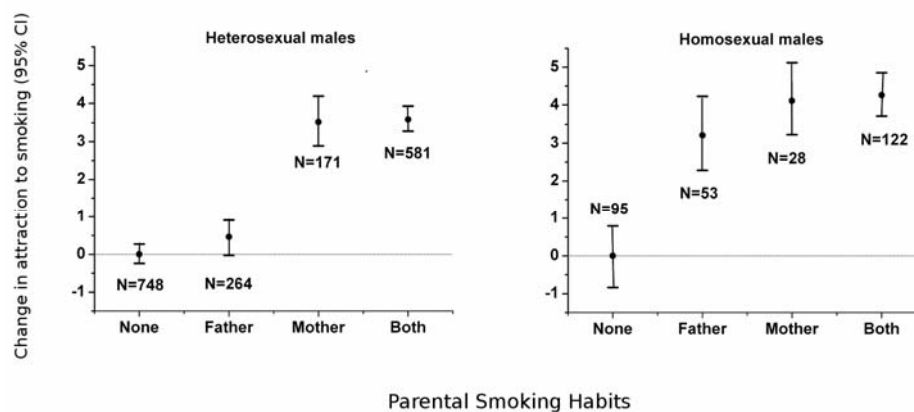


Figure 1. Change in mean attraction to smoking partners as a function of parental smoking habits for hetero- and homosexual males. The mean attraction relative to subjects without smoking parents is used as baseline in all cases. Error bars denote 95% confidence limits, obtained from bootstrapped distributions (see Methods)

Sexual imprinting or sexual conditioning effect of primary caregiver

It is desirable to separate sexual imprinting effects from effects of association learning, or sexual conditioning in this particular case. A parental effect can be expected from both types of learning, but in different ways. According to the theory of sexual conditioning, smoking fetishism would arise as the result of experiencing a sexual reward, such as an orgasm, while, for instance, playing with a cigarette (remember the case of the boy who becomes a glove fetishist as a result of having experienced his first ejaculation while playing with a glove and rubbing it against his penis, described in the Introduction). This would only require the presence of cigarettes in the home, irrespective of who smoked them. Sexual imprinting on the other hand takes place in a social context, and the parental effect has been shown to be sex specific. Therefore, the maternal effect and lack of paternal effect on heterosexual males seem more consistent with imprinting, unless respondents were more likely to become conditioned to cigarettes that their mother had smoked. This might be the case if the mother was the primary caregiver for the majority of respondents and thus were more present in the homes of respondents and therefore were more likely to leave behind cigarettes that respondents could play with. That there is a maternal but no paternal effect on heterosexual males would thus be a result of the mother

being more present during the respondents' childhood. But since there is a paternal effect on homosexual males, this hypothesis would require the father to be more present for homosexual than heterosexual males. However, the data we have on the number of years from birth that the respondent lived with father does not suggest a difference between hetero- and homosexual males ($P = 0.521$, $N = 4250$, Mann-Whitney Test). Furthermore, it can be assumed that among males with a smoking father, having seen father smoke daily is a measure of how likely one was to become conditioned to cigarettes he had smoked. There was no difference in having seen father smoke daily between homo- and heterosexual males having a smoking father and having lived with father up to at least age 15 ($P = 0.4$, $N = 1058$, Mann-Whitney Test), so this does not seem to be the cause of the different influences of father on attraction in hetero- and homosexual males.

Partner choice

The relationship between attraction to smoking and having a smoking partner was explored in order to find out if attraction to smoking affects partner choice. In heterosexual males, there was a weak positive correlation between attraction to smoking and having a partner that smokes or used to smoke when respondent and partner met ($r_s = 0,221$, $p < 0,01$) while in homosexual males, there was no significant correlation between attraction to smoking and having a partner that smokes ($r_s = -0,01$, ns). It should be noted that information on partner's (and own smoking habit) were only collected from respondents to the smoking survey, and therefore data is skewed towards respondents with high ratings of attraction to smoking, which might influence the result of this analysis.

Partner, self, or parents?

It has been objected that the correlation between parental smoking and attraction to smoking could be due to socioeconomic or genetic factors influencing the propensity to become a smoker, rather than to parents directly influencing sexual preferences through learning. While these factors might explain that subjects smoke and perhaps that their partners smoke, there do not seem to be any strong theories about the mechanisms whereby this would create a, sometimes very strong, *attraction* to smoking persons. However, we assume that the rationale for thinking that these factors could cause attraction to smoking is that the attraction is an effect of own or partner's smoking habit in one of the following ways:

- 1) because of socioeconomic status or genetic predisposition to become a tobacco addict, both parents and subjects smoke. Subjects are sexually attracted to other smoking persons

- a) because of self-referent phenotype matching (that is a preference for self-similar individuals), or
 - b) because they for other social reasons associate with sexual partners that also smoke, and having a smoking partner causes attraction to smoking.
- 2) because of socioeconomic status, both parents and partners of subjects smoke, and having a smoking partner causes attraction to smoking.

To start with, it is not clear why these scenarios should yield a sex-specific parental influence. It could be argued, however, that hypothesis 2 is consistent with a case where, for instance, males attracted to smoking females belong to a community where it is more common for females to smoke, and therefore both mothers and partners smoke, of which the latter causes attraction to smoking. Nevertheless, from hypothesis 1a and b, we expect a correlation between parental and own smoking habit, and from hypothesis 1b and 2, we expect a correlation between parental and partner's smoking habits. However, we found no association between parental and own smoking habits, and no associations between parental and partner's habit (*Table 3*). Furthermore, remember that in homosexual males, there was not even a significant correlation between attraction to smoking and partner's habit in the first place, which would be expected if it is smoking partners that cause attraction to smoking (hypothesis 1b and 2). It should be noted that information on own and partner's smoking was only collected from respondents to the smoking survey.

Table 3. Spearman correlations between mother's and father's smoking habit and partner's and own smoking habit

	Mother's smoking habit		Father's smoking habit	
	Partner's smoking habit	Own smoking habit	Partner's smoking habit	Own smoking habit
Heterosexual males	,026	,004	-,010	,052
Homosexual males	,019	,114	,082	,109

Spearman correlation

Does attraction to smoking cause biased reporting of parental smoking habits?

It is possible that respondents' attraction to smoking may bias their report of parental smoking habits. Such biases would confound our results. Although we cannot rule out this possibility directly, we note that respondents declare to be equally certain about parental smoking habits independent of their attraction to smoking. The correlations between attraction to smoking and the proportion of respondents uncertain about maternal and paternal smoking habits were, respectively, $r_s = -0,30$ ($N =$

11, $p > 0.05$) and $r_s = -0.18$ ($N = 11$, $p > 0.5$). Overall, among all respondents that lived together with their parents up to 15 years of age ($N = 3239$), only about 2% reported that they were uncertain about either maternal or paternal smoking habits, suggesting that the scope for an effect of biased reporting on our results is limited.

Lifestyle and attraction to smoking

It has been suggested that smoking might be an indicator of riskful behaviour, and further, that such behaviour might be correlated with a sexually liberal lifestyle and extreme sexual preferences, and that this might explain our results. Riskful behaviour was not assessed in this study. However, three variables concerning sexual behaviour and parents' attitudes towards sexuality was investigated: age of first sexual intercourse, respondents' rating of how liberal a sexual upbringing they received and their judgement of how often they saw their parents naked. These variables are the closest estimation of a sexually liberal lifestyle in the current data set. The correlations between these variables and attraction to smoking were very small (*Table 4*). The correlation with first intercourse was negative.

Table 4. Correlations between sexual attraction to smoking and possible indicators of a sexually liberal lifestyle

Category	Age of first sexual intercourse	Liberal sexual upbringing	Seeing parents naked
Heterosexual males	-,089**	,077**	-,015
Homosexual males	-,063	,013	-,010

Spearman correlation. * $p < 0.05$. ** $p < 0.01$.

DISCUSSION

Parental smoking and sexual attraction to smoking

In our data, parental smoking during childhood was strongly associated with sexual attraction to smoking in males irrespective of sexual orientation. Attraction to smoking was larger in both groups when both parents smoke as compared to when neither parent smoke. The individual contribution of maternal and paternal smoking was explored by looking at cases where only the mother or the father smoke. We found a strong effect of maternal smoking, but no effect of paternal smoking, on attraction to smoking in heterosexual males. In homosexual males, there was likewise a strong effect of maternal smoking but also a strong effect of paternal smoking

(Figure 1). This suggests that there is an early effect of mothers on individuals who grow up to prefer females as sexual partners, and an early effect of mother *and* father on individuals who grow up to prefer males as sexual partners. We could not explain this pattern considering factors other than parental smoking habits, such as biased reporting, self-referent phenotype matching or indicators of a sexually liberal lifestyle. In fact, the correlation with first sexual intercourse was negative, failing to support the suspicion that an attraction to smoking is associated with an adventurous lifestyle. However, it is also clear that parental smoking habits do not account for all the variation in the sample. For instance, around 20% of heterosexual males that rated attraction to smoking as the strongest imaginable sexual stimulus (10 on the attraction scale) reported growing up with a mother that never smoked, and about 60% of heterosexual male respondents growing up with a smoking mother (excluding respondents to the smoking sample because this sample is biased towards persons attracted to smoking), reported 0 attraction to smoking. There must also be other factors that influence a person's sexual preferences.

Imprinting or conditioning

It appears that the parental effect found in this study might well be an effect of learning. The prime candidates for such learning is sexual imprinting and sexual conditioning. Sexual conditioning to an object is hypothesized to happen when this object is associated with a sexual reward. In the case of early sexual conditioning to smoking, a plausible scenario might be a child experiencing genital stimulation while playing with a cigarette, and as a consequence, begins to associate cigarettes with sexual arousal and satisfaction. In this case, one would expect the parental effect to be independent of the sex of the smoking parent, since conditioning would only require the presence of cigarettes in the home of the child. Sexual imprinting, on the other hand, have been shown in animal experiments to occur in a social context, in the *absence* of sexual reward, and to be a sex specific mechanism (e.g. VOS 1994). Males are for instance known to imprint positively to the mother (KENDRICK et al. 1998; VOS 1994), and sometimes even negatively to the father (VOS et al. 1993). For heterosexual males in our data, attraction to smoking increased when only the mother smokes, but not when only the father smokes, indicating a maternal but no paternal effect on attraction to smoking. This pattern is consistent with sexual imprinting. One could nevertheless speculate that a conditioned preference for smoking is correlated to maternal, but not paternal smoking, because the mother is more present than the father during a person's childhood, and that the child therefore is more likely to find and play with a cigarette that the mother has smoked, than to find and play with a cigarette that the father has smoked. However, in homosexual males there was also a paternal effect on attraction to smoking. The only way this pattern would be consistent with a conditioning effect of primary caregiver is if fathers were more present for the homosexual than the heterosexual males. We

could not find any support for this hypothesis in our data. A paternal effect on individuals preferring males as sexual partners could on the other hand be expected of sexual imprinting. WITTE and SAWKA (2003) for instance found that female zebra finches imprint on a red feather possessed by the father. In our data, there is also a maternal effect on homosexual males. This is not inconsistent with sexual imprinting, since in animal studies, both males and females have been shown to imprint to the mother (VOS 1994, 1995a; KENDRICK et al. 1998).

Partner choice

The present study looked at reported *attraction* to the investigated trait, in contrast to several previous studies investigating actual *partner choice* (e.g. JEDLICKA 1980; ZEI et al. 1981; WILSON and BARRETT 1987; BERECKZEI et al. 2002; LITTLE et al. 2003). However, it is an interesting question whether the reported attraction has consequences for actual partner choice. Our data indicate that, at least in heterosexual males, persons with a strong attraction to smoking often choose a smoking partner.

Alternative explanations to the correlation between parental smoking habit and attraction to smoking

It has been objected that the correlation between parental smoking and attraction to smoking could be due to socioeconomic or genetic factors influencing the propensity to become a smoker, rather than to parents directly influencing sexual preferences through learning. Such socioeconomic or genetic factors could theoretically explain why subjects smoke, and perhaps why their partners smoke (for instance, if smokers associate with other smokers or if both parents and partners smoke because they have the same socioeconomic status). The rationale for assuming that these factors can also cause an *attraction* to smoking must be either that own smoking causes an attraction to smoking, that is self-referent phenotype matching, or that a partner's smoking habit causes an attraction to smoking. However, we found no associations between parental and own smoking habits, which would be expected from phenotype matching, and no associations between parental and partner's habit, which would be expected from the hypothesis that partner's habit causes attraction to smoking. Furthermore, in homosexual males, there was not even a significant correlation between attraction to smoking and partner's habit in the first place, which would be expected if it is smoking partners that causes attraction to smoking. It is also interesting that some of our respondents with a preference for smoking explicitly report that they do not want a smoking partner as exemplified by the following quotes taken from our surveys:

“Many with the fetish find smoking to be repulsive outside of sex.”

”Although I have strong sexual fantasies about smoking women, I am not married to, or drawn to, relationships with women that smoke. In real life, I find the smoke to be an irritant. In my fantasy life, and from a distance, I find it incredibly erotic.”

At the very least, it is clear that a partner’s habit cannot always explain the preference for smoking.

In theory, another way in which genetic factors could cause a sexual preference for smoking persons is if the preference itself is genetically determined. It was argued in the Introduction that an explanation in terms of genetically determined adaptations for traits that signal mate quality is highly unlikely since the cigarette is a novel trait in evolutionary history. However, it has been suggested that smoking could be perceived as attractive because it is a risk taking behaviour and such behaviour has been suggested to signal mate quality. Although this provides an ultimate explanation to a preference for smoking partners, it is unclear what the proximate mechanism is. That a genetically determined adaptation to prefer smoking partners should exist is unlikely since, as already noted, cigarettes are evolutionary novelties. Furthermore, one of the few empirical studies of riskful behaviour as a signal of mate quality found a negative relationship between riskiness of a behaviour and attraction (WILKE et al. 2006). In fact, while widely accepted among scholars studying human behaviour, biologists question whether sexual preferences reflect mate quality (e.g. ENQUIST et al. 2002). Human studies have, for instance, generally not found any relationship between a person’s attractiveness and his/her genetic or phenotypic quality (KALICK et al. 1998; SHACKELFORD and LARSEN 1999). This does not support mate quality hypotheses (see ENQUIST et al. 2002). When it comes to non-human animal studies, evidence is rather accumulating that sexual preferences have other explanations, such as sensory biases (e.g. SMITH et al. 2004; RODD et al. 2002). Smoking as a signal of mate quality would also predict universality of this preference, which does not seem to be the case. Above all, it does not explain the sex-specific parental influence on attraction to smoking found in this study.

Evolutionary significance of imprinting

One may ask what the evolutionary function of sexual imprinting is. It is easy to understand that a sexually reproducing organism needs a mechanism for recognising a partner of the right species, and sexual imprinting is such a mechanism. Theoretically, however, one might think that genetically determined preferences would be better because they eliminate the risk of acquiring nonfunctional preferences for artefacts or other nonfunctional preferences that in certain circumstances might result from imprinting. However, the vertebrate ancestors of humans, in whom sexual imprinting first arose, were not very likely to encounter such circumstances. We should also remember that evolution cannot be expected to generate perfection.

There are likely to be constraints on the possibilities for evolution, and, as already touched upon, there might be limitations on what kind and how much information can be effectively genetically encoded (see LALAND and BROWN 2002). In fact, it seems that normal development of all perceptual systems in birds and mammals requires environmental input (HOGAN 2001).

Nevertheless, it has been suggested that imprinting has certain evolutionary advantages over genetically determined preferences. An adaptive function of sexual imprinting might be to avoid inbreeding with close relatives, since exactly what your mother or brother looks like cannot be stored in your genes, as well as prevent cross-breeding with other species (EIBL-EIBESFELDT 1975; VOS 1995b). Sexual imprinting has also been proposed to be adaptive in that it guides individuals to mate with not too distantly related conspecifics, which could potentially be beneficial, for instance by preventing the loss of genes required for adaptation to a particular environment (BATESON 1983). Imprinting also ensures flexibility. The preferences of the individual become adapted to the present phenotypes of the local population. A genetically determined, fixed preference for an “ideal” partner, on the other hand, might result in the individual never finding a partner that matches the ideal (GRAMMER et al. 2003). Finally, a strong evolutionary reason for believing that a sexual imprinting-like mechanism should exist in humans is that it has been shown to exist in many of the vertebrates with whom we share a common evolutionary history (fish: IMMELMAN 1980; KÖRNER et al. 1999; birds: TEN CATE et al. 1993; mammals: D’UDINE and ALLEVA 1983; KENDRICK et al. 1998).

CONCLUSION

In our data, we found an association between parental smoking habits during childhood and attraction to smoking suggesting that adult sexual preferences are influenced by early experience. Moreover, maternal, but not paternal, smoking was associated with an increased attraction to smoking was males preferring female sexual partners, while maternal *and* paternal smoking was associated with an increased attraction to smoking in males preferring male sexual partners. This sex specificity seems consistent with sexual imprinting. However, to determine that the parental influence on sexual preferences is a case of sexual imprinting, rather than sexual conditioning, would require proof of a sensitive period for acquisition of sexual preferences and that acquisition takes place in the absence of sexual reward. Further research is needed to elucidate whether this is the case. In addition, in order to separate sexual imprinting effects from confounding factors, future studies could benefit from more elaborate questions on socioeconomic status, sexually liberal lifestyle, and partner choice.

Despite the difficulties of proving that sexual imprinting plays a role in the development of human sexual preferences, it remains a viable alternative to prevailing theories presupposing genetically inherited preferences, especially since our results

conform to the predictions made by sexual imprinting theory. Sexual imprinting is a phylogenetically widespread (D'UDINE and ALLEVA 1983; TEN CATE et al. 1993; KENDRICK et al. 1998) phenomenon firmly rooted in biological theory that accommodates both the developmental and functional aspects of sexual preferences. It also seems more compatible with the existing variation in human sexual preferences than rival evolutionary theories. Human sexual preferences range from common preferences for features of the human body to rare preferences for artefacts. There is also a considerable variation in preferences between cultures and historical times (GRAMMER et al. 2003). Sexual imprinting can provide an explanation to much of this diversity in sexual preferences, although other factors are probably also involved in determining a person's sexual preferences.

APPENDIX

Surveys

Below are reprinted the questions from the Smoking, Glasses, BBL, Plaster and Body surveys (see Methods) relevant to this paper, with possible answers in brackets. Respondents had to be 18 years old to partake. Questions marked with * were included in the Smoking survey only.

Respondent information:

1. Year of birth [Type year]
2. Month of birth [Select month]
3. Sex [Male/Female]
4. Preferred sex of partner [Male/Female/Both]
5. Country of origin [Forced choice from extensive list of countries]
6. Age of first sexual intercourse? [Age, or Never]
7. Age of first stable relationship? [Age, or Never]
8. Number of siblings (including full, half and adopted siblings) [Forced choice between 0 and 20]
9. In what year was your mother born? [Year, or Not sure]
10. In what year was your father born? [Year, or Not sure]
11. How long did you live with your mother after you were born? (in years) [Forced choice between 0 and 100]
12. How long did you live with your father after you were born? (in years) [Forced choice between 0 and 100]
13. On a scale from 1 (meaning very strict) to 10 (meaning very liberal), how liberal was your upbringing regarding sexuality? [Scale from 1 to 10]
14. As a child you saw your parents naked: [Never, or very rarely / Sometimes / Often]

Questions asked for each sibling:

1. Year of birth [Year, or Don't know]
2. Month of birth [Select month, or Don't know]
3. Sex [Male / Female]
4. Genetic relationship between yourself and this sibling [Same mother and father / Same mother different father / Same father different mother / Both mother and father different]

Questions about smoking:

Items marked with * were included only in the Smoking questionnaire.

1. On a scale from 0 (no sexual attraction) to 10 (the sexual stimulus that is strongest to you), how strong is your sexual attraction to smoking in a partner or potential partner? [0 to 10 or Don't know]
- 2.* At what age did you become aware of this attraction? [Age/Never / Don't know]
- 3.* What is most sexually attractive to you? [Cigarette smoking / Cigar smoking / Pipe smoking / Other kind of smoking / I am uncertain / No sexual attraction]
4. Did your mother smoke regularly during your childhood (0–15 years of age)? [Yes, during my whole childhood / Yes, but only for a part of my childhood / No, she only smoked occasionally / No, she NEVER smoked / I am uncertain about the smoking habits of my mother]
5. If your mother only smoked for part of your childhood, can you specify your age when she smoked? E.g., write “3–9” if she smoked from when you were 3 to when you were 9. [Free text]
6. How often did you see your mother smoke during your childhood (0–15 years of age)? [My mother NEVER smoked / Daily / Several times a week but not daily / Less than once a week / Rarely / It varied during my childhood / I am uncertain]
7. Did your mother try to hide her smoking from you? [My mother NEVER smoked / Usually / Sometimes / Rarely / I am uncertain]
- 8.* During my childhood (0–15 years of age), my mother mainly smoked: [My mother NEVER smoked / Cigarettes / Cigars / Pipe / A kind not listed above / Several kinds / I am uncertain]
9. Did your father smoke regularly during your childhood (0–15 years of age)? [Yes, during my whole childhood / Yes, but only for a part of my childhood / No, he only smoked occasionally / No, he NEVER smoked / I am uncertain about the smoking habits of my father]
10. If your father only smoked for part of your childhood, can you specify your age when he smoked? E.g. write “3–9” if he smoked from when you were 3 to when you were 9. [Free text]

11. How often did you see your father smoke during your childhood (0–15 years of age)? [My father NEVER smoked / Daily / Several times a week but not daily / Less than once a week / Rarely / It varied during my childhood / I am uncertain]

12. Did your father try to hide his smoking from you? [My father NEVER smoked / Usually / Sometimes / Rarely / I am uncertain]

13.* During my childhood (0–15 years of age), my father mainly smoked: [My father NEVER smoked / Cigarettes / Cigars / Pipe / A kind not listed above / Several kinds / I am uncertain]

14. Which one of your parents did you most often see smoking? [My mother and father NEVER smoked / My mother / My father / No clear difference / It varied during my childhood / I am uncertain]

15.* Do you smoke regularly yourself? [Yes / No, but I used to / No, I have never smoked]

16.* Does your partner smoke regularly? [Yes / No, but she/he used to when we met / No, she/he has never smoked during the time we have been together / I have no partner]

17.* If you are a bisexual we would be happy if you could comment on whether the attraction for smoking applies to men and women alike: [free text]

18.* Any comments about the questionnaire (optional): [free text]

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