

Genetic Factors Increase Fecundity in Female Maternal Relatives of Bisexual Men as in Homosexuals

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ABSTRACT

Introduction. Recent studies on male homosexuals showed increased fecundity of maternal female relatives of homosexual probands, compared to those of heterosexual controls. We have suggested that these data could be explained by the transmission, in the maternal line, of an X-linked genetic factor that promotes androphilic behavior in females and homosexuality in males.

Aim. Our original studies were on relatives of male subjects who declared themselves to be exclusively homosexual. However, the relationship between homosexuality and bisexuality, including the possibility of shared genetic factors, is complex and largely unexplored. To cast light on this issue, in the present study we examined whether relatives of bisexuals show the same indirect fitness advantage as previously demonstrated for homosexuals.

Main Outcome Measures. Subjects completed a questionnaire on their sexual orientation, sexual behavior, and their own and their relatives' fecundity.

Methods. We studied 239 male subjects, comprising 88 who were exclusively or almost exclusively heterosexual (pooled to comprise our "heterosexual" group), 86 who were bisexual, and 65 exclusively or almost exclusively homosexual individuals (pooled in our "homosexual" group). Bisexuals were here defined on the basis of self-identification, lifetime sexual behavior, marital status, and fecundity.

Results. We show that fecundity of female relatives of the maternal line does not differ between bisexuals and homosexuals. As in the previous study on homosexuals, mothers of bisexuals show significantly higher fecundity, as do females in the maternal line (cumulated fecundity of mothers, maternal grandparents, and maternal aunts), compared to the corresponding relatives of heterosexual controls. This study also shows that both bisexuals and homosexuals were more frequently second and third born. However, only homosexuals had an excess of older male siblings, compared to heterosexuals.

Conclusions. We present evidence of an X-chromosomal genetic factor that is associated with bisexuality in men and promotes fecundity in female carriers. **Camperio Ciani A, Iemmola F, and Blecher SR. Genetic factors increase fecundity in female maternal relatives of bisexual men as in homosexuals. J Sex Med 2009;6:449–455.**

Key Words. Male Homosexuality; Male Bisexuality; Fecundity; Androphilia; Birth Order; X-Chromosomal Genetic Factor

Introduction

Different lines of research have suggested the existence of genetic factors in the causation of male homosexuality [1–4]. Recent studies [5,6] have shown that females in the maternal line of homosexual males are significantly more fecund than females in the maternal line of heterosexual males, producing almost one third more offspring.

No significant differences emerged when paternal relatives of homosexuals and heterosexuals were compared. We proposed that these results could be accounted for by (an) X-linked gene(s) that promote(s) male homosexuality and increase(s) female fecundity [5]. More recently we have suggested that the hypothetical X-chromosomal genetic factor(s) may act by promoting sexual attraction to males (androphilia) in both male and female

carriers [7,8]. Results of studies to test this hypothesis support the existence of such androphilic factors [8,9]. These results contribute to explaining the genetics, and thus to solving the so-called “Darwinian paradox,” of male homosexuality.

Sexual orientation is a continuum, and between exclusive homosexuality and exclusive heterosexuality there are people (bisexuals) who, to varying degrees, entertain affectionate and sexual relationships with both sexes. The data cited above concern only male homosexuals; nothing is known about the genetics of bisexuality. The goal of the present research was to determine whether genetic factors such as those we identified in maternal relatives of male homosexuals are also present in family members of male bisexuals.

There are different types of bisexuality, depending on self-identities, behaviors, feelings or combinations of these three factors [10,11]. However, it is well known that the classical questionnaire used to investigate sexual orientation, the Kinsey Scale, fails to identify bisexuals, possibly due to its internal structure. Research on homosexuality has often underlined the lack of tools to classify intermediate sexual preferences [12–14]. Individuals who self-identify as bisexuals are rare [15,16]. In a society in which individuals are generally socialized as heterosexual, bisexuality may often be a stage in which individuals who are becoming conscious of their homosexuality experiment, as part of the process of dawning awareness. Most people who have had bisexual experiences tend to self-identify as homosexuals or heterosexuals on the Kinsey Scale. Bisexual people may not be equally attracted to males and females; most of the time they are attracted by characteristics that are independent of the sex of the object of their affections [11], and they perceive their identity as fluctuating [17].

A bisexual person is not necessarily sexually involved with men and women simultaneously. Some self-identified bisexuals have never had any sexual experience with one or the other (or either) of the sexes. As in the case of heterosexuals and homosexuals, attraction is not expressed by acting on every desire [18]. Most bisexuals have extended monogamous sexual relationships. Others have open marriages, with partners of the same sex, threesomes, or several partners of the same or other sex [19–23]. Though it might not be permanent, an orientation is, however, valid for the time in which it is practiced. Bisexuality, like homosexuality and heterosexuality, can either be a stage of transition in the process of sexual self-discovery, or

a stable, long-term identity. Nevertheless, data from a recent Italian study show that the proportion of people who identify themselves as bisexual stays constant, independent of age, suggesting that this identity can also be preserved for many years [14].

Because of the heterogeneity described above, we recognized the need to formulate operational definitions specifically for the purpose of this study (see below: Classification of Subjects).

Methods

The Ethics Committee of the Department of General Psychology, University of Padua, approved the methods and questionnaire used in this study.

Subjects

A total of 239 males, 18 years of age or older, who had knowledge of their parents and biological relatives, was recruited. Sampling methods, questionnaires and data analysis were as described previously [5]. The distribution of subjects was:

Heterosexuals $N = 88$ (Mean age 32.69 years, SD 9.02); Bisexuals $N = 86$ (Mean age 32.72 years, SD 9.41); Homosexuals $N = 65$ (Mean age 31.40 years, SD 9.09). There were no significant differences between the three groups ($t = 0.43$; $P < 0.695$; ns).

Of the 239 subjects, 65 were recruited on beaches and at seaside resorts, 50 in bars and night clubs, 35 among hotel employees and holidaymakers, 53 in soccer clubs and gay clubs, 40 at university institutes, and seven in gyms. All subjects came from Italy, and most from Northern Italy.

Recruitment

Two methods of recruitment were used, depending on the location. The first procedure was used on beaches, at seaside resorts, in bars, nightclubs, gyms, university discotheques, soccer clubs, and for employees recruited in workplaces. In these cases, after verifying the availability of the subject the questionnaire package (see below) and a pen were personally handed over, with the request to complete every part of the questionnaire, if possible within 10 minutes (the time estimated to be adequate for its completion), after which the questionnaires were collected. The second method of recruitment was used in gay clubs, which in Italy are organized by political (Associazione ricreativa Comunisti Italiani Omosessuali [Italian Communist Recreational Club for the Gay]) or religious

Table 1 Questionnaire submitted to probands

Biographical information

Age ___ Place of birth ___ Region of present domicile ___ Education ___ Profession ___

Kinsey scale definitions and related key questions

0 Completely heterosexual
 1 Predominantly heterosexual but occasionally (rarely) attracted to other men
 2 Heterosexual but also attracted by men more than occasionally
 3 Completely bisexual, interested both in men and women
 4 Homosexual but also attracted by women more than occasionally
 5 Predominantly homosexual but occasionally (rarely) attracted to women
 6 Completely homosexual

1) How would you define yourself according to the Kinsey scale, shown above.

0	1	2	3	4	5	6
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Answer the following questions by choosing a score between 0 and 6 where 0 is "always and only women" and 6 is "always and only men".

2) If, at a party, you were to desire a sexual relationship, which sex of partner would you choose?

0	1	2	3	4	5	6
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3) When you fantasize sexual intercourse, what is the sex of your partner?

0	1	2	3	4	5	6
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4) In the last year, what was the sex of your sexual partners?

0	1	2	3	4	5	6
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5) In the last five years of your life, what was the sex of your sexual partners?

0	1	2	3	4	5	6
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Additional Questions

6) What is your marital status? _____

7) Number of children (if any) _____

8) Would you ever accept, given a particularly favorable occasion such as at a party, to have intercourse with an available and very attractive woman? Yes___ No___

9) Would you ever accept, given a particularly favorable occasion such as at a party, to have intercourse with an available and very attractive man? Yes___ No___

10) How many: 1) older brothers 2) younger brothers 3) older sisters 4) younger sisters) do you have? 1___ 2___ 3___ 4___

11) Fecundity data of biological relatives (both living and deceased, including still births)

<p>Paternal Line</p> <p>Paternal grandparents Number of sons ___ daughters ___ Number of paternal uncles ___ Number of paternal aunts ___ Number of children from paternal uncles (cousins) (uncle no. 1: sons ___ daughters ___) (uncle no. 2: sons ___ daughters ___) (. . . etc . . .) Number of children from paternal aunts (cousins) (aunt no. 1: sons ___ daughters ___) (aunt no. 2: sons ___ daughters ___) (. . . etc . . .)</p>	<p>Maternal Line</p> <p>Maternal grandparents Number of sons ___ daughters ___ Number of maternal uncles ___ Number of maternal aunts ___ Number of children from maternal uncles (cousins) (uncle no. 1: sons ___ daughters ___) (uncle no. 2: sons ___ daughters ___) (. . . etc . . .) Number of children from paternal aunts (cousins) (aunt no. 1: sons ___ daughters ___) (aunt no. 2: sons ___ daughters ___) (. . . etc . . .)</p>
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(Associazione Cristiana Lavoratori Italiani [ACLI, Italian Christian Workers Association]; this association includes people of all sexual orientations) associations, and in similar political (Associazione Ricreativa Comunisti Italiani Cacciatori Sportivi [Italian Communist Recreational Club for Sport Hunters]) and religious (ACLI) clubs for heterosexuals. In these clubs we enlisted the help of club managers to hand out questionnaires to subjects during club meetings, and to collect them when completed. Using this procedure we ascertained 14 homosexual, 14 bisexual, and 10 heterosexual subjects.

As previously mentioned [5], we strove to recruit heterosexual, homosexual, and bisexual subjects with exactly the same procedures, in order to not bias inclusion criteria and further comparisons.

Main Outcome Measures

The questionnaire, shown in Table 1, was handed out with an explanatory letter and an instruction sheet on how to complete the questionnaire.

Classification of Subjects

Subjects were assigned to the three sexual orientation groups according to their answers to questions, one through five of the questionnaire (i.e., self-assessment score on the Kinsey scale, and the other four of the five classic questions of Kinsey [24]). Below we give the criteria used for the three groups.

Heterosexual

Individuals with a Kinsey score of 0–3 who have never had sexual intercourse with a man.

Table 2 Distribution of probands in groups, based on the criteria described in classification of subjects

Kinsey level	Distribution into groups, based on answers to questionnaire			Total subjects
	Heterosexual	Bisexual	Homosexual	
0	76	1	—	77
1	12	6	—	18
2	—	9	—	9
3	—	16	—	16
4	—	7	—	7
5	—	34	9	43
6	—	13	56	69
Total	88	86	65	239

Bisexual

Individuals with a Kinsey score of 0–3 who have had one or more complete sexual relationships with a man, and individuals with a Kinsey score of 3–6 who have had one or more complete sexual relationships with a woman, and/or are married and/or have at least one child.

Homosexual

Individuals with a Kinsey score of 3–6 who are not married, have no children, have never had sexual intercourse with a woman, or have only had intercourse with a woman once and would not have it again (Table 2).

Statistical Analysis

Due to the nonnormal distribution of most of our data we used nonparametric tests in the analysis. Differences between groups, classified by sexual orientation as determined from answers to the questionnaire, were analyzed by a chi-squared test.

We calculated the average fecundity of each sexual orientation group and then compared the

three groups, using the Kruskal-Wallis test. We further compared the sexual orientation groups pair-wise, using the Mann-Whitney test with the correction of Bonferroni (P value $0.05/3 = 0.017$).

Results

Fecundity

There is a significant difference in fecundity between heterosexuals and bisexuals. Heterosexuals have an average of 0.63 children, $SD = 0.93$; bisexuals have an average of 0.21 children, $SD = 0.63$; homosexuals do not have children. With respect to fecundity of relatives, significant differences between the three groups are confined to the maternal line (Table 3).

The average fecundity of mothers of bisexuals (Mean = 2.67; $SD = 1.51$) is very similar to that of mothers of homosexuals (Mean = 2.63; $SD = 1.32$), whereas that of mothers of heterosexuals is significantly lower (Mean = 2.09; $SD = 1.03$; Table 4).

Cumulated fecundity of mothers, maternal grandmothers, and maternal aunts of heterosexuals is significantly lower than that of bisexuals ($P = 0.001$) and homosexuals ($P = 0.001$), whereas the latter two do not differ.

Birth Order Effect

In the heterosexual sample there are more first-born individuals (54.5%) than there are among bisexuals (39.5%) or homosexuals (38.5%). A significant tendency of bisexuals to be lower in birth order emerges: 45.5% of heterosexuals are second-born or lower in order, compared to 60.5% of bisexuals ($\chi^2 = 5.34$; $DF = 2$; $P < 0.07$). Furthermore, there was an excess of older brothers in

Table 3 Comparison of fecundity of maternal line and paternal line relatives of individuals in the three sexual orientation groups

	Heterosexuals			Bisexuals			Homosexuals			<i>P</i>
	N	Average fecundity	SD	N	Average fecundity	SD	N	Average fecundity	SD	
Mothers	88	2.09	1.03	86	2.67	1.51	65	2.63	1.36	0.01
Mothers of firstborn sons	48	1.58	0.85	34	1.71	0.68	25	1.68	0.75	0.43
Maternal aunts	55	1.50	0.99	72	1.73	1.12	49	1.90	1.04	0.08
Maternal uncles	58	1.73	0.78	53	2.05	1.06	39	1.70	0.80	0.19
Maternal grandmothers	87	3.23	1.61	84	3.64	1.39	64	3.64	1.74	0.14
Mothers and maternal aunts	143	1.80	0.76	158	2.27	1.11	114	2.28	0.99	0.001
Females in maternal line*	230	2.16	0.69	314	2.57	0.85	178	2.55	0.77	0.001
Paternal aunts	51	1.79	1.04	54	2.01	0.96	42	1.58	0.96	0.1
Paternal uncles	46	1.98	0.95	45	1.80	1.44	38	1.69	0.87	0.2
Paternal grandmothers	85	2.88	1.25	83	3.12	1.47	63	3.14	1.64	0.62
Females in paternal line†	136	2.18	0.77	137	2.36	0.86	105	2.12	0.65	0.15

*Cumulated fecundity of mothers, maternal grandmothers, and maternal aunts.

†Cumulative fecundity of paternal grandmothers and paternal aunts.

Table 4 Paired comparisons of maternal line fecundity of relatives of individuals in the respective sexual orientation groups (*P* values calculated using the Mann-Whitney test with Bonferroni correction, *P* < 0.017)

	N	Average fecundity	SD	N	Average fecundity	SD	<i>P</i>
		Heterosexuals			Bisexuals		
Mothers	88	2.09	1.03	86	2.67	1.51	0.01
Mothers of first-born sons	48	1.58	0.85	34	1.71	0.68	0.21
Maternal aunts	55	1.50	0.99	72	1.73	1.12	0.09
Maternal uncles	58	1.73	0.78	53	2.05	1.06	0.15
Mothers and maternal aunts	143	1.80	0.76	158	2.27	1.11	0.002
Females in maternal line*	230	2.16	0.69	314	2.57	0.85	0.001
		Heterosexuals			Homosexuals		
Mothers	88	2.09	1.03	65	2.63	1.36	0.01
Mothers of first-born sons	48	1.58	0.85	25	1.68	0.75	0.41
Maternal aunts	55	1.50	0.99	49	1.90	1.04	0.03
Maternal uncles	58	1.73	0.78	39	1.70	0.80	0.72
Mothers and maternal aunts	143	1.80	0.76	114	2.28	0.99	0.002
Females in maternal line*	230	2.16	0.69	178	2.55	0.77	0.002
		Bisexuals			Homosexuals		
Mothers	86	2.67	1.51	65	2.63	1.36	0.92
Mothers of first-born sons	34	1.71	0.68	25	1.68	0.75	0.80
Maternal aunts	72	1.73	1.12	49	1.90	1.04	0.60
Maternal uncles	53	2.05	1.06	39	1.70	0.80	0.10
Mothers and maternal aunts	158	2.27	1.11	114	2.28	0.99	0.61
Females in maternal line*	314	2.57	0.85	178	2.55	0.77	0.89

*Cumulated fecundity of mothers, maternal grandmothers, and maternal aunts.

comparison to older sisters among the homosexuals (observed: 41 brothers, 25 sisters; expected: 33 brothers, 33 sisters ($\chi^2 = 5.61$; $DF = 2$; $P < 0.06$). The same significant excess of older brothers was not observed for bisexuals. A small (nonsignificant) majority of firstborn among the heterosexuals and of second and third-born among the bisexuals and homosexuals was observed. The heterosexuals have somewhat fewer older brothers than older sisters (observed: 25 brothers and 34 sisters; expected: 30 brothers and 30 sisters), whereas in bisexuals there was no significant difference (observed: 48 brothers and 45 sisters; expected: 47 brothers and 47 sisters).

Discussion

In a previous study [5] we showed that maternal relatives of homosexual men demonstrate increased fecundity compared to the corresponding relatives of heterosexual controls. We concluded that an X-linked genetic factor promotes this effect and that this factor, when passed to male offspring on the maternal X, predisposes to homosexuality. The present research was designed to explore whether or not a similar effect is transmitted by maternal relatives of bisexual men. An answer to this question would contribute to eluci-

dating the broader issue of whether homosexuality and bisexuality share features of genetic control.

Scientific research of homosexuality is in its early stages and that of bisexuality even more so [25,26]. The concept of bisexuality is not well delineated and its definition is still under scientific debate.

Some researchers suggest that bisexuality is a consequence of hypersexuality [9]. However, our data suggest that bisexuality is a specific sexual orientation with a biological basis, and not just the consequence of hypersexual behavior.

Bisexual individuals have sexual interest in persons of both their own and the opposite sex, but this statement covers a large range of variation. One approach would be to classify as bisexuals those who so define themselves. At the other extreme, a strict definition would be that bisexual men are those who are neither exclusively heterosexual (Kinsey 0) nor exclusively homosexual (Kinsey 6), and it can be argued that future scientific work should consider restricting usage in this way. For this study we used an operational definition, which took into account both the individual's self evaluation and answers to other key questions concerning the individual's sexual and emotional behavior. This enabled us to delineate bisexual men as a group of subjects, which, though not clearly identified by the Kinsey

scale, is distinct from homosexuals with respect to sexual and affective behavior.

The results of this study show that maternal relatives of male bisexuals have increased fecundity similar to that of maternal relatives of homosexual men. This suggests, but does not prove, that male homosexuality and bisexuality may share features of genetic control. In the following we consider the implications of our findings and the light they cast on the genetic nature of bisexuality and homosexuality.

The average fecundity of bisexuals was lower than that of heterosexuals (0.21, SD 0.63, vs. 0.63, SD 0.93), while that of homosexuals was, in this study, zero. Since the average age of the bisexual cohort was 32 years, it is possible that this group has the potential for “residual fecundity”. Evidence for genetic control of sexual orientation is said by some to create a “Darwinian paradox”—the perceived difficulty of reconciling a heritable cause for a trait with the phenomenon of reduced fecundity or functional sterility associated with that trait. There are, however, numerous prior instances of such traits including, in humans, the prototypical example of sickle-cell anemia.

To account for how the postulated X-linked factor produces increased fecundity in maternal relatives of homosexuals, while also predisposing males to homosexuality, we have proposed [27] that the gene confers on both male and female bearers increased attraction toward males, a trait which has been defined as Androphilia [27,28].

There are numerous possible mechanisms that might account for our data, and several possible ways in which further insights might be gained. Applying Occam’s Razor, we take as our starting point the two simplest propositions.

First, it is possible that one or more X-linked gene(s) confer(s) “androphilia” on both male and female bearers, and that the differences between homo- and bisexual behaviors could be accounted for by interaction between this X-linked gene and other genes. That is, the phenotypes would be polygenically determined (i.e., by genes at multiple loci), with the postulated X locus exerting a so-called major gene effect. Other, previously described or postulated genetic factors could provide such interactions [1,4]. In as much as environmental effects can at all be envisaged as influencing sexual orientation, one possibility is that in genetically bisexual individuals, the extent to which same-sex activity is practiced may be influenced by the societal pressures of the individual’s

circumstances at any given time and place. If homo- and bisexuality do indeed share one or more major X-linked genes, pedigree genetic studies should be able to demonstrate the occurrence of both homo- and bisexual individuals in the same families, related to each other through common maternal X-chromosomal inheritance.

Second, it is possible that multiple alleles may exist at the postulated X-linked locus for androphilia. Allelic variation could account for differences between homo- and bisexual predisposition. If homo- and bisexual men are not shown to be present in the same pedigrees, this possibility would become more likely. As in the previous possible scenario, interaction of the postulated X-chromosomal locus with other, including autosomal, genetic loci would not be excluded.

Conclusions

We have presented evidence for the existence of an X-chromosomal factor that is associated with bisexuality in men and promotes fecundity in female carriers. We hypothesize that this factor confers a tendency to androphilia on both male and female bearers of the factor. Our current data closely mimic previous findings on families of homosexual men. The polymorphic traits of homo- and bisexuality may share identical or, alternatively, multiple allelic genes at the postulated X locus. Interactions between the putative X locus and autosomal loci are possible. Our data do not allow us to determine the extent to which the postulated X-linked factor(s) actually cause(s), or merely predispose(s), to homo- or bisexuality. Pedigree studies are required to explore the penetrance and expressivity of the gene(s) of interest.

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Statement of Authorship

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Category 3**(a) Final Approval of the Completed Article**

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