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LEFT-HANDEDNESS IN HOMOSEXUAL MEN AND WOMEN: NEUROENDOCRINE IMPLICATIONS

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SUMMARY

Although numerous researchers have hypothesized a biological factor in the etiology of homosexuality, there is a lack of empirical evidence. Previous investigations did not focus on behavioral functions of the brain. Using neuropsychological testing, we found an increased incidence of left-hand preference (defined as non-consistent right-hand preference) in a group of 32 homosexual women. A trend in the same direction was found in a group of 38 homosexual men. These results suggest that homosexual orientation has a neurobiological component possibly related to hemispheric functional asymmetry. The results are consistent with previous reports that (1) prenatal neuroendocrine events are a factor in the development of human sexual orientation and functional brain asymmetries, and (2) the mechanisms associated with homosexual orientation and related neuropsychological characteristics are different between the sexes, i.e. elevated levels of prenatal sex hormones in women and decreased levels in men.

INTRODUCTION

THE ETIOLOGY of homosexuality is not known. Recently, the search for possible biological factors has gained prominence, partly due to results of experimental work of the last few decades which show that much of the sexual behavior of nonhuman animals is driven by sex hormones (for review cf. Goy & McEwen, 1980). Evidence for biological factors in homosexuality in humans is limited and apparently inconsistent. Some studies have implicated genetic factors, but only in male homosexuals, not in female homosexuals (e.g., Eckert *et al.*, 1986). Other studies have found that measures of secondary sex characteristics differentiate women of different sexual orientation (e.g., Perkins, 1981), but not men (for review cf. Meyer-Bahlburg, 1977). Several studies have compared sex hormone levels between homosexual and heterosexual men; the majority found no difference, and the few that did yielded results in opposite directions (for review cf. Meyer-Bahlburg, 1977; 1984). However, for women, there is some evidence that homosexuals may have higher androgen levels than heterosexuals (for review cf. Meyer-Bahlburg, 1979; 1984). Nevertheless, the consensus appears to be that the search for differences in levels of hormones in adulthood is unlikely to explain variation in sexual orientation (e.g., Ehrhardt *et al.*, 1985; Ellis & Ames, 1987).

Given that sexual orientation, typical or atypical, is a behavioral phenomenon, it may be more fruitful to investigate the organ of behavior, the brain, with respect to differences between homosexual and heterosexual people. Work with nonhuman animals has shown that prenatal and

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perinatal sex hormones influence brain anatomy (e.g., the size of the sexually dimorphic nucleus of the preoptic area and the thickness of the cortex of the right and left hemispheres) and brain function (e.g., the sexually dimorphic pattern of secretion of hypothalamo-pituitary gonadotropins) (for review cf. Gorski, 1985). Both androgen and estrogen have masculinizing effects on the developing brain in a variety of species (McEwen, 1981). To a certain extent, sexual differentiation of the brain is independent of the sexual differentiation of other parts of the body (Jost, 1983). Thus, one may predict neural differences between homosexuals and heterosexuals without expecting other biological differences.

There have been two approaches to the study of a possible association between sexual differentiation of the brain and sexual orientation: (1) the study of aspects of sexual differentiation of the brain in homosexual individuals and (2) the study of the behavior of clinical populations exposed to atypical levels of prenatal sex hormones. In reference to the first approach, the secretion pattern of pituitary gonadotropins in homosexuals has been tested by the administration of a dose of estrogen. There is a sex difference in the secretion of luteinizing hormone (LH) following an estrogen challenge: Women are more likely than males to show an increase in LH, referred to as positive estrogen feedback (for review cf. Dörner, 1988). Some studies reported that homosexual men show an elevated LH response to estrogen compared to heterosexual men (Dörner *et al.*, 1975; Gladue *et al.*, 1984) and suggested that the difference is due to the process of sexual differentiation. This interpretation is controversial. Others suggested that the differences in neuroendocrine response may be the result of differences in testicular function and not in hypothalamic function (e.g., Baum *et al.*, 1985). Other studies found no significant difference in positive estrogen feedback between homosexual and heterosexual men (Gooren, 1986; Hendricks *et al.*, 1989).

A review of the behavioral studies of clinical populations exposed to atypical levels of prenatal sex hormones is consistent with the hypothesis of an association between variation in prenatal hormonal events and the incidence of homosexual orientation. Additionally, the studies suggest an association in such individuals between prenatal hormonal events and patterns of hemispheric functional asymmetry, one manifestation of which is hand preference (Bryden, 1982). Women exposed prenatally via their pregnant mothers to diethylstilbestrol (DES, a synthetic nonsteroidal estrogen with masculinizing effects in female mammals) received higher ratings of homosexual behavior (Ehrhardt *et al.*, 1985) and showed an increased incidence of left-hand preference (Geschwind & Galaburda, 1985b) compared to female controls. Similarly, women with congenital adrenal hyperplasia (CAH, an inherited condition which involves an excessive secretion of adrenal androgens) received higher ratings of homosexual behavior (Money *et al.*, 1984; Money, 1987) and showed an increased incidence of left-hand preference (Nass *et al.*, 1987) compared to female controls. In summary, there appears to be an association, at least in women, among excessive prenatal exposure to masculinizing hormones, homosexual behavior, and increased left-hand preference.

The associations appear different for men. Among CAH men, who may have higher prenatal androgens, homosexual behavior was extremely rare (Money & Lewis, 1982; 1987; Money, 1987). Also, CAH men did not show increased left-hand preference compared to male siblings (Nass *et al.*, 1987). Similarly, DES-exposed men showed no increase in homosexual behavior (Kester *et al.*, 1980). In contrast, men with Klinefelter's syndrome [KS, 47,XXY karyotype, a syndrome associated with reduced development of male secondary sex characteristics and possibly lower levels of prenatal androgens (Ratcliffe, 1976; Sørenson *et al.*, 1981; Nielsen *et al.*, 1982)] showed a greater prevalence of left-hand preference than control males (Netley & Rovet, 1982; Braun, 1988). There does not appear to be a higher prevalence of homosexuality in KS men (Nielsen, 1969). However, given the lower libido of KS men (Nielsen, 1969; Raboch *et al.*,

1979), comparisons of prevalence of atypical sexual behavior between KS men and normal men might not be appropriate. In sum, the available evidence suggests that, in contrast to women, higher exposure to masculinizing sex hormones in men is not associated with homosexual behavior and increased left-hand preference. It is open to question whether the latter two behavioral manifestations are associated with lower exposure to masculinizing hormones.

If the associations of prenatal hormonal status with sexual orientation and with hand preference, suggested by the evidence from clinical populations, are valid, then the associations should be evident in homosexual individuals. The prenatal events experienced by homosexuals cannot be tested retrospectively. However, it is possible to investigate the association between sexual orientation and hand preference.

Hand preference can be used as a neuropsychological index of one aspect of brain function, hemispheric lateralization. Left-handers have more frequent reversed and greater bihemispheric representation of cognitive skills than do right-handers (Bryden, 1982). Thus, a difference between homosexuals and heterosexuals in hand preference would support the suggestion of a neurobiological component to the etiology of homosexuality.

We predicted that (1) homosexual women would show a greater prevalence of left-hand preference than the general population, the proposed mechanism being exposure to higher-than-normal levels of prenatal masculinizing hormones, and (2) homosexual men also would show a greater prevalence of left-hand preference, the proposed mechanism being exposure to lower-than-normal levels of prenatal masculinizing hormones.

SUBJECTS AND METHODS

Subjects

Subjects were recruited from the general membership of a local homophile organization. Seventy-four homosexual men and women volunteered to participate. The criterion for inclusion in the study was that the subjects rated their sexual experience in both behavior and imagery as primarily homosexual, defined here by a score of 5 or 6 on the Kinsey scale (Kinsey *et al.*, 1948) and by a clear pattern of homosexual response on the Sexual Orientation Method questionnaire (Sambrooks & MacCulloch, 1973). Four subjects (two male, two female) with bisexual preference were excluded. Thus, the final sample consisted of 70 homosexuals (38 men: median age = 30 yr, min/max age = 19/60 yr; 32 women: median age = 26 yr, min/max age = 19/45 yr).

Procedure

The subjects completed a 12-item hand preference questionnaire (Annett, 1970) to indicate their hand preference for various unimanual skills such as brushing teeth and bimanual skills such as threading a needle. The questionnaire was self-administered. Hand preference was classified as either consistent right-hand preference (CRH; defined as only right-hand preference with no left-hand preference for any of the 12 tasks) or as non-consistent right-hand preference (non-CRH; defined as left-hand preference for at least one of the 12 tasks, regardless of hand used for writing). The category non-CRH encompasses the two categories of mixed-hand preference and consistent left-hand preference in Annett's (1970) classification system.

The population estimate of the distribution of CRH and non-CRH that was used for comparison with the homosexual subjects was that of Annett (1970). In three British samples (servicemen, n=630; psychology students, n=460; non-psychology students, n = 1232), Annett found approximately 65 percent to show CRH and 35 percent to show non-CRH. The advantage of the Annett questionnaire is its high reliability and validity with actual performance (McMeekan & Lishman, 1975). This classification of hand preference (CRH vs. non-CRH) may have biological validity because it was associated with size of the corpus callosum, a neuroanatomical structure involved in interhemispheric communication (Witelson, 1985; 1989). A large comparison group of North Americans for the Annett questionnaire was not available. However, there is no reason to expect a significant difference between North American and British samples with the Annett questionnaire, because the only item on the questionnaire that is sensitive to cultural pressure is writing hand (Salmaso & Longoni, 1985). The incidence of writing with the left hand (approximately 10%) is similar in North American and Northern European samples (Tan, 1985; Ellis *et al.*, 1988; Lansky *et al.*, 1988; Levander & Schalling, 1988).

RESULTS

The proportion of homosexual women who showed non-CRH (22/32, 69%) was significantly greater than that of the general population (35%) ($z = 3.55$, $p = 0.0005$, two-tailed). If the most common definition of hand preference was considered — hand used for writing — the female homosexuals showed only a trend toward greater left-hand preference (6/32, 19%) than in the general population (10%) ($z = 1.71$, $p = 0.09$, two-tailed).

The proportion of homosexual men who showed non-CRH (17/38, 45%) was not statistically different from that of the general population (35%) ($z = 1.20$, $p = 0.23$, two-tailed). The male homosexuals showed a similar proportion of left-hand preference based on writing hand (4/38, 11%) as in the general population (10%). The results for both groups are summarized in the Table.

PERCENT OF DIFFERENT HAND-PREFERENCE CATEGORIES FOR THE GENERAL POPULATION AND HOMOSEXUAL MEN AND WOMEN

Group	N	CRH[1] (%)	non-CRH[2] (%)	non-CRH Right writer (%)	non-CRH Left writer (%)
General Population* (men and women)	1692	65	35	25	10
Homosexual Men	38	55	45	34	11
Homosexual Women	32	31	69†	50	19

[1] CRH = consistent right-handed.
[2] non-CRH = non-consistent right-handed.
* Annett (1970).
† Significantly different from that of the general population ($z = 3.55$, $p = 0.0005$, two-tailed).

DISCUSSION

The results for the women were as predicted: Homosexuals showed a higher prevalence of left-hand preference than did the normative sample. The sexual orientation of Annett's normative subjects is unknown, and likely a small proportion was homosexual. This suggests that the difference we report is conservative.

Our finding that the majority of female homosexuals had some left-hand preference does not imply that the majority of left-handed women are homosexual. Two percent of the female population is estimated to be homosexual (Pillard *et al.*, 1981), and 35% of the female population is non-CRH (Annett, 1970). Based on these estimates and our results (30% CRH and 70% non-CRH among homosexual women), one would expect <1% of CRH women to be homosexual [$(2 \times 30)/65 = 0.92$] and 4% of non-CRH women to be homosexual [$(2 \times 70)/35 = 4$]. Thus, based on our results, women showing non-CRH are four times as likely to have homosexual orientation than are women with CRH.

Given that hand preference is an indirect measure of brain lateralization, the increased incidence of left-hand preference in homosexual women suggests an atypical pattern of hemispheric specialization in this group. Brain lateralization appears to be present soon after birth (Witelson, 1987), although it may be modified by exogenous factors such as brain damage.

Therefore, the atypical pattern of brain organization in homosexuals could be part of a neurobiological difference between homosexual and heterosexual women, likely present from birth, and argues against a solely environmental basis to homosexuality. The results from the few studies of DES and CAH women described previously are consistent with the hypothesis of an association in women among the factors of homosexuality, increased left-hand preference, and high exposure to prenatal masculinizing hormones.

Homosexual men showed a statistically nonsignificant trend toward a higher prevalence of non-CRH compared to men in the general population. Since our previous short report (McCormick *et al.*, 1987), another study of hand preference found a significantly greater prevalence of left-hand preference in a sample of 94 homosexual men compared to a sample of 100 heterosexual men (Lindesay, 1987). Our finding that 45% of homosexual men were non-CRH would be statistically significant in a sample the size of Lindesay's. Together, these two studies suggest that the prevalence of left-hand preference and, by inference, the prevalence of atypical hemispheric specialization, are increased in homosexual men. Two other studies of brain lateralization using visual and auditory perceptual measures found asymmetry in homosexual men to be less than that in heterosexual men (Sanders & Ross-Field, 1986; McCormick & Witelson, 1989).

Lindesay (1987) predicted an increased prevalence of *right-hand* preference in homosexual men based on the speculation of Geschwind and Behan (1982) and Geschwind and Galaburda (1985a) that left-hand preference is associated with elevated exposure to testosterone, and on the results from animal studies that male sexual behavior is reduced when exposure to prenatal androgens is minimized. Contrary to his prediction, Lindesay (1987) found increased left-hand preference in homosexual men and concluded that, because male homosexuality was associated with increased left-hand preference, then homosexuality must be associated with elevated exposure to testosterone.

We suggest the alternative hypothesis that, in men, homosexuality and its related left-hand preference are associated with decreased exposure to masculinizing agents, which is consistent with the experimental evidence from animal studies and the very limited results available to date on KS, CAH, and DES-exposed men described previously. We note, however, that the suggestion of an association in women between elevated prenatal androgens and increased left-hand preference is consistent with the hypothesis of Geschwind and Behan (1982) and Geschwind and Galaburda (1985a).

Our results also support the concept of different mechanisms underlying lateralization and sexual orientation in the sexes; in contrast, Geschwind and colleagues did not hypothesize different mechanisms underlying lateralization for the two sexes. Other studies also have found that the biological factors associated with sexual orientation may be different for men and women. Genetic (Eckert *et al.*, 1986), familial (Pillard & Weinrich, 1986), and birth order and parental age factors (Hare & Moran, 1979) appear operative in male but not in female homosexuality. In contrast, circulating levels of sex hormones (Meyer-Bahlburg, 1979) and secondary sex characteristics (Meyer-Bahlburg, 1977; Perkins, 1981) appear as factors in female but not in male homosexuality. In addition, the incidence of homosexuality is reported to be different in the sexes (4–5% in men versus 2% in women) (for review cf. Pillard *et al.*, 1981). Hand preference also appears to be different in the sexes. Women show stronger, and a slightly greater prevalence of, right-hand preference than do men (e.g., Chapman & Chapman, 1987). Hand preference may be associated with a different pattern of cognitive skills in men and women (Harshman *et al.*, 1983). Moreover, brain anatomy may vary with hand preference differently between the sexes: Hand preference was associated with size of the isthmus of the corpus callosum in men but not in women (Witelson, 1989). Thus, a behavioral characteristic, even if it is not sexually dimorphic, may not be the same phenomenon in men and women. Similarly, Gualtieri and Hicks (1985)

indicated that there may be separate etiologies for the sexes for a variety of developmental disorders such as learning disabilities and schizophrenia.

Although many researchers have suggested that homosexuality may be associated with atypical sexual differentiation of the brain (e.g., Ellis & Ames, 1987; Dörner, 1988), there is little evidence from studies of homosexual individuals to support this hypothesis. The results of the present paper indicate that a neuropsychological approach may be more fruitful. The suggestion of an association among the factors of sexual orientation, hemispheric functional asymmetry, and sexual differentiation of the brain can be tested further using neuropsychological approaches. For example, one may predict differences between homosexual and heterosexual people in performance on cognitive tests associated with brain lateralization or with sex differences in ability. Magnetic resonance imaging may be used to investigate possible neuroanatomical differences between homosexuals and heterosexuals. In female rats, perinatal administration of androgens increased the size of the corpus callosum (Fitch *et al.*, 1987); thus, one could predict a larger corpus callosum in homosexual than in heterosexual women.

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