

# LEFT-HANDEDNESS, HOMOSEXUALITY, HIV INFECTION AND AIDS

S.E. Marchant-Haycox<sup>1</sup>, I.C. McManus<sup>1,2</sup> and G.D. Wilson<sup>3</sup>

(<sup>1</sup>Department of Psychology, University College, London; <sup>2</sup>Department of Psychiatry, St. Mary's Hospital Medical School, London; <sup>3</sup>Institute of Psychiatry, London)

RM. 176

Geschwind and Behan (1982) proposed a novel theory of the origins of cerebral lateralisation, suggesting that high levels of fetal testosterone during embryogenesis acted to slow the development of the normally dominant left hemisphere, allowing the right hemisphere to become predominant and hence handedness (and language lateralisation) to shift from the left hemisphere to the right hemisphere. In addition they proposed that since testosterone was known to affect the development of the immune system, there should also be an association between adult disorders of immune functioning (such as myasthenia gravis) and left-handedness.

Geschwind and Galaburda (1987) examined the question of how homosexuality, left-handedness and the Acquired Immune Deficiency Syndrome (AIDS) might be related through the mechanism of testosterone. They point out that there is some evidence from animal experiments that mid-pregnancy stress causes a high testosterone level in male foetuses, low free testosterone level in the adult offspring, and homosexual behaviour (Ward and Weisz, 1980; Dörner, Gotz and Docke, 1983; see also Ellis and Ames, 1987). Since high intra-uterine testosterone levels would also cause left-handedness in humans, the implication is that homosexuals may show a greater incidence of left-handedness than in the general population. In addition, high intra-uterine levels of testosterone are expected to impair the functioning of the immune system, and hence may result in a greater vulnerability to disorders such as AIDS, which precisely are deficits of immune function. Geschwind and Galaburda therefore conclude by saying "it may be useful to study the handedness patterns of homosexuals, and in particular those with AIDS" (p. 176).

Several studies previously have indeed looked at the lateralisation of homosexual men, albeit with conflicting results. In a small study of 20 male homosexuals and 20 controls, Willmott and Brierley (1984) found no significant difference in the incidence of left-handedness. In a larger study, Lindesay (1987) compared 94 homosexual men with 100 heterosexual controls. Approximately 14% of the homosexual men were left-handed compared with 9% of the heterosexual men. More interestingly there was a significant trend for the homosexual men to show a lesser degree of lateralisation than the heterosexuals, which Annett (1988) has interpreted in terms of a "reduction in right shift". Ro-

senstein and Bigler (1987) compared a group of 38 male and female homosexuals (who varied in extent of homosexuality from 1 to 6 on the Kinsey et al., 1948, scale) with 51 male and female heterosexuals; no significant relationship was found between handedness and homosexuality. Although not specifically so interpreted by the authors, Lansky, Weinstein and Peterson (1988) have reported an excess of non-right-handedness in unmarried subjects, which James (1988) has interpreted as a possible excess of left-handedness in homosexuals (who tend to be unmarried). Finally, McCormick, Witelson and Kingstone (1987) studied 38 homosexuals and 32 female homosexuals (all rated at least 5 on the Kinsey scale), and in comparison with population norms described by Annett (1970), found a lower incidence of consistent right-handedness in female homosexuals than in male homosexuals.

Taken together, the above results provide little evidence for Geschwind and Galaburda's hypothesis of a raised incidence of left-handedness in male homosexuals, although there is some slight suggestion that male homosexuals may be less lateralised than heterosexuals.

In this study we describe a large study of male homosexuals, in which we assess both direction and degree of handedness, and we also consider whether handedness may be related either to AIDS itself, to infection with the Human Immunodeficiency Virus (HIV), or to testing for HIV. In addition we also assess the relationship between left-handedness and a range of other conditions which have been implicated in the Geschwind-Behan-Galaburda hypothesis.

## MATERIALS AND METHOD

### *Subjects and Procedure*

A large number of subjects were contacted at clinics for the treatment of venereal disease, and at hospices and clinics for AIDS patients, in London and New York, and through gay clubs and gay organisations with a national membership in Britain, in which case a stamped, addressed envelope was included with the postal questionnaire. The sample consisted of all subjects who were willing to complete our questionnaire, which consisted of two sides of an A4 sheet of paper. Clinics were contacted by SEM-H, and clinic or organisation staff generally asked subjects to complete the questionnaire. In some cases SEM-H directly asked subjects to complete the questionnaire. No attempt was made to include only homosexuals and male and female heterosexuals were included as controls.

The questionnaire asked subjects their age, sex, profession, sexual preference (heterosexual, bisexual, gay or lesbian), their AIDS and HIV status (never tested for HIV, tested for HIV and negative, tested for HIV and positive, and suffering from AIDS), whether they had suffered from a range of 17 conditions of varying degrees of relevance to the Geschwind-Behan-Galaburda hypothesis (and including some control conditions), and a handedness inventory, which had previously been used in a study of the relationship between left-handedness and myasthenia gravis (McManus et al., 1989). The handedness inventory contained nine hand preference items, each of which was rated on a five point scale from "Always Left" to "Always Right". The items could be divided into three categories: Culturally biased, culturally unbiased, and reversed (in which a right-hander would be expected to answer "Left"). Separate laterality indices in the range  $-100$  (extreme left-handedness) to  $+100$  (extreme right-handedness) were calculated for each of the three sub-scales and the overall score. Degree of handedness was assessed on the overall scale as the absolute value of the laterality index (in the range 0 to  $+100$ ), and direction of handedness was classified as "Right-handed" if the total laterality index was greater than zero, and left-handed if the index was less than

or equal to zero. The laterality inventory also asked subjects to describe their typical hand-clasping and arm-folding positions (McManus and Mascie-Taylor, 1979) and their eye-dominance.

## RESULTS

791 subjects completed the questionnaire; 52% from London, 11% from New York and 37% from nationally organised groups in Britain. Nine questionnaires were not analysed because of missing data, and a further six from female homosexuals were also excluded as being too few for analysis. Of the 774 subjects whose data were analysed, 109 (16.4%) were female, and 665 (85.9%) were male, and the mean age was 33.7 years (SD 9.3, 95% interval 20-56); 396 (51.2%) subjects were heterosexual, 346 (44.7%) homosexual, and 32 (4.1%) bisexual. 365 (47.2%) subjects had not been tested for HIV, 112 (14.5%) had been tested and were negative, 103 (13.3%) had been HIV tested and were positive, and 194 (25.1%) knew themselves to be suffering from AIDS. Male bisexual subjects were included within the homosexual group for the purposes of analysis.

A total of 1204 questionnaires was distributed, of which 791 were returned (65.6%). The response rate was somewhat lower in the 550 postal questionnaires (40.4%) than in the direct contacts (87.0%).

Tables I and II summarise the laterality scores in male homosexuals, male heterosexuals and female heterosexuals, in each of the HIV/AIDS status categories. The inter-relationship between sex, sexual preference and HIV/AIDS status was assessed for statistical significance by multiple logistic regression for categorical variables, and by three-way regression approach ANOVA for continuous variables.

Analysis of direction of handedness (Table I) showed a trend towards a significant relationship between handedness and homosexuality (Chi-squared = 2.6, 1 d.f., NS), although this was not significant when HIV/AIDS status was taken into account (Chi-squared = 0.82, 1 d.f., NS). There was, however, a significant association between handedness and HIV/AIDS status (Chi-squared = 9.22, 3 d.f.,  $p < .05$ ), which remained almost significant after the influence of homosexuality was taken into account (Chi-squared = 7.44, 3 d.f.,  $p < .1$ ). Fitting of a linear trend across the four groups, using co-efficients of 1, 2, 3 and 4 for the "not tested", "HIV - ve", "HIV + ve" and "AIDS" groups respectively, showed no significant evidence that likelihood of infection was related to left-handedness (Chi-squared = 0.48, 1 d.f., NS). However, a quadratic effect (co-efficients 1, 2, 2, 1) was highly significant (Chi-squared = 7.53, 1 d.f.,  $p < .01$ ), which was consistent with scrutiny of the data which had suggested that the overall significant effect was entirely due to a difference between those individuals who had explicitly been HIV tested (whether HIV - ve or HIV + ve) and those who had either not been tested or whose infection was revealed by actually having AIDS. There was no evidence of a significant cubic effect (Chi-squared = 1.21, 1 d.f., NS). A posteriori paired comparisons of the "Not tested", "HIV - ve", "HIV + ve" and "AIDS" groups in relation to handedness showed that the "HIV + ve" group had a significantly higher incidence of left-

TABLE I

*Association of the Discrete Measures from the Laterality Inventory with Sexual Preference and HIV/AIDS Status. Values are percentages (with N)*

	HIV/AIDS status	Male homosexuals	Male heterosexuals	Female heterosexuals	Total
% Left-handed (LI < 0)	Not tested	5.6% ( 54)	7.7% (220)	6.6% ( 91)	7.1% (365)
	HIV - ve	14.5% ( 55)	11.4% ( 44)	0.0% ( 13)	11.6% (112)
	HIV + ve	18.7% ( 91)	0.0% ( 9)	33.3% ( 3)	17.5% (103)
	AIDS	8.4% (178)	0.0% ( 14)	0.0% ( 2)	7.7% (194)
	Total	11.6% (378)	7.7% (287)	6.4% (109)	9.4% (774)
% Left hand-clasping	Not tested	44.4% ( 54)	46.8% (220)	50.5% ( 91)	47.4% (365)
	HIV - ve	43.6% ( 55)	34.1% ( 44)	30.8% ( 13)	38.4% (112)
	HIV + ve	45.1% ( 91)	22.2% ( 9)	66.7% ( 3)	43.7% (103)
	AIDS	48.9% (178)	35.7% ( 14)	50.0% ( 2)	47.9% (194)
	Total	46.7% (378)	43.6% (287)	48.6% (109)	45.8% (774)
% Left arm-folding	Not tested	51.9% ( 54)	57.5% (220)	46.2% ( 91)	54.0% (365)
	HIV - ve	58.2% ( 55)	34.1% ( 44)	61.5% ( 13)	49.1% (112)
	HIV + ve	57.1% ( 91)	22.2% ( 9)	100.0% ( 3)	55.3% (103)
	AIDS	45.5% (178)	71.4% ( 14)	100.0% ( 2)	47.9% (194)
	Total	48.9% (378)	53.7% (287)	50.5% (109)	52.0% (774)
% Left eye dominant	Not tested	18.5% ( 54)	31.4% (220)	25.3% ( 91)	27.9% (365)
	HIV - ve	27.3% ( 55)	20.5% ( 44)	30.8% ( 13)	25.0% (112)
	HIV + ve	31.9% ( 91)	0.0% ( 9)	33.3% ( 3)	29.1% (103)
	AIDS	27.5% (178)	7.1% ( 14)	100.0% ( 2)	26.8% (194)
	Total	27.4% (378)	27.5% (287)	27.5% (109)	27.5% (774)

TABLE II

*Association of the Continuous Measures from the Laterality Inventory with Sexual Preference and HIV/AIDS Status. Values are means (with SD and N)*

	HIV/AIDS status	Male homosexuals	Male heterosexuals	Female heterosexuals	Total
LI (total)	Not tested	70.0 (40.7, 54)	68.5 (38.3, 220)	71.5 (34.7, 91)	69.5 (38.0, 365)
	HIV - ve	61.7 (46.7, 55)	66.7 (38.2, 44)	87.2 (16.6, 13)	66.6 (41.4, 112)
	HIV + ve	51.2 (53.6, 91)	64.8 (24.7, 9)	42.6 (65.8, 3)	52.1 (51.8, 103)
	AIDS	62.0 (42.5, 178)	75.8 (18.8, 14)	86.1 (19.6, 2)	63.2 (41.3, 194)
	Total	60.5 (46.0, 378)	68.5 (18.8, 287)	72.8 (32.2, 109)	65.2 (41.7, 774)
LI (non-cultural items)	Not tested	67.6 (48.5, 54)	63.4 (50.0, 20)	69.6 (48.9, 91)	65.6 (49.5, 365)
	HIV - ve	60.0 (60.7, 55)	62.5 (47.0, 44)	82.1 (37.6, 13)	63.5 (53.4, 112)
	HIV + ve	48.0 (69.6, 91)	66.7 (36.3, 9)	55.6 (77.0, 3)	49.8 (67.2, 103)
	AIDS	61.4 (54.2, 178)	73.8 (27.5, 14)	100.0 (0.0, 2)	62.6 (52.6, 194)
	Total	58.8 (58.7, 378)	63.9 (48.3, 287)	71.2 (47.9, 109)	62.4 (53.6, 774)
LI (cultural items)	Not tested	78.7 (41.6, 54)	76.9 (39.8, 220)	77.2 (38.8, 91)	77.3 (39.7, 365)
	HIV - ve	79.1 (41.0, 55)	74.4 (35.1, 44)	88.5 (30.0, 13)	78.3 (37.6, 112)
	HIV + ve	70.3 (54.4, 91)	66.7 (41.5, 9)	100.0 (0.0, 3)	70.9 (52.6, 103)
	AIDS	73.5 (46.7, 178)	82.1 (22.8, 14)	100.0 (0.0, 2)	74.4 (45.2, 194)
	Total	74.3 (47.1, 378)	76.5 (38.4, 287)	79.6 (32.3, 109)	75.8 (42.8, 774)
LI (reversed items)	Not tested	61.7 (47.3, 54)	63.3 (45.9, 220)	66.3 (40.2, 91)	63.8 (44.7, 365)
	HIV - ve	48.8 (58.8, 55)	62.1 (46.1, 44)	87.2 (22.7, 13)	58.5 (52.0, 112)
	HIV + ve	39.2 (58.3, 91)	50.0 (30.0, 9)	-5.6 (82.2, 3)	38.8 (57.2, 103)
	AIDS	49.8 (57.5, 178)	65.5 (41.6, 14)	58.3 (58.9, 2)	51.0 (56.4, 194)
	Total	48.8 (56.8, 378)	62.8 (45.2, 287)	66.7 (41.9, 109)	56.5 (51.3, 774)
LI (total)	Not tested	78.4 (19.4, 54)	75.3 (23.2, 220)	76.4 (21.8, 91)	76.0 (22.3, 365)
	HIV - ve	74.0 (21.8, 55)	71.7 (27.2, 44)	87.2 (16.6, 13)	74.6 (23.8, 112)
	HIV + ve	69.2 (25.9, 91)	64.8 (24.7, 9)	64.8 (27.4, 3)	68.7 (25.6, 103)
	AIDS	70.3 (26.5, 178)	75.8 (18.8, 14)	86.1 (19.6, 2)	70.8 (30.0, 194)
	Total	71.4 (24.9, 378)	74.4 (23.7, 287)	77.5 (21.5, 109)	73.5 (24.1, 774)

handedness than the "Not tested" group (Chi-squared = 10.11,  $p = .0015$ ) and the "AIDS" group (Chi-squared = 6.47,  $p = .011$ ); no other paired comparisons were significant.

Analysis of the continuous measures of handedness (Table II) showed no evidence of significant effects of homosexuality on any of the measures, with the possible exception of the reversed items, for which homosexuals had a non-significant trend toward lower scores ( $F = 3.31$ ;  $d.f. = 1, 741$ ;  $p < .1$ ). Similarly HIV/AIDS status showed no significant differences for any of the dependent variables with the exception of the reversed items for which there was a non-significant trend ( $F = 2.51$ ;  $d.f. = 3, 741$ ;  $p < .1$ ).

Statistical testing of hand-clasping, arm-folding and eye-dominance (Table I) showed no significant relation either to homosexuality (Chi-squared = .70, .44 and .04, 1  $d.f.$  respectively) or HIV/AIDS (Chi-squared = 3.37, 3.04 and .56, 3  $d.f.$  respectively).

Table III shows the relationships between left-handedness, homosexuality, HIV/AIDS status and the seventeen miscellaneous conditions which had been included on the questionnaire. Simple associations were tested by means of chi-square tests. Table III shows that none of the seventeen conditions was associated with left-handedness, although there were significant associations be-

TABLE III

*Proportion of Subjects Indicating that They or Had Suffered from the Seventeen Conditions Included on the Questionnaire, in Relation to Homosexuality, HIV/AIDS status and left-handedness*

	Homosexual	Heterosexual	Not tested	HIV - ve	HIV + ve	AIDS	Right-handed	Left-handed	
Hepatitis A	91/394 (23.1%)	20/396 (5.1%)	*** 16/374 (4.3%)	16/114 (14.0%)	30/104 (28.8%)	48/197 (24.4%)	*** 96/715 (13.4%)	15/75 (20.0%)	NS
Hepatitis B	96/394 (24.4%)	8/396 (2.0%)	*** 6/374 (1.6%)	12/114 (10.5%)	27/104 (26.0%)	59/197 (29.9%)	*** 96/715 (13.4%)	8/75 (10.7%)	NS
Syphilis	141/394 (35.8%)	22/396 (5.6%)	*** 21/374 (5.6%)	16/114 (14.0%)	43/104 (41.3%)	83/197 (42.1%)	*** 143/715 (20.0%)	20/75 (26.7%)	NS
Herpes	143/394 (36.3%)	34/396 (8.6%)	*** 28/374 (7.5%)	20/114 (17.5%)	26/104 (25.0%)	103/197 (52.3%)	*** 162/715 (22.7%)	15/75 (20.0%)	NS
Arthritis	35/394 (6.3%)	25/396 (8.9%)	NS 5/374 (1.3%)	7/114 (6.1%)	8/104 (7.7%)	25/197 (12.7%)	* 55/715 (7.7%)	5/75 (6.7%)	NS
Gout	5/394 (1.3%)	5/396 (1.3%)	NS 5/374 (1.3%)	3/114 (2.6%)	0/104 (0.0%)	2/197 (1.0%)	NS 10/715 (1.4%)	0/75 (0.0%)	NS
Migraine	93/394 (23.6%)	71/396 (17.9%)	* 68/374 (18.2%)	22/114 (19.3%)	22/104 (21.2%)	52/197 (26.4%)	NS 152/715 (21.3%)	12/75 (16.0%)	NS
Dyslexia	20/394 (5.1%)	11/396 (2.8%)	NS 10/374 (2.7%)	7/114 (6.1%)	6/104 (5.8%)	7/197 (4.1%)	NS 27/715 (3.8%)	4/75 (5.3%)	NS
Thyroid disorders	9/394 (2.3%)	5/396 (1.3%)	NS 5/374 (1.3%)	1/114 (0.9%)	2/104 (1.9%)	6/197 (3.0%)	NS 13/715 (1.8%)	1/75 (1.3%)	NS
Haemophilia	1/394 (0.3%)	1/396 (0.3%)	NS 0/374 (0.0%)	0/114 (0.0%)	1/104 (1.0%)	1/197 (0.5%)	NS 2/715 (0.3%)	0/75 (0.0%)	NS
IV Drug User	11/394 (2.8%)	21/396 (5.3%)	NS 5/374 (1.3%)	0/114 (0.0%)	12/104 (11.5%)	15/197 (7.6%)	*** 31/715 (4.3%)	1/75 (1.3%)	NS
Stomach Ulcers	34/394 (8.6%)	20/396 (5.1%)	* 15/374 (4.0%)	7/114 (6.1%)	8/104 (7.7%)	24/197 (12.2%)	** 47/715 (6.6%)	7/75 (9.3%)	NS
Stuttering	23/394 (5.8%)	13/396 (3.3%)	NS 14/374 (3.7%)	4/114 (3.5%)	3/104 (2.9%)	15/197 (7.6%)	NS 31/715 (4.3%)	5/75 (6.7%)	NS
Obesity	16/394 (4.1%)	18/396 (4.5%)	NS 15/374 (4.0%)	10/114 (8.8%)	4/104 (3.8%)	5/197 (2.5%)	NS 30/715 (4.2%)	4/75 (5.3%)	NS
Baldness	57/394 (14.5%)	36/396 (9.1%)	* 38/374 (10.2%)	13/114 (11.4%)	13/104 (12.5%)	29/197 (14.7%)	NS 86/715 (12.0%)	7/75 (9.3%)	NS
Eczema	85/394 (21.6%)	27/396 (6.8%)	*** 29/374 (7.8%)	11/114 (9.6%)	17/104 (16.3%)	55/197 (27.9%)	*** 102/715 (14.3%)	10/75 (13.3%)	NS
Psoriasis	40/394 (10.2%)	10/396 (2.5%)	NS 3/274 (3.2%)	1/114 (0.9%)	9/104 (8.7%)	28/197 (14.2%)	*** 45/715 (6.3%)	5/75 (6.7%)	NS

NS, not significant; \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$ .

tween several of the diseases and homosexuality and/or AIDS/HIV status. In interpreting Table III it should be noted that these are marginal tables derived from all subjects, and effects are unstandardised for other effects within the table. In particular this is important for the association between baldness and homosexuality, which although significant statistically, does not take into account the different incidences of male and female subjects in the two groups.

## DISCUSSION

This study has failed to find any statistically significant evidence that left-handedness is related to homosexuality per se, and thus it cannot be seen as supporting the hypothesis put forward by Geschwind and Galaburda (1987), although we do note that our difference between homosexuals and heterosexuals is in the same direction as that found by Lindesay (1987). The hypothesis of Geschwind and Galaburda is, as James (1989) has pointed out, somewhat surprising in that it seems contradictory to the work of Dorner, Schenk et al. (1983), and Dorner, Gotz and Docke (1983). Dorner et al. proposed that it is low levels of testosterone which produce homosexuality whereas Geschwind and Galaburda propose that it is high levels of testosterone that produce homosexuality. James sees an interesting potential resolution of this theoretical impasse, in that the work of Ward and Weisz (1984) found that stress in pregnant rats produced *higher* fetal testosterone levels on day 16 and 17, but *lower* levels on days 18 and 19. James therefore proposes that there should be a positive relationship between left-handedness and homosexuality only in those who have suffered maternal stress while in utero, and that there should be a negative association in those who are unstressed. We cannot test that hypothesis directly using our data, but we note that under it our results would only be possible if approximately half of homosexuals were stressed and the other half unstressed.

The present study has found no links between any of the seventeen illness conditions and left-handedness, despite Geschwind and Behan arguing that there are such associations (for instance of left-handedness with migraine, dyslexia and stuttering) or implying that there should be such associations (in the case of several of the infectious conditions); however the base-rates of some conditions are fairly low, which would reduce the power of such comparisons. Nevertheless several of the conditions *are* associated with HIV/AIDS status, which confirms both the validity of our study for detecting associations if they are present: AIDS patients have previously been reported to have a high incidence of previous infection with hepatitis A and B, syphilis and herpes (Quinn et al., 1988), and the disease is associated with both haemophilia and intravenous drug abuse (Lifson et al., 1986). The quality of our data is shown in the clear association found between HIV/AIDS status and eczema and psoriasis, both of which have been reported previously as being associated with AIDS (Johnson et al., 1985). It therefore seems probable that the absence of a correlation between these conditions and left-handedness reflects a true lack of an association, although it must be accepted that our study had not been designed specifically to look for such an association.

Our study has found a statistically significant association between HIV/AIDS status and the overall percentage of left-handers. However, the association cannot be interpreted readily in terms of the Geschwind-Behan-Galaburda hypothesis since there is no simple linear trend across the categories, as might be expected if likelihood or severity of HIV infection were the principal correlate, and neither is there a clear distinction between HIV - ve and HIV + ve subjects, as might be expected if HIV infection were the determining factor. Instead the quadratic trend suggests that there is a raised incidence of left-handedness principally in those who have been tested for HIV infection, albeit with a positive or negative result.

A simple interpretation of this result is in terms of a response bias, in which a subset of the population, particularly those who regard themselves as potentially vulnerable to HIV infection, are well-informed scientifically and have read in the popular press both about HIV testing and also about the hypothesis that left-handedness is related to immune disorders. As a result those who are left-handed themselves would be particularly likely to be HIV tested, giving the distribution of results reported here. An alternative, but less likely hypothesis, is that the percentage of left-handers in the AIDS group is artefactually low due to the premature deaths of left-handed patients who are either more vulnerable to infection or succumb to it more readily. A final hypothesis which would be compatible with our results is that left-handers are both more likely to become infected by HIV and are less likely for it subsequently to develop into AIDS itself. Our present data cannot separate these hypotheses, and additional information must be collected thoroughly to test each of them. In particular the fact that a posteriori testing shows that the "HIV - ve" group does not have a significantly different incidence of left-handedness from either the "not tested" or "HIV + ve groups" (which do however have significantly different incidences) suggest that a larger study, with a greater sample size and hence more power, will be necessary both to replicate the findings we have reported here and to tease apart the possible explanations. Our study did not collect information on the reasons why some individuals rather than others had chosen to be HIV tested, and neither did it differentiate between those AIDS patients who had or had not been HIV tested before the onset of the illness. Clearly this information would be useful in helping to differentiate between the various hypotheses to account for the association with left-handedness, and it would be worth collecting in future studies.

#### ABSTRACT

Left-handedness was assessed in a large sample of male homosexuals and male and female heterosexuals, some of whom had been tested for HIV infection, and others of whom had AIDS. No association was found between left-handedness and homosexuality, although there was an excess of left-handers in subjects who had been tested for HIV infection (irrespective of whether the test was negative or positive). This result can be interpreted in three possible ways: as a response bias on the part of left-handers who were aware of the Geschwind hypothesis that left-handedness may confer a vulnerability to AIDS; as due to left-handedness being associated with AIDS infection and the incidence in AIDS patients being artefactually low due to an excess mortality in left-handed AIDS patients; and as left-handers showing

both an increased vulnerability of HIV infection and a reduced likelihood of progression of HIV infection into AIDS. Our data are unable to distinguish between these hypotheses.

Left-handedness was not associated with any of seventeen specific conditions, including migraine, dyslexia and stuttering.

## REFERENCES

- ANNETT, M. A classification of hand preference by association analysis. *British Journal of Psychology*, *61*: 303-321, 1970.
- ANNETT, M. Comments on Lindsay: Laterality shift in homosexual men. *Neuropsychologia*, *26*: 341-343, 1988.
- DORNER, G., SCHENK, B., SCHMIEDEL, B., and AHRENS, L. Stressful events in pre-natal life of bi- and homosexual men. *Experimental and Clinical Endocrinology*, *81*: 83-7, 1983.
- DORNER, G., GOTZ, F., and DOCKE, W.-D. Prevention of demasculinisation and feminization of the brain in pre-natally stressed male rats by perinatal androgen treatment. *Experimental and Clinical Endocrinology*, *81*: 88-90, 1983.
- ELLIS, L., and AMES, M.A. Neurohormonal functioning and sexual orientation: a theory of homosexuality-heterosexuality. *Psychol Bulletin*, *101*: 233-258, 1987.
- GESCHWIND, N., and BEHAN, P. Left-handedness: Association with immune disease, migraine and developmental learning disorder. *Proc Natl Acad Sci USA*, *79*: 5097-5100, 1982.
- GESCHWIND, N., and GALABURDA, A.M. *Cerebral Lateralization: Biological Mechanisms, Associations and Pathology*. Cambridge, Mass.: MIT Press, 1987.
- JAMES, W.M. Foetal testosterone levels, homosexuality and handedness: a research proposal for jointly testing Geschwind's and Dörner hypotheses. *Journal of Theoretical Biology*, *136*: 177-180, 1989.
- JOHNSON, T.M., DUVIC, M., RAPINI, R.P., and RIOS, A. AIDS exacerbates psoriasis. *New England Journal of Medicine*, *313*: 1415, 1985.
- KINSEY, A.C., POMEROY, W.B., and MARTIN, C.E. *Sexual Behaviour in the Human Male*. Philadelphia: Saunders, 1948.
- LANSKY, L.M., FEINSTEIN, H., and PETERSON, J.M. Demography of handedness in two samples of randomly selected adults (N = 2083). *Neuropsychologia*, *26*: 465-477, 1988.
- LIFSON, A.R., ANCELLE, R.A., BRUNET, J.B., and CURAN, J.W. The epidemiology of AIDS worldwide. *Clinics in Immunology and Allergy*, *6*: 441-465, 1986.
- LINDSAY, J. Laterality shift in homosexual men. *Neuropsychologia*, *25*: 965-969, 1987.
- MCCORMICK, C.M., WITELSON, S.F., and KINGSTONE, E. Sinistrality in male and female homosexuality: neurobiological implications. *Soc Neurosci Abstracts*, *13*: 851, 1987.
- MC MANUS, I.C., and MASCIE-TAYLOR, C.G.N. Hand-clasping and arm-folding: a review and a genetic model. *Annals of Human Biology*, *6*: 527-558, 1979.
- MC MANUS I, C., NAYLOR, J., and BOOKER, B. Myasthenia gravis and left-handedness. *Neuropsychologia*, 1990 (in press).
- QUINN, T.C., GLASSER, D., CANNON, R.O., et al. Human immunodeficiency virus infection among patients attending clinics for sexually transmitted diseases. *New England Journal of Medicine*, *318*: 197-202, 1988.
- ROSENSTEIN, L.D., and BIGLER, E.D. No relationship between handedness and sexual preference. *Psychological Reports*, *60*: 704-706, 1987.
- WARD, I.L., and WEISZ, J. Maternal stress alters plasma testosterone in fetal males. *Science*, *207*: 328-329, 1980.
- WILLMOTT, M., and BRIERLEY, H. Cognitive characteristics and homosexuality. *Archives of Sexual Behaviour*, *13*: 311-319, 1984.

S.E. Marchant-Haycox, BSc, Department of Psychology, University College London, Gower Street, London WC1E 6BT.  
I.C. McManus, MA, MD, PhD, Department of Psychiatry, St. Mary's Hospital Medical School, Praed Street, London W2 1NY.

G.D. Wilson, MA, PhD, Institute of Psychiatry, De Crespigny Park, Denmark Hill, London SE5 8AF.