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Sexual Orientation and Visuo-Spatial Ability

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On the basis of a literature review it was concluded that sex differences in cognitive ability and the etiology of male homosexuality may have a common biological base, leading to the prediction that in terms of cognitive ability homosexual males (HmM) would resemble heterosexual females (HtF) rather than heterosexual males (HtM). This prediction was investigated using visuo-spatial tasks on which males are known to perform better than females. In Experiment 1 HtM performed better on a water level task than HmM and HtF whose performances did not differ significantly. A different version of the water level task and the Vincent Mechanical Diagrams Test were used in Experiment 2; on both tasks the HtM performed better than the HmM and the HtF whose performance did not differ significantly. The results are interpreted as support for a common biological determinant of cognitive ability and male sexual orientation.

INTRODUCTION

The relative contributions of biological and environmental factors have been debated in many fields of psychology. In two areas, the etiology of male homosexuality and the origins of sex differences in cognitive ability, there is growing support for some form of biological determination. A review of the combined evidence suggests that the same prenatal events could be responsible for both outcomes. This possibility leads to the prediction that in cognitive ability male homosexuals will resemble female rather than male heterosexuals.

The existence of sex differences in some cognitive abilities has been well documented. In adolescence and adulthood women score higher than men on verbal tasks while men show superior visuo-spatial abilities (Maccoby & Jacklin, 1974). The extent to which these differences are determined by biological and social factors has yet to be ascertained;

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however, Maccoby and Jacklin found "a surprising degree of similarity in the rearing of boys and girls" and concluded "we see nothing in the socialization of the two sexes that would produce different patterns of intellectual abilities." On the question of the origins of sex-type behavior these authors note that such behavior is well established before the choice of a same-sex model begins to occur. In addition, children have not been shown to resemble closely the same-sex parent in their behavior nor does children's sex-type behavior closely resemble that of adult models. For these reasons Maccoby and Jacklin reject the psychoanalytic and social learning theories, which emphasize imitation, in favor of a biological predisposition to same-sex-type behavior upon which subsequent learning builds.

Most studies of homosexuality have been restricted to male homosexuals who, until recently, were regarded by psychiatrists as neurotics, the products of domineering, physically intimate mothers and cold, rejecting fathers. However, these conclusions were based on the study of homosexuals who had sought psychiatric treatment. Nonneurotic, well-adjusted homosexuals have normal parental relationships (Siegelman, 1974). This finding was confirmed in a large scale study by Bell, Weinberg, and Hammersmith (1981) who reported that whereas therapy-seeking homosexuals did describe their fathers as cold and rejecting, those who had never sought therapy did not. The study provided little evidence to support the traditional "social" theories of the etiology of homosexuality and, although Bell et al. present no data directly relevant to the question of biological determination, they conclude that their "findings are not inconsistent with what one would expect to find if, indeed, there was a biological basis for sexual preference."

Evidence for a genetic factor in the etiology of male homosexuality comes from studies reporting a high level of concordance in monozygotic but not in dizygotic twins (Kallman, 1952; Schlegel, 1962). However, the twin studies have been criticized (Acosta, 1975) and others (Heston & Shields, 1968; Feldman & MacCulloch, 1971; Zuger, 1976) have reported the existence of monozygotic twins reared together who were completely discordant for sexual preference and behavior. Although a genetic basis for homosexuality now seems unlikely, support for a biological origin is provided by indications that homosexual males have physical characteristics which resemble women rather than men. Schlegel (1966) reports that homosexual males tend to have the tube-shaped pelvis typical of women as opposed to the characteristically masculine funnel-shaped pelvis. Dorner, Rohde, Stahl, Krell, and Masius (1975) recorded that an estrogen injection produced a luteinizing hormone (LH) surge (a typically female response) in homosexual males whereas in heterosexual and bisexual males no such positive feedback occurred. This crucial finding of a positive LH feedback to estrogen in homosexual males has recently been confirmed by Gladue, Green, and Hellman (1984).

Biological theories of male homosexuality stress an inadequate exposure to androgens during a critical interuterine period (MacCulloch & Waddington, 1981). The role played by androgens in the development of a masculinized brain is well established (Plapinger & McEwen, 1978) and the changes which occur are known to affect adult sexual behavior (Feldman & MacCulloch, 1971). It seems probable that the bases for sex differences in cognitive abilities are similarly determined. Differences for male and female brain anatomy have been recorded for the splenium (de Lacoste-Utamsing & Holloway, 1982) and the Sylvian fissure and the planum temporale (Wada, Clarke, & Hamm, 1975). Studies of cerebral asymmetry indicate that, whereas both men and women have the left hemisphere specialized for language functions, women alone tend to have additional language abilities in the predominantly visuo-spatial right hemisphere (McGlone, 1980). The presence of language in the right hemisphere may reduce and/or interfere (Levy, 1969) with the individual's capacity for visuo-spatial functions, thus providing an explanation for both the verbal superiority of women and the visuo-spatial superiority of men. Developmental studies demonstrating that the basic differences in hemispheric functional specialization are present in neonates (Entus, 1977; Molfese & Molfese, 1979a, 1979b) support the view that sex differences in cognitive ability are biologically determined.

If male homosexuality and sex differences in cognition are biologically determined it is possible that they are dependent on the same mechanism. We decided to investigate the implications of this hypothesis by comparing the cognitive abilities of homosexual males (HmM) with those of heterosexual males (HtM) and heterosexual females (HtF). In the present paper we report our studies of visuo-spatial abilities using the Vincent Mechanical Diagrams Test (NFER, 1980) and two versions of the water level task described by Thomas, Jamison, and Hummel (1973) in which subjects are required to indicate the level that water would take in a tilted bottle. Of 91 women tested by Thomas et al. only 28 performed at a level comparable with the performance of 62 unselected men. The performance of the remaining 63 women was significantly inferior, even after training. Interview data indicated that 56 of these 63 women were unable to verbalize an effective strategy before or after training. Thomas et al. concluded "we do not have a satisfactory explanation for our results, especially when we would expect from theory that the knowledge of the principle would be acquired years before and probably by self-discovery."

We suggest that the different performance levels of men and women on the water level task may be the product of differences in male and female brain organization. If cognitive abilities and sexual orientation are similarly established (e.g., by fetal hormone levels) then we would

expect HmM to perform like HtF on the water level and other visuo-spatial tasks.

EXPERIMENT 1

Methods

Subjects. All of the subjects were right-handed, non-psychology students, aged 20–30 years, who were recruited from the undergraduate population through personal contact and referral by those already participating in the study. There were eight subjects in each of three groups; heterosexual females, heterosexual males, and homosexual males. All of the HmM were declared lifelong homosexuals who were satisfied with their sexual orientation and had no history of seeking treatment, that is, primary (Feldman & MacCulloch, 1971) or ego-syntonic (DSM III) homosexuals.

Materials and Procedure

Subjects were tested using an A5-sized booklet in which each page carried a line drawing of a bottle. On the front cover the bottle was vertical and a horizontal line representing the water level indicated that the bottle was about one-third full. Written instructions appeared above the bottle. Subsequent pages showed similar bottles with the water levels omitted and the bottles tilted 15, 30, 55, 70, or 85° to the right or left. The 10 such pages appeared in a different random order in each of the booklets used. A pencil and ruler were provided.

Subjects were asked to read the following instructions which appeared at the top of the front cover of the booklet.

> Please note the water level in the bottle on this page and draw in, using the ruler, where you think the water level would be in the bottles on the subsequent pages. Assume that all the bottles contain the same amount of water as the bottle on this page.

When the instructions were clearly understood the subjects were reminded that the ruler was to be used to facilitate drawing the water level lines and not for measurement. The subjects were then allowed to complete the task at their own pace.

Results

The performances of the HtF and the HmM on the water level task were very similar and some 10-fold less accurate than that of the HtM (Fig. 1). Only one HtM performed worse than the best HtF and only three HmM performed better than the worst HtM. A Kruskal–Wallis one-way analysis of variance indicated a significant difference between the group scores ($H = 12.65$, $p < .01$). Mann–Whitney tests showed that the HtF and the HmM scores were significantly different from those of the HtM ($U = 1$ and 5, respectively, $p < .001$) but not from each other ($U = 31.5$, $p > .48$).

EXPERIMENT 2

Methods

Subjects. A total of 39 subjects were tested, 13 in each of three groups: heterosexual females aged 20–40 years, heterosexual males aged 20–43 years, and homosexual males

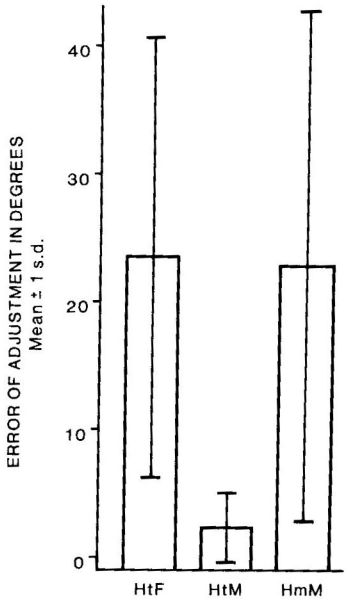

FIG. 1. A comparison of the mean error of adjustment recorded in Experiment 1 on the pencil and paper version of the water level task by heterosexual females (HtF), heterosexual males (HtM), and homosexual males (HmM). The measurements are in degrees and the vertical bars indicate one standard deviation above and below the mean.

aged 22–43 years. All of the subjects were recruited from the local population through personal contact or referral by those already taking part in the study. At the first contact potential subjects were fully briefed on the nature of the investigation and those who participated did so on a voluntary basis. Subjects in the three groups were matched for age and educational attainment. All were classified right-handed, having recorded a minimum of six right-dominant responses on seven items selected from the Harris Test of Lateral Dominance (Harris, 1974). The HmM were declared lifelong homosexuals who were satisfied with their sexual orientation and had no history of seeking treatment, that is, primary (Feldman & MacCulloch, 1971) or ego-syntonic (DSM III) homosexuals.

Materials and Procedure

Sexual Orientation Method (SOM). This questionnaire, devised by Feldman, MacCulloch, Mellor, and Pinschof (1966), and modified by Sambrooks and MacCulloch (1973), cannot be used to detect a hidden sexual orientation because responses to the undisguised questions are easily faked but it does provide a reliable measure of the level of homo- and heteroerotic interest when used with individuals who freely admit to a particular sexual orientation. A copy of the SOM was kindly supplied by Dr. M. J. MacCulloch, Park Lane Hospital, Liverpool, England.

The SOM was completed by the subjects in their own time and scored according to the revised instructions (Sambrooks & MacCulloch, 1973). Subjects then attended a laboratory session to complete the other tasks.

Vincent Mechanical Diagrams Test (VMD). This is a standard test in which subjects must select a mechanism composed of levers, cogs, or pulleys which would produce the

movement illustrated in the test diagrams. The VMD forms part of the National Institute of Industrial Psychology Engineering Selection Test Battery (NFER, 1980).

The VMD was administered according to the standard instructions. Two performance measures were used, the total number of questions answered (a measure of speed) and the proportion of correct answers (a measure of accuracy).

Water level task. The apparatus used was a modified version of that described by Thomas et al. (1973). Subjects faced a black Perspex disk mounted on a white board. The two-dimensional shape of a bottle, viewed from the side, had been cut from the center of the disk and through this hole another disk composed of white and red semicircles could be seen. The two disks could be independently rotated and with appropriate adjustments the red semicircle appeared to be a red liquid filling approximately half the bottle. From the rear of the apparatus the experimenter could rotate both disks and determine the positions of the bottle and the water level from a scale marked in degrees. From the front, subjects could rotate the water level but not the bottle.

Subjects sat at a table facing the simulated bottle. They were asked to imagine that the bottle was real and that it contained a red liquid. Subjects were told that the experimenter would tilt the bottle and that they should use the knob beneath the bottle to rotate the level of the liquid until it occupied the correct position within the tilted bottle. Subjects were encouraged to make certain that they were completely satisfied with each adjustment before indicating that the experimenter could continue with the next trial. When three practice trials had been completed satisfactorily the experimental trials began.

Ten bottle orientations (15, 30, 55, 70, and 85° from the vertical to both right and left) were each presented twice giving a total of 20 trials which followed a different random sequence for each subject. At the start of each trial the experimenter positioned the bottle at the required angle and adjusted the water level so that it ran vertically from the top to the bottom of the bottle (an orientation which was always inappropriate). Performance was measured in terms of the discrepancy in degrees between the true horizontal and the water level as adjusted by the subject. During execution of the task questions were discouraged and no feedback on performance was given.

Results

Sexual Orientation Method. The declared sexual orientation of the subjects was confirmed by their scores on the SOM (Table 1). HtF and HtM scored low on the homosexual scale and high on the heterosexual scale while HmM showed the reverse pattern. There was a complete

TABLE 1
MEAN SCORES (AND RANGE) ON THE SOM

	n	Homosexual scale	Heterosexual scale
Heterosexual females	13	15.00 (7–26)	45.50 (29–48)
Heterosexual males	13	10.61 (6–16)	47.56 (46–48)
Homosexual males	13	46.92 (41–48)	13.50 (6–23)

Note. Minimum score 6; maximum score 48.

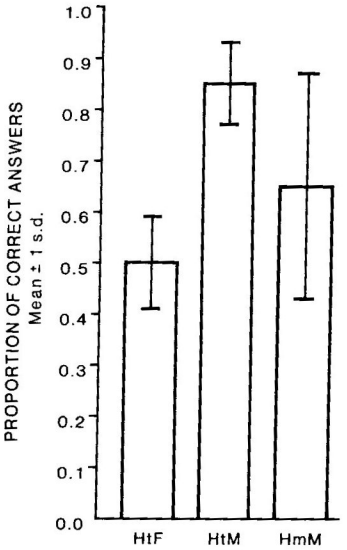

FIG. 2. A comparison of the mean proportion of correct answers recorded on the Vincent Mechanical Diagrams Test in Experiment 2 by heterosexual females (HtF), heterosexual males (HtM), and homosexual males (HmM). The vertical bars indicate one standard deviation above and below the mean. The other dependent variable, the number of questions attempted within the time limit, showed a similar pattern of results.

separation of the homosexuals and the heterosexuals on each of the two scales, with no overlap between their scores.

Vincent Mechanical Diagrams. The HtM attempted more questions within the time limit and gave a higher proportion of correct answers than the HtF while the HmM produced an intermediate level of performance on both measures. Using the proportion of correct answers (Fig. 2), a Kruskal–Wallis one-way analysis of variance indicated a significant difference between the group scores ($H = 19.19, p < .001$). Mann–Whitney tests showed that the performances of the HtF and the HmM were significantly different from those of the HtM ($U = 0, p < .001$ and $U = 36.5, p < .02$, respectively) but not from each other ($U = 46.5, p > .05$).

Water level task. As in Experiment 1 the mean error on this task is high for the HtF and the HmM but very low for the HtM (Fig. 3). A Kruskal–Wallis one-way analysis of variance indicated a significant difference between the group scores ($H = 24.86, p < .001$). Mann–Whitney tests showed that the performances of the HtF and the HmM were significantly different from those of the HtM ($U = 0$ and 9, respectively, $p < .001$) but not from each other ($U = 46.5, p > .05$).

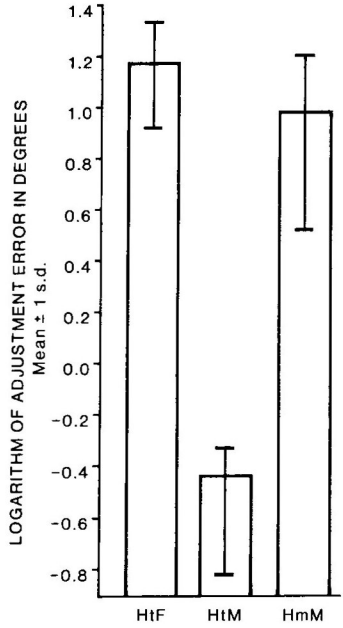

FIG. 3. A comparison of the mean error of adjustment recorded in Experiment 2 on the mechanical version of the water level task by heterosexual females (HtF), heterosexual males (HtM), and homosexual males (HmM). The original measurements in degrees have been expressed as logarithms to facilitate the display of the small mean error of the HtM. The vertical bars indicate one standard deviation above and below the mean.

DISCUSSION

We have compared the performance of homosexual males, heterosexual males, and heterosexual females using visuo-spatial tasks on which males are known to perform better than females. Our results, which confirm the sex difference with almost no overlap between the HtM and HtF scores, show that HmM not only score significantly lower than the HtM but also, in performance on these visuo-spatial tasks, the HmM are consistently closer to the HtF than they are to the HtM (Figs. 1–3). If we accept that men and women, of whatever sexual orientation, are likely to have equal experience of liquids in containers, the marked differences recorded on the water level task are intuitively the most surprising. However, the water level effect is robust, appearing with two different versions of the task (Figs. 1 and 2).

Homosexual heterogeneity has been extensively considered by Feldman and MacCulloch (1971) who differentiate primary homosexuals, those who have never experienced heterosexual arousal, from secondary homo-osexuals, those who have. In the DSM III classification, ego-syntonics and ego-dystonics correspond to primary and secondary homosexuals,

respectively. Although the Sexual Orientation Method (Feldman et al., 1966; Sambrooks & MacCulloch, 1973) may not provide a clear-cut distinction between the two groups, secondary homosexuals tend to score higher than 20 on the heterosexual scale whereas primary homosexuals tend to score less (M. J. MacCulloch, personal communication).

Feldman and MacCulloch (1980) suggest that the categories "secondary homosexual" and "bisexual" are equivalent. If so, the report that homosexual, but not bisexual, males show a luteinizing hormone surge in response to estrogen injections (Dorner et al., 1975) implies that in males, primary but not secondary homosexuals have a biologically determined, feminine brain organization. On this basis we would expect male secondary homosexuals to show scores for visuo-spatial tasks similar to those of the HtM. Two of the HmM subjects in Experiment 2 did score more than 20 on the heterosexual scale of the SOM so it is possible that they were secondary homosexuals. However, omitting the data for these two subjects did not significantly alter the outcome of the analyses.

The present finding that, in terms of visuo-spatial abilities, HmM resemble HtF rather than HtM supports the view that male homosexuality and sex differences in cognitive abilities share a common origin. Although we have argued that both are biologically determined we do not wish to imply that a single event, such as the level of fetal androgens during a critical prenatal period, is the sole responsible factor. While a biological determinant is favored for primary homosexuality it is probable that environmental factors are important in the development of secondary homosexuality (MacCulloch & Waddington, 1981).

As for cognitive ability, there is evidence that visuo-spatial abilities can be affected by postnatal endocrine changes. Kwashiorkor is a protein deficiency disease which, in extreme cases, may produce hormonal changes causing the appearance in males of feminine characteristics including gynecomastia, the swelling of the male mammary gland. Dawson (1967a, 1967b) reports that males showing this symptom had higher verbal and lower visuo-spatial scores than normal males. No indication of sexual orientation is given for the gynecomastic subjects but they did score significantly higher than their controls on two tests of feminine interest.

Our prediction that male homosexuals would resemble female rather than male heterosexuals in visuo-spatial ability has been confirmed. This finding is compatible with the outcome of our recent study of cerebral asymmetry in these subjects (Sanders & Ross-Field, 1986). Whereas heterosexual males showed a marked left visual field (right hemisphere) superiority in a tachistoscopic dot detection task, the homosexual males and the heterosexual females showed no significant field advantages. Taken together, these findings establish a link among three phenomena, the etiology of sexual orientation, sex differences in cognitive ability, and sex differences in cerebral asymmetry. In each of these areas there

is a growing support for some form of biological determination; hence, the indication that they are linked adds weight to this view. Our present hypothesis is that a single biological event, such as the level of fetal androgens during a critical prenatal period, initiates processes which establish sexual orientation, cerebral asymmetry, and, thereby, a particular pattern of cognitive abilities.

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