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Twin Studies of Homosexuality

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1. INTRODUCTION

The phenomenon of homosexuality is one that has endured, to a greater or lesser extent, throughout all societies from the ancient Greeks and beyond to the present day (e.g. Bullough 1976).

In 1948, Kinsey *et al.* reported that 37% of white American males in their study of 20 000 individuals had had some homosexual experience. Kinsey was the first researcher in this field to distinguish between exclusive homosexuality and bisexuality, and proposed a scale to classify a person's sexuality covering the whole spectrum from exclusive heterosexuality (Kinsey Scale 0) to exclusive homosexuality (Kinsey Scale 6). An individual's rating is not constant, but may change throughout his or her lifetime, although Kinsey (1948, 1953) showed that by the age of 25 in men and 40 in women, a person's Kinsey rating had usually stabilised. Kinsey's estimate for the prevalence of predominant homosexuality (Kinsey scale 4-6) in white males at age 25 was 7.6%.

The Kinsey *et al.* study has subsequently been criticised (e.g. Pillard *et al.* 1986, Fay *et al.* 1989) for bias by the inclusion of substantial numbers of subjects with prison experience, and substantial numbers from college campuses. Also, the data are applicable only to men distinguished by their willingness to co-operate with an investigation of sex behaviour (Kallman 1952).

More recent attempts to determine the base rate of homosexuality in Western society include McConaghy *et al.*'s 1979 study of medical students at the University of New South Wales. Such a sample was chosen so that nonpatients could be investigated in which the homosexual and heterosexual groups were drawn from the same population. The results of the study showed that 60% of the students reported that they were aware of some homosexual feelings during adolescence, and more than 40% were still aware of such feelings. Although this study has the advantage of being highly representative of the given population (84% of all the medical students participated), most subjects were in their late 'teens or early twenties, so many may not have reached their final adult sexual orientation. Also, a sample of medical students can hardly be generalised onto the Australian population as a whole.

Probably the most accurate estimate of the prevalence of male homosexuality available is that of Fay *et al.* (1989). From the secondary analysis of a sample of over 3000 adults interviewed in 1970, they

suggested the following lower-bound estimates: "20.3% of adult men in the United States in 1970 had sexual contact to orgasm with another man at some time in life; 6.7% had such contact after age 19; and between 1.6 and 2.0% had such contact within the previous year."

In estimations of prevalence, as in most other areas of study related to homosexuality, we find the peculiar fact that very little has been mentioned of female homosexuality. It is generally agreed that the prevalence of lesbianism is somewhat lower than that of male homosexuality (e.g. Reinisch, 1991).

Whatever the precise figures, it is clear that a significant number of the population in Western societies have some homosexual inclinations.

Krafft-Ebing (1922) gave, on the basis of the cases published up to 1877, the first exhaustive scientific exposition of homosexuality. He states that "the more painstakingly one investigates the so-called acquired cases of homosexuality, the more clearly it appears that the real decisive factor is a *predisposition.*" Thus, as early as the turn of the century, a genetic basis of homosexuality was suspected, although the appearance of Freud's "Three Essays on Sexuality" and the birth of the psychoanalytic school signalled a shift of emphasis in explanations of sexual orientation. The various theories that have been proposed to explain homosexuality will be described in more detail later.

For such an apparently evolutionary unfavourable trait, it is not surprising that many attempts to explain its aetiology have concerned themselves with abnormal parent-child relationships, childhood seductions and the like, rather than purely genetic explanations.

Many researchers claim to have shown that homosexuality, or, at least, male homosexuality, is familial in nature (e.g. Henry 1941 (also see Zuger 1978), Pillard *et al.* 1981, Pillard & Weinrich 1986). For example, Pillard and Weinrich found that, in the Boston area of the United States, "heterosexual men had about as many homosexual brothers as would be predicted given national prevalence figures for homosexuality, but homosexual index men had about four times as many homosexual brothers, although in both cases most brothers were heterosexual." No significant difference was found in the number of homosexual sisters of homosexual men compared to heterosexual men. However, some studies have found evidence for the familial nature of female homosexuality (e.g. Kenyon 1968).

Of course, if homosexuality is familial, this could be explained by either a genetic or an environmental theory. Generally, many of the theories advanced are not mutually exclusive. For example, a theory which supposes that child-parent interactions are the crucial factor for determining sexual orientation does not tell us why such interactions are as they are; the way that a child interacts with his environment, and the extent to which the same environmental event can cause different subjective experiences in different children is largely controlled by the genetic makeup of each child. Further consideration to this subject is given in a later section.

What is required to give us a better understanding of the aetiology of homosexuality is direct evidence for or against the involvement of genes. A common paradigm to research such a question is the Twin Study method. A brief outline of the rationale of this method is given in the next section, followed by a summary of all of the twin studies of homosexuality conducted to date.

2. TWIN STUDIES OF HOMOSEXUALITY

2.1. Why twin studies?

Twins potentially provide us with one of the most powerful techniques available for separating the influences of genetic and environmental factors on psychological and behavioural traits. An identical (monozygotic) twin has exactly the same genes as his cotwin. Fraternal (dizygotic) twins, on the other hand, are no more closely related genetically than are normal siblings, i.e. roughly 50% of their genes are the same.

If index cases for a particular trait (e.g. homosexuality) are selected from twins in a given population, then the rate of concordance for that trait between the index case and his or her cotwin can be compared for monozygotic and dizygotic twins. It is assumed that the environment in which each member of a twin pair is reared is virtually identical, as twins are identical in age, and tend to have very similar experiences during childhood (e.g. they get similar attention from their parents, attend the same schools, etc.). Therefore, any difference in the concordance rates for the trait between monozygotic and dizygotic twins must be due to the former sharing all of their genes and the latter only sharing half of their genes.

In other words, the rationale behind twin studies of homosexuality is that if there is a difference between the concordance rate for homosexuality in monozygotic twins and dizygotic twins, then this is strong evidence that there is some genetic component to the aetiology of homosexuality. However, if the concordance rate in monozygotic twins is not 100%, then environmental factors must be exerting some influence.

Another technique involving twins is the study of identical twins reared apart. In such cases, we can look at the effect of varying the environment whilst keeping genetic factors constant (c.f. the previous method, where the environment that both twins experience is constant, but genetic factors are varied by comparing monozygotic with dizygotic twins). Looking at a particular trait in a sample of identical twins, the difference in variability of the trait observed among twins reared together and twins reared apart must be predominantly due to the variability in the rearing-environments experienced by twins reared apart. Obviously, the number of cases of homosexual identical twins who have been reared apart that come to the attention of researchers is minimal, but at least one report has been published on this subject (Eckert *et al.* 1986).

There now follows a summary of the methods and results of all of the major twin studies of homosexuality conducted to date, together with a summary of smaller studies and reports of individual twin pairs.

2.2. The major studies to date

Kallman, 1952

Kallman obtained 85 male index cases who were predominantly or exclusively homosexual, members of a twinship, and over the age of 20. Of these 85 index cases, 40 were monozygotic twins, and 45 were dizygotic twins, although no mention is made of tests administered to prove zygosity. The exact method

of recruitment is unclear from the report, but it is stated that "the search for potential index cases was organized not only with the aid of psychiatric, correctional, and charitable agencies, but also through direct contacts with the clandestine homosexual world."

Each index case and his cotwin were given a Kinsey rating from 0 (exclusive heterosexuality) to 6 (exclusive homosexuality), although the precise method by which these ratings were obtained is, again, unclear.

For the dizygotic twins, Kallman found a concordance rate of 11.5% (3/26) for predominant homosexuality (Kinsey ratings 3-6), and 42.3% (11/26) for any homosexuality (Kinsey ratings 1-6). These figures exclude 19 of the 45 dizygotic index twins, 14 of whom had female twins, and 5 of whom had unclassified male twins (deceased or otherwise unavailable).

For the monozygotic twins, a very different picture emerged. Of the 37 index cases whose cotwins were classified, all were concordant for homosexuality (Kinsey ratings 3-6); a concordance rate of 100%. Kallman noted that "the majority of one-egg pairs not only are fully *concordant* as to the overt practice and quantitative rating of their aberrant sex pattern, but they even tend to be *very similar* in both the part taken in their individual sex activities and the visible extent of feminized appearance and behavior displayed by some of them" (Kallman's italics). He also pointed out that most of these twins had "developed their sexual tendencies *independently* and often *far apart* from each other, and that all of them deny categorically any history of mutuality in overt sex relations."

Heston & Shields, 1968

Heston and Shields reported on the male homosexual twins on the Maudsley Twin Register as of July 31, 1966. Such a sample appeared to be representative of Maudsley patients as a whole, not being selective regarding concordance or zygosity.

12 index cases were obtained. Zygosity was determined using blood samples and fingerprints, revealing that five were monozygotic, and the remaining seven were dizygotic. The report states that "the proband twins were examined as psychiatric patients. They and their cotwins were further assessed . . . through personal interviews and . . . by means of psychological tests of intelligence . . . and personality . . ."

The family of one of the monozygotic twins was studied extensively, as it contained three sets of male identical twins, two of which were concordant for homosexuality; the other pair being concordant for heterosexuality. As in Kallman's study, Heston and Shields reported that the two sets of homosexual twins "denied any sexual contact or feeling for each other and reported the idea as distasteful."

Of the other probands, only one of the other four monozygotic twins had a cotwin clearly concordant for homosexuality, although one other cotwin had had delusions of sex change and other psychiatric complaints. Of the seven dizygotic twin pairs, one, again, was clearly concordant for homosexuality, and the cotwin of another dizygotic proband was suspected of latent homosexuality, although this was not proved.

There was evidence for other psychiatric disorders in many of the probands and their cotwins, but Heston and Shields concluded that, "in general, the presence or absence of other diagnosed psychiatric conditions in the MZ probands does not appear to account for the resemblance in homosexuality." They also commented that there "appears to be no good evidence from the present material or from other work for supposing that twins [*per se*] have a high risk of being homosexual."

It must be remembered that the conclusions of such a study, as Heston and Shields emphasized themselves, are limited due to the small numbers involved, and the fact that the sample cannot be considered representative of homosexuals as a whole. As the report says, "similar objections can be raised to most clinical studies of homosexuality."

Bailey & Pillard, 1991

In the most recent twin study of homosexuality, Bailey and Pillard report on a sample of 161 male homosexual probands, all over the age of 18 with a twin or adoptive brother. Recruitment was through advertisements placed in homophile publications in several cities in the Midwest and Southwest of the United States. For probands with adoptive brothers, it was stipulated that they must have entered a common rearing environment when both were no more than 2 years old.

Most of the probands were interviewed in person with informed consent. Questionnaires were sent to the cotwins and adoptive brothers, with a cover letter explaining that they were being asked to participate in a general study of personality, attitudes and behaviour. Five questions regarding sexual orientation were imbedded in over 100 other items about social attitudes, personality, and childhood behaviour.

Bailey and Pillard determined the zygosity of the subjects using a questionnaire containing items relating to physical similarity, past and present likelihood of twins being mistaken for each other, etc. They claim that "such questionnaires generally range in accuracy from 90% to 95%."

The distribution of sexual orientation among cotwins of the monozygotic probands appeared to be bimodal. In other words, most subjects classified themselves as heterosexual or homosexual, with very few giving evidence of significant bisexuality. This finding is in agreement with other recent studies (e.g. Buhrich *et al.* 1991).

According to their data, 52% (29/56) of monozygotic cotwins, 22% (12/54) of dizygotic cotwins, and 11% (6/57) of adoptive brothers were homosexual. Heritabilities of homosexuality were calculated using these results under a wide range of assumptions of the population base rate and ascertainment bias. Under all conditions considered, heritabilities were substantial (h_2 was between .31 and .74 in all cases). However, "the rate of homosexuality among nontwin biological siblings, as reported by probands, 9.2% (13/142), was significantly lower than would be predicted by a simple genetic hypothesis and other published reports."

Bailey and Pillard suggested that this anomaly between the present data and previous reports might be due to the fact that they were looking at nontwin biological siblings of *twin* probands, whereas other reports had reported the concordance rate between pairs of nontwin siblings where, on the whole, neither sibling was a member of a twin pair. A difference in concordance rates may then occur "if the causes of homosexuality in twins and singletons were different, i.e., if a special twin environment contributes to the development of sexual orientation." Alternatively, the difference could just be due to sampling fluctuations, so the desirability of replicating the results was stressed.

The results of the three twin studies of homosexuality described above are summarised in table 1. It is notable that all three have concentrated on exclusively male samples; no large scale investigation of homosexuality in female twins has yet been conducted.

Table 1. *Summary of the major twin studies of homosexuality.*

		AGE	REPORTED CONCORDANCE		
STUDY	**DATE**	**RANGE**	**MALE MZ TWINS**	**MALE DZ TWINS**	**SAMPLE SOURCE**
Kallmann	1952	>20	37/37 (100%)	3*/26 (12%)	Psychiatric, correctional and charitable agencies, plus direct contacts
Heston & Shields	1968	20-52	3/7 (43%)	1/7 (14%)	Hospital Twin Register
Bailey & Pillard	1991	19-65	29/56 (52%)	12/54 (22%)	Homophile publications

* Concordance rate varies from 3/26 (Kinsey scale 3-6) to 11/26 (Kinsey scale 1-6)

N.B. The data in this table represent only those cases where the sexual orientation of each subject is 'fairly certain', and is either predominantly homosexual or predominantly heterosexual.

2.3. Small scale studies and individual case-studies

In addition to the three studies just described, there have also been numerous smaller scale investigations and reports, some being more useful scientifically than others. Many of these reports have included cases where the sexual orientation of one or more of the subjects was by no means certain (e.g. Parker, 1964; Holden, 1965; Green & Stoller, 1987). Table 2 summarises the reported cases where there was some degree of certainty regarding an individual's orientation, and where such orientation is predominantly homosexual or heterosexual (rather than significantly bisexual).

Table 2. *Summary of small scale reports and individual case studies of homosexuality in twins.*

			REPORTED CONCORDANCE				
		AGE	MZ TWINS		DZ TWINS		
STUDY	**DATE**	**RANGE**	**MALE**	**FEMALE**	**MALE**	**FEMALE**	**SAMPLE SOURCE**
Lange	1929	24 & mid 20s	1/2				Criminal and psychiatric records
Sanders	1934	ND	5/6		0/1		Homosexual probands

Habel	1950	ND	3/5		0/5		Prison Population
Rainer, Mesnikoff, Kolb & Carr	1960	29 & ND	0/1	0/1			Psychoanalytic agency
Klintworth	1962	20	0/1				Hospital
Mesnikoff, Rainer, Kolb & Carr	1963	ND	0/2*		0/1		Psychoanalytic and psychotherapeutic patients
Koch	1965	>25		0/1	0/1		Follow-up on non-psychiatric, non-delinquent twins
Pardes, Stinberg & Simons	1967	36		1/1			Psychiatric clinic
Green & Stoller	1971	24		0/1			Referral to Gender Identity Research and Treatment Programme
Perkins	1973	45		1/1			ND
Zuger	1976	23	0/1				Reported by family doctor
Friedman, Wolleson & Tendler	1976	25	0/1				Volunteers
McConaghy & Blaszczynski	1980	21	0/1				Psychiatric centre
Myers	1982	27	1/1				Psychiatric centre
Eckert, Bouchard, Bohlen & Heston	1986	25-48	1/1	0/3			Minnesota study of MZ twins reared apart
Buhrich, Bailey & Martin	1991	19-40	4/9		0/2		Australian NH & MRC Twin Registry

ND No Data

* Report also included the two MZ twins reported by Rainer et al. (1960).

N.B. The data in this table represent only those cases where the sexual orientation of each subject is 'fairly certain', and is either predominantly homosexual or predominantly heterosexual.

It is also apparent that some reports are describing twins who have already been reported by other authors. Mesnikoff *et al.* (1963) report five twins, two of which were already reported by Rainer *et al.* (1960). Parker (1964) and Heston & Shields (1968) both obtained probands through the Maudsley Twin Register, so that the two male twin pairs reported by Parker are also included in Heston & Shields' study. In both of these cases, the twins are only recorded once in table 2.

Because of the limited information regarding the relative importance of environmental and genetic factors that may be obtained from such reports, most will not be described in detail.

Many of the cases are drawn from prison populations (Lange, 1929; Habel, 1950) or through psychiatric clinics (e.g. Rainer *et al.*, 1960; Mesnikoff *et al.*, 1963; Pardes *et al.*, 1967; McConaghy & Blaszczynski, 1980; Myers, 1982). Samples drawn from such sources are unlikely to be representative of a larger population. In some of the reports, especially the earlier ones (e.g. Lange, 1929; Sanders, 1934), cotwins of some probands were not explicitly asked about their sexual orientation, which was just inferred from other sources of information.

After Kallmann's 1952 report of a 100% concordance rate for homosexuality in male twins, many subsequent investigations have been biased towards searching for discordant pairs (e.g. Rainer *et al.*, 1960; Klintworth, 1962).

In Habel's 1950 report of homosexuality in twins from a German prison population, he drew the distinction between 'genuine' homosexuality and 'pseudohomosexuality', important for prison populations in particular. In fact, other reports (e.g. Slater, 1962; Parker, 1964) have also suggested that there are various different 'types' of homosexuality, all with a different combination of environmental and genetic aetiological influences. If this is true, then estimations of heritability for homosexuality in a given population can only be seen as referring to an 'average' of all of the different 'types'. Individual types may be much more strongly heritable than the overall estimate, or much less so.

The discordant male monozygotic twins studied by Davison *et al.* (1971) are peculiar among all of the cases mentioned in that the homosexual twin, Paul, was given aversion therapy at age 18, and claimed to have lost all homosexual desires after this. He subsequently became engaged to a girl, but broke this off before marriage. Two years later he still claimed to be free from homosexual desires. Bearing in mind the work of Kinsey (1948) and others, some doubt is cast onto the relevance of any report that deals with the sexual orientation of people under 25 years old.

Throughout the 1960s and 70s we see a spate of reports, each of one or two concordant or discordant twin pairs, usually written from a psychoanalytic point of view.

Such psychoanalytic reports often investigate inter-family environmental influences in the childhood of the probands that appear to have been influential in the subsequent development of sexual orientation. Such factors will be discussed at a later stage.

Two recent reports (Eckert *et al.* 1986, Buhrich *et al.* 1991) have investigated sexual orientation in relatively large series of twins (55 and 158 twin pairs respectively) unselected for homosexuality.

Eckert *et al.* utilised data from the Minnesota Study of Twins Reared Apart. "That the twins are highly selected cannot be doubted; they are not representative of twins or homosexuals," the authors warn. "Nevertheless, study of them has yielded clues which warrant description." Six pairs of monozygotic twins were found in which at least one member was homosexual (in five cases) or bisexual (in one case).

Of the four female twin pairs, three were discordant for homosexual behaviour. The fourth case contained the bisexual index case, who had had a prolonged and intense homosexual affair in her late twenties, but regarded herself as exclusively heterosexual at the time of the study. Her cotwin was heterosexual. One of the male twin pairs reported was clearly concordant for homosexuality, and after their reunion at age 25 became sexual partners. In the other male twin pair, one member was exclusively

homosexual, and reported being sexually attracted to his cotwin after reunion. The cotwin regarded himself as exclusively heterosexual, although he had had a homosexual affair with an older man between ages 15-18. For the male twins, Eckert *et al.* conclude that, "despite problems of ascertainment and diagnosis, it is hard to deny genetic factors an aetiological role." As for the females, the "pattern of findings suggests that female homosexuality is a trait acquired after conception, most likely after birth, but before menarche . . . Our evidence, though based on a small sample, implicates environmental factors as the major determinant of female homosexuality." Similar findings have been reported elsewhere (e.g. Bell *et al.* 1981)

In the study by Buhrich *et al.*, 95 pairs of male monozygotic twins and 63 pairs of dizygotic twins were assessed for present and childhood sexual identity, sex-dimorphic behaviours and sexual orientation. A significantly higher rate of adult homosexuality was found among the monozygotic than the dizygotic twins; the precise figures of concordance for predominant homosexuality (ratings 4-6) were 44% (4/9) for monozygotic twins, and 0% (0/2) for dizygotic twins. These figures were not explicitly quoted in the report, whose authors warned against ignoring the evidence "that sexual feelings and sexual orientation have a continuous (if skewed) distribution."

A model-fitting approach was employed to test for genetic and environmental influences on variation for each trait singly and on the covariation among all traits. The results of multivariate analyses suggested that "over half the variance in Adult Sexual Orientation was attributable to the additive effects of genes. Only about 1% of the variance was attributable to the influence of environmental factors shared by siblings." However, because of the restrictive nature of some of the models, and because the sample showed different rates of orientation by zygosity, Buhrich *et al.* concluded that their results "are best considered tentative but do suggest that further biometrically oriented studies of sexual orientation and its correlates would be worthwhile."

This concludes the résumé of twin studies of homosexuality conducted to date. Clearly, many of these studies have (sometimes severe) methodological shortcomings. As Parker (1964) notes, "as long as there is an associated stigma attached to any deviation from normal sexual behaviour, difficulty will be experienced in obtaining co-operative twin pairs, and this has been repeatedly emphasized in the literature." Even if we just consider the less selective reports, there is still considerable debate as to how much the results of *any* twin study can tell us of the relative strengths of genetic and environmental factors. These problems are discussed in the next section.

3. CRITICAL ANALYSIS OF THE STUDIES

3.1. Explaining the observed variability of a trait: The theory behind twin studies

Before an analysis of the studies mentioned in the previous section is attempted, a brief introduction to the theory behind twin studies is required.

The heritability of a given trait in a given population is that proportion of the total variance observed in that trait in that population which is attributable to inherited, genetic differences between members of that population. The remainder of the observed variation may be attributed to environmental differences, namely, differences in *common* environment (i.e. *between* families) and differences in *specific* environment (i.e. *within* families).

Thus, the simple equation for explaining phenotypic variance is:-

$$V(P) = V(G) + V(CE) + V(SE) \quad (1)$$

[where V(P) is the observed phenotypic variance,

V(G) is the variance attributable to differences in genetic factors,

V(CE) is the variance attributable to differences in common environment, &

V(SE) is the variance attributable to differences in specific environment]

Analysing the relative contributions of genetic and environmental factors in terms of variance has the advantages of simplicity and generalizability; trait variation so expressed may be divided into additive components that sum to the whole. Also, the use of variance allows us to generalise the results of an individual study onto the given population as a whole, while still retaining the additive nature of the model. However, a better indication of the relative importance of the respective influences on individual differences in a trait is given by the square root of each expression of variance (this is Wright's formulation - see Eysenck 1979, p107).

Equation 1 requires that the components due to genetic factors, common environmental factors and specific environmental factors are independent. The true situation is complicated by the possibility of genotype-environment interaction and of covariance of genotype and common environment. An interaction occurs when particular combinations of genes and environments have unexpected effects: for example, although a given environment might be beneficial for most genotypes, it may be detrimental to one specific genotype. Such effects can alter the apparent differences in the amount that genetic and environmental factors contribute towards the observed variation of a trait in either direction. Covariance can occur when a particular genotype tends to be associated with a particular common environment. This would have the effect of reinforcing genetic and common environmental influences, whilst accentuating individual differences and artificially lowering the true degree of variance from all sources.

The simple model of heritability groups all variability in a trait due to genetic factors under the label V(G). In fact, there may be several components to genetic variance. The *additive* component is that

attributable to all individual genes whose action does not depend on their genetic context. The *dominance* component is the proportion of genetic variance attributable to dominant genes, that is, where the effect of a gene may depend on what other allele is present at that chromosomal locus. Finally, an *epistatic* component may exist, where the effect of a particular gene may depend on what other genes are simultaneously present.

The distinction is therefore often made between *broad* heritability, which refers to all of the genetic variance, and *narrow* heritability, which refers to just that portion of the genetic variance which is additive in nature.

There are several situations in which the additive genetic component of variance may deviate from expected values. One example is that of *assortative mating* (when mating tends to occur between individuals who are similar in the particular trait in question). Almost by definition, assortative mating must be a significant factor in the genetics of sexual orientation. Such a situation tends to increase the amount of additive genetic variance from that expected from random mating, but the average level of the trait in the population is not affected (see Fuller & Thompson 1978, or Loehlin *et al.* 1975 for further details).

The simple model of heritability is further complicated by the fact that the environment in which a child grows up is, in part, determined by the *genetic* makeup of its parents. Such cultural influence means that many aspects of what we consider to be environment (e.g. social class differences, cultural quality of the home) may themselves be partly genetic in origin.

Bearing the above points in mind, it is hardly surprising that studies attempting to investigate the relative importance of genetic factors versus environmental factors in determining the phenotypic expression of a trait are often easily criticised on theoretical, as well as methodological, grounds. The use of twins to study such factors also introduces problems. All such criticisms are discussed in the next section.

3.2. Problems with the twin study method

One of the fundamental assumptions of the twin study method is that closer resemblance in monozygotic twins is due to closer genetic similarity rather than more shared environment, i.e. that monozygotic and dizygotic twins share environment to the same extent. However, there is considerable evidence that the common environment is not the same for the two types of twins; the 'twinning reaction', or mutual dependence between twins, is greater between identical twins than between fraternal twins (e.g. Farber 1981, Eysenck 1979). Kamin notes that identical twins tend to be treated very similarly by parents, teachers etc., spend more time together, have more mutual friends, and so on, than do fraternal twins. Conversely, identical twins may, possibly unconsciously, try to make themselves slightly different from their cotwins in appearance, manner etc., in order to achieve a greater degree of individuality. Farber suggests that such "minute interpersonal and intrapsychic events may be the most potent in altering at least some traits fundamentally linked to the somatic blueprint of the individual."

Such tendencies of monozygotic twins to differentiate themselves from each other are, of course, related to their initial degree of similarity. However, a small proportion of monozygotic twins are *not* strikingly similar in appearance (see, e.g. Eysenck & Kamin 1981). If a twin study relies purely on physical similarity to determine the zygosity of twins, then it is likely that a number of monozygotic twins will therefore be misclassified as dizygotic. This criticism can be applied to some of the earlier twin studies in many fields, but more recent research has utilised more reliable techniques for zygosity determination

(e.g. blood-group matching, fingerprint ridge counts etc.).

Roughly two-thirds of identical twins are monochorionic, that is, they shared the same chorion, and hence the same blood supply, during prenatal development. In such an arrangement, one twin receives the maternal blood supply after it has passed through the other, and is therefore at a severe competitive disadvantage regarding oxygen supply, hormone supply, etc.. The consequences of this on the later development of the twins can include gross phenotypic differences, even before postnatal influences of the family are considered (Mesnikoff *et al.* 1963). Such a process can lead to an over-estimation of the proportion of variance attributable to the specific postnatal environment of the twins.

Conversely, if we consider the production of hormones by the foetus as opposed to those supplied by the mother, the quantity of hormones produced, along with the absolute and relative timing of production, is controlled by the genetic code of the developing individual. Therefore, monozygotic twins experience higher similarity in *foetal* hormone production, both in timing and in amount, than do dizygotic twins. This has the effect of increasing the similarity for prenatal-hormonally determined traits in monozygotic twins relative to dizygotic twins.

Considering the penultimate point, even monozygotic twins, sharing exactly the same genes, may display phenotypic differences due to their different prenatal environment. Things becomes even more complicated, however, when one considers that not all of an individual's genes are active at any point in his or her life. Gottesman (1974) states that "it cannot be over-emphasized that it is *environmental* factors through such extracellular metabolic intermediates as hormones, vitamins and toxins that determine *which* genes get switched on and how long they function . . . Since only a small portion of the genome (perhaps 5-20%) is activated at any one time, the *effective* genotype upon which environmental factors are acting is constantly changing." Farber (1981) points out that such genetic 'timetables' of vulnerability to environmental influence may be more similar among identical twins than fraternal twins, and more similar among fraternal twins than non-twins. She therefore suggests that "some of the similarity in specific traits is not so much because the trait itself is strongly predetermined, but because the twins were susceptible to environmental influence when they were in similar stages of psychological and maturational organisation." Such factors would lead to an overestimate of heritability estimated from twin studies.

It is, in fact, generally found that twin studies of a particular trait suggest higher estimates of heritability than do adoption studies (Plomin, 1990). In addition to Farber's proposed process, this may also be explained by nonadditive genetic variance, such as epistasis, which covaries completely for identical twins, but contributes little to the resemblance of first-degree relatives.

In many twin studies it is likely that at least two types of bias operate in the selection of twins pairs for inclusion in the sample from all possible twins in the population who meet the criteria for the study. One such bias is *concordance dependent ascertainment*, where the probability of twin pairs being included in a study of a particular trait is dependent on whether they are concordant or discordant for that trait. Such a bias can occur in a number of ways, even when a voluntary recruitment procedure is adopted. Another bias that may occur is that of *non-independent ascertainment*, where ascertainment probability depends on the combination of within-pair similarity and the type of relative (e.g. monozygotic or dizygotic twins); for example, it may happen that concordant monozygotic twins are more likely to be included in a particular study than are concordant dizygotic twins.

If a twin sample is obtained which has avoided all such biases, then we still have to ask whether *any* sample of twins can be representative of the population from which they were drawn. For example, the

probability of a twin birth increases with the age of the mother until about the age of 39 (see Farber 1981, chapter 1). This leads to an increased chance of chromosomal anomalies in twins which could affect the concordance rate for traits associated with that chromosomal locus. Farber also points out that there is a high frequency of premature births in multiple deliveries. She suggests the possibility that prematurity can make an individual differently susceptible to the environment than a full-term individual is.

Gottesman and Carey (1983) suggest several internal checks that may be performed on twins sample data so that some confidence may be felt regarding their representativeness. These include checking the proportion of the two sexes, the proportion of various zygosities, and whether twins are over-represented in the reference population of the trait in question. Of course, such checks require knowledge of the corresponding figures for the reference population, which are often uncertain.

All of the above represent formidable, if not insurmountable, problems for the experimental design of a twin study from which we can hope to obtain any meaningful, generalizable results. This has not, as we have seen, prevented a substantial number of researchers from conducting such studies. But even if we assume that these problems have been overcome, the interpretation of the results of twin studies, usually given in terms of concordance rates for monozygotic and dizygotic twins, is problematic.

The ratio of concordance in identical twins to that in fraternal twins may seem like a promising statistic, but is, in fact, not very informative. For example, such a ratio is sensitive to the base rate of the trait in the given population, and will usually have a considerable associated standard error (Kendler, 1989). Also, Gottesman and Carey (1983) demonstrated that quite different concordance rates between the sexes can reduce to the same estimates of underlying heritability.

For a better understanding of the results of twin studies, Gottesman and Carey recommend "that appropriate population risks be determined and that the concordance rates be converted into correlations in the liability toward developing the disorder." They end their report on twin studies on an optimistic note, by listing recent innovations and developments which should assist twin research. Such developments include multivariate analysis, longitudinal twin study analysis, brain scan differences, the use of data on other relatives to check on the assumptions of twin strategies, and a renewal of interest in identical twins reared apart.

3.3. Specific problems with the twin studies of homosexuality

Many of the criticisms of twin studies mentioned in the previous section apply to the twin studies of homosexuality.

Rosenthal (1970) has severely criticised Kallman's 1952 study for the high incidence of psychiatric disorders among the probands and their cotwins. He comments that "only 10 of the 80 monozygotic twins and 18 of the entire sample (170 individuals) were thought to be 'sufficiently adjusted' emotionally and socially." There is a possibility that the homosexuality shown by some of the twins is secondary and reactive to their psychopathology, or vice versa. Kallman's study could also be subject to non-independent ascertainment and concordance-dependent ascertainment, although the exact method of recruitment is not explained in his report. As for the 100% concordance rate reported among monozygotic twins, Kallmann himself regarded this as a "statistical artifact" (see his discussion at the end of Rainer *et al.*'s 1960 report), and was not surprised when monozygotic twins discordant for sexual orientation were reported. Lykken *et al.* (1987) point out that many twin studies have a disproportionate

number of monozygotic probands compared to the given population. This criticism applies to Kallman's report, which included 40 monozygotic pairs and 45 dizygotic pairs. The proportion of monozygotic to dizygotic twins in American and European populations is roughly 1:2 (see Lykken *et al.* 1987). For these reasons, Kallman's study cannot be considered as representative of the American population as a whole, but is best looked upon as a useful and provocative preliminary publication that has prompted much subsequent research.

Heston and Shields (1968) explain their recruitment and interview techniques in more detail. They emphasize that twins recruited through the Maudsley Twin Register are unselected as regards concordance and zygosity, and attempt to show that monozygosity *per se* is not associated with homosexuality, and that the incidence of homosexuality in members of same-sexed male twins is no greater than in the parent Maudsley population. Their data may therefore reasonably be considered as representative of this population (but note the small numbers of probands involved), but, again, we see a high incidence of psychiatric disorders in probands and their cotwins. Hence, there is difficulty in generalizing the results of this study onto a larger population.

As Bailey and Pillard point out, their 1991 investigation falls short of the ideal recruitment procedure of systematic sampling from a well-specified population. They admit that concordance-dependent ascertainment (which they term type 1 bias) might have occurred, but note that "concluding that sexual orientation is partially heritable based on different patterns of monozygotic and dizygotic twin concordance is equally valid whether or not type 1 bias occurred." Non-independent bias may also have affected the results; probands with heterosexual adoptive brothers were significantly less likely to consent to have their relative contacted than probands with heterosexual twins, whereas cooperation did not differ notably if relatives were homosexual. Bailey and Pillard suggest that this could lead to an underestimation of the proportion of heterosexual relatives in the adoptive brothers, compared with the twin subsamples, resulting in an *underestimation* of heritability. They also found that, contrary to the predictions of a simple genetic hypothesis, the rate of homosexuality in nontwin brothers was lower than that of dizygotic cotwins, and roughly equal to that of adoptive brothers. Two possible explanations for this finding were suggested, as described in the previous section, one being merely fluctuations in sampling. Hence, the desirability of replicating the findings is emphasized. Despite these shortcomings, this study clearly represents the most significant research in twin studies of homosexuality conducted to date, and its findings suggest many questions which should be addressed by future studies.

The smaller case studies of homosexuality in twins may be useful in highlighting similarities or differences in the environment experienced by each twin of a pair that have lead to their concordance or discordance for sexual orientation. However, by their very nature (e.g. small sample sizes, bias in recruitment etc.) they cannot produce results which can be generalised to a wide population. It should be noted that many of these reports are of a psychoanalytic nature, and the combined results of many such cases have lead to the development of psychoanalytic theories of homosexuality (see Freud 1953, Friedman 1988, Lewes 1989, and next section). However, such theories can, at best, only be generalised onto the population of individuals receiving psychoanalytic treatment.

The only study of homosexuality in identical twins reared apart is that of Eckert *et al.* (1986). Some of the problems associated with the data were discussed in the previous section. Although the Minnesota study maintains notably stringent criteria for inclusion of twins, such studies can never fulfil all of the theoretical assumptions upon which heritability calculations are based. It has been suggested (see, e.g. Farber 1981) that even an awareness of twinship in separated twins can affect their development. Even twins separated at birth have shared the prenatal environment of the uterus, which, according to recent theories, may have a critical role in the development of sexual orientation (see next section). Therefore,

if separated identical twins show concordance for a particular trait, this cannot, in practice, be directly attributed entirely to their shared genes.

3.4. Conclusions from the studies conducted to date

For the many reasons mentioned in the previous section, it is inappropriate to pool the data from the studies to perform some type of meta-analysis (e.g. Rosenthal 1984, Oakes 1986). In their paper on the analysis of twin data, Gottesman and Carey (1983) emphasize the importance of only comparing data pertaining to common population risk and diagnostic criteria.

The studies summarised are of inconsistent quality, with biased and limited samples. Lykken *et al.* (1987) suggest that the "only wholly dependable method of avoiding errors of recruitment bias may be to employ an incentive or method of recruitment that is about equally effective with dizygotic as with monozygotic twins, preferably a method that is successful with most (>80%) of pairs solicited." Unfortunately, such methods are seldom, if ever, available.

The greatest problem for studies of this type remains that of recruiting large numbers of non-institutionalised probands due to the social ostracism of homosexuals. This problem is gradually diminishing, as evidenced by Bailey and Pillard's 1991 study, but is still far from being negligible.

As for the theory behind twin studies, it has been shown that there are flaws in many people's understanding of the concept of heritability. For example, Bouchard *et al.* (1990) point out that heritability must increase as V(E), the variance affected by the environment, decreases. Hence, the heritability of a psychological trait reveals as much about the culture as it does about human nature.

Bailey and Pillard's 1991 study is clearly superior to any of its predecessors in terms of experimental design and analysis of results. Although it, too, has its weak points, it is notable that the estimates of heritability derived from the data were significant under a wide range of assumptions concerning the base rate of homosexuality and the degree of ascertainment bias. In contrast, estimates of the proportion of phenotypic variance explained by shared environmental differences were not significant under the same range of assumptions.

These results give reason to believe that there is *some* constitutional component to male homosexuality. However, the twin data are consistent not only with a purely genetic explanation, but also with one involving possible differences in the degree of shared prenatal environment between monozygotic and dizygotic twins (as explained earlier, monozygotic twins experience higher similarity in *foetal* hormone production, both in timing and in amount, than do dizygotic twins). Some recent theories of the genesis of homosexuality, to be mentioned in the next section, place critical importance on hormone levels in the prenatal environment of an individual. If such theories are true, then the difference in concordance rates between monozygotic and dizygotic twins could be explained largely in these terms (see next section). It should be noted that such an explanation still relies on *genetically* controlled prenatal hormone production to account for observed differences in concordance between monozygotic and dizygotic twins.

4. CURRENT THEORIES OF THE GENESIS OF HOMOSEXUALITY

A detailed review of the many theories that have been proposed to explain the genesis of homosexuality is beyond the scope of this report. However, a very brief description of three accounts is given in order to demonstrate the different angles from which the question has been tackled.

4.1. Within family determinants: Psychoanalysis and beyond

Freud believed that all humans were born bisexual in nature, and from this state, as a result of restriction in one direction or the other, both heterosexuality and homosexuality developed (see his 'Three Essays on the Theory of Sexuality' 1953). He also made the distinction between two types of homosexual (or 'invert', to use his terminology); those who are like women, seeking masculine men, and others who seek feminine qualities in their partners. Some individuals may display predominantly one type of inversion or the other, whereas others might display a certain amount of both types of inversion. Different causal factors were therefore suspected for the two. Freud realised that the aetiology of homosexuality was complex, and suspected that "the choice between 'innate' and 'acquired' is not an exclusive one, or . . . it does not cover all the issues involved".

Early psychoanalytic theory claimed that all homosexual men have unresolved pre-oedipal conflicts, that is, they did not successfully negotiate the separation-individuation phase of early childhood. In this way, early childhood stress leads to obligatory, exclusive homosexuality, whereas stress in the later oedipal phase leads to partial, non-obligatory homosexuality.

As scientific knowledge of homosexuality has expanded, and Western society has become gradually more tolerant towards homosexuals, so the psychoanalytic theory has evolved (e.g. Friedman 1988, Lewes 1989). Indeed, in 1973 the American Psychiatric Association decided to drop homosexuality (*per se*) from the diagnostic nomenclature. It should be noted that Freud himself had maintained that "it is not scientifically feasible to draw a line of demarcation between what is psychically normal or abnormal; so that the distinction, in spite of its practical importance, possesses only a conventional value."

Freud's earlier work has since been criticised because, for example, he confounded gender-related behaviour and sexual behaviour in his writings. Much recent work in psychoanalytic theory has involved developing more sophisticated classification schemes for the different facets of homosexuality (Lewes, 1989). However, any such theory can be criticised for being generalizable only to those members of a population who attend psychoanalytic clinics.

Many of the case studies described in the previous sections have looked for specific aspects in an individual's environment during development which can lead to adult homosexuality. Such reports have commonly found one or more of the following factors to be unusual in some respect in the childhood of homosexuals: parental hopes before birth for a child of the other sex; difficulties at birth; slight anatomical differences between identical twins leading to a special attachment of one child or the other to their mother; parental attitude toward the role of the individual child, disclosed through the naming of the child; the position of the father in the family; strength of the relationship between father and child; competition for the affections of the mother; and, a 'twinning reaction' or mutual dependence between

twins, especially noticeable in identical pairs (Rainer *et al.* 1960, Joseph & Tabor 1961, Mesnikoff *et al.* 1963, Bene 1965, Holden 1965, Myers 1982, Ainslie 1985). However, such studies can tell us little of the *importance* of such factors in the genesis of sexual orientation.

Other factors within a family that have been suggested to correlate with homosexuality include the individual's birth order, parental age at birth, and family size (e.g. Slater 1962, Abe & Moran 1969, Siegelman 1973).

Homosexuality has also been linked to childhood opposite sex-dimorphic behaviour, such as effeminacy in boys (Bell *et al.* 1981, Green 1987, Buhrich *et al,* 1991). However, such behaviour is not observed in all pre-homosexual children while it is seen is some pre-heterosexual children. It is quite possible that, rather than being causative of adult sexual orientation, such behaviour is the manifestation of an innate predisposition towards homosexuality.

4.2. Genetic theories: Sociobiology and homosexuality

The last decade has seen a revival of interest in genetic theories of homosexuality (e.g. Ruse 1981 & 1988, Kirsch & Rodman 1982), due largely to the development of human sociobiology (e.g. Smith 1983).

Even before these recent theories, there was, of course, a suspicion that genetic factors were involved. Indeed, this is one of the fundamental questions addressed by twin studies. However, many previous reports (e.g. Rosenthal 1970, Fuller & Thompson 1978) have presumed that homosexuality arises through the interaction of particular genetic propensities with specific rearing environments. The sociobiological theories of sexual orientation attempt to show that it is *possible* that homosexuality can be sustained in a population through purely genetically controlled processes which have been subject to the pressures of natural selection.

The two most popular hypotheses in this field are those of balanced superior heterozygote fitness and of kin selection for altruistic behaviour.

Briefly, the former hypothesis supposes that phenotypic homosexuality is the result of homozygosity for recessive 'homosexual' genes. If a heterozygote, possessing one 'homosexual' genetic allele and one 'heterosexual' allele, is phenotypically heterosexual, *and more reproductive than an individual who is homozygotic for the 'heterosexual' alleles,* then the heterozygotic combination will be preferentially selected in future generations. In this way, the 'homosexual' genes are preserved. This explanation may seem implausible; for one thing, it hardly seems likely that only a single, major gene is involved in determining sexual preference However, various genetic concepts (incomplete penetrance, epistasis, etc.) may be utilised to expand the hypothesis (e.g. Klintworth 1962, Fuller & Thompson 1978).

The key to the kin selection hypothesis is that it does not matter *how* one's genes are passed to the next generation, as long as they are. Siblings share, on average, 50% of their genes. Therefore, if an individual shows altruistic behaviour towards its siblings which results in an increased likelihood of the siblings leaving or raising offspring, then that individual is, in effect, favouring its own success. Although it is hard to see how such a process could operate in modern society, sociobiology concerns itself with how behavioural traits have *evolved* and been *selected* from primitive societies to the present day. It has been suggested that, in primitive societies, homosexuals may have formed a 'sterile caste' which could devote itself to helping mothers to rear their young.

Sociobiological explanations of homosexuality are recent and very speculative, and are currently intended only to highlight the *possibility* of genetic transmission of such a trait. Much more research is required before these hypotheses can develop into credible scientific theories.

4.3. Neurohormonal theories

Early studies of hormonal influences on sexual orientation concentrated on levels of circulating sex hormones in adults. Different investigations reported conflicting results (see Ruse, 1988), and, in general, little evidence has been found for consistent differences in the levels of these hormones in homosexuals compared to heterosexuals.

Since the 1970s, hormonal theories emerged which concentrated on differences in prenatal hormone levels (see Ellis & Ames, 1987). Many studies have shown that abnormal levels of some prenatal hormones can lead to an increased chance of homosexuality in an individual (e.g. Dörner *et al.* 1983, Money *et al.* 1984, Ehrhardt *et al.* 1985).

Ellis and Ames (1987) have proposed a very comprehensive gestational neurohormonal theory of human sexual orientation, which deals with the genesis of heterosexuality as well as homosexuality. They propose that sexual orientation is primarily determined by the degree to which the nervous system is exposed to testosterone, estradiol, and to certain other sex hormones while neuro-organization is taking place, predominantly between the middle of the second and the end of the fifth month of gestation. According to this theory, "complex combinations of genetic, hormonal, neurological, and environmental factors operating prior to birth largely determine what an individual's (adult) sexual orientation will be."

This theory makes many testable predictions, e.g. that homosexuality should primarily be a male phenomenon, that homosexuals should have higher frequencies of other sexual inversions than heterosexuals, that relationships between parents and homosexual offspring may be strained and/or assume some cross-sex characteristics, and that homosexuality should reflect a significant degree of heritability (as hormone production and action is under significant genetic control). Such predictions seem to agree with previous research and general intuitions regarding homosexuality.

In addition, as prenatal testosterone levels are of great importance according to the theory, and as, during the proposed critical period, intra-uterine testosterone is primarily of foetal, rather than maternal, origin, this theory could explain the observed differences in concordance rates for sexual orientation between monozygotic and dizygotic twins. According to such an explanation, the increased concordance in monozygotic twins is due to their greater similarity in prenatal hormone production (both in quantity and in timing) and hormone control; processes which are under significant genetic control.

Support for the gestational neurohormonal theory includes a recent study (LeVay, 1991) which reported a difference in hypothalamic structure between heterosexual and homosexual men, although Ellis and Ames warn that several decades of intense, further research may be required to adequately test the theory.

4.4. Which is correct?

The many different theories of the origins of homosexuality are not all mutually exclusive. For example, psychoanalytic theories describe interfamily and intrapsychic factors leading to inversion, and it is

perfectly possible that such environmental factors are largely governed by the genetic makeup of the members of the family. Sociobiological theories, on the other hand, concentrate on genetic mechanisms for the transmission of homosexuality, while accepting that such mechanisms may operate by influencing the environment which an individual experiences during development. The gestational neurohormonal theory allows for significant control from both genetic and environmental factors.

Psychoanalytic theories may be criticised for being largely descriptive rather than explanatory, and for being derived from a sample which is unrepresentative of the wider population. The sociobiology of homosexuality lies more in the realm of the hypothetical than the proven, and neurohormonal theories still require much corroboratory research. However, research in many areas of homosexuality is proceeding at an accelerating pace, so we can expect a much clearer understanding of the genesis of homosexuality within the next few decades.

5. SUMMARY AND CONCLUSION

The phenomenon of homosexuality is widespread throughout history and society. Recent studies have estimated the prevalence of predominant homosexuality in adult males of Western societies to be in the range of 2-8%. As early as the turn of the century, Krafft-Ebing (1922) suggested that sexual orientation was genetically determined, and the recent development of human sociobiology has led to several other theories which link homosexuality exclusively to genetically-controlled processes.

The use of twin studies provides us, in theory, with a method of investigating the relative importance of genetic and environmental factors in the genesis of homosexuality. Three notable twin studies in this area have been conducted to date, by Kallman (1952), Heston and Shields (1968) and Bailey and Pillard (1991). However, the former pair of studies were based on highly biased samples so that their findings cannot be generalized to a larger population. Bailey and Pillard's results suggested that homosexuality has a high component of heritability. Many smaller studies of the sexual orientation of twins have also been reported, which, while not widely generalizable, often give insights of differences in the rearing environment experienced by members of a twin pair which can lead to divergent orientation in adulthood. Eckert *et al.* (1986) studied sexual orientation in identical twins reared apart, and found concordance in a male pair, but discordance in three female pairs. However, many methodological problems are associated with such investigations.

Several reports have suggested that homosexuality is not a diagnostic entity, but rather that several types of homosexuality, each with a different combination of aetiological factors, may exist. There is some evidence that the determinants of sexual orientation in females may be different to those in males. It is hard to draw any conclusions on this from the existing literature, as very little attention has so far been given to lesbianism. There are also problems associated with the methods of classification used by researchers, and growing dissatisfaction with categorizing an individual as *either* homosexual *or* heterosexual.

Theoretical problems of twin studies have been considered, which cloud the distinction between genetic and environmental influences of a trait. Such problems mean that the results of twin studies can, at best, only be considered as suggestive of the relative importance of such influences.

Many theories have been proposed to explain the genesis of homosexuality, including psychoanalytic, sociobiological and gestational neurohormonal theories. Of these, the latter is the most scientifically comprehensive and testable. The gestational neurohormonal theory is consistent with many of the data used as evidence for genetic contributions, because production and control of the critical hormones are under significant genetic control.

From the data reviewed in this report, it seems reasonable to conclude that male homosexuality, or, at least, some 'types' of male homosexuality, are under some degree of genetic control, although various problems with this data prevent more precise conclusions from being drawn. Little can be said of the origins of female homosexuality.

Research, including twin studies of improved design, is continuing at a rapid pace. We can therefore expect clearer answers to many of the questions highlighted in this report within the coming years.

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