Chapter 10

Review of the evidence: sexual orientation

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Background

10.1 There has always been considerable interest in biological explanations of homosexuality, as in other aspects of human behaviour. Until the 1970s, homosexuality was classified as a mental disorder in many Western countries, which meant that much research was aimed at developing 'cures' for the 'disease'.[1] Today, the vast majority of countries do not classify homosexuality as a disease. Nevertheless, attitudes towards homosexuals are often negative, hostile and discriminatory. Homosexual behaviour remains illegal in over 40 countries across Africa, Asia, Europe, the Middle East and the Americas, and in some, it is punishable by death.[2] Even in those countries in which homosexuality is not illegal, it is often the case that homosexual couples are not awarded the same legal rights and recognition as heterosexual couples.

10.2 There remains considerable controversy about whether sexual orientation is a matter of choice and whether it is possible to change one's sexual orientation. A recent Gallup poll conducted in June 2001 on Americans' attitudes towards homosexuality asked 'In your view, is homosexuality something a person is born with or is homosexuality due to other factors such as upbringing or environment?' 40% of respondents said that it was something a person was born with, while 39% felt that it was the result of environmental factors. This was the first time that opinion had been equally split since the first poll in 1977, at which time the respective figures were 13% and 56%. During the period 1977–2001, there was also a gradual increase in adherence to the belief that homosexuality is an acceptable alternative lifestyle, though approximately half of those questioned in 2001 still thought it was not. Various polls have shown that people who believe homosexual orientation cannot be changed, is biologically based or is not a choice are more likely also to believe that there should not be social or criminal sanctions against homosexual behaviour.[3]

Trait measurement and definition

10.3 The scale most commonly used to measure sexual orientation is the Kinsey Scale, which was developed in 1948. This measures sexual behaviour and fantasies on a continuum from 'exclusively heterosexual' to 'exclusively homosexual' (see Box 10.1). Individuals obtain scores of between zero and six, with zero and one usually classed as heterosexual and five and six classed as homosexual, for the purposes of the research. There is an additional category for individuals with no sexual contacts or reactions. Other measures, such as the

[1] Most countries use one of two classification and diagnostic systems for psychiatric illness: the Diagnostic Statistical Manual for Mental Disorders (DSM), published by the American Psychiatric Association, or the International Classifications of Diseases, Mental Disorders Section (ICD). Homosexuality was removed from the DSM in 1973. A new 'disorder' of ego-dystonic homosexuality was included in the 3rd edition in 1980 but was removed six years later after considerable criticism. Homosexuality was included as a psychiatric disorder in the ICD until the publication of its 10th edition in 1993.

[2] The International Lesbian and Gay Association. (September 1999). International Lesbian and Gay Association World Legal Survey 1999. http://www.ilga.org/Information/Legal_survey/ilga_world_legal_survey%20introduction.htm. (9 August 2002).

[3] See, for example, Whitley, B. E., Jr. (1990). The relationship of heterosexuals' attributions for the causes of homosexuality to attitudes toward lesbians and gay men. *Pers. Soc. Psychol. B.* **16**, 369–77; Piskur, J. & Degelman, D. (1992). Effect of reading a summary of research about biological bases of homosexual orientation on attitudes toward homosexuals. *Psychol. Report*. **71**, 1219–25.

Klein Sexual Orientation Grid, include a wider range of variables such as sexual attraction, self-identification, emotional preferences, social preferences and lifestyle. However, these more detailed measures complicate the analysis of data and are thus used less commonly.

Box 10.1: The Kinsey scale of sexual orientation

0 Exclusively heterosexual
1 Predominantly heterosexual/only incidentally homosexual
2 Predominantly heterosexual but more than incidentally homosexual
3 Equally heterosexual and homosexual
4 Predominantly homosexual but more than incidentally heterosexual
5 Predominantly homosexual/only incidentally heterosexual
6 Exclusively homosexual

10.4 Scales such as the Kinsey Scale are designed for self-reporting. In many studies of the biological basis of sexual orientation, data about family members and relatives are also collected. Often this is done by administering questionnaires or interviews, but in some cases, research participants are asked to estimate the sexual orientation of their relatives based on their own experience of them. The correlation of self-reports by relatives and reports about their relatives by research participants is usually high, but does leave open the possibility that some individuals will be assigned to the wrong group.

10.5 There are numerous ways in which biological features could, in theory, influence sexual orientation. For example, they could affect sexual orientation directly by influencing the physical development of the brain. Alternatively, they could operate indirectly by affecting personality and temperament, which in turn could affect an individual's development and interaction with environmental factors. These biological influences need not be genetic; they could, for example, be chemical or hormonal. However, it should be remembered that the control of hormones is largely mediated through genetic factors. This section summarises the results of key research into genetic and other biological influences on human sexual orientation.

Current findings: quantitative genetics

Families

10.6 The rate of homosexual orientation in the general population has been variously estimated between 2% and 10% depending on the criteria used, with 4–5% being the most common estimate for males, and around 2–4% for females.[4] Calculations of the rate of homosexuality are made difficult by the fact that some individuals may not wish to divulge their sexual orientation to a third party, and because of the various ways in which sexual orientation can be defined and measured.

10.7 A number of studies have calculated the rate of homosexual orientation among siblings where one sibling is homosexual.[5] Most studies show that the rate of homosexuality among

[4] See for example Le Vay, S. (1993). *The Sexual Brain*. Cambridge, MA: MIT. p.108. The British National Survey of Sexual Attitudes and Lifestyles (2000) found rates of up to 8.5% in males aged 26–44.

[5] Bailey, J. M. & Pillard, R.C. (1995). Genetics of human sexual orientation. *An. Rev. Sex Res.* **6**, 126–50.

the brothers of a male homosexual appears to be around 9%, though one study found a much higher rate of 22%. The rate of homosexuality among the sisters of a male homosexual appears to be around 5%. Findings of the rate of homosexuality among the sisters of a homosexual female range from 6% to 25%.[6] The rate of homosexuality among the brothers of a homosexual female appears to be around 10%. These results indicate that homosexual males may be more likely to have homosexual brothers than homosexual sisters. Homosexual females may be more likely to have homosexual sisters than homosexual brothers. This suggests that the factors influencing homosexual orientation may be different for males than for females.

Twins and adopted siblings

10.8 In recent years, three studies have examined the concordance rates for sexual orientation among monozygotic (MZ) and dizygotic (DZ) twins and their biological and adoptive siblings. These studies show that there is a significant genetic influence on sexual orientation. However, although all the studies show the same general trend, there is considerable variation in the levels of concordance identified. This may be explained by the sampling methods used. The studies that found the highest concordance rates were those obtained in samples recruited through homophile publications rather than selecting participants from the general population, which may have led to biased samples. Further, an obvious point, but one worth making, is that even the highest concordance rates found for identical twins are in the region of 50%, which indicates that environmental factors are at least as important as genetic factors in explaining variation in sexual orientation.

Male homosexuality

10.9 Bailey and Pillard found that 52% of the MZ co-twins of male homosexual twins were also homosexual or bisexual.[7] For DZ male twins, this fell to 22%, which suggests that genetic factors may be influential. The researchers estimated the heritability of male homosexuality and bisexuality to be between 0.31 and 0.74. Analysis of the various models of the possible influences on sexual orientation developed by the researchers showed that genetic influences were always statistically significant, while non-shared environmental influences were sometimes significant, and shared environmental influences were never significant.

10.10 The study also found that 11% of the adopted brothers of homosexual or bisexual male twins were also homosexual or bisexual, and that 9% of non-twin biologically-related brothers of homosexual or bisexual male twins were homosexual or bisexual. If the rate of homosexuality in the general population is estimated at around 4%,[8] the higher rate of concordance for homosexuality in adopted siblings than in the general population points to a substantial environmental contribution. However, since there is no agreed rate of homosexual orientation in the population, and since this research assessed rates of homosexuality and bisexuality together, this conclusion must be treated with caution.

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[6] Pillard, R. C. & Weinrich, J. D. (1986). Evidence of familial nature of male homosexuality. *Arch. Gen. Psychiat*. **43**, 808–12.

[7] Bailey, J. M. & Pillard, R. C. (1991). A genetic study of male sexual orientation. *Arch. Gen. Psychiat*. **48**, 1089–96. The researchers defined a score of greater than 1 on the Kinsey scale as homosexual or bisexual, treating homosexuality and bisexuality as one group for their research.

[8] Gebhard, P. H. Incidence of overt homosexuality in the United States and Western Europe. In Livingood, J. M., editor. (1972). *NIMH Task Force on Homosexuality: Final Report and Background Papers*. Rockville, MD: National Institute of Mental Health. Other estimates range from 2 to 10%. Female homosexuality is less prevalent, perhaps about half as common as male homosexuality.

10.11 It is interesting to note the discrepancy between concordance rates between DZ twins (22%), and those for DZ twins compared to their non-twin brothers (9%). Since DZ twins and their non-twin siblings are genetically similar to the same degree, the difference in concordance points to an important environmental factor that makes non-identical twins more similar than siblings. Bailey and Pillard acknowledge this possibility but observe that another study found the concordance rates to be more similar and note that their results could be explained by sampling fluctuations. Another interesting feature of their study is that non-twin biological brothers show the lowest rates of concordance, lower even than adopted siblings, which seems, at first impression, to contradict a biological explanation. It is possible that this finding is the result of ascertainment bias, or some other feature of the research: in any case, it strongly suggests that further studies are needed before firm conclusions can be made.

10.12 More recently, Kendler *et al* conducted a study that used a random sample of approximately 3,000 people. The researchers found a concordance rate of 32% for non-heterosexual orientation in MZ twins.[9] For DZ twins of the same sex, the chance of the second twin also being homosexual or bisexual fell to 13%. The researchers estimated that the heritability of male sexual orientation was between 0.28 and 0.65.

Female homosexuality

10.13 Bailey *et al* found that 48% of MZ co-twins of female homosexual twins were also homosexual.[10] For DZ female twins, the chance of the second twin also being homosexual fell to 16%; 6% of adoptive sisters of female homosexual twins were also homosexual. The homosexual female twins studied reported concordance rates of 14% with their non-twin sisters. The researchers calculated the heritability of sexual orientation to be between 0.27 and 0.76.

Current findings: molecular genetics

10.14 In the light of the evidence from family, twin and adoptive studies which suggests that genetic factors, along with environmental factors, may influence sexual orientation to some degree, attempts have been made to identify the particular genes involved. The most well-known research is that of Dean Hamer, who received considerable publicity in the early 1990s and was widely reported as having discovered the 'gay gene'. Hamer studied 40 pairs of homosexual brothers who all had family histories that indicated a high rate of homosexuality on the mother's side.[11] He interpreted this to mean that a genetic influence on sexual orientation might be found on the X chromosome in these families. In 33 of the 40 sibling pairs, he identified significant similarities in the genetic markers in a particular region of the X chromosome called Xq28, which contains 4 million base pairs and approximately one hundred genes. Since male children only inherit one X chromosome from their mothers, who have two X chromosomes, the probability of both brothers in a sibling pair having inherited the same part of the X chromosome is only 50%. Thus, the finding of 82% of sibling pairs with shared DNA in this region was found to be significant.

[9] Kendler, K. S., Thornton, L. M., Gilman, S. E. & Kessler, R. C. (2000). Sexual Orientation in a US National Sample of Twin and Nontwin sibling pairs. *Am. J. Psychiat*. **157**, 1843–6.

[10] Bailey, J. M., Pillard, R. C., Neale, M. C. & Agyei, Y. (1993). Heritable factors influence female sexual orientation. *Arch. Gen. Psychiat*. **50**, 217–23.

[11] Hamer, D. H., Hu, S., Magnuson, V. L., Hu, N. & Pattatucci, A. M. L. (1993). A linkage between DNA markers on the X chromosome and male sexual orientation. *Science* **261**, 321–7.

10.15 Two years after Hamer's original study, his group of researchers replicated the Xq28 finding, but with less significant results, and using a smaller number of families.[12] They found that 67% of homosexual brothers had inherited the same Xq28 region as each other. The researchers also found that there was no significant linkage for homosexual female siblings.

10.16 In 1998, Sanders *et al* replicated the work in a study involving 54 homosexual sibling pairs. They found that 66% of the pairs of brothers shared the Xq28 region. Their work was presented at the American Psychiatric Association Annual Meeting in Toronto in 1998 but has not yet been formally published. In a similar-sized sample to the Sanders *et al* study, Ebers and Rice found no indication that Xq28 contained a gene that influenced sexual orientation.[13] They examined 52 pairs of homosexual brothers and found that only 46% shared the Xq28 region, which was not statistically significant. Their study differed from the original work in that it did not select participants on the basis of evidence of maternal transmission. However, the researchers argued that even if this methodology were applied, their data would still fail to yield significant results.

10.17 In 1999, Hamer combined the data from these four studies and estimated the percentage of brothers who shared the Xq28 region at 64%. While this result is less significant than his initial result, Hamer's meta-analysis of DNA linkage data continues to support the hypothesis that Xq28 may contain genes that have a role in sexual orientation in males, but indicates that the association is not as strong as was first suggested.

Current findings: research involving animals

10.18 Homosexual behaviour in animals has been widely reported,[14] but research into the genetic basis of such behaviour is less common. One study involving fruit flies showed that by manipulating an individual gene, male fruit flies could be made to initiate homosexual courtship.[15] It is interesting to note that the male fruit flies that had not been genetically modified nevertheless also engaged in courtship and sexual behaviour with the 'homosexual' fruit flies. However, the issue of the extent to which human traits can be meaningfully compared to animal behaviour seems particularly pertinent in the context of sexual orientation, in view of the many facets of this trait in humans, beyond overt, observable behaviours:

> 'flies do not have beliefs and desires. This is a quite serious objection to the view that flies have sexual orientations in anything like the sense that humans do and, thereby, the views that flies can be useful models of human sexual desire'.[16]

[12] Hu, S. *et al*. (1995). Linkage between sexual orientation and chromosome Xq28 in males but not in females. *Nat. Genet*. **11**, 248–56.

[13] Rice, G., Anderson, C., Risch, N. & Ebers, G. (1999). Male homosexuality: absence of linkage to microsatellite markers at Xq28. *Science* **23**, 665–7.

[14] See, for example, Vines, G. (1999). Queer Creatures [editorial]. *New Scientist* 7 August.

[15] Zhang, S.-D. & Oswald, W. F. (1995). Misexpression of the white (w) gene triggers male–male courtship in *Drosophila*. *Proc. Natl. Acad. Sci. USA* **92**, 5525–9.

[16] Stein, E. (1999). *The Mismeasure of Desire: the Science, Theory and Ethics of Sexual Orientation*. Oxford: Oxford University Press. pp. 167–9.

Current findings: other biological influences

10.19 The research into genetic influences on sexual orientation does not provide any information about the mechanisms by which genes might influence behaviour. However, a number of studies have examined physiological features that may be correlated with sexual orientation. In 1991, LeVay conducted research into an area of the brain called the anterior hypothalamus, which contains four cell groups called the interstitial nuclei of the anterior hypothalamus (INAH).[17] The INAH neurons had already been shown to be larger in men than in women, and LeVay hypothesised that they could be relevant in sexual behaviour. His research found that a particular group of neurons called INAH3 was significantly larger in heterosexual men than in homosexual men. However, his research was criticised for using as its sample the brains of men who had died of AIDS, since it was possible that the disease may have affected their brains, and for having a small sample of only 41 people. Le Vay noted that his research left open the question of whether 'the structural differences were present at birth and later influenced the men to become gay or straight, or whether they arose in adult life, perhaps as a result of the men's sexual behaviour'.[18]

10.20 The same year, other researchers showed that a bundle of nerves that connects a small region of the right and left sides of the brain, the anterior commissure, is bigger in homosexual men than in heterosexual men.[19] However, evidence of a correlation between aspects of brain structure and a behavioural trait does not by itself provide any guidance on which came first, or whether both are influenced by an entirely separate variable. The idea of neuroplasticity – that experience itself changes the way the brain is formed – is an important concept.

10.21 Other researchers have examined the possibility that exposure to particular hormones and chemicals before birth may be linked to sexual orientation later in life. In 1994, it was reported that homosexual men have a leftward asymmetry in the number of ridges on their fingerprints.[20] Fingerprint ridge development takes place before birth and is influenced by androgens released from the mother to the fetus. Androgens are also thought to be responsible for finger length, and a recent study showed that the ratio of second finger length to fourth finger length is greater in women than in men; women's fingers are on average more similar in length.[21] Homosexual women had a significantly smaller ratio than heterosexual women (in other words, their hands were more like men's hands) but no significant difference was found between homosexual men and heterosexual men. However, as the researchers noted, there is considerable overlap and it is not possible to use finger ratios to predict sexual orientation with any accuracy.

10.22 In 1998, Ellis reported that very high levels of stress during the second trimester of

[17] Le Vay, S. (1991). A difference in hypothalamic structure between heterosexual and homosexual men. *Science* **253**, 1034–7.

[18] Le Vay, S. (1993). *The Sexual Brain*. Cambridge, MA: MIT. p.122.

[19] Allen, L. S. & Gorski, R. A. (1992) Sexual orientation and the size of the anterior commissure in the human brain. *Proc. Natl. Acad. Sci. USA* **89**, 7199–202.

[20] Hall, J. A. Y. & Kimura, D. Dermatoglyphic asymmetry and sexual orientation in men. *Behav. Neurosci*. **108**, 1203–6.

[21] Williams, T. J. *et al*. (2000). Finger-length ratios and sexual orientation. *Nature* **404**, 455–6.

[22] Ellis, L., Ames, M. A., Peckham, W. & Burke, D. (1988). Sexual orientation of human offspring may be altered by severe maternal stress during pregnancy. *J. Sex Res*. **25**, 152–7. See also Ridley, M (1993). *The Red Queen*. London: Penguin. pp. 264–5.

pregnancy increases the probability that a male child is homosexual.[22] Other findings include an increased rate of left-handedness among homosexuals,[23] worse performance on visuospatial tasks by homosexual men compared to heterosexual men,[24] and an association, at least in women, between sexual orientation and exposure prenatally to particular hormones.[25] The findings in this area of research into sexual orientation has led some commentators to conclude that hormones have a key role in sexual orientation: 'The "gay gene" ... is widely expected to turn out to be a series of genes that affect the sensitivity of certain tissues to testosterone.'[26]

Critical assessment of the validity of this evidence

10.23 There are numerous problems with genetic and other biological research into sexual orientation which mean that any reported findings must be viewed with caution. First, studies in molecular genetics have relied on very small sample sizes, usually fewer than 100 homosexual participants. Recruiting enough participants to obtain sufficient statistical power appears to be difficult, and the problem of small samples may account for the failure to replicate the Xq28 finding conclusively. Twin studies face similar problems of sample size, of which the researchers are aware. In reporting research that tested 71 identical twin pairs and 37 non-identical twin pairs, Bailey *et al* state 'we urge that our results be evaluated cautiously ... they are not conclusive'.[27]

10.24 Secondly, the method of recruitment of participants has been criticised, not least by the researchers themselves. There are numerous problems associated with self-selecting samples, in particular, ascertainment bias. In the case of twins, for example, 'the most likely way in which this would occur is that gay men whose twins are also gay would be more willing to volunteer than gay men with heterosexual twins'[28] perhaps because of the fear of conflict between twins with different orientations.

10.25 Thirdly, it is not clear whether researchers in behavioural genetics are able to define and measure sexual orientation adequately or comprehensively. One study has demonstrated that reported rates of familial homosexuality differ depending on the criteria used to define the trait.[29] As discussed, different scales are used in different projects. Some rely on simple questions, such as 'Have you ever had a fantasy about a member of the same sex?', which might be expected to generate higher rates of homosexual orientation than those scales which ask about life experiences and self-identification. The study by Kendler *et al* simply asked 'How would you describe your sexual orientation? Would you say you are heterosexual, homosexual or bisexual?' As the researchers note, 'the assessment of the complex phenotype of sexual orientation with a single item is far from ideal'.[30] However, it

[23] See, for example, Gotestam, K. O. *et al*. (1992). Handedness, dyslexia and twinning in homosexual men. *Int. J. Neurosci*. **63**, 179; McCormick, C. Witelson, S. & Kingstone, E. (1990). Left-handedness in homosexual men and women: neuroendocrine implications. *Psychoneuroendocrinology*. **15**, 69–76.

[24] Gladue. B. A. & Beatty, W. W. (1990). Sexual orientation and spatial ability in men and women. *Psychobiology* **18**, 101–8.

[25] McCormick, C. Witelson, S. & Kingstone, E. (1990). Left-handedness in homosexual men and women: neuroendocrine implications. *Psychoneuroendocrinology*. **15**, 69–76.

[26] Ridley, M (1993). *The Red Queen*. London: Penguin.

[27] Bailey, J. M., Pillard, R. C., Neale, M. C. & Agyei, Y. (1993). Heritable factors influence female sexual orientation. *Arch. Gen. Psychiat*. **50**, 217–23.

[28] Bailey, J. M. & Pillard, R.C. (1995). Genetics of human sexual orientation. *An. Rev. Sex Res.* **6**, 126–50.

[29] Bailey, J. M. & Benishay, D. (1993). Familial aggregation of female sexual orientation. *Am. J. Psychiat*. **150**, 272–7.

[30] Kendler, K. S., Thornton, L. M., Gilman, S. E. & Kessler, R. C. (2000). Sexual orientation in a US national sample of twin and nontwin sibling pairs. *Am. J. Psychiat*. **157**, 1843–6.

is not clear whether using multiple scales could circumvent this problem, nor is it clear whether attempts to integrate the different aspects of sexual orientation could ever accurately reflect the components of human sexual preferences. The implications of disagreement about what counts as homosexuality for research are important, as the category in which individuals are placed and the rate of sexual orientation estimated in the general population will both affect whether results appear significant. There is a tendency deliberately to conflate homosexuality and bisexuality in order to achieve more statistical power. Furthermore, researchers themselves are internally inconsistent with their classification. In the study by Bailey and Pillard described above, the researchers study both homosexual and bisexual males and calculate concordance rates accordingly, but their conclusions refer only to homosexuality.

10.26 A fundamental conceptual difficulty must be addressed by researchers in this field: is sexual orientation a dimorphic, trimorphic, or continuously distributed trait? That is to say, are there two or three distinct categories of sexual orientation or is there a spectrum of orientation? Many studies place homosexual and bisexual people in one category and contrast them with heterosexual people. This could suggest either that sexual orientation is viewed as a continuously distributed trait with easily defined points along it, or that the various orientations are entirely distinct. The former position is afflicted by the criticisms outlined regarding the measurement of the trait (paragraph 10.25). The latter position was taken by Hamer in his research into Xq28. He found that there was little overlap between individuals' self-reports on the Kinsey scale on four different aspects of sexuality: self-identification, attraction, fantasy and behaviour. Around 90% of individuals classed themselves as either 0 or 1, or 5 or 6 in all areas. Therefore, 'it was appropriate to treat sexual orientation as a dimorphic rather than as a continuously variable trait'. It is interesting to note that despite the use of measures such as the Kinsey scale, which was developed in order to reflect the spectrum of human sexual behaviour, some researchers nevertheless regard sexual orientation as dimorphic, and categorise the results of Kinsey questionnaires accordingly. A further problem is that there is no consensus about whether homosexuality in men and women is the same type of trait, or has the same origins in both sexes. It has been suggested that the specific genetic influences on sexual orientation will be different for males than for females.[31] All these uncertainties contribute to inconsistencies across research projects which make replication and comparison difficult, and allow great variation in the interpretation of results.

Evolutionary arguments against genetic influences on homosexuality

10.27 An argument often made against the possibility that homosexuality has a genetic origin is that such genes would not 'survive' in evolutionary terms, because gay couples generally do not have children. Various possible explanations for the survival of genes that influence homosexuality have been put forward. One is that the gene or genes in question have a beneficial effect on female fertility, meaning that women with the relevant genes are likely to have more children. Another possibility is that the genes are part of female mitochondrial DNA. If that were the case, they would be inherited by both male and female offspring, but only the female offspring would go on to reproduce. The resulting reduction of competition for resources among the extended family might have enhanced the reproductive success of the females.[32] Another suggestion is that homosexual family

[31] Bailey, J. M., Pillard, R. C., Neale, M. C. & Agyei, Y. (1993). Heritable factors influence female sexual orientation. *Arch. Gen. Psychiat*. **50**, 217–23.

[32] Ridley, M (1993). *The Red Queen*. London: Penguin.

members contribute to the reproductive success of an extended family by assisting with raising offspring. Finally, it has been proposed that homosexuality may be associated with another trait which is linked with improved reproductive success. All these hypotheses are no more than speculation: it is exceedingly difficult to guess how evolution may have worked with regard to a particular genetic variant. Such arguments are of very little value in answering the question of whether a genetic influence on a trait exists.

Future directions for research

10.28 Research into genetic influences on sexual orientation continues. Hamer and his colleagues are attempting to locate specific genes within the Xq28 region, although he has stated that 'There is no "gay gene" and I have never thought there was. Genes play a role, and there are probably more than one of them, and other factors as well.'[33] Other researchers are attempting to replicate Hamer's Xq28 research with larger samples, and to identify other regions of DNA that might be involved. Ongoing projects include the Australian Twin Study of Sexual Attitudes and Behaviour,[34] with data on almost 5,000 twins, and the Gay Brothers Study,[35] which has both molecular genetic and psychological components.

[33] Lehrman, S. (1995). 'Gay gene' study under scrutiny. *San Francisco Examiner* 7 July.

[34] Research on this project is led by Professor N Martin, Queensland Institute of Medical Research, Australia.

[35] Research on this project is led by Dr Khytam Dawood, Northwestern University and Professor Richard Pillard, Associate Professor of Psychiatry, Boston University.