

The Biological Evidence Challenged

Even if genetic and neuroanatomical traits turn out to be correlated with sexual orientation, causation is far from proved

by William Byne

Human-rights activists, religious organizations and all three branches of the U.S. government are debating whether sexual orientation is biological. The discussion has grabbed headlines, but behavioral scientists find it passe. The salient question about biology and sexual orientation is not whether biology is involved but how it is involved. All psychological phenomena are ultimately biological.

Even if the public debate were more precisely framed, it would still be misguided. Most of the links in the chain of reasoning from biology to sexual orientation and social policy do not hold up under scrutiny. At the political level, a requirement that an unconventional trait be inborn or immutable is an inhumane criterion for a society to use in deciding which of its nonconformists it will grant tolerance. Even if homosexuality were entirely a matter of choice, attempts to extirpate it by social and criminal sanctions devalue basic human freedoms and diversity.

Furthermore, the notion that homosexuality must be either inborn and immutable or freely chosen is in turn misinformed. Consider the white-crowned sparrow, a bird that learns its native

song during a limited period of development. Most sparrows exposed to a variety of songs, including that of their own species, will learn their species's song, but some do not. After a bird has learned a song, it can neither unlearn that song nor acquire a new one. Although sexual orientation is not a matter of mimicry, it is clear that learned behavior can nonetheless be immutable.

Finally, what evidence exists thus far of innate biological traits underlying homosexuality is flawed. Genetic studies suffer from the inevitable confounding of nature and nurture that plagues attempts to study heritability of psychological traits. Investigations of the brain rely on doubtful hypotheses about differences between the brains of men and women. Biological mechanisms that have been proposed to explain the existence of gay men often cannot be generalized to explain the existence of lesbians (whom studies have largely neglected). And the continuously graded nature of most biological variables is at odds with the paucity of adult bisexuals suggested by most surveys.

TO understand how biological factors influence sexual orientation, one must first define orientation. Many researchers, most conspicuously Simon LeVay, treat it as a sexually dimorphic trait: men are generally "programmed" for attraction to women, and women are generally programmed for attraction to men. Male homosexuals, according to this framework, have female programming, and lesbians have male programming. Some researchers suggest that this programming is accomplished by biological agents, perhaps even before birth others believe it occurs after birth in response to social factors and subjective experiences. As the function of the brain is undoubtedly

ly linked to its structure and physiology, it follows that homosexuals' brains might exhibit some features typical of the opposite sex.

The validity of this "intersex" expectation is questionable. For one, sexual orientation is not dimorphic; it has many forms. The conscious and unconscious motivations associated with sexual attraction are diverse even among people of the same sex and orientation. Myriad experiences (and subjective interpretations of those experiences) could interact to lead different people to the same relative degree of sexual attraction to men or to women. Different people could be sexually attracted to men for different reasons; for example, there is no a priori reason that everyone attracted to men should share some particular brain structure.

Indeed, the notion that gay men are feminized and lesbians masculinized may tell us more about our culture than about the biology of erotic responsiveness. Some Greek myths held that heterosexual rather than homosexual desire had intersex origins: those with predominately same-sex desires were considered the most manly of men and womanly of women. In contrast, those who desired the opposite sex supposedly mixed masculine and feminine in their being. Classical culture celebrated the homosexual exploits of archetypally masculine heroes such as Zeus, Hercules and Julius Caesar. Until a decade ago (when missionaries repudiated the practice), boys among the Sambia of New Guinea would form attachments to men and fellate them; no one considered that behavior a female trait. Indeed, the Sambia believed ingesting semen to be necessary for attaining strength and virility.

But there is a more tangible problem for this intersex assumption: the traits

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of which homosexuals ostensibly have opposite-sex versions have not been conclusively shown to differ between men and women. Of the many supposed sex differences in the human brain reported over the past century, only one has proved consistently replicable: brain size varies with body size. Thus, men tend to have slightly larger brains than women. This situation contrasts sharply with that for other animals, where many researchers have consistently demonstrated a variety of sex differences.

If brains are indeed wired or other-

wise programmed for sexual orientation, what forces are responsible? Three possibilities come into play: The direct model of biological causation asserts that genes, hormones or other factors act directly on the developing brain, probably before birth, to wire it for sexual orientation. Alternatively, the social learning model suggests that biology provides a blank slate of neural circuitry on which experience inscribes orientation. In the indirect model, biological factors do not wire the brain for orientation; instead they predispose individuals

toward certain personality traits that influence the relationships and experiences that ultimately shape sexuality.

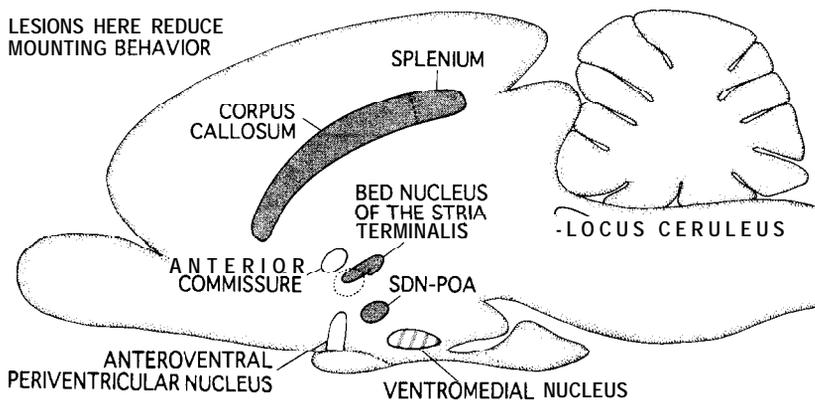
During past decades, much of the speculation about biology and orientation focused on the role of hormones. Workers once thought an adult's androgen and estrogen levels determined orientation, but this hypothesis withered for lack of support. Researchers have since pursued the notion that hormones wire the brain for sexual orientation during the prenatal period.

According to this hypothesis, high



When they met, they threw their arms round one another and embraced in their longing to grow together again, -Plato, Symposium

○ LESIONS HERE REDUCE MOUNTING BEHAVIOR



SEXUALLY DIMORPHIC NUCLEUS of the preoptic area (SDN-POA) in the rat brain is among the regions whose size varies between **males** and **females**. Attempts to find an **analogous cell** group in humans have met with varying success [see *table below*]. Some nuclei have not even been confirmed to exist in other rodents. Regions **larger** in males are shaded in brown, and those larger in females are shaded in blue.

prenatal androgen levels during the appropriate critical period cause heterosexuality in men and homosexuality in women. Conversely, low fetal androgen levels lead to homosexuality in men and heterosexuality in women. This hypothesis rests largely on the observation that in rodents early exposure to hormones determines the balance between male and female patterns of mating behaviors displayed by adults. Female rodents that were exposed to androgens early in development show more male-typical mounting behavior than do normal adult females. Males deprived of androgens by castration during the same critical period display a female mating posture called lordosis (bending of the back) when they are mounted.

Many researchers consider the castrated male rat that shows lordosis when mounted by another male to be homosexual (as is the female rat that mounts others). Lordosis, however, is little more than a reflex: the male will take the same

posture when a handler strokes its back. Furthermore, the male that mounts another male is considered to be heterosexual, as is the female that displays lordosis when mounted by another female. Applying such logic to humans would imply that of two people of the same sex engaged in intercourse only one is homosexual and which member of the couple it is depends on the positions they assume.

In addition to determining rodent mating patterns, early hormonal exposure determines whether an animal's brain can regulate normal ovarian function. A male rat's brain cannot respond to estrogen by triggering a chain of events, called positive feedback, that culminates in the abrupt increase of luteinizing hormone in the bloodstream, which in turn triggers ovulation. Some researchers reasoned from this fact to the idea that homosexual men (whose brains they allege to be insufficiently masculinized) might have a stronger

positive-feedback reaction than do heterosexual men.

Two laboratories reported that this was the case, but carefully designed and executed studies, most notably those of Luis J. G. Gooren of the Free University in Amsterdam, disproved those findings. Furthermore, the feedback mechanism turns out to be irrelevant to human sexual orientation: workers have since found that the positive-feedback mechanism is not sexually dimorphic in primates, including humans. If this mechanism is indistinguishable in men and women, it is illogical to suggest that it should be "feminized" in gay men.

Moreover, a corollary of the expectation that luteinizing hormone responses should be feminized in homosexual men is that they should be "masculinized" in lesbians. If that were true, homosexual women would neither menstruate nor bear children. The overwhelming proportion of lesbians with normal menstrual cycles and the growing number of openly lesbian mothers attest to the fallacy of that idea.

If the prenatal hormonal hypothesis were correct, one might expect that a large proportion of men with medical conditions known to involve prenatal androgen deficiency would be homosexual, as would be women exposed prenatally to excess androgens. That is not the case.

Because androgens are necessary for development of normal external genitals in males, the sex of affected individuals may not be apparent at birth. Males may be born with female-appearing genitals, and females with male-appearing ones. These individuals often require plastic surgery to construct normal-appearing genitals, and the decision to raise them as boys or as girls is sometimes based not on genetic sex but on the possibilities for genital reconstruction.

Research into the sexual orientation of such individuals tends to support the social learning model. Regardless of their genetic sex or the nature of their prenatal hormonal exposure, they usually become heterosexual with respect to the sex their parents raise them as, provided the sex assignment is made unambiguously before the age of three.

Nevertheless, some studies report an increase in homosexual fantasies or behavior among women who were exposed to androgens as fetuses. In accordance with the notion of direct biological effects, these studies are often interpreted as evidence that prenatal androgen exposure wires the brain for sexual attraction to women. The neurobiologist and feminist scholar Ruth H.

| RESEARCHERS | BRAIN REGION | | | |
|------------------------|-------------------|----------------------------------|--|-------------------|
| | INAH1 | INAH2 | INAH3 | INAH4 |
| Swaab and Fliers, 1985 | Larger in men | Not studied | Not studied | Not studied |
| Allen et al., 1989 | No sex difference | Larger in men than in some women | Larger in men | No sex difference |
| LeVay, 1991 | No sex difference | No sex difference | Larger in heterosexual men than in women or homosexual men | No sex difference |

HYPOTHALAMIC NUCLEI are reported to be sites of sexual differences in humans. Yet speculations about the possible contribution of those nuclei to sexual orientation are premature because no differences between men and women have been conclusively demonstrated in these regions.

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Bleier has offered an alternative interpretation. Rather than reflecting an effect of masculinizing hormones on the sexual differentiation of the brain, the adaptations of prenatally masculinized women may reflect the impact of having been born with masculinized genitalia or the knowledge that they had been exposed to aberrant levels of sex hormones during development. "Gender must seem a fragile and arbitrary construct," Bleier concluded, "if it depends upon plastic surgery."

Stephen Jay Gould of Harvard University has written of the way that the search for brain differences related to sex and other social categories was for the most part discredited during the past century by anatomists who deluded themselves into believing that their brain measurements justified the social prejudices of their day. The search for sex differences in the human brain was revitalized in the late 1970s, when Roger A. Gorski's team at the University of California at Los Angeles discovered a group of cells in the preoptic part of the rat hypothalamus that was much larger in males than in females. The researchers designated this cell group the sexually dimorphic nucleus of the preoptic area (SDN-POA). The preoptic area has long been implicated in the regulation of sexual behavior.

Like the sex differences in mating behaviors and luteinizing hormone regulatory mechanisms, the difference in the size of the SDN-POA was found to result from differences in early exposure to androgens. Shortly thereafter, Bleier and I, working at the University of Wisconsin at Madison, examined the hypothalamus of several rodent species and found that the SDN-POA is only one part of a sexual dimorphism involving several additional hypothalamic nuclei.

Three laboratories have recently

sought sexually dimorphic nuclei in the human hypothalamus. Laura S. Allen, working in Gorski's lab, identified four possible candidates as potential homologues of the rat's SDN-POA and designated them as the interstitial nuclei of the anterior hypothalamus (INAH1-INAH4). Different laboratories that have measured these nuclei, however, have produced conflicting results: Dick F. Swaab's group at the Netherlands Institute for Brain Research in Amsterdam, for example, found INAH1 to be larger in men than in women, whereas Allen found no difference in that nucleus but reported that INAH2 and INAH3 were larger in men. Most recently, LeVay found no sex difference in either INAH1 or INAH2 but corroborated Allen's finding of a larger INAH3 in men. LeVay also reported that INAH3 in homosexual men tends to be small, like that of women. (Neurologist Clifford Saper of Harvard and I are in the process of measuring the interstitial nuclei; at present, we have no definitive results.)

LeVay's study has been widely interpreted as strong evidence that biological factors directly wire the brain for sexual orientation. Several considerations militate against that conclusion. First, his work has not been replicated, and human neuroanatomical studies of this kind have a very poor track record for reproducibility. Indeed, procedures similar to those LeVay used to identify the nuclei have previously led researchers astray.

Manfred Gahr, now at the Max Planck Institute for Animal Physiology in Seewiesen, Germany, used a cell-staining technique similar to LeVay's to observe what appeared to be seasonal variations in the size of a nucleus involved in singing in canaries. Two more specific staining methods, however, revealed that the size of the nucleus did not change. Gahr suggested that the less specific method might have been

influenced by seasonal hormonal variations that altered the properties of the cells in the nucleus.

Furthermore, in LeVay's published study, all the brains of gay men came from AIDS patients. His inclusion of a few brains from heterosexual men with AIDS did not adequately address the fact that at the time of death virtually all men with AIDS have decreased testosterone levels as the result of the disease itself or the side effects of particular treatments. To date, LeVay has examined the brain of only one gay man who did not die of AIDS. Thus, it is possible that the effects on the size of INAH3 that he attributed to sexual orientation were actually caused by the hormonal abnormalities associated with AIDS. Work by Deborah Commins and Pauline I. Yahr of the University of California at Irvine supports precisely this hypothesis. The two found that the size of a structure in mongolian gerbils apparently comparable to the SDN-POA varies with the amount of testosterone in the bloodstream.

A final problem with the popular interpretation of LeVay's study is that it is founded on an imprecise analysis of the relevant animal research. LeVay has suggested that INAH3, like the rat's SDN-POA, is situated in a region of the hypothalamus known to participate in the generation of male sexual behavior. Yet studies in a variety of species have consistently shown that the precise hypothalamic region involved in male sexual behavior is not the one occupied by these nuclei. Indeed, Gorski and Gary W. Arendash, now at the University of South Florida, found that destroying the SDN-POA on both sides of a male rat's brain did not impair sexual behavior.

Jefferson C. Slimp performed experiments in Robert W. Goy's laboratory at the Wisconsin Regional Primate Research Center (shortly before I joined that group) that suggested that the

Hormonal Exposure and Mating Behavior in Rats

Mating behavior of rats is affected by exposure to hormones before birth. Males that receive insufficient androgens display stereotypically female postures, whereas fe-

males that receive an excess engage in stereotypically male behaviors. Extrapolating such data to sexual orientation, however, is difficult at best.

MALE MOUNTS FEMALE

Male rat is considered heterosexual
Female rat is considered heterosexual



FEMALE MOUNTS FEMALE

Top female rat is considered homosexual
Bottom female rat is considered heterosexual



MALE MOUNTS MALE

Top male rat is considered heterosexual
Bottom male rat is considered homosexual



FEMALE MOUNTS MALE

Female rat would be considered homosexual
Male rat would be considered homosexual

(Not studied in experiments)

precise region involved in sexual behavior in male rhesus monkeys is located above the area comparable to that occupied by INAH3 in humans. Males with lesions in that region mounted females less frequently than they did before being operated on, but their frequency of masturbation did not change. Although some have taken these observations to mean that the lesions selectively decreased heterosexual drive, their conclusion is unwarranted; male monkeys pressed a lever for access to females more often after their operations than before. Unfortunately, these males had no opportunity to interact with other males, and so the study tells us nothing about effects on homosexual as opposed to heterosexual motivation or behavior.

Interstitial hypothalamic nuclei are not the only parts of the brain to have come under scrutiny for links to sexual orientation. Neuroanatomists have also reported potentially interesting differences in regions not directly involved in sexual behaviors. Swaab and his co-worker Michel A. Hofman found that another hypothalamic nucleus, the suprachiasmatic nucleus, is larger in homosexual than in heterosexual men. The size of this structure, however, does not vary with sex, and so even if this finding can be replicated it would not support the assumption that homosexuals have intersexed brains.

Allen of U.C.L.A., meanwhile, has reported that the anterior commissure, a structure that participates in relaying information from one side of the brain to the other, is larger in women than in men. More recently, she concluded that the anterior commissure of gay men is feminized—that is, larger than in heterosexual men. Steven Demeter, Robert W. Doty and James L. Ringo of the University of Rochester, however, found just the opposite: anterior commissures larger in men than in women. Furthermore, even if Allen's findings are correct, the size of the anterior commissure alone would say nothing about an individual's sexual orientation. Although she found a statistically significant difference in the average size of the commissures of gay men and heterosexual men, 27 of the 30 homosexual men

in her study had anterior commissures within the same size range as the 30 heterosexual men with whom she compared them.

Some researchers have turned to genetics instead of brain structure in the search for a biological link to sexual orientation. Several recent studies suggest that the brothers of homosexual men are more likely to be homosexual than are men without gay brothers. Of these, only the study by J. Michael Bailey of Northwestern University and Richard C. Pillard of Boston University included both non-

twin biological brothers and adopted (unrelated) brothers in addition to identical and fraternal twins.

Their investigation yielded paradoxical results: some statistics support a genetic hypothesis, and others refute it. Identical twins were most likely to both be gay; 52 percent were concordant for homosexuality, as compared with 22 percent of fraternal twins. This result would support a genetic interpretation because identical twins share all of their genes, whereas fraternal twins share only half of theirs. Nontwin brothers of homosexuals, however, share the same proportion of genes as fraternal twins;

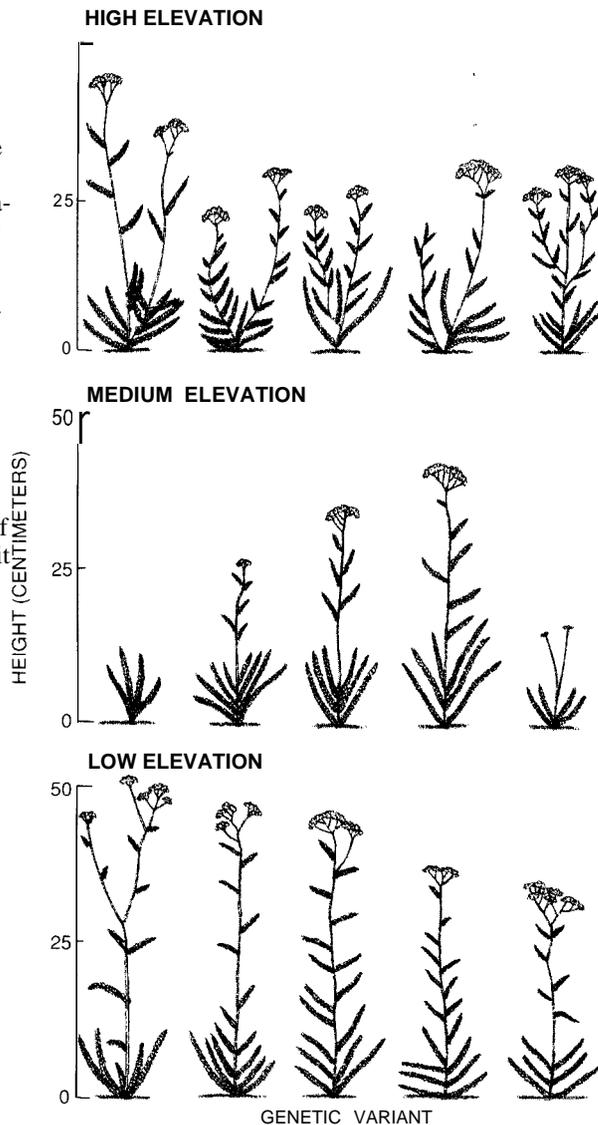
however, only 9 percent of them were concordant for homosexuality. The genetic hypothesis predicts that their rates should be equal.

Moreover, Bailey and Pillard found that the incidence of homosexuality in the adopted brothers of homosexuals (11 percent) was much higher than recent estimates for the rate of homosexuality in the population (1 to 5 percent). In fact, it was equal to the rate for nontwin biological brothers. This study clearly challenges a simple genetic hypothesis and strongly suggests that environment contributes significantly to sexual orientation.

Two of three other recent studies also detected an increased rate of homosexuality among the identical as opposed to fraternal twins of homosexuals. In every case, however, the twins were reared together. Without knowing what developmental experiences contribute to sexual orientation—and whether those experiences are more similar between identical twins than between fraternal twins—the effects of common genes and common environments are difficult to disentangle. Resolving this issue requires studies of twins raised apart.

Indeed, perhaps the major finding of these heritability studies is that despite having all of their genes in common and having prenatal and postnatal environments as close to identical as possible, approximately half of the identical twins were nonetheless discordant for orientation. This finding underscores just how little is known about the origins of sexual orientation.

Dean H. Hamer's team at the



CUTTINGS FROM *Achillea* plants have the same genes, yet they develop in significantly different ways depending on their environment. Furthermore, knowing how the five genetic variants above differ in one environment does not help predict their traits in another one. That plants can display such a complex response to their surroundings makes clear the illogic of expecting direct, easily predictable links between human genes and as diffuse a trait as sexual orientation.

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National Institutes of Health has found the most direct evidence that sexual orientation may be influenced by specific genes. The team focused on a small part of the X chromosome known as the Xq28 region, which contains hundreds of genes. Women have two X chromosomes and so two Xq28 regions, but they pass a copy of only one to a son (who has a single X chromosome). The theoretical probability of two sons receiving a copy of the same Xq28 from their mother is thus 50 percent. Hamer found that of his 40 pairs of gay siblings, 33 instead of the expected 20 had received the same Xq28 region from their mother.

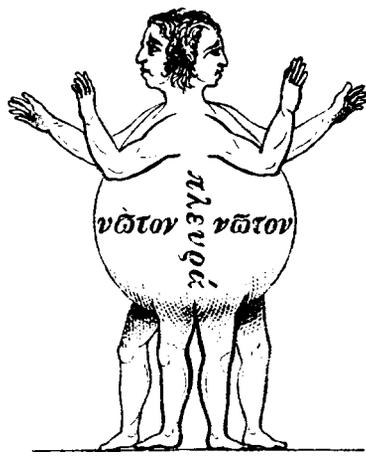
Hamer's finding is often misinterpreted as showing that all 66 men from these 33 pairs shared the same Xq28 sequence. That is quite different from what the study showed: Each member of the 33 concordant pairs shared his Xq28 region only with his brother—not with any of the other 32 pairs. No single, specific Xq28 sequence (a putative "gay gene") was identified in all 66 men.

Unfortunately, Hamer's team did not examine the Xq28 region of its gay subjects' heterosexual brothers to see how many shared the same sequence. Hamer suggests that inclusion of heterosexual siblings would have confounded his analysis because the gene associated with homosexuality might be "incompletely penetrant"—that is to say, heterosexual men could carry the gene without expressing it. In other words, inclusion of heterosexual brothers might have revealed that something other than genes is responsible for sexual orientation.

Finally, Neil J. Risch of Yale University, one of the developers of the statistical techniques that Hamer used, has questioned whether Hamer's results are statistically significant. Risch has argued that until we have more details about the familial clustering of homosexuality, the implications of studies such as Hamer's will remain unclear.

Studies that mark homosexuality as a heritable trait (assuming that they can be replicated) do not say anything about how that heritability might operate. Genes in themselves specify proteins, not behavior or psychological phenomena. Although we know virtually nothing about how complex psychological phenomena are embodied in the brain, it is conceivable that particular DNA sequences might somehow cause the brain to be wired specifically for homosexual orientation. Significantly, however, heritability requires no such mechanism.

Instead particular genes might influ-



MALE-MALE creature from Plato's early race appeared in a 19th-century commentary on the *Symposium*.

ence personality traits that could in turn influence the relationships and subjective experiences that contribute to the social learning of sexual orientation. One can imagine many ways in which a temperamental difference could give rise to different orientations in different environments.

The *Achillea* plant serves as a useful metaphor: genetic variations yield disparate phenotypes depending on elevation. The altitude at which a cutting of *Achillea* grows does not have a linear effect on the plant's growth, however, nor is the impact limited to a single attribute. Height, number of leaves and stems, and branching pattern are all affected [see illustration on opposite page]. If a plant can display such a complex response to its environment, then what of a far more complex organism that can modify its surroundings at will?

The possible interaction between genes and environment in the development of sexual orientation can be sketched here only in the most oversimplified of ways. For example, many researchers believe aversion to rough-and-tumble play in boys is moderately predictive of homosexual development. (Direct-model theorists argue this aversion is merely the childhood expression of a brain that has been wired for homosexuality.) Meanwhile psychoanalysts have noted that of those gay men who seek therapy, many report having had poor rapport with their fathers. They thus suggest that an impaired father-son relationship leads to homosexuality.

One could combine these observations to speculate that a genetically based aversion to rough-and-tumble play in boys could impair rapport with fathers who demand that they adhere to rigid sex-role stereotypes. Fathers who made no such demands would maintain a rap-

port with their sons. As a result, the hypothetical gene in question could affect sexual orientation in some cases but not in others. Even such a reductionist example (based on traits that reflect cultural stereotypes rather than biology) shows how neither temperament nor family environment might be decisive. Studies focusing on either one or the other would yield inconclusive results.

These speculations reemphasize how far researchers must go before they understand the factors—both biological and experiential—that contribute to sexual orientation. Even if the size of certain brain structures does turn out to be correlated with sexual orientation, current understanding of the brain is inadequate to explain how such quantitative differences could generate qualitative differences in a psychological phenomenon as complex as sexual orientation. Similarly, confirmation of genetic research purporting to show that homosexuality is heritable makes clear neither what is inherited nor how it influences sexual orientation. For the foreseeable future, then, interpretation of these results will continue to hinge on assumptions of questionable validity.

While attempts to replicate these preliminary findings continue, researchers and the public must resist the temptation to consider them in any but the most tentative fashion. Perhaps more important, we should also be asking ourselves why we as a society are so emotionally invested in this research. Will it—or should it—make any difference in the way we perceive ourselves and others or how we live our lives and allow others to live theirs? Perhaps the answers to the most salient questions in this debate lie not within the biology of human brains but rather in the cultures those brains have created.

FURTHER READING

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