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## Pas de Deux of Sexuality Is Written in the Genes

By [NICHOLAS WADE](#)

When it comes to the matter of desire, evolution leaves little to chance. Human sexual behavior is not a free-form performance, biologists are finding, but is guided at every turn by genetic programs.

Desire between the sexes is not a matter of choice. Straight men, it seems, have neural circuits that prompt them to seek out women; gay men have those prompting them to seek other men. Women's brains may be organized to select men who seem likely to provide for them and their children. The deal is sealed with other neural programs that induce a burst of romantic love, followed by long-term attachment.

So much fuss, so intricate a dance, all to achieve success on the simple scale that is all evolution cares about, that of raising the greatest number of children to adulthood. Desire may seem the core of human sexual behavior, but it is just the central act in a long drama whose script is written quite substantially in the genes.

In the womb, the body of a developing fetus is female by default and becomes male if the male-determining gene known as SRY is present. This dominant gene, the Y chromosome's proudest and almost only possession, sidetracks the reproductive tissue from its ovarian fate and switches it into becoming testes. [Hormones](#) from the testes, chiefly [testosterone](#), mold the body into male form.

In puberty, the reproductive systems are primed for action by the brain. Amazing electrical machine that it may be, the brain can also behave like a humble gland. In the hypothalamus, at the central base of the brain, lie a cluster of about 2,000 neurons that ignite puberty when they start to secrete pulses of gonadotropin-releasing hormone, which sets off a cascade of other hormones.

The trigger that stirs these neurons is still unknown, but probably the brain monitors internal signals as to whether the body is ready to reproduce and external cues as to whether circumstances are propitious for yielding to desire.

Several advances in the last decade have underlined the bizarre fact that the brain is a full-fledged sexual organ, in that the two sexes have profoundly different versions of it. This is the handiwork of testosterone, which masculinizes the brain as thoroughly as it does the rest of the body.

It is a misconception that the differences between men's and women's brains are small or erratic or found only in a few extreme cases, Dr. Larry Cahill of the [University of California, Irvine](#), wrote last year in *Nature Reviews Neuroscience*. Widespread regions of the cortex, the brain's outer layer that performs much of its higher-level processing, are thicker in women. The hippocampus, where initial memories are formed, occupies a larger fraction of the female brain.

Techniques for imaging the brain have begun to show that men and women use their brains in different ways even when doing the same thing. In the case of the amygdala, a pair of organs that helps prioritize memories according to their emotional strength, women use the left amygdala for this purpose but men tend to use the right.

It is no surprise that the male and female versions of the human brain operate in distinct patterns, despite the heavy influence of culture. The male brain is sexually oriented toward women as an object of desire. The most direct evidence comes from a handful of cases, some of them circumcision accidents, in which boy babies have lost their penises and been reared as female. Despite every social inducement to the opposite, they grow up desiring women as partners, not men.

"If you can't make a male attracted to other males by cutting off his penis, how strong could any psychosocial effect be?" said J. Michael Bailey, an expert on sexual orientation at [Northwestern University](#).

Presumably the masculinization of the brain shapes some neural circuit that makes women desirable. If so, this circuitry is wired differently in gay men. In experiments in which subjects are shown photographs of desirable men or women, straight men are aroused by women, gay men by men.

Such experiments do not show the same clear divide with women. Whether women describe themselves as straight or lesbian, "Their sexual arousal seems to be relatively indiscriminate — they get aroused by both male and female images," Dr. Bailey said. "I'm not even sure females have a sexual orientation. But they have sexual preferences. Women are very picky, and most choose to have sex with men."

Dr. Bailey believes that the systems for sexual orientation and arousal make men go out and find people to have sex with, whereas women are more focused on accepting or rejecting those who seek sex with them.

Similar differences between the sexes are seen by Marc Breedlove, a neuroscientist at [Michigan State University](#). “Most males are quite stubborn in their ideas about which sex they want to pursue, while women seem more flexible,” he said.

Sexual orientation, at least for men, seems to be settled before birth. “I think most of the scientists working on these questions are convinced that the antecedents of sexual orientation in males are happening early in life, probably before birth,” Dr. Breedlove said, “whereas for females, some are probably born to become gay, but clearly some get there quite late in life.”

Sexual behavior includes a lot more than sex. Helen Fisher, an anthropologist at [Rutgers University](#), argues that three primary brain systems have evolved to direct reproductive behavior. One is the sex drive that motivates people to seek partners. A second is a program for romantic attraction that makes people fixate on specific partners. Third is a mechanism for long-term attachment that induces people to stay together long enough to complete their parental duties.

Romantic love, which in its intense early stage “can last 12-18 months,” is a universal human phenomenon, Dr. Fisher wrote last year in *The Proceedings of the Royal Society*, and is likely to be a built-in feature of the brain. Brain imaging studies show that a particular area of the brain, one associated with the reward system, is activated when subjects contemplate a photo of their lover.

The best evidence for a long-term attachment process in mammals comes from studies of voles, a small mouselike rodent. A hormone called vasopressin, which is active in the brain, leads some voles to stay pair-bonded for life. People possess the same hormone, suggesting a similar mechanism could be at work in humans, though this has yet to be proved.

Researchers have devoted considerable effort to understanding homosexuality in men and women, both for its intrinsic interest and for the light it could shed on the more usual channels of desire. Studies of twins show that homosexuality, especially among men, is quite heritable, meaning there is a genetic component to it. But since gay men have about one-fifth as many children as straight men, any gene favoring homosexuality should quickly disappear from the population.

Such genes could be retained if gay men were unusually effective protectors of their nephews

and nieces, helping genes just like theirs get into future generations. But gay men make no better uncles than straight men, according to a study by Dr. Bailey. So that leaves the possibility that being gay is a byproduct of a gene that persists because it enhances [fertility](#) in other family members. Some studies have found that gay men have more relatives than straight men, particularly on their mother's side.

But Dr. Bailey believes the effect, if real, would be more clear-cut. "Male homosexuality is evolutionarily maladaptive," he said, noting that the phrase means only that genes favoring homosexuality cannot be favored by evolution if fewer such genes reach the next generation.

A somewhat more straightforward clue to the origin of homosexuality is the fraternal birth order effect. Two Canadian researchers, Ray Blanchard and Anthony F. Bogaert, have shown that having older brothers substantially increases the chances that a man will be gay. Older sisters don't count, nor does it matter whether the brothers are in the house when the boy is reared.

The finding suggests that male homosexuality in these cases is caused by some event in the womb, such as "a maternal immune response to succeeding male pregnancies," Dr. Bogaert wrote last year in the [Proceedings of the National Academy of Sciences](#). Antimale antibodies could perhaps interfere with the usual masculinization of the brain that occurs before birth, though no such antibodies have yet been detected.

The fraternal birth order effect is quite substantial. Some 15 percent of gay men can attribute their homosexuality to it, based on the assumption that 1 percent to 4 percent of men are gay, and each additional older brother increases the odds of same-sex attraction by 33 percent.

The effect supports the idea that the levels of circulating testosterone before birth are critical in determining sexual orientation. But testosterone in the fetus cannot be measured, and as adults, gay and straight men have the same levels of the hormone, giving no clue to prenatal exposure. So the hypothesis, though plausible, has not been proved.

A significant recent advance in understanding the basis of sexuality and desire has been the discovery that genes may have a direct effect on the sexual differentiation of the brain. Researchers had long assumed that [steroid](#) hormones like testosterone and [estrogen](#) did all the heavy lifting of shaping the male and female brains. But Arthur Arnold of the University of California, Los Angeles, has found that male and female neurons behave somewhat differently when kept in laboratory glassware. And last year Eric Vilain, also of U.C.L.A., made the surprising finding that the SRY gene is active in certain cells of the brain, at least in mice. Its brain role is quite different from its testosterone-related activities, and women's neurons

presumably perform that role by other means.

It so happens that an unusually large number of brain-related genes are situated on the X chromosome. The sudden emergence of the X and Y chromosomes in brain function has caught the attention of evolutionary biologists. Since men have only one X chromosome, natural selection can speedily promote any advantageous mutation that arises in one of the X's genes. So if those picky women should be looking for smartness in prospective male partners, that might explain why so many brain-related genes ended up on the X.

"It's popular among male academics to say that females preferred smarter guys," Dr. Arnold said. "Such genes will be quickly selected in males because new beneficial mutations will be quickly apparent."

Several profound consequences follow from the fact that men have only one copy of the many X-related brain genes and women two. One is that many neurological diseases are more common in men because women are unlikely to suffer mutations in both copies of a gene.

Another is that men, as a group, "will have more variable brain phenotypes," Dr. Arnold writes, because women's second copy of every gene dampens the effects of mutations that arise in the other.

Greater male variance means that although average IQ is identical in men and women, there are fewer average men and more at both extremes. Women's care in selecting mates, combined with the fast selection made possible by men's lack of backup copies of X-related genes, may have driven the divergence between male and female brains. The same factors could explain, some researchers believe, why the human brain has tripled in volume over just the last 2.5 million years.

Who can doubt it? It is indeed desire that makes the world go round.

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