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Sex Differences

Suppose now that a baby's sex has been determined—the baby's gene committee has met during early development and somehow managed to come to a decision. What next? How does development continue? Will all males graduate from uterine school wearing the same coat and tie, and all females the same dress? Obviously not. How much biological difference is there among males, and among females, and between males and females?

A motivation behind this chapter is that genetic and anatomical differences are increasingly being detected between gay and straight people, between transgendered and nontransgendered people, and between and among intersexed and nonintersexed people. These differences are publicized as anomalous deviations from the supposed norm set by straight males and females. But differences between gays and straights, or between any two groups, must be assessed relative to differences within the groups. If straight males, for example, show great biological variation among themselves, then the difference between a straight male and a gay male may be no more than that among straight males anyway, and therefore not biologically noteworthy.

Similarly, in education the unspoken assumption is that people are, for the most part, biologically the same, and that with instruction everyone can acquire the same skills and knowledge. Of course, everyone

knows that people differ genetically from one another, but "normal" people are assumed to be more or less the same biologically, so that a one-size-fits-all approach to education can be applied, except for "special" cases. But what happens if we realize that people are as different biologically as they are culturally?

GENETIC DIFFERENCES

Research on the human genome is beginning to clarify how genetically different people are from one another. These differences can be divided into those that arise from the nonsex chromosomes and those that come from the sex chromosomes. Furthermore, males have their own ways of differing from other males and females from other females.

We each have about thirty thousand genes total. I estimate that each of us differs from the next person by about sixty genes, not including genes on the sex chromosomes, X and Y. Thus in this sense we're all very much alike: we differ by only sixty out of thirty thousand genes, or 0.2 percent. Yet this difference is enough to make for lots of biochemical variation among us because of the ripple effect of how these genes interact. Moreover, any two people differ from each other by a particular set of sixty genes that are different from the set by which two other people differ from each other. Thus people differ from one another in different ways.[1]

VARIETY FROM THE X CHROMOSOME

An X chromosome has about 1,500 genes, and two people differ from each other in about three of these. XX people express only one of their chromosomes, and XY people have only one to begin with. Thus people differ genetically from each other, on the average, by sixty genes on the nonsex chromosomes, plus three more from genes on whichever X chromosome is being expressed.[2]

Humans with XX chromosomes are typically women, and most differences among women are from the sixty genes that have nothing to do with sex. However, the additional three genes from X can lead to further differences that are unique to women. Males have an X chromosome too, so three genes of difference coming from the X chromosome could apply to men as well as to women. However, the phenomenon of X chromosome inactivation is unique to XX people and provides a way that women may differ genetically from one another that is unavailable to men.

Two women may differ in genetic expression because different Xs remain active in different cells. One woman may have X chromosomes from her dad active in her kidney cells, while her sister has X chromosomes from her mom active there instead. This variability in the way genes are expressed adds to the underlying variability in the genes themselves. If one of the three genes that differ between the two Xs happens to be harmful, then the body can prune some of the cells expressing the bad X and use cells with the good X instead. Males carrying the bad X suffer the most severe disease, whereas women carrying the bad X suffer only in those cells that haven't been pruned.[3] Furthermore, women can differ from each other in the severity of a disease, depending on how many of the cells with the bad X were successfully pruned.

The incidence of autoimmune disease is higher in women than in men.[4] I conjecture that susceptibility to autoimmune disease is a side effect of X inactivation and the ability to prune cells that express harmful genes. The immune system faces the challenge of detecting which cells are self and which are foreign, and removing the foreign ones. In XX bodies, two types of cells are self, depending on which X chromosome is active. Having two types of self cells may make the discrimination of foreign cells more difficult, leading to more autoimmune response in XX people than in XY people.

Women may also differ from one another because of which specific genes on the X remain active and which become inactive. The big-picture view of X inactivation is that one X chromosome is completely active while the other is all scrunched up in a ball. In fact, only 80 percent of the genes on the inactive chromosome are truly turned off, while 15 percent are still expressed. These 15 percent are said to escape inactivation. The remaining 5 percent are especially interesting: they are expressed from the inactive chromosome in some women and not others. And finally, one gene is known that is expressed only from the inactive chromosome and not from the active one, the reverse of the typical pattern.[5]

Thus the distinction between active and inactive does not apply to an

entire X chromosome, but rather applies selectively to various parts of both X chromosomes. As a result, the cells within the body of an XX person can be quite heterogeneous, and women whose genes are similar can still differ a lot biologically because of genes being active or inactive.[6] All of these ways in which XX bodies differ from one another guarantee that women differ from each another in ways unavailable to men.

VARIETY FROM THE Y CHROMOSOME

Based on statistics for the other chromosomes, a Y chromosome potentially has about five hundred genes and is one-third the size of the X chromosome. Two people with Y chromosomes would be expected to differ from each other in about one of these genes.[7] Yet only about two dozen genes have been identified so far on Y, well below the estimated five hundred, leading some biologists to describe the Y chromosome as a "genetic wasteland," a "degraded relic."[8] These two dozen genes come in two functional clusters. One cluster contains genes for male versions of cellular biochemistry, such as the gene for the male form of ribosome mentioned in chapter 10. The other cluster consists of genes expressed only in the testes. They affect sperm development, and their absence leads to male sterility.

Humans with XY chromosomes are typically men. Most genetic differences among men come from the sixty genes that have nothing to do with sex, plus the three from the one X chromosome males have. XY people might conceivably also differ by an additional gene from their Y chromosomes. If such differences exist, they would provide ways in which men uniquely differ from one another that are unavailable to women.

However, the variation on the Y chromosome is low compared to the variation on other chromosomes. Most genes on the Y chromosome are bundled into a large unit called a linkage group. Except at tiny spots at both ends of the chromosome, the genes on Y don't pair to recombine with genes of any other chromosome—Y goes alone; it is haploid. Therefore, the genes on Y, except the few at the ends, all stand or fall together.

At any particular time, a single version of the Y chromosome is temporarily the best, and all others are quickly weeded out within any well-mixed local population. But when times change, what was once a weed

comes rushing back, displacing the previously best Y. At any particular time, then, Y doesn't have much variation within a species, but can vary across species and over time. Some variation in Y is always waiting around, ready to mount a triumphant return, but there is not as much variation as on the other chromosomes. A possible implication is that XY bodies are more uniform than XX bodies.

Here SRY—a major gene affecting masculinity in mice and men, one of the gender genes—comes into play. If males differ in SRY, they differ in an influential gene for how male gender is embodied. And SRY is one of the fastest evolving of all known genes. This gold standard of masculinity differs greatly across species.[9] SRY is also variable across populations within a species, so the expression of masculinity is not constant from place to place within a species either.[10] Primates have undergone especially fast evolutionary change in SRY, implying that the embodiment of masculinity is not static but rather quickly changes over evolutionary time. This evolution is clearly caused by natural selection, not random genetic drift, because new DNA molecules replace old ones faster at sites where the difference affects SRY's protein than at sites where the substitution doesn't change the protein.[11]

The protein made by SRY consists of a central portion called the HMG-box. The portions to the left and right, the flanking regions, are called the N-terminal and the C-terminal regions. The HMG-box portion doesn't change much—this conserved part binds to the DNA and allows the SRY protein to affect how the DNA is translated. The evolutionary action is in the flanking regions, particularly the C-terminal region.

Variation in SRY causes variation along a masculine-feminine body continuum. Laboratory mice have three types of SRY genes, which cause different body types. In one type, XY bodies are male; in another, XY bodies are intersex as embryos and male as adults; and in a third, XY bodies are female or intersex as adults. The differences among these SRY genes turn out to be simply eleven, twelve, or thirteen repeats of a certain sequence, CAG, in the C-terminal region of the DNA.[12] Thus evolutionary changes in SRY outside of the HMG-box affect the gendered body.

Moreover, SRY can directly influence many parts of the body other than the gonads and the reproductive track. SRY indirectly influences the

entire body because the testes whose differentiation SRY helps initiate secrete a hormone (AMH) that affects nearby cells, as well as testosterone, which affects distant cells. SRY probably influences many tissues directly, without bothering to use hormones as an intermediary. Depending on the species, SRY is expressed in tissue from bone to brain.[13] Quite possibly, SRY influences gendered bone growth and brain development.

SRY's impact on gendered embodiment is perhaps why it's evolving so quickly. If SRY is a gene for male gender, it would evolve in response to the turbulent winds of social change, endowing males with the latest body style and pickup lines for success in the "meet market."

GENETICS AND THE GENDER BINARY

As already mentioned, people differ from each other in sixty genes, on the average, from the nonsex chromosomes. They also differ in the genes provided by the sex chromosomes. Let's compare these sources of genetic variation among people. Because of the Y chromosome, XY people have two dozen genes not in XX people. Because of having two X chromosomes, XX people have about 225 genes (the 15 percent of the inactive X chromosome escaping inactivation) that are expressed in a double dosage relative to the single X chromosome of XY people. Considering both the presence or absence of Y and the presence or absence of the genes on X that escape inactivation, an XX person and an XY person differ by about 250 genes total from their sex chromosomes, or about four times their difference of 60 genes from the nonsex chromosomes. Thus a male and female differ from each other on the average by about four times as many genes as two males, or two females, do from each other.[14] These data suggest a clear-cut genetic binary distinction between males and females. In fact, though, this genetic system allows for a great deal of overlap at the whole-body level.

The XX/XY system of sex determination is widely believed to define a biological basis for a gender binary. Yet this system allows for both a sharp gender binary and great overlap between XX and XY bodies, as well as gender crossing. The details of what's actually on the X and Y chromosomes, and which tissues respond to the products of these genes, determine the degree of male/female difference at the whole-body level, as well as allowing for transgendered bodies.

The bodies of males and females in mammalian species may be very similar overall, even though they differ in gamete size and associated plumbing, or they may be very different. Compare guinea pigs, where females and males can't be distinguished without plopping their genitals under a magnifying glass, to lions and lionesses, who personify the distinction between masculinity and femininity in the popular imagination. Clearly, XX/XY sex determination doesn't dictate any fixed difference between male and female within a species.

How can XX bodies and XY bodies vary from being nearly identical in some species to strikingly dimorphic in others? First, look at Y. Natural selection can tune the duration and number of tissues in which gender genes like SRY are expressed. If SRY is expressed for a few hours only in the gonad, as in mice, then its impact is limited. If SRY is expressed for months and in many tissues, as in some marsupials, then dimorphism becomes widespread throughout the body. Natural selection can also tune how closely the genes governing cellular biochemistry on Y resemble their ancestral counterparts on X. The gene on Y that determines the male ribosome could be replaced by other alleles, either more or less similar to its ancestor on X, thereby affecting the gendered difference in how proteins are manufactured. Thus evolution on the Y chromosome can affect the average difference of males from females.

Next, look at X. The extent of X inactivation controls how many genes in XX bodies are expressed in different dosages than in XY bodies. If X inactivation is 100 percent, then both male and female bodies will see only one X chromosome, minimizing dimorphism. At the other extreme, if there is no X inactivation, XX bodies see all 1,500 genes in a double dose compared with XY bodies, potentially leading to huge body differences between the sexes. Natural selection can modify the percentage of genes that escape X inactivation, as evidenced by the 5 percent of the genes on X that are inactive in some people and active in others. This represents genetic variation in the extent of X inactivation, variation that can be acted on by natural selection. Natural selection can also tune how closely the dozen genes on X for cellular biochemistry resemble their counterparts on Y. The gene on X controlling the female ribosome could be replaced by other alleles either more or less similar to its descendant on Y, thereby affecting the gendered difference in how proteins are manufactured. Thus evolution on the X chromosome can affect the average difference of females from males.

Together, evolution on X and evolution on Y control the overall degree of sexual dimorphism—the sum of the X-determined differences of females from males and the Y-determined differences of males from females.[15] Further, variation on X can produce transgender expression. To obtain feminine males and masculine females, the X and Y chromosomes must first have genes that maintain enough average body difference between the sexes so that feminine and masculine are statistically well defined. Then, because X occurs differentially in males and females, allelic variation on X at loci that escape X inactivation can hypothetically cause some males to resemble females, and vice versa.

To obtain feminine males, imagine that five units of pigment produce pink, and ten units make red. Quantities of pigment above ten are also red because ten units are enough to saturate the color. Suppose X has a locus for pigment that escapes X inactivation with two alleles. One allele makes only five units of pigment and appears in 99 percent of the gene pool; another allele makes ten units of pigment, but is rare, at only 1 percent. All females, then, are red because, with any of the alleles from two Xs, they make either ten, fifteen, or twenty units of pigment, all of which appear simply as red. Among males, 99 percent are pink, because they have only the allele for five units, and 1 percent wind up red with the allele for ten units. These 1 percent of males appear as feminine males with respect to the trait of redness. To obtain masculine females, imagine now that twenty units of blue are automatically made in both males and females, and that X has a locus for degradation of the pigment that escapes X inactivation. The pigment saturates at navy blue with ten units. Suppose one allele degrades none of the pigment but is rare at 1 percent of the gene pool, whereas the other degrades 50 percent of the pigment and is common at 99 percent. All males are then navy blue because they have either twenty or ten units of pigment. Among the females, 99 percent are light blue, as they have only five units of pigment, because one of their alleles degrades half of the original twenty units and the other the remaining ten. The remaining 1 percent are navy blue because they have either ten or twenty units of pigment. This 1 percent of females appear as masculine females with respect to the trait of blueness.

Although the genetics of transgender expression are unknown and, in humans at least, may be superseded by late embryonic and early postnatal developmental experience, transgender bodies are fully consistent with an XY system of sex determination. Indeed, feminine males might easily be feminine enough, and masculine females masculine enough, to count socially and to identify as women and men, respectively, even though they possess XY and XX bodies.

Thus genetics does not dictate a gender binary. Although the mammalian system of sex chromosomes produces a binary based on gamete size, the gendered bodies that make those eggs and sperm are not constrained by the genetics of sex determination; they are free to adapt evolutionarily to local context. Indeed, research on the human genome is revealing that all people are genetically different. Individuality is not skin-deep, but extends deep into our DNA. When any two people are compared, genetic differences can be found. And if people sort themselves into social categories that reflect innate inclinations, then genetic differences will also be found between the people of those categories. "Normal" people are not a sea of homogeneous genotypes, bodies, and brains. "Normal" people are as genetically diverse as snowflakes.

HORMONAL SEX DIFFERENCES

A major source of diversity in the developmental narratives of people is their differing hormonal experiences. Yet the story of hormones begins not with diversity, but with failed attempts to define a binary "male" and "female" in terms of chemicals. An authoritative summary in 1939 asserted, "As there are two sets of sex characters, so there are two sex hormones, the male hormone . . . and the female."[16] But was this any more than a wish? In 1927 female hormone was extracted from pregnant women's urine, and in 1931 male hormone from men's urine. Already in 1928, however, reports of female hormones in men elicited scientific rejoinders of "disconcerting," "anomalous," and "somewhat disquieting." In 1935 a cherished symbol of male virility, the stallion, turned out to have large amounts of female hormone in his urine, eliciting remarks such as "surprising," "curious," "unexpected," and "paradoxical." Conversely, the male hormone was shown to operate on female tissue. Testes transplanted into female rabbits whose ovaries had been removed induced uterine growth. In the 1930s the male hormone was shown to increase mammary glands, enlarge the uterus and the clitoris, and pro-

long estrus in female rats.[17] So both sexes possessed and responded to "male" and "female" hormones.

In fact, everyone possesses testosterone, estrogen, and all the other "sex" hormones. Sex hormones are instruments in the body's chemical orchestra. The body's score calls for all these instruments at various times, and together they help make the body's music.

Once isolated, the sex hormones turned out to be chemically similar to one another—as close as, say, the sugars in honey and sugarcane. Humans, both males and females, can synthesize all the sex hormones starting from cholesterol. The recipe goes through two steps to progesterone, then three more to testosterone, the hormone that signals an embryo to make male internal plumbing plus male secondary sex characteristics at puberty. An additional step leads to dihydrotesterone, the hormone that shapes the male external genitals. A different step converts testosterone to estradiol, which interconverts with estrogen to produce female secondary sex characteristics at puberty, bone growth, and masculine brain anatomy.[18] These hormones, called steroid hormones, are widespread throughout the vertebrates. Each person has different amounts of each hormone, forming part of our biochemical individuality, but everyone has at least some of every type of sex hormone.

Making hormones is half the story; the other half is whether cells have receptors for them. All the hormones in the world will have no effect unless cells contain certain substances that chemically bind to the hormone. The overall impact of a hormone depends on both how much has been made and how much receptor is present to respond. Thus, the committee of genes that composes the body's sex hormone symphony includes gender genes like SRY, genes for sex hormone receptors, and genes for the many enzymes that catalyze sex hormone synthesis and interconversion. Quite a large committee.

UTERINE ENVIRONMENT

At birth, a baby is chemically experienced. While still in the uterus, an embryo makes hormones both in the gonads and in the adrenal glands. The placenta, a structure jointly made by baby and mother, is also a site

of hormone synthesis, and the mother contributes some hormones of her own. All these hormones irreversibly influence behaviors in later life.

In species that give birth in litters—producing a group of fraternal "twins"—brothers and sisters influence each other's development because of the shared effect of their hormones.[19] Certain behavioral inclinations of rodents—such as mice and rats, for example—have been measured in the laboratory. A male mouse was offered a choice of two females, one who had lived in the uterus next to two sisters (a two-sister female) and one who had lived next to two brothers (a two-brother female). The male mated twice as often with the two-sister female as with the two-brother female. Male rats who developed next to two sisters in the uterus (a two-sister male) had a higher sexual appetite than male rats who developed next to two brothers (a two-brother male). When paired with a receptive female, the two-sister males mated and came to climax more often than the two-brother males. In mice, the two-sister males had a higher appetite for same-sex matings as well. When two-brother males and two-sister males were paired with a reference male, the reference male mated more with the two-sister males than with the two-brother males. Lots of differences that can be detected in mice and rats point to an effect of their embryonic hormonal environment on temperament later in life.

The data for humans are scantier, in part because humans typically give birth singly rather than in litters. One behavioral trait has been studied, however: a peculiar trait called inner-ear clicking. Believe it or not, clicking sounds are generated inside the ear. These sounds travel out of the ear (instead of into the ear like most sounds) and can be recorded with a microphone. People don't hear the sounds made in their own ears—they get used to them. These clicking sounds are made more often by women than by men. A female with a twin brother, however, doesn't produce these sounds. Apparently, the brother's hormones masculinize his sister's ear development, as indicated by the absence of click production.[20] Lesbian and bisexual women also produce fewer clicking sounds than straight women (see p. 246).

Another clue that hormones from twins influence each other's later development comes from asymmetries in the teeth. Teeth are generally more asymmetrical in men (the right jaw has larger teeth than the left

jaw) than in women. A woman with a twin brother has a more asymmetrical jaw than other women.[21]

MATURATION

Hormones have long been known to have a large effect on morphology, during embryonic growth as well as in puberty. In males, external body changes begin while the person is still embryonic. At three months, a typical penis might be 0.3 centimeters in length, growing 0.7 centimeters per week until birth, when it reaches 3.5 centimeters. Penis growth is caused by dihydrotestosterone, converted from testosterone circulating in the blood. While the penis is growing, the vaginal pouch is reabsorbed, although some men still retain a small pouch called a prostatic utricle.[22] Puberty starts with growth of the testes at about eleven years, just a few months after the first signs of puberty in females.

In females, the average age at which breasts start to grow is 10.6 years for girls of European descent and 9.5 years for girls of African descent, with a range from 6 to 13 years. The first menstrual period begins about two or three years later, at 12.9 years in women of European descent and 12.2 years in women of African descent.[23] Estrogen secreted by the ovaries causes breast growth. At the same time, testosterone secreted by the adrenal glands and the ovaries causes the pubic hair to grow.

Before puberty, boys and girls grow at about the same rate. At puberty, boys wait two years later than girls for their spurt, winding up about 12.5 centimeters taller than girls on the average. Their greater height results from starting their spurt at a taller height and having a faster maximum growth speed during the spurt. The growth spurt in both girls and boys results from estradiol. One of the "female" sex hormones, estradiol has long been known to produce the growth spurt in girls, but it also causes the spurt in boys. Boys' testosterone from the testes is converted to estradiol in the bones, where the growth occurs. Indeed, testosterone often has its effect only after conversion in local tissues to estrogen and/or estradiol.[24]

HOW HORMONES MAKE US FEEL

In 1889 the physiologist Charles Edouard Brown-Séquard injected himself with extracts from crushed animal testicles and claimed renewed

vigor and greater mental clarity. A decade later, he admitted that the effects were short-lived and he couldn't rule out that he had been mistaken all along.[25]

In what I first assumed was a spoof, around April Fool's Day in 2000, the *New York Times Magazine* printed an homage to testosterone.[26] The author, a man taking testosterone as part of HIV therapy, offers this description: "It has a slightly golden hue, suspended in an oily substance and injected in a needle about half as thick as a telephone wire. . . . I push the needle in . . . [and] as I pull it out . . . an odd mix of oil and blackish blood usually trickles down my hip." "Within hours," he declares, "my wit is quicker, my mind faster, but my judgment more impulsive." A transgendered man the author interviewed adds, "My sex-drive went through the roof. I felt like I had to have sex once a day or I would die,"[27] and a forty-year-old executive taking testosterone for body-building gushes, "I walk into a business meeting now and I just exude self-confidence." The author credits the big T for increasing his weight from 165 to 185 pounds, his collar size from 15 to 17.5 inches, and his chest from 40 to 44 inches.

The article continues, "Men and women differ biologically mainly because men produce 10 to 20 times as much testosterone as most women do and this chemical, no one seriously disputes, profoundly affects physique, behavior, mood and self-understanding. . . . It helps explain . . . why inequalities between men and women remain so frustratingly resilient in public and private life." This claim is misleading. Testosterone doesn't stand alone; by itself testosterone doesn't do anything and needs receptors to have any effect.

The author declares that affirmative action for women is impossible, and we "shouldn't be shocked if gender inequality endures" because of the hormone differences between men and women. Instead, the "medical option" is to give "women access to testosterone to improve their sex drives, aggression and risk affinity and to help redress their disadvantages." So, to cure women of their womanhood, testosterone should be administered, although "its use needs to be carefully monitored because it can have side effects . . . but that's what doctors are there for." Rectifying social injustice by giving women testosterone to convert them into men is, shall we say, inadvisable.

Why would someone write such an irresponsible article? An answer

is suggested in the concluding sentence: "It seems to me no disrespect to womanhood to say that I am perfectly happy to be a man, to feel things no woman will ever feel . . . to experience the world in a way no woman ever has. And to do so without apology or shame." Male-male posturing.

The article details a stereotypical view of how testosterone affects behavior: "I feel a deep surge of energy. It is less edgy than a double espresso, but just as powerful. My attention span shortens, . . . I find it harder to concentrate on writing and feel the need to exercise more. . . . Lust is a chemical. It comes; it goes. It waxes; it wanes. You are not helpless in front of it, but you are certainly not fully in control. Then there's anger . . . mere hours after a T shot . . . I had nearly gotten into the first public brawl of my life." The article seems only dimly aware that it subverts the value of manhood, even as manhood is being championed. Men are portrayed as irrational creatures, ricocheting from one impetuous mistake to another, as testosterone propels their quest for sex. Women have long borne the brunt of criticism as irrational creatures, victims of a monthly hormone cycle, monsters on "bad hormone days." Men apparently have bad hormone days every day of their lives, suffering mental cramps, not menstrual cramps.

Transgendered people have much to contribute on how hormones "feel." Transgendered people tell of great variability in hormone sensation, probably reflecting differences in hormone receptors as much as hormone production. Perhaps most interesting is the seemingly unanimous report from transgendered men that testosterone calms them. The *New York Times Magazine* article provides only a partial picture of the transgendered man quoted as saying testosterone gave him an enhanced libido. In fact, that man, Drew Seidman, also stated that it is a "myth" that testosterone is a cause of undue aggression, that testosterone has a "calming effect" on him, and that he "feels much better" with it.

Similarly, Patrick Califia, a prominent transgendered writer who transitioned recently, said in an interview, "I've been much more comfortable on T. I feel like a calmer and more reasonable human being. Men are supposed to be more angry, but I just keep getting more mellow and loving and sweet, and I think it's because I'm happier. This chemical balance just feels right."[28] The distinguished transgendered leader Jamison Green writes, "The initial effect of testosterone was that it allowed me to feel 'normal'

for the first time in my life. It allowed me to feel calm, balanced, centered, the absolute antithesis of the clichés about . . . testosterone poisoning. And once I got comfortable with that feeling . . . along came libido."[29] I have spoken with other transgendered men about testosterone. They all confirm the reports of Seidman, Califia, and Green that testosterone has been calming. All also confirm a large increase in libido and speak of how they've accommodated this new, happy sensation into their lives.

What transgendered women say about testosterone differs markedly from what transgendered men say. Concerning the male libido, transgendered women talk about freedom from the burning in their groin, from the never-ending need for relief; they talk about pacing in romance, not wham-bam. For me, testosterone was a triple-espresso buzz, razzing, annoying, clouding thought, taking me where I didn't want to go. When I replaced testosterone with estradiol, within a day I felt a deep calm and happiness.

Transgendered people speak of hormones as the most important step in gender change, tipping the balance of subtle signs connoting gender identity as a man or woman. Transgendered people tell too of losing their partner or spouse soon after starting hormones because intimate relations were fundamentally altered.

A major reason for individuality, for the emergence of diversity in body and temperament, is the effect of hormones and their receptors. Hormones early in life cause irreversible effects on temperament later in life, and hormones later in life can reversibly affect mood and activity.

MENTAL SEX DIFFERENCES

Our quest for the developmental sources of human diversity leads now to the brain, the most mysterious of all our organs. Here lies the circuitry that activates sex drive, hunger, temperament. Here, too, lies creative spirit, free will, love, humor. Somehow our personhood emerges from the substance of our brains. Clues about what kind of people we are reside in brain size and shape, in its pattern of electrical discharges.

Brain and behavior work together in a back and forth. Just as weightlifting strengthens the biceps, and big biceps then allow heavier weights

to be lifted, parts of the brain shrink and expand with use, especially early in life. People's biceps start at different sizes, before any weight-lifting. Likewise, brains differ at birth, reflecting an inherent disposition to different behaviors. How, then, are our brains involved in our sex lives, in the disposition we have to express gender and sexuality?

The brain listens to sights and sounds from outside, as well as to the music of the hormones within the body. The brain secretes hormones too, playing in the hormonal orchestra—it does its listening as a performer in the orchestra pit, not as a spectator in the audience. The brain "hears" the body's hormones using receptors located in the preoptic area of the hypothalamus, running from the back of the brain, near the spinal cord, along its bottom, to the front near the eyes. The brain also listens directly to genes, such as gender genes like SRY in the male, without going through hormones as intermediaries.[30]

BIRD BRAIN ANATOMY

Biologists who study brain anatomy are used to looking for fine details, differences between a few cells here and there. In 1976 brain anatomists were amazed by what they found. It was known that while male canaries and zebra finches sing, female canaries sing only a little, and female zebra finches don't sing at all. It was also known that in both species males learn their song from listening to other males.[31] The surprise was that the brains of the males and the females in these species are so different that they can be told apart with the naked eye.[32] Place the brains from a male and a female zebra finch next to one another, and with practice, you can tell their sex just by looking. In the upper part of his brain, a male bird has extra nerve cells, which occur in clusters containing extra hormone receptors as well—hormone receptors in addition to those along the base of the brain.[33] These upper-brain nerve cells enable the male bird's singing.

Although the neurobiology of avian brains isn't directly comparable to that of mammalian brains, avian brains set valuable biological precedents.[34] Here's a list:

1. The brains of males and females can differ, and differ substantially, as in canaries and zebra finches.

2. The degree of difference between male and female brains correlates with the degree of difference in their behavior. In species where males sing and females don't, the difference in the size of nerve-cell clusters responsible for learning and producing bird song is most marked. In dueting species, where males and females sing to each other at courtship with interlocking songs, the nerve-cell clusters that control song are the same size in both sexes.[35] A survey of twenty songbird species spanning six families shows that the degree of dimorphism in brain anatomy correlates with the degree of dimorphism in both variety and quantity of song.[36]
3. Testosterone organizes the brain of newly hatched male chicks to develop song-control clusters of nerve cells. These clusters don't develop in the absence of testosterone, and they can be caused to form in females if testosterone is administered.[37]
4. Hormones activate nerve-cell clusters in adults, expanding and shrinking the size of the clusters to match the breeding season.[38]
5. The brain is masculinized by estrogen that has been converted from testosterone by the enzyme aromatase. Because some aspects of the male body are masculinized directly by testosterone, other parts by estrogen that has been converted from testosterone, and still other parts by direct expression of genes without any involvement of hormones, reconstructing the developmental pathways of sexual differentiation is complicated.[39]
6. Personality differences can be traced to brain differences. Reproductively active male Japanese quail vary in aggressiveness by fourteenfold. This variation relates to the amount of aromatase in the hypothalamus of their brains—the more aromatase, the more aggressiveness.[40]
7. Female parents influence the temperament of their chicks by introducing estradiol or testosterone into the egg yolk. Birds given more testosterone in their yolk are more aggressive. A female bird deposits increasingly more testosterone in the eggs as the egg-laying season progresses, so the birds hatched last in the nest are the most aggressive, presumably to defend themselves against their older siblings. This effect is comparable to the role of maternal hormones in the developing mammal fetus.[41]
8. The direction of partner choice for adult female zebra finches shifts from between-sex to same-sex after estradiol is

administered to hatchlings. Estradiol masculinizes the brain and changes the direction of sexual preference.[42]

9. The white-throated sparrow has a territorial white-striped morph and a nest-tending tan-striped morph in both sexes (see chapter 6). This reciprocal transgender expression in body color and behavior extends to the brain too. Within a sex, the song-control clusters of neurons are larger in the territorial morph than in the nest-tending morph. Between sexes, a male nest-tending morph has larger song-control neural clusters than a female territorial morph, even though both sing about the same amount.[43]

Transgender gender identity apparently has not been investigated. In birds like canaries, males learn their song from male "tutors," often their fathers. How does a male chick know to listen to his father instead of his mother? Female canaries sing a different song from males. I wonder if an occasional male chick learns his mother's song, and an occasional female chick learns her father's song.

Birds have reverse chromosomal sex determination relative to mammals (see p. 204). In birds, estrogen from the ovaries feminizes a body that would otherwise be masculine, whereas in mammals, testosterone from the testes masculinizes a body that would otherwise be feminine. Although hormones work somewhat differently in birds than in mammals, they bring about the same overall result in gender and sexuality.

The connection between brain structure and behavior may be more direct in birds than in mammals, as though birds relied more on instinct and less on thought than mammals. However, I'm struck by how clear-cut the data are linking differences in bird brain structure to differences in gender presentation, personality, sexual orientation, and transgender expression. I wonder to what extent something similar happens in mammals.

RODENT BRAIN ANATOMY

Like birds, mammals have some sexual dimorphism in brain anatomy. Here's a list of brain dimorphisms in rodents:

1. Male rodents, including gerbils, guinea pigs, ferrets, and rats, have a larger cluster of cells in the preoptic area of the brain, along the base of the brain toward the front. The clusters are about five times larger in males than females, and the difference can be seen with the naked eye.[44] Testosterone near the time of birth, converted to estrogen in the brain, organizes this difference. Testosterone given later in life doesn't cause these cell clusters to form.[45] Nobody knows what this cluster of cells does in a male. If they are removed surgically, little effect on behavior is noticed. However, if the whole preoptic area is removed, male copulation is affected, so the clusters may have something to do with male mating behavior.[46]
2. A nearby cluster of cells, called the bed nucleus of the stria terminalis, also shows a sexual dimorphism that is controlled by testosterone near the time of birth.[47] This cluster is of interest because recent work on transgender identity in humans has focused on the human equivalent of this structure.
3. A cluster of nerve cells in the spinal cord in the lower back also differs between males and females. In males, these nerve cells control muscles in the base of the penis. These cells and muscles are present in newborn animals of both sexes. In males testosterone prevents this muscle and the nerve cells that control it from shrinking, whereas in females testosterone causes the muscles and nerve cells to shrink. Testosterone produces this effect directly, without needing to be converted into estrogen.[48]

When pregnant female rats are stressed in the laboratory by shining bright lights on them all day long, the male embryos in the litter produce less testosterone during their fetal period. They wind up with smaller clusters of nerve cells in the preoptic area and fewer nerve cells in the spinal cord for control of the penile muscle.[49]

The scent of testosterone in a male offspring induces his mother to groom his genital region more often than the genital region of a female offspring. If the mother isn't able to smell, then she doesn't groom either sex very much. A young male offspring who isn't groomed winds up with fewer penile-muscle-controlling nerve cells in his spinal cord and takes more time to copulate than a male who is groomed.[50]

Thus, in mammals too, brain and spinal cord anatomy can differ between the sexes, and these differences partly reflect the hormonal and so-

cial environment in which the animals develop. Again, temperament and inclination originate near the time of birth.

HUMAN BRAIN ANATOMY

Human brains show few sex differences compared with other species. Lots of research has been directed to showing brain differences between males and females, and many small differences have been found. Overall, though, male and female human brain anatomy is very similar—the big story here is the overlap between the sexes, not their difference. Picture two bell-shaped curves placed on top of one another. Then *gently* nudge one to the right and the other to the left, so the curves are just slightly askew. That's how close together the two sexes' brain anatomy is.[51] Here is a summary of the small differences that have been found:

1. Males have a somewhat bigger total brain size, 120 to 160 grams in adults. The difference is almost absent at birth, becoming more pronounced during puberty, partly reflecting the overall size differential at that age. Even at birth, though, a group of newborns who weighed the same showed a 5 percent difference in brain weight by sex.[52] This 5 percent, although statistically valid, is tiny compared to the overall variation in brain size.[53]
2. Both male and female humans have the counterpart of the penis-controlling muscle found in mice. In human males, the muscle wraps around the base of the penis to aid in the ejaculation of semen. In human females, the muscle encircles the opening of the vagina and can constrict its entrance. The muscle is somewhat larger in males, although the male/female difference is not as great as in mice. Males have about 25 percent more nerve cells to control this muscle than females. As in mice, the cells are located in the spinal cord. As in mice, females and males have the same-size muscle and same amount of controlling neurons at birth, but testosterone directly causes the female muscle and neurons to shrink and die back.[54]
3. The preoptic area of the hypothalamus in humans features a cluster of cells called the SDN-POA (the sexually dimorphic nucleus of the preoptic area), which is the counterpart to that in mice. Both males and females are born with about 5,000 cells in this cluster; both increase to about 50,000 by age four, and then a dimorphism develops as the number of cells in this cluster declines in females to about 25,000 by age twenty. This approximately twofold difference in cell number persists through adulthood. The function of SDN-POA remains unknown, although it is presumed somehow to influence mating behavior. SDN-POA is minute, a cluster of nerve cells the size of a grain of rice in a quart-sized brain.[55]
4. Another minute cluster of nerve cells that has been publicized in relation to gender and sexuality is found slightly above SDN-POA. It is called BSTc (the central subdivision of the bed nucleus of the stria terminalis). As in rodents, men have a larger BSTc than women, about 2.5 cubic millimeters with 35,0000 cells in men, and 1.75 cubic millimeters with 20,0000 cells in women.[56] (See also chapter 13, concerning transgender gender identity.) BSTc is part of a region called the septum, which is involved in sexual function. Electrical discharges in this part of the brain occur during orgasm, and electrically stimulating this part of the brain causes orgasm.[57] Altered sexual behavior, such as hypersexuality, as well as change of sexual orientation and fetishism, results from damage to the septum,[58] suggesting that natural variation in sexuality may be associated with corresponding variations in particular areas of the brain. Moreover, hypersexuality raises the possibility that typical human sexuality is not as intense as is biologically possible, that through evolution our sexuality has been set at some optimum intermediate level. The septum provides a natural veil of modesty covering a potential for increased sexuality.
5. Slightly below SDN-POA is a third, even smaller rice-grain of nerve cells, a 0.25 cubic millimeter cluster called VIP-SCN (vasoactive intestinal polypeptide containing subnucleus of the suprachiasmatic nucleus). After about ten years of age, a sexual dimorphism can be detected, wherein males have about 2,500 cells and females about 1,000 cells in this cluster. (See also chapter 14, concerning sexual orientation.)[59] But just how important could a difference in a teeny neuron cluster be? We don't know yet. They seem too tiny to account for much of the behavioral differences in gender and sexuality, but then even the small bite of a black widow spider or yellow-jacket wasp can pack quite a wallop. Let's keep an open mind (so to speak).

6. The human brain shows some right-to-left specialization, especially in right-handed males. Males process verbal information faster and more accurately on the left side, and spatial information on the right side.[60] Females don't show such a pronounced asymmetry. Strokes also reveal a male/female difference: females recover better overall, whereas the impact for males can be predicted by knowing which side of the brain the stroke is on.[61] The differences in brain symmetry have a slight anatomical basis.[62] The corpus callosum is a conduit of nerve cells that bridges the two sides of the brain. Males and females differ slightly in the shape, but not size or number, of neurons in their corpus callosum. The corpus callosum may be positioned slightly more toward the back in females than in males.[63]
7. Moving up from the base of the brain into the cerebral cortex at the top of the brain, dissections of brains from six males and five females show that males have more nerve cells with fewer connections among them, whereas females have fewer cells but more connections among them. Both males and females have the same overall amount of brain material. Males have about 115,000 ± 30,000 neurons per cubic millimeter, whereas females have about 100,000 ± 25,000 neurons per cubic millimeter. Moreover, males are more asymmetric between right and left sides of the brain. Males have an average of 1.18 more neurons per cubic millimeter on their right side compared with the left side, and females have an average of 1.13 more neurons per cubic millimeter on the right compared to left.[64] These differences between the brains of males and females follow the familiar script: small statistically valid differences in the averages, with a large overlap.

When the brain first forms, more nerve cells are produced than needed. The cells are pruned through a process of programmed cell death, called apoptosis. Testosterone slows the pruning. Females wind up with fewer but more selected neurons than males do at the end of this process, which occurs during the last ten weeks before birth.[65]

Although certain mental functions can be pinned down to specific locations in the brain, more general-purpose cognitive processes emerge from the collective activity of many neurons distributed throughout the brain.[66] Do human males and females differ in these general-purpose mental abilities too?

MALE AND FEMALE THINKING

Men and women differ in cognitive abilities and aptitudes, much as it might seem inflammatory to say so. Overall intelligence, whatever that is, doesn't differ between men and women, regardless of what you hear each gender saying about the other in moments of mutual incomprehension, but some specific mental skills do differ. As with brain anatomy, the differences are small, but statistically detectable nonetheless, and show great overlap.

Women test better than men, on the average, in verbal fluency, articulation, and memory. Fluency is measured in tests such as trying to think of all the words that begin with a specific letter (for example, every word that starts with "t," or words that rhyme with "mind," or all the words that pertain to some subject or category, like "ice cream"). Women can usually say a tongue twister, such as "Sweet Susie swept seashells," faster than men. Women can also more quickly scan an array of symbols or figures and remember which one matches a previous symbol or figure. This memory advantage applies to visual and spatial information as well as to letters and words.[67]

The enhanced aptitude of females for verbal fluency may result in part from estrogen. One clue comes from the female gorilla Koko, who was trained to communicate in American Sign Language. Both the number of different signs and the total number of signs she gave increased during the part of her monthly cycle when her estrogen level was highest. This effect of estrogen is temporary and does not affect brain structure (activational, not organizational).[68] In humans, too, performance on tests for articulatory skill improves, and performance for spatial ability declines, at the preovulatory phase, the time of highest estrogen, compared to the intervening time of lowest estrogen.[69] Postmenopausal women on estrogen hormone-replacement therapy show cognition benefits.[70] Young women may also receive cognitive benefits from estrogen. Dyslexia, a reading disability, was originally thought to reflect a visual difficulty. Instead, dyslexia results from not discerning the components of words cor-

rectly. About an equal number of boys and girls are born with dyslexia. Of those who develop the ability to compensate, 72 percent are girls, resulting in more adult males with the disability than adult females. Apparently the estrogen available to girls at puberty leads to their developing verbal abilities that permit them to compensate for the dyslexia.[71]

Men test better than women, on the average, at visualizing how to rotate a shape or object in two-dimensional or three-dimensional space.[72] This ability to visualize spatial relations shows up especially in tests of quantitative aptitude such as the SATs. The gender gap on this test progressively widens toward the high end. Boys outscore girls 2:1 at scores of 500 and above, 5:1 at scores of 600 and above, and 17:1 at scores of 700 and above. High scores on this test are particularly sensitive to performance in spatial relations.

Beyond these details, if you've sometimes felt that men and women just *think* differently, there is some hard evidence to back up your feeling. Functional magnetic resonance imaging (fMRI) now makes it possible to take a picture of the brain while it's thinking in real time. The picture lights up the places in the brain where thinking is going on. In one study a group of men and women were given the same verbal task: they were given a written list of nonsense words, like "lete" and "jete," and asked to say them out loud, making them decide if the words rhymed. As they thought about how to pronounce these words, their brains were photographed using fMRI. The results were astounding. For the same task, the men and the women used their brains differently. Men relied on only one part of their brain (the left inferior frontal gyrus), whereas women used two parts of their brain (both left and right inferior frontal gryi). This shows that female brains function more symmetrically than male brains, even though this claim has been difficult to demonstrate anatomically. The photographs of this result are dramatic: they show different parts of the brain lighting up.[73] These differences don't pertain to tiny clusters of nerve cells, but rather to large regions of the brain. An anatomical underpinning to these functional differences between how men and women think hasn't been discovered.

Men and women also think about spatial tasks in different ways. A group of men and women were asked to find their way out of a three-dimensional virtual-reality maze. To traverse the maze, men used one part of their brain (left hippocampus) and women two parts (right parietal cortex and right prefrontal cortex). This difference in where thinking goes on may correlate with the observation that women rely on landmark cues rather than geometry for navigation.[74]

What are we to make of these mental differences between men and women? Such differences can be amplified by social convention. If the ratio of men to women who are excellent at an occupation requiring spatial rotation abilities is 60:40, then the occupation may acquire a masculine character, which discourages women from joining. If the ratio of men to women who are excellent at an occupation requiring verbal fluency is 40:60, then the occupation may acquire a feminine character, which dissuades men from joining. The social character acquired by an occupation may lead to the belief that an occupation is a "man's job" or "woman's work," far outweighing differences in native skill.

Each of us can compare ourselves to the averages for human males or females and find we don't completely match. Almost everyone seems to cross over the statistical norms for their sex in some way or another. The average values for the sexes don't have much meaning for us as individual people: it's like saying the average American lives in Kansas, which doesn't apply to most of us.

The combination of average differences and a great overlap in mental characteristics sets the stage for many kinds of transgender expression. The reality of differences between male and female averages means the statement that *A* is a male trait and *B* is a female trait is statistically valid. But the great overlap also means that many males will have *B* and many females will have *A*. Transgender presentations necessarily occur in all sorts of dimensions simply because everywhere the averages differ the overlap is also huge. The same can be said of gender identity.

Why should men have more ability at spatial relations than women, and women be more verbally fluent than men? Spatial rotation skills might help in throwing a spear or evading an attacker, as evidenced by the male high-risk life history (see pp. 236–37). Spatial skills are also needed to build structures to contain women, enabling mate guarding, and are used in constructing weapons too. Conversely, verbal ability is fundamental to teaching children, to nursing the mind. The higher degree of interconnections among neurons in women's brains may permit performing more simultaneous activities. Such conjectures raise the major issue of human evolution—why we have the

brains we do—because the human brain is perhaps the single trait that defines our species.

HUMAN BRAIN EVOLUTION

Our brain size has swelled by a factor of three in the last 2.5 million years. That's fast. Why? Evolutionary psychologists have developed a tortuous theory based on sexual selection to explain the brain's evolution. Their theoretical machinations illustrate how they have become intellectually addicted to sexual selection theory. We can't begin to account for something as basic as the human brain's evolution until we "just say no" to sexual selection.

The traditional explanation is that our brains evolved as we developed technology to solve ever more complex problems, allowing us to become tool-using animals. This view is seriously challenged by the observation that technological innovation was at a standstill during our brain's evolutionary expansion.[75] Only after all the evolutionary action was over did any cumulative tradition of technological progress emerge. Only then did any global migration take place from the tropics into colder climates, or any population spurt occur. Natural selection can't look ahead millions of years and produce a brain in the hope that it will be valuable in the future. How did natural selection propel the brain's evolution forward if it was only intended for future use?

Instead, the evolutionary psychologist Geoffrey Miller suggests that our brains serve to create "the more ornamental and enjoyable aspects of human culture: art, music, sports, drama, comedy, and political ideals."[76] His theory goes on to state that cultural products somehow promote finding mates, whereas tool use mostly promotes survival. Perhaps the brain evolved primarily to aid in reproduction rather than survival. As Miller explains, "The human mind and the peacock's tail may serve similar biological functions. . . . The peacock's tail evolved because peahens preferred larger, more colorful tails. . . . The peacock's tail evolved to attract peahens. . . . The mind's most impressive abilities are like the peacock's tail: they are courtship tools, evolved to attract and entertain sexual partners. . . . The mind evolved by moonlight . . . as an entertainment system to attract sexual partners." According to this theory, intelligence signifies the "great genes" that men supposedly have and women supposedly seek.

But wait a minute. Sexual selection theory only applies if the attracting trait is a male ornament that is not also possessed by females, and it must actually be preferred by females in heterosexual courtship. This brain-as-a-peacock's-tail theory is incorrect because men and women have nearly identical brains. In peacocks, only the male has large tail feathers; peahens don't bother with such decor. If the human brain were just a man's tail feather, then women wouldn't bother to develop a similar brain.

Miller has therefore suggested several modifications to the sexual selection theory to account for brain evolution. One modification postulates that both men and women use their brain to advertise the absence of bad genes rather than the presence of great genes: "Any deviation from the genetic norm is a deviation from optimality." According to this theory, if you're smart and witty, you're also healthy. "The human mind's most distinctive capacities evolved through sexual selection as fitness indicators. . . . The healthy brain theory suggests that our brains are different from those of other apes because . . . the more complicated the brain, the easier it is to mess up. The human brain's great complexity makes it vulnerable to impairment through mutations, and its great size makes it physiologically costly. . . . Our creative intelligence could have evolved . . . to reveal our mutations."

This modification is fatally flawed from the onset by its assumption that variation from the norm is suboptimal. Sexual reproduction exists to maintain genetic variation. This theory of brain evolution contradicts itself by postulating that the purpose of mate choice is to eliminate the very variation that sexual reproduction is there to promote. This flawed theory is diversity-repressing.

Yet another modification notes, "It takes a sense of humor to recognize a sense of humor. Without intelligence, it is hard to appreciate another person's intelligence." According to this view, women have brains in order to admire the brains of men. But as Miller finally acknowledges, "I do not think that female creative intelligence . . . arose simply as a way of assessing male courtship displays."

So we're back to where we started. Why our brains have evolved re-

mains as mysterious today as in the past. To move forward, let's analyze where evolutionary psychology has gone wrong:

1. Evolutionary psychology overemphasizes the amount of cultural production that goes directly into mate choice. A peacock is believed to show his tail feathers to a peahen during courtship—this is why Darwin's theory seems plausible, even if not demonstrated, for the special case of peacock tails. Except for the occasional love poem, few cultural expressions seem intended for one-to-one heterosexual courtship in the way a peacock's display is claimed to be.
2. Evolutionary psychology accepts biological sexual selection theory too enthusiastically and uncritically. Sexual selection theory is an elite male heterosexist narrative projected onto animals. Basing a theory of human behavior on sexual selection theory naturalizes this narrative and transfers the narrative back to people, as though it were a theory of human nature.
3. Evolutionary psychology needs a deeper conceptualization of female perspective. Females are viewed as what males think females ought to be.
4. Evolutionary psychology is in denial about same-sex sexuality. Miller claims that "homosexual behavior is just not very important in evolution. . . . Its existence in 1 or 2 percent of modern humans is a genuine evolutionary enigma."[77] Homosexuality is a valid color in the human gender/sexuality rainbow. It needs explanation, not dismissal. Imagine if the theory of light had ignored some of the rainbow's colors—we wouldn't have both RGB color monitors and CMY color photographs.

I suggest the human brain is a social-inclusionary trait for membership in the community of humans. People require the modes of interaction that the human brain supports in order to be included in human society and to have access to the chance to reproduce and to survive as human beings. This function of the human brain may account for its rapid evolution in humans and for its uniqueness to people. Playing at being human involves finding mates, raising young, and surviving, all in a social context. Functioning as a human requires building relationships,

both within and between the sexes, navigating social power networks, and teaching the young how to enter society. The complexity of our society reflects our complex brain, which in turn socially selects for an increasingly complex brain to be effective in an increasingly competitive society, leading to runaway evolution in brain size and complexity. The brains of men and women would seem to be mostly the same because we are both playing in the same society overall.

LIFE-HISTORY SEX DIFFERENCES

Is there any pattern to all the small sex differences we've just enumerated? We've seen in other animals that each gender has a characteristic approach not only to mating but to its entire life. The three male genders of bluegill sunfish, for example, differ not only in mating and social behavior, but also in body size and life span. The traits these fish exhibit come together as a suite of tactics that carry out a life-history strategy. Perhaps human males and females too have slightly different life-history strategies that tie together their differences.

One basic feature of a life-history strategy is life span. Before 1940, men and women had about the same life span. During the last sixty years, though, women have been living longer than they used to, and longer than men. By 1998 the expected life span of a baby girl was 79.5 years, while that of a baby boy was 73.8 years, about five years less. A woman of age 75 was expected to live an additional 12.2 years, and a man an additional 10.0 years. Overall, improved health care is revealing an inherent tendency for women to live longer than men.[78]

The immediate cause of higher mortality in older men is more heart disease and cancer, but males have a higher death rate from injury and illness across all ages. Rather than considering what men might learn from women about how to live longer, some have attempted to demean the quality of life that women experience: "The female longevity advantage, however, is not without cost. Although females live longer," they "experience more disabling problems than males." By adjusting for "quality of life . . . a 5.38-year advantage for women is reduced to 1.3 years."[79] What this statistic means is debatable. The surviving women are, after all, surviving, whereas their male counterparts have already

died. If we average in the dead males as being seriously disabled, male quality of life may drop below that of women. One suspects too that men are likely to underreport health problems compared with women. Moreover, the health professions overall have emphasized male care more than female care, so disabilities more common among women, such as autoimmune diseases, are less well understood than those in men, and the treatment less effective.

Women live longer by about five to ten years in all ethnic and cultural groups. This difference in life span is substantial: 5 percent. Using the categories Native American, Native Hawaiian, Samoan, Guamanian, Hispanic, Puerto Rican, Black, U.S. Virgin Islands Black, Chinese, Japanese, Filipino, and White, researchers found that females lived longer than males within each category. The average life spans varied from a low of 65 and 74 years for male and female Blacks, to a high of 80 and 86 years for male and female Chinese.[80] That women live longer than men is undeniable.

Why is this? An ecological perspective offers a possible answer. Ecologists use the concept of a "life history" for the biologically programmed schedule of important events through life. Key events are when reproduction can begin, how many young are produced at the same time, how long reproduction can last, and when death is likely to occur. Ecologists observe that life-history traits usually come bundled in distinct suites. In dangerous environments, animals evolve an early maturation age, have large numbers of young at a time, and senesce early—the high-mortality suite. In safer environments, animals postpone the start of reproduction to a relatively late age, raise fewer young at any one time, and live longer—the low-mortality suite.[81]

If we reflect on the full life cycle of many mammalian males and females, including humans, sexual dimorphism in life history emerges. The dimorphism shows that males, on the average, may have more of a high-mortality suite of life-history traits, and females more of a low-mortality suite. Specifically, sperm are more numerous and senesce faster than eggs. Male embryos grow faster from conception than female embryos. SRY grabs early control of the gonadal ridge to accelerate male body differentiation. At puberty, males have their first intercourse about one year earlier than females,[82] and the male growth spurt is timed to yield a larger body size. The reproductive skew is more pronounced in males

than females, with 14 percent of males not having any intercourse in a year, compared with 10 percent for females.[83] Adulthood ends with faster male senescence and a shorter life span. Thus, on the average, males exhibit a high-mortality suite of life-history traits compared to females. Not only do males on the average encounter more danger than females, as evidenced by their higher mortality rate in the population, but through evolution their life history has apparently become adapted to this higher danger.