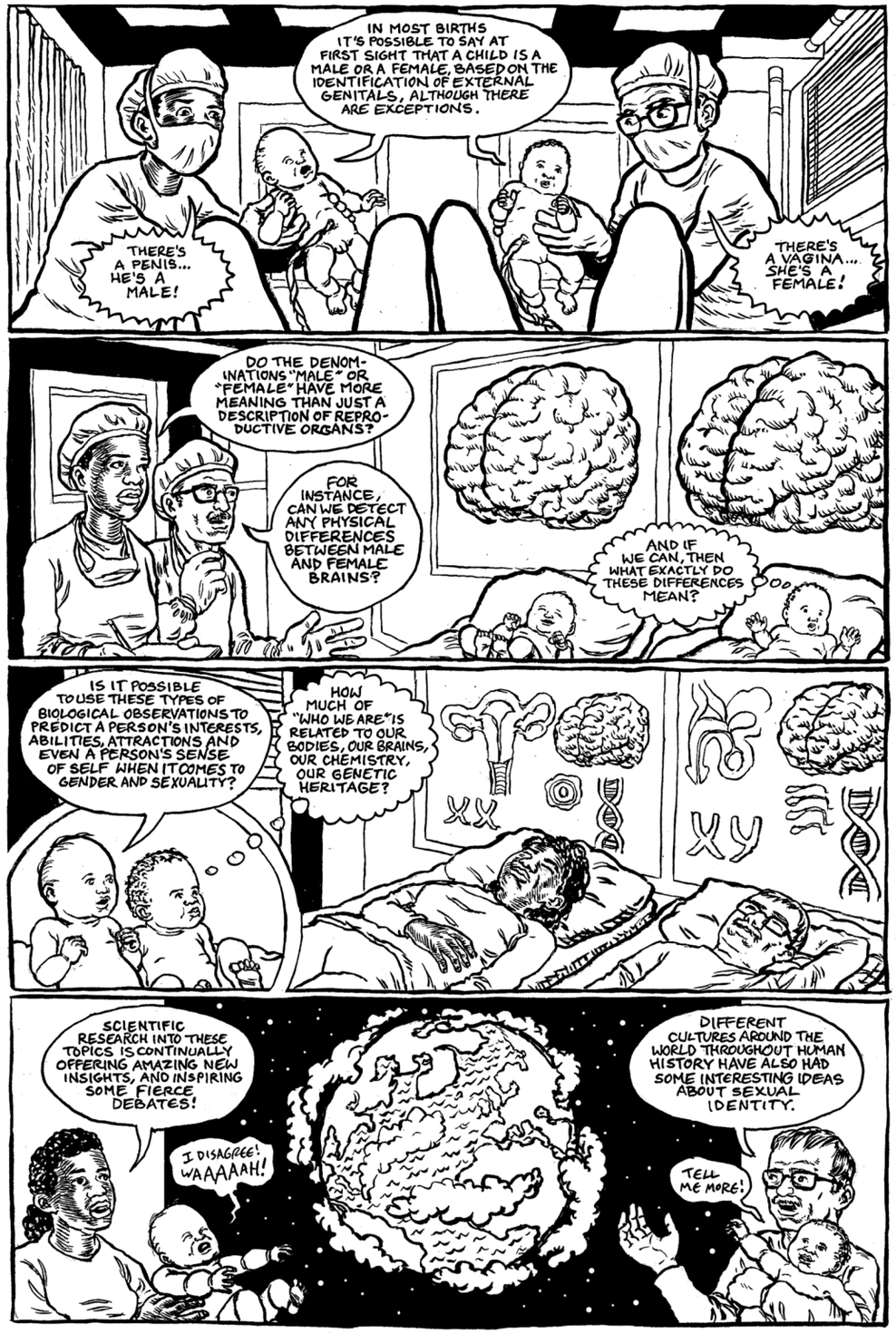


CHAPTER 1

THE BIOLOGY OF SEX AND GENDER

When do we first become aware of gender? Is it when certain clothing or toys are given to us to match a culturally-specific model of how a child should look and play? Is it when we see genitals other than our own and are forced to compare and contrast? Or maybe the first time we truly process the idea of gender occurs when checking off a box to identify ourselves, almost invariably as either "male" or "female".

Neurobiologists often suggest that the formation of gender identity starts much earlier than any of these events. Some say that gender is simply embedded in our genes. Others believe that the introduction of particular hormones in the womb shape how we will emerge. It is commonly held that the number of X vs. Y chromosomes an individual has in their cells provides the basic determination of an individual's sex. And yet, few contest that chromosomes fall quite shy of explaining the roles and patterns of behavior that are associated in our society with being a man or a woman. What's more, there are plenty of individuals who don't fall neatly into either of these categories, either biologically speaking or with regards to their personality and sense of identity. And, of course, being a man or a woman (as well as combinations thereof and other identity classifications entirely) has meant different things to different cultures throughout the course of history.

SEX VS. GENDER: A BASIC GLOSSARY

One's "sex" refers to the physical attributes that distinguish between typical male, female and intersex people. "Gender," on the other hand, refers to the behaviors, activities, roles and actions that are socially attributed to boys, girls, men, women, and transgender people in a given society. Descriptions of genders and gender roles differ in each culture, and many people's gender (or genders) do not match the socially-designated attributes of the sex that they are assigned at birth. The term "gender identity" describes the gender that a person inhabits, experiences and expresses in their daily life.

"Sexuality" refers to desire and attraction. One's "sexual orientation" indicates who one is generally attracted to, emotionally, romantically, and/or sexually. People can be attracted to members of their own sex or a different sex, to more than one sex or gender, or not experience attraction at all. Some people also have emotional and romantic feelings for people they are not sexually attracted to (or sexual attraction to someone they do not have romantic or emotional feelings for); this also falls under one's sexual orientation. A "sexual identity" describes how someone feels about or relates to their sex, gender(s) and sexual orientation.

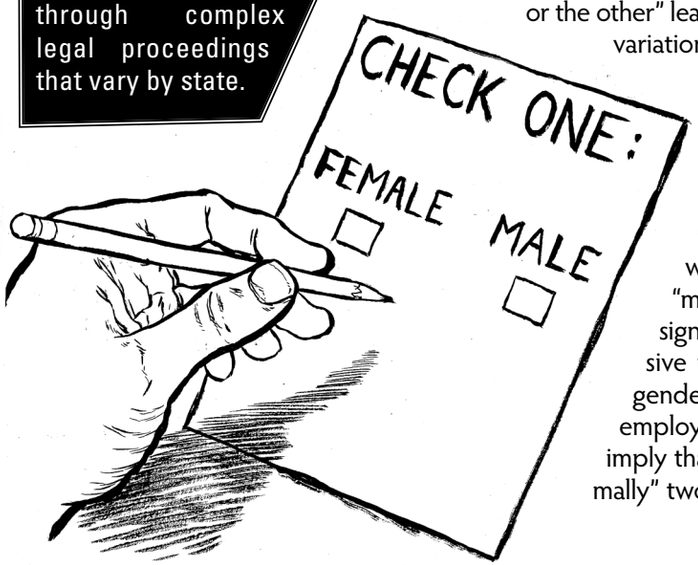
These categories continue to evolve as economics, politics, popular culture, art, science and other factors shift society's perception of itself, and alter the roles which comprise our collective and individual sense of identity.

When examining gender as a category, one of the first distinctions we explore is dividing people on the basis of their genitals, hormones or chromosomes. Although, is this not as arbitrary as dividing the world up on the basis of left and right-handedness or by eye color? Such logic may be valid in theory, but dividing people on the basis of handedness or eye color would ignore the historical and cultural meaning, weight and power assigned to a man or a woman. On the other hand, separating people according to genitals, hormones and chromosomes ignores the experience of transgender, intersex, androgynous, and genderqueer people (to name a few categories).

For this discussion, the categories of male and female will be overrepresented due to the amount of pertinent study that has strictly attended to those two identities. It should nevertheless be noted that on almost every continent throughout history a variety of cultures have acknowledged more than two genders. Western society's currently rigid description of people as deterministically "one or the other" leaves little room for variation in one's experience of a mixed or changing gender identity, gender expression, or variance within what the words "men" and "women" signify. Even progressive terms like "transgender" are sometimes employed in ways that imply that there are "normally" two sexes (male and female), and two genders (man and woman). This leaves out equally legitimate identities such as "nádleehí", a designation in Navajo culture for an individual who considers themselves both a boy and a girl. The Navajo are far from the only culture with a malleable concept of gender identity, but Western traditions have marginalized all but a binary notion of gender, and by extension, the sexuality of those genders.

SEX ASSIGNMENT AND GENDER DOCUMENTATION

It is telling that very few surveys, tests or paperwork requiring someone to check a box noting their sex or gender provide alternative options to 'male' or 'female.' In the majority of binding legal, medical and governmental documentation it is assumed that gender is fixed, assigned at birth, and has no room to evolve, change, or fall outside of those two boxes. When a doctor signs a legally-binding birth certificate, they personally and permanently assign a child's sex, which can only be changed through complex legal proceedings that vary by state.



GENETICS 101

DNA contains the genetic instructions that manage the development of all living organisms. These molecules store information in a code-like fashion. The segments carrying this data are referred to as genes. Genes pass on traits between generations of organisms and determine what characteristics each individual organism will inherit. For example, there is a gene for eye color.

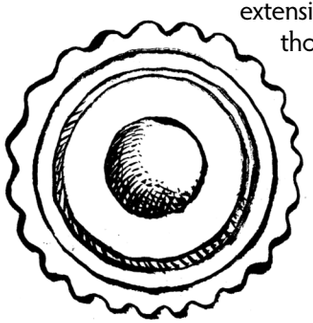
A chromosome is a structure of DNA and protein that is found in cells. Chromosomes organize DNA into a discrete package that regulates its genes' meaning and expression. In humans, there are two kinds of chromosomes: autosomes and sex chromosomes. The traits which are connected to someone's sex are transmitted through their sex chromosomes. All other hereditary information resides in autosomes. All human cells contain 23 pairs of nuclear chromosomes – 1 pair of sex chromosomes and 22 pairs of autosomes.

Most people have one pair of sex chromosomes per cell; usually, females have two X chromosomes and males have one X and one Y. Both sexes retain one of their mother's X chromosomes, and females inherit a second X chromosome from their father. Males inherit their father's Y chromosome instead.

Although X chromosomes contain several thousand genes, almost none (if any) relate specifically to the determination of sex. As females develop in the womb, one of their X chromosomes is almost always deactivated in all cells (except for in egg cells). This process guarantees that both males and females have one working copy of the X chromosome in each cell. The Y chromosome contains the SRY gene which prompts testis to develop, distinguishing male organisms from females. Y chromosomes also house the genes that produce sperm.

MALE = OF OR DENOTING THE SEX THAT PRODUCES SMALL, TYPICALLY MOTILE GAMETES.

In the Oxford English Dictionary, a male is "of or denoting the sex that produces small, typically motile gametes, especially spermatozoa, with which a female may be fertilized or inseminated to produce offspring." This definition is strictly biological, and refers only to a male's ability to impregnate a female; to some biologists, this is the only char-



FEMALE = OF OR DENOTING THE SEX THAT CAN BEAR OFFSPRING OR PRODUCE EGGS.

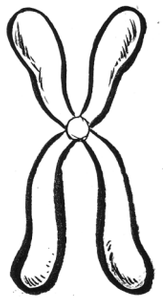
acteristic which differentiates the male sex in an inarguable fashion. A female, by contrast, is "of or denoting the sex that can bear offspring or produce eggs, distinguished biologically by the production of gametes (ova) that can be fertilized by male gametes." By this account, an animal, plant, or human is a female if "she" can produce eggs and therefore bear children or offspring.

Doctors assign humans' sex at birth on the basis of genitalia, not the ability to reproduce. Likewise, doctors seldom check individuals to verify whether or not they have XX or XY chromosomes, but generally assume the presence of a penis or a vagina is indicative of these chromosome pairings.

VIRILITY AND FERTILITY

Legally-speaking, a woman who cannot conceive or a man who cannot inseminate a female is not considered any less representative of their sex. Still, there are definitely social connotations surrounding women's infertility and men's virility. For example, men who are impotent (or assumed to be on the basis of exhibiting fewer masculine traits) are sometimes mocked by their peers. Likewise, women who are unable to bear children or choose not to sometimes experience stigmatization.

This is not always the case, as with intersex people who may have both male and female genitalia, atypical genital and/or reproductive anatomy, or ambiguous sex characteristics. Being intersex is relatively common, occurring in 1.7% of the population. Intersex people sometimes have gonosomes (sex chromosomes) that are different from the most typical XX-female or XY-male presentations. According to the Intersex Society of North America, intersex genitals, "may signal an underlying metabolic concern, but they themselves are not diseased; they just look different. Metabolic concerns should be treated medically, but [intersex] genitals are not in need of medical treatment."



CHROMOSOME

Despite the fact that intersex genitals do not require treatment, there is a history of medical practitioners stepping in and performing surgeries that carry significant risk to intersex infants which has had a pathologizing effect on intersex people and their families. As biologist, historian and feminist Anne Fausto-Sterling explains, "If a child is born with two X chromosomes, oviducts, ovaries, and a uterus on the inside, but a penis and scrotum on the outside,...is the child a boy or a girl? Most doctors declare the child a girl, despite the penis, because of her potential to give birth, and intervene using surgery and hormones to carry out the decisions. [But] choosing which criteria to use in determining sex, and choosing to make the determination at all, are social decisions for which scientists can offer no absolute guidelines." Because these "normalizing" surgeries are generally irreversible, if they are performed at birth or in infancy without the individual's consent, they also run a serious risk of assigning a sex that may not fit the child's identification when they grow up.

INTERSEX SURGERIES TODAY

While "normalizing" surgeries are now less commonly medically advised at birth, some parents of intersex infants still request them. Individuals with intersex characteristics may more safely opt for a surgery later in life to more clearly distinguish their sex. Such a surgery is not automatically necessary or desirable for life or health. It is usually performed mainly to ease social and sexual interactions or to help an intersex person achieve a lack of ambiguity about their gender. These surgeries can sometimes result in difficulty with sexual functioning later in life, in problems with fertility, continence, or sensation; they can also be life-threatening.

Aside from chromosomes and genitals, there are other physical characteristics that are commonly used to distinguish between males and females, but they are far from foolproof and do not indicate one's gender identity. Secondary sex characteristics are physical features that occur more frequently in either male or female members of a species, which do not relate to reproduction or sex organs. In humans, most secondary sex characteristics are fairly similar in male and female children until puberty, when hormone levels increase and result in both similar and different changes to the body.

In males, once puberty hits, facial and body hair growth occurs (abdominal, chest, underarm and pubic), as well as a possible loss of scalp hair, enlargement of the larynx and a deepened voice. Their shoulders and chest will broaden as they gain more muscle mass, a heavier skull and bone structure, and larger stature in general (males, on average, are taller than females). A male's face will also become more square, and their waist will narrow (though it typically remains wider than in females).

Females, by contrast, experience breast growth and nipple erection during puberty, as well as widening of their hips, and a rounder face. Females generally develop smaller hands and feet than males. They grow some body hair during puberty as well, but it is mostly limited to the underarm and pubic areas. Their upper arms are generally a bit longer than men's, proportionately, and their weight distribution will change, distributing more fat into the thighs, hips, and buttocks. There are also

a variety of other changes occurring in puberty to male and female sex organs, but these are not considered secondary sex characteristics.

Sometimes individual or several secondary male sex characteristics may be present in a female-identified person, or the reverse, complicating a "common sense" definition of what makes a "man" or "woman." For example, some males retain erect nipples or develop tissue in their pectoral muscles, resulting in a chest similar in appearance to female breasts. Many females grow some facial hair on their chin or upper lip, or have square jaw lines. People of both sexes often have larger or smaller feet, hands, thighs, or buttocks than is typical of their assigned sex. Plenty of males are short or have high voices; lots of females are tall or have low voices. Suffice to say, while secondary sex characteristics describe the "average" male and female traits, very few real people fit

ONLY TWO SEXES?

Recently, the "general reducibility" of the biological sexes to male and female has been called into serious question by various biological researchers and feminists who posit that beliefs about gender may, "affect what kinds of knowledge scientists produce about sex."17 For example, grouping and sampling methods may reflect and reinforce ideas of "hardwired" sex-specific intelligence and behaviors in studies that seek to examine sex differences in the brain. Without these preconceptions, it's possible that we might find several distinct sexes, or at least a blurrier boundary between males and females.

It is possible to use gonads (gametes that make ova or sperm; i.e. ovaries and testicles) and chromosomes as the basis for differentiating females from males, but this leaves a lot of gray area regarding many people's more ambiguous primary or secondary sex characteristics. While the vast majority of babies' genitalia may be clearly regarded as biologically male or female, their chromosomes may not reflect that assigned sex. They may develop secondary sex characteristics later that complicate that definition. Furthermore, once one's sex is assigned, the way in which an infant is treated by its parents, caretakers and everyone they meet will be profoundly shaped by assumptions about the child's sex. Being raised as a boy, girl, a combination of the two or identifying as neither is in many respects an entirely separate concern from one's sex.

Gender differs from one's assigned sex in that it can be self-defined. Doctors may look at a baby's genitals and say that it is a male, but the baby itself, in tandem with their parents' rearing and social experiences, will ultimately define what gender it is identified as. The distinction between a biological sex and a gender "role" was first introduced by the work of sexologist John Money in 1955. Before that, "gender" was strictly

a grammatical term that referred to words with masculine or feminine connotations within a given culture. For example, in most languages derived from Latin ("romance languages", which are part of the Indo-European language family, and include French, Catalan, Italian, Portuguese, Romanian, Spanish and others), many nouns are assigned a gender and corresponding pronoun. In Spanish, chairs, cities, and radios are a few random nouns which are considered feminine, while plates, hearts and days of the week are deemed masculine.

One's "sex", on the other hand, was formerly used all-inclusively to describe someone's body and identity without any consideration of a possible distinction. Money's definition of the word gender spread to popular culture and usage in the 1970s when feminists began to debate the rigid categories of social roles for men and women. Today, cultural models of male and female roles greatly influence the opportunities, behaviors and personality profiles that are assumed to correspond to one's gender. The impact gender has on a person's experience necessitates analyzing whether (or to what degree) gender is biological as opposed to culturally imposed or shaped by one's environment and raising.

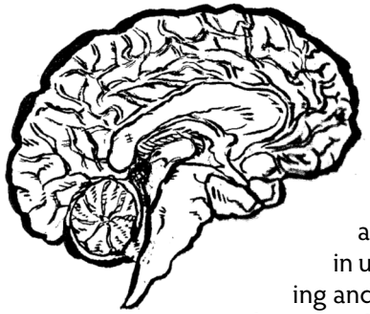
JOHN MONEY (1921-2006)

CISGENDER

As defined by sociologists Kristen Schilt and Laurel Westbrook, "cisgender" is a label that describes all "individuals who have a match between the gender they were assigned at birth, their bodies, and their personal identity." A cisgender woman, for example, is someone whose body fits into our society's description of a female body, who was called a "girl" at birth, and who sees herself as female or a woman. Most of the test subjects used in the studies in this chapter to examine brain structure and hormone levels were cisgender people, which, it may be argued, make the studies more narrow and less inclusive. From the viewpoint of the scientists, though, the subjects were likely selected that way in order to keep the results as clear and uncomplicated as possible.

SEXOLOGY

Sexology is the scientific study of human sexuality, including sexual interests, behavior, and function. Sexologists primarily study puberty, sexual orientation, sexual relationships, sexual intercourse, and sexual disorders or dysfunctions.



From a neurological standpoint, scientists have been debating for some time about the differences between men and women's brains, and by extension, their abilities, personalities and tendencies. It was once believed that male and female brains developed differently in utero in non-human animals and that mating and bearing children was, for them, a hardwired instinct. Scientists thought that sex differences in humans, by contrast, came purely from how children were raised. Today, some studies show neurological differences between typical male and female brains prior to birth; but again, many scientists question the methods by which these differences are ascertained. If it turns out to be true that male and female infants have measurable brain differences, the way in which a child is socialized and treated by its parents and peers would still have tremendous impact, perhaps equal to or even surpassing any biological hardwiring. What's more, the alleged brain distinctions in no way appear to be predictive of behavior, gender-specific interests, or cognitive strengths and weaknesses.

According to Louann Brizendine, a prominent neuropsychiatrist, all brains begin as female, until eight weeks after conception when testosterone present in males shrinks the communication center of their brains, reduces the hearing cortex and making the part of the brain that processes thoughts about sexual activity twice as large. She believes that male and female infants do not enter the world with the same brain structure, that the communication and emotional memory center is larger in the female brain, and that male brains have more cells which correspond to aggression.

Contrary to arguments for the importance of socialization, Brizendine contends that hormones triggered at different stages in women's lives relate to their capacity to cope with stress, the desire to pursue one's own interests, concern for others' emotions, and even to the desire to be attractive. Brizendine thinks these hormones stimulate an interest in procreating, childbirth and nursing at different stages of a woman's life, and affect their behavior and emotions. She essentially says that if you give a female child a toy truck, she will invariably cuddle it.

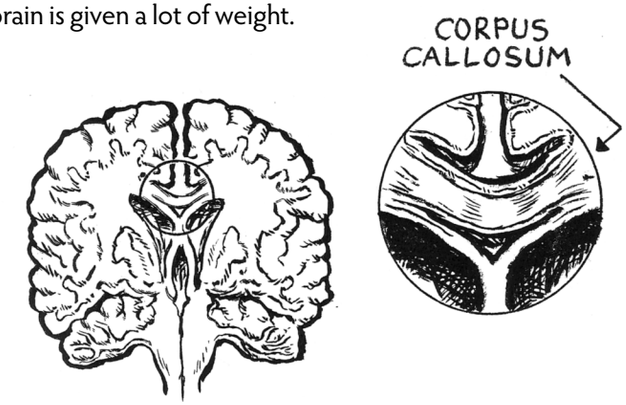
Moods are certainly affected by hormones, and over time they can help to shape our sense of how we see the world. Just as ingesting chocolate (which contains theobromine, a stimulant similar to caffeine) or wine (which acts as a depressant, slowing down one's heart rate and breathing) can shift one's attitude by altering the chemicals in our brains, Brizendine believes that hormones cause male and female brains to form entirely different structures that stimulate, explain and categorize our impulses and desires. For example, the pituitary gland produces fertility hormones, affects milk production, and, in Brizendine's opinion, turns on the "nurturing behavior" switch in women. The anterior cingulate cortex (or ACC), on the other hand, helps people to weigh options, make decisions, and is the "worrying center" of the brain; according to Brizendine's interpretation of the studies she cites, the ACC is larger in women.

Her conclusions have struck a common sense chord in many readers, as they reinforce archetypal behavior for men and women in our society, but Brizendine's sex-specific structures do not have a reputable basis in scientific research. She pointedly mentions her dismay at learning that many neurological studies are based on males alone, yet several of the studies Brizendine cites to demonstrate sex-based differences used only male or female participants. Brizendine nevertheless calls on these studies to make sexed contrasts that are necessarily speculative. In fact, numerous reviews of her book, *The Female Brain* (2006) found that, "despite the author's extensive academic credentials,…[t]he text is rife with 'facts' that do not exist in the supporting references."

Even when researchers are meticulous, there are a number of drawbacks to considering the size and function of brain regions as direct proof that gender is rooted in brain structure. Likewise, there are concerns when assuming that "gender-specific" behavior and strengths can be understood by examining male and female brains. For starters, human brains definitely cannot be as easily "sexed" as Brizendine describes (that is, consistently sorted into "male" and "female"), and in many researchers' opinions, they can't be sexed at all. In *Brain Storm* (2010), sociomedical scientist Rebecca M. Jordan-Young asserts, "In spite of much trumpeting that there exist 'female brains' and 'male brains,' the extent and nature of physical differences in the brains of human females and males is highly controversial, with some scientists claiming there are no clear-cut differences, others claiming that there are some subtle average differences, and still others claiming that the differences are dramatic." Jordan-Young rebukes the notion that there are sex-related centers in the brain at all, much less that men's are much larger. She explains that while there is a small cell group in the hypothalamus that is generally larger in men (the $INAH_3$), and it *may* be related to some aspect of sexual function (or something "as nonpsychological as menstruation"), no one knows yet what

it does. There's no evidence at all that it's related to "processing thoughts about sex," as Brizendine claims. Jordan-Young goes on to say that literally no reported sex differences in other areas of the brain have "held up to independent replication". In other words, when researchers attempt to retry one another's experiments on brain structure differences to check the conclusions, not a single one has been able to yield the same results.

A perfect example of this is the corpus callosum. A large bundle of nerve fibers that connect the two hemispheres of the brain, the corpus callosum's varying size and structure has been credited as explaining almost every strength and ability that has been attributed at one point or another to sex. From affirming the holistic thinking of women or men's visuo-spatial skills, to the female intuition and superior communication skills that Brizendine describes, this "slice" of the brain is given a lot of weight.



Unfortunately, the corpus callosum is a nearly impossible region of the brain to partition off. The fibers aren't really separable from other brain portions, and the fibers themselves are tangled and do not lay flat. Methods for actually examining parts of the corpus callosum are disparate and highly debated. What's more, in Anne Fausto-Sterling's examination of numerous scientific papers based on the corpus callosum, all of which were using the newest and greatest technology, no one found absolute size differences. The only differences found were in adults, offering no conclusive evidence about children or fetuses' structure before conditioning.

Moreover, as science journalist Sharon Begley pointed out in a 1995 *Newsweek* cover story, even if the studies alleging that the corpus callosum is larger in females are correct, there is another problem: "A bigger corpus callosum matters only if it has more neurons, the cells that carry communications. After all, fat phone cables carry more conversations only if they contain more wires. But despite years of searching, scientists cannot say for sure that women's corpus callosum has more neurons." Add to this, the obvious preference in the approach and analysis of sex and gender research for finding differences instead of similarities, which Jordan-Young thinks encourages scientists to overstate even very modest findings. Pretty soon, it starts to almost seem strange that we don't see *more* sex differences in the brain, if only because of differing male and female reproductive abilities.

99% of male and female DNA coding is the same. That said, a 1% difference influences every cell in our bodies. Studies show that mothers respond more to the facial expressions of female children, particularly with regards to their happiness. So it may be true that infant girls' skill with eye contact and face gazing improves 400% in the first few months while boy babies' skills in this area remain stagnant, but how can we be sure that this is not simply an adaption to the habits of the mother? Perhaps brains simply develop in response to the way that we stimulate them. In other words, assuming scientists could eliminate all the problems in conducting brain studies, how would we know that any neurological differences they may find are innate?

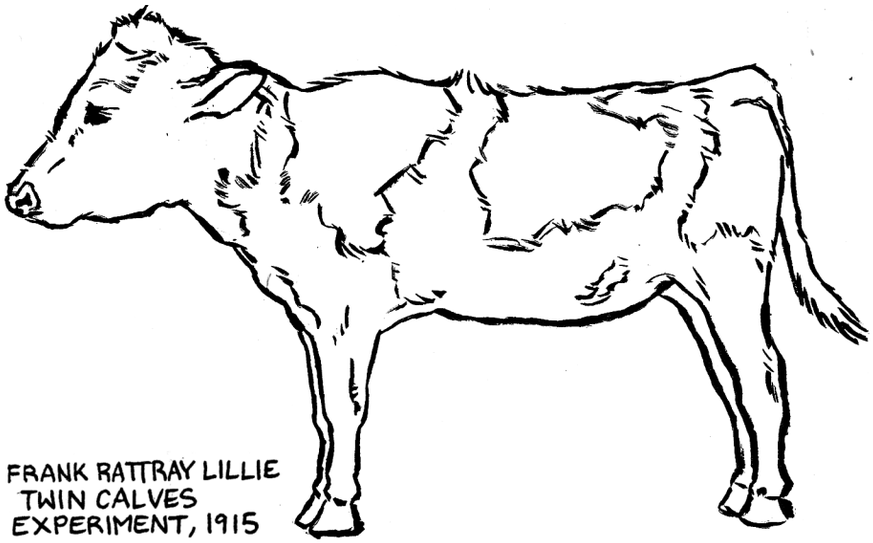
While one can hotly debate Brizendine's analysis of the hormones at play in a female brain and their corresponding relationship to women's behavior, her assertion that a surge in testosterone typically occurs in utero for males and not females appears fairly incontrovertible. The impact that testosterone has on development and any developmental differentiation between the sexes, however, warrants some closer examination.

Let's take a look at how hormones first came to be associated with gender and sex: For starters, farmers have known for centuries that castration (or removing the gonads) changes the body and demeanor of animals. Yet it was not until British gynecologist William Blair Bell declared that social sex differences and hormones were related, that gonads stopped being regarded as the fundamental sex distinction. Anne Fausto-Sterling notes in her research that once scientists began to measure male and female hormones, all of the changes those hormones produced gained a sexed connotation.

Despite the fact that testosterone and estrogen affect nerves, blood, the heart, bones and kidneys, these non-reproductive areas are considered secondary to what is viewed as hormones' main function – the differentiation of the male and female.

EMBRYOLOGY

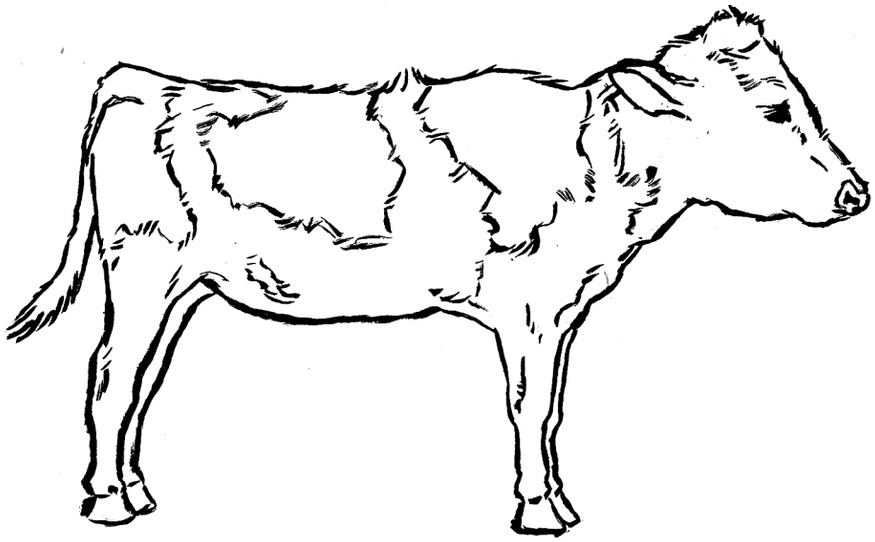
Embryologists study embryos from fertilization to the fetus stage. Embryology is "the branch of biology that deals with the formation, early growth, and development of living organisms."



As early as 1915, scientists were at an impasse about whether chromosomes or hormones defined sex development, until an embryologist named Frank Rattray Lillie demonstrated how the two could work hand-in-hand. Lillie conducted a series of experiments with calves where "a genetic female whose development [was] altered by hormones from her twin brother," produced a "masculinized" female. Essentially, he laid the foundation work for the view that genes determine the basis for sex distinction, and hormones continue to shape masculine or feminine characteristics afterward.

Male levels of testosterone prompt growth of the penis and testicles, as well as affecting the prostrate, while estradiol (one form of estrogen) works with other hormones to develop female breasts, induce uterine growth, and regulate menstruation. That said, estrogen is necessary in men for normal bone growth and fertility, and is used by the brain, lungs, bones, intestines, liver, and blood vessels for growth and development. Today, both estrogen and testosterone are taken by both males and females for a number of medical reasons. Testosterone treatments, for example, can promote more energy, sexual interest, and youthful virility in both men and women. It is, indeed, fascinating that hormones which affect so many areas of the body are so commonly reduced to being called "sex" hormones instead of signifying growth in general.

Male and female fetuses have the same gonads until the sixth week of gestation in the womb, when the male Y chromosome forms testes. Without a Y chromosome, the fetus will instead begin to form female ovaries. Between the eighth to sixteenth week of pregnancy, a male fetus produces testosterone in large quantities. Its testosterone surge abates after the sixteenth week, and by the twenty-sixth week is on par with a



female fetus again. A genetic male who does not produce adequate testosterone between the eighth and sixteenth week of gestation will be born with feminized external genitalia, such as a phallus (penis) that appears rather like an enlarged clitoris. Such a "feminized male" may retain internal gonad structures for functional testicles. Likewise, genetic females who produce large amounts of testosterone during that period often grow external genitalia with masculine characteristics and may be assigned as a male upon birth.

Does this testosterone bath "organize" the brain in a masculine way, though? Concerned about how socialization might affect an infant brain, developmental psychobiologist Celia Moore set out to study how early hormones bring about sex-specific behavior in postnatal life in rats. Among other discoveries, she found that young rats' brain stems developed relative to the amount of genital licking they received from their mother. The amount of licking was in turn greatly influenced by the level of testosterone the mother smelled in their urine. Yes, rats brains developed differently on the basis of their sex (or at least on the basis of their testosterone level), but the maternal treatment they received had everything to do with this divergence in development.

Behavioral neurologist Norman Geschwind famously argued that the male surge in fetal testosterone causes a smaller left hemisphere in the brain. He believed that this gave males an advantage for artistic, musical and mathematical talent, which are often associated with the brain's right hemisphere. Yet, postmortem studies of fetal brains do not demonstrate a reduced or "cramped" left hemisphere in males.[58] Nor does neuroimaging of newborns.

So, are boys with more fetal testosterone more masculine than boys

(or girls) with lower levels? Are their brains more likely to develop aptitudes that correspond to gender stereotypes for men? As Cordelia Fine points out in *Delusions of Gender* (2010), blood is only very rarely sampled from an unborn baby, making it impossible for doctors to quantify the testosterone in their blood. Instead, researchers look at the testosterone in the pregnant mother's blood or in the amniotic fluid in the sac surrounding the fetus.

This all leads to a pretty surprising truth: "researchers don't actually know for sure whether what they are measuring correlates well, or even at all, with the level of testosterone acting on the fetal brain." So then, on the basis of the testosterone level in the amniotic fluid, do scientists find that eye contact for one year olds or social relationships for four year olds corresponds to gendered stereotypes for male and female children? Or what about the amount that male- and female-assigned children describe experiences using terms that refer to their mental state, or their scoring on an empathy test? Apparently, the differences are negligible between the sexes.

Examining how prenatal hormones "organize" the brain is further complicated by another aspect of testing methods. Jordan-Young's *Brain Storm* draws on a close analysis of over three hundred studies exploring the hypothetical connection between prenatal hormone exposures, gender and sexuality. She concludes that studies on prenatal hormones are not "true experiments". Unlike the normal academically accepted format for an experiment, these test subjects are not randomly assigned to receive hormone exposures, their development is not consistently watched, nor can it generally be followed throughout a test subject's entire life span. Their environments and experiences cannot be controlled or kept constant at all. Instead, scientists glean information from animal studies and partial, relatively uncontrolled human studies. Thus, their results clearly cannot be considered verified.

In addition, many of the assumptions about the very character of testosterone have also been called into question in the last twenty years. In *Gender Shock: Exploding the Myths of Male & Female* (1996), Phyllis Burke cites the case of endocrinologist Dr. Christina Wang, who treated men who produce too little testosterone. Apparently, when Dr. Wang gave those men testosterone replacement therapy, "they became optimistic and friendly." If aggression and testosterone's link doesn't turn out to be valid after all, what does that say about some of the "hypermasculine" traits that testosterone is associated with?

ENDOCRINOLOGY

Endocrinologists are doctors specially trained to diagnose diseases that affect glands. They diagnose and treat hormone imbalances and related problems.

ENDOCRINOLOGIST DR. CHRISTINA WANG

As far back as 1983, psychologists Nancy Eisenberg and Randy Lennon discovered that the so-called female empathetic advantage diminishes when it isn't obvious that empathy is the focus of a study or assessment. It turns out that the difference previously observed was probably related to how empathetic the test subjects wanted to appear to others. In Eisenberg and Lennon's study, and many others, a trend has emerged implying that aptitude (male, female or otherwise) may be shifted by associations that people link to abilities. Since society places positive and negative connotations on different supposedly gender-related abilities and behaviors, test subjects often strive (consciously or subconsciously) to meet those expectations. This may be mirrored in our everyday lives. What we know for sure is that gender differences in aptitude show up at astonishingly higher rates in self-reported studies than when measures are more objective. In fact, Begley states that in most studies with large sample pools, men and women's scores on most psychological tests overlap so much that, "Any randomly chosen woman might do better at a 'male' skill than a man and vice versa."

We also know that hormonal shifts can cause growth or shrinkage in parts of the brain, even in adulthood. Ironically, instead of reinforcing the idea of biological determinism, this information may actually support the hypothesis that experience plays a role in adult nervous system changes, potentially affecting both gender identity and behavior. After puberty, the hormone levels that result from any genetic predisposition generally become relatively constant for most of one's adult life, with the exception of a drop in testosterone levels in men later in life and a drop in estrogen levels in women after menopause. But nutrition, stress, sex and other day-to-day experiences continue to shift adult hormone levels, sometimes dramatically. As such, it is more than plausible to suggest that experience plays a significant role in our hormone levels and the way our brains develop, including after puberty.

"Myelinization" is when fat covers the nerve fibers of a neural connection like a sheath. This process is what causes the brain to slowly harden, and stop growing and shifting as easily. Myelinization has not finished at birth, and continues throughout the course of one's life, increasing by twofold between one's first and second decade, and 60% between one's fourth and sixth decade, leaving the door open for ex-

perience shifting one's neural patterns and connections. This could explain why some people's gender identities change over the course of their life, or simply provide evidence that our brains continue to change as a result of our environment and life experiences. Either way, if one is still at all inclined to reduce aptitudes and behavior to hormones and gendered brain structure, then one must also concede that these structures and hormones are mutable and affected by conditioning.

Why then, do we have gender specific expectations for male and female children's behavior patterns, interests, tendencies and aptitudes? Regardless of whether one actively buys into stereotypes of pink and blue, the brain has stored associations from representations of people, feelings, behavior, and motives. Our brains draw parallels between experiences when one has paired concepts together. So when you see ads where men do heavy lifting outside their home as women fix dinner, regardless of what your conscious mind thinks about these roles, there is a lasting impression stored in the brain. Patterns in media and society are registered in our minds and are difficult to fully dismiss, at least on a subconscious level. For example, if asked to categorize personality traits by gender, your first impulse might be to pair emotion-oriented terms like "compassionate" or "sensitive" with women and active or task-focused terms like "analytical" or "dominant" with men.

Many people might reject the idea that they would make such gross generalizations, but keep in mind how flexible your self-image is relative to social context. Do you act differently when you're around family members, work colleagues, classmates, friends, or potential romantic partners? In *Delusions of Gender*, Cordelia Fine points to a study where French high school students were asked to rate the legitimacy of gender stereotypes relative to aptitude in math and the arts and then to rank their own talent. Afterwards, they were asked their scores on a standardized test they had taken two years prior. They almost invariably inflated or downgraded their scores relative to the stereotype that boys excel in math while girls have artistic sensibilities. If a male and female child have the same ability at a given subject, but the female thinks that she's less talented, which one is more likely to succeed?

BIOLOGICAL DETERMINISM

Biological determinism is a theory hypothesizing that genes and early biology shapes humans absolutely, including our abilities and personalities.

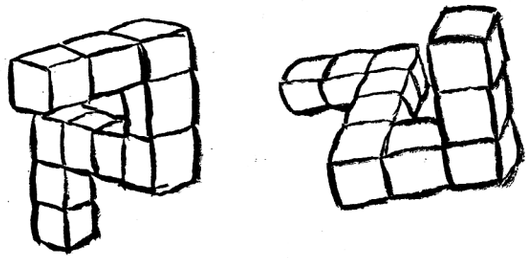
Author Barbara J. Berg expands on this principle in *Sexism in America* (2009). Berg cites the high numbers of women working in technology in many parts of the world, (especially Eastern Europe), and asserts that there is no biological basis for differences in subject aptitudes. She states quite simply that in the U.S., "the culture has convinced girls they don't belong in [the fields of science, math, and computer science]." She cites instances of teachers telling girls not to take certain courses, favoring boys in the classroom (or simply giving them more opportunities to speak), and off-color jokes and comments in classrooms that discourage female participation. Berg acknowledges Janet Shibley Hyde, who conducted a meta-analysis of forty-six research studies by different psychologists, and found tremendous similarity between the sexes, rather than differences. "One's sex has little or no bearing on personality, cognition, and leadership," according to Hyde and her colleagues.

Another argument questioning the validity of sex differences goes like this: Scientists' experiments and medical practices create "truths" about human sexuality and gender. Then the media and education institutions reinforce those ideas through constant reiteration until, in various ways, we change to conform to these "norms". Sometimes these changes are overt – like changing one's breast size or dieting to fit a cultural ideal of beauty. Other times, it's less obvious or even subconscious, like not being able to concentrate on an aptitude test because of the expectation that you will fail. Eventually, small shifts due to a scientist's manner of study (such as a geneticist looking at things on a sub-molecular level or a sociologist examining economic statistics), can result in a changed culture.

Of course, there are some indisputable biological differences between most representatives of the sexes, including pelvic bones, females' ability to give birth, and average height differentiation. But the differences, according to scientists like Janet Shibley Hyde, are far less dramatic than we have been led to believe. It is also possible that most of the supposed "biological differences" that some scientists link to abilities or capacities (like amygdala size in girls enhancing communication skills) are not innate biological differences, but rather ways that males and females develop as the result of social conditioning. Again, no brain structure besides the $INAH_3$ is consistently found to be sex-specific or to have a consistent size difference between male and female subjects.

So is hardwiring anything to write home about? Are there any demonstrable differences in male and female aptitude that suggest inherent variation in perception, behavior, strengths and weaknesses? Keep in mind that male and female brains are so similar that many scientists say they cannot be differentiated on an individual basis. If viewed through a lens acknowledging that psychology and neurobiology tend to look for differences rather than similarities, and if we take into account that socialization makes gender study participants perform relative to what they believe is expected of them, then there is only one area in which scientists have consistently found a disparity in ability: mental rotation tests.

In a mental rotation test, one performs a kind of 3-dimensional Tetris©. You are given a figure of connected blocks to examine, and then shown several pictures where that block or a strikingly similar block has been turned to another angle. It is the task of the participant to determine which blocks match the original. In these tests, male participants outperform females from three to four months of age upwards. That said, it should be noted that mental rotation is a skill that can be honed through practice. And when an Italian researcher, Angelica Moè, gave a mental rotation test to some high school students, she obtained very different results. After breaking up the class into three sections, she informed one portion that "men perform better than women in this test, probably for genetic reasons," then told another portion that women performed better (using the same language); the last portion was given no disclaimer at all. The females who had been told that women outperform men matched the skill level of the males in their group. This example suggests that even this one supposed "male advantage" has more to do with practice and expectation around their ability than genuine aptitude.



MENTAL ROTATION TEST

Furthermore, it can be gleaned from numerous studies that the brain works to suppress stereotypes in situations that call for an ability with a social gender association. For example, Dr. Christine Logel's research found that women who are interrupted in the midst of a difficult math test will be delayed in responding to terms that have been used to stereotype women as having poor math aptitude, such as "illogical" or "intuitive". It appears that the need to ignore negative messages uses up concentration that makes it more difficult to perform the task at hand. As Cordelia Fine says, "these jittery, self-defeating mechanisms are not characteristic of the *female* mind-they're characteristic of the mind *under threat*."

If male and female brains (and bodies in general) don't clearly account for gender differences, then why do we perpetuate them? Why are gonads, chromosomes, hormones and brain structures the factors that we use to define sex or gender, particularly when we know that there is variance in all three? If experience can shift our hormones and brains, then is any biological distinction that we *do* find between sexes truly innate? Phyllis Burke makes a strong case when she states that, "The single most important fact in the biological comparisons of the sexes is that there are greater differences between men *as a group* and between women *as a group*, than there are between men and women." But if that's true, what purpose does the category of gender serve? Why has a dual category for men and women been so pervasive in Western society? And what about everyone who is left out of that binary classification? By examining some of the history behind gender roles, and male and female socialization, perhaps it will become clearer where our ideas about gender come from.